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HOW TO START MANUFACTURING INDUSTRIES

Technological and Investment Perspectives

Volume IV

UNIDO

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

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* Numéro de code dans la classification internationale type, par industrie, de toutes les branches d'activité économique.

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* Numéro de code dans la classification internationale type, par industrie, de toutes les branches d'activité économique.

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* Numéro de code dans la classification internationale type, par industrie, de toutes les branches d'activité économique.

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* Numéro de code dans la classification internationale type, par industrie, de toutes les branches d'activité économique.

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G24	3511	Acrilonitrilo
G25	3511	Acido adípico
G26	3511	Amoniaco
G27	3511	Anilina
G28	3511	Extracción de aromáticos - BTX a partir de reformato
G29	3511	Caprolactama
G30	3511	Cloro cáustico (pila de diafragma)
G31	3511	Cumeno
G32	3511	Ciclohexano
G33	3511	Tereftalato de dimetilo (TDM)
G34	3511	Etanol
G35	3511	Etilbenceno
G36	3511	Etileno a partir de etano
G37	3511	Etileno de GPL/propano
G38	3511	Etileno a partir de nafta
G39	3511	Etileno a partir de gasóleo
G40	3511	Dicloruro de etileno - oxicloración equilibrada
G41	3511	Oxido de etileno

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G42	3511	Etilenglicol
G43	3511	Formaldeído
G44	3511	Hidrógeno a partir de gas natural
G45	3511	Isopropanol
G46	3511	Metanol a partir de gas natural
G47	3511	Metacrilato de metilo mediante cianhidrina de la acetona
G48	3511	Acido nítrico - débil
G49	3511	Acido nítrico - concentrado
G50	3513	Nilón-6
G51	3511	Recuperación de parafinas
G52	3511	Fenol
G53	3511	Anhidrido Ftálico (oxidación de xileno)
G54	3513	Caucho de polibutadieno
G55	3513	Polietileno de débil densidad (PEDD) - Reactor tubular
G56	3513	Polietileno de débil densidad (PEDD) - Reactor de autoclave
G57	3513	Polietileno de elevada densidad (PEED) - Proceso de lechada
G58	3513	Polietileno de elevada densidad (PEED) - Proceso de fase gaseosa
G59	3513	Polipropileno - proceso de fase líquida
G60	3513	Polipropileno - polimerización en fase de vapor (BASF)
G61	3513	Poliestireno
G62	3513	Cloruro de polivinilo - polimerización en suspensión
G63	3511	Oxido de propileno - proceso de la clorhidrina
G64	3511	Oxido de propileno (estireno como producto)
G65	3511	Oxido de propileno - (TBA como coproducto)
G66	3511	Propilenglicol por hidratación de óxido
G67	3513	Estireno
G68	3513	CEB - proceso de emulsión en frío
G69	3511	Acido sulfúrico (proceso de absorción simple)
G70	3511	Gas de síntesis a partir de la oxidación parcial de fuelóleo
G71	3511	Acido tereftálico - calidad: fibra
G72	3513	Poliésteres insaturados
G73	3511	Urea
G74	3511	Acetato de vinilo-etileno (oxidación en fase de vapor)
G75	3511	Cloruro de vinilo
G76	3511	P-xileno-recuperación por adsorción
G77	3511	Acido oxálico
G78	3513	Fábrica de resina de poliestireno
G79	3511	Fábrica de nitrobenceno
G80	3511	Fábrica de pentaeritrita
G81	3512	Fábrica de EPN
G82	3511	Fábrica de dióxido de titanio
G83	3511	Fábrica de formaldehído
G84	3513	Fábrica de resina de poliéster insaturado
G85	3511	Fábrica de carbonato cálcico
G86	3513	Fábrica de CMC
G87	3510	Fábrica de productos obtenidos por hidrólisis del almidón

G88	3511	Fábrica de sulfato de lauril
G89	3511	Fábrica de sosa cáustica
G90	3511	Fábrica de ácido sulfúrico
G91	3511	Fábrica de tricloroetano
G92	3512	Tecnología de síntesis de TAM
G93	3512	Tecnología de síntesis de FDE
G94	3512	Tecnología de síntesis de FDDV
G95	3511	Fábrica de azodicarbonamida

<u>Volumen III:</u>

G96	3513	Fábrica de resina de pasta de CPV
G97	3511	Fábrica de clorito sódico
G98	3512	Fábrica de fertilizantes fosfatados
G99	3511	Instalaciones de separación de xileno mezclado
G100	3511	Fábrica de carburo cálcico
G101	3513	Fábrica de resina epoxídica
G102	3511	Fábrica de disolventes de hexano/ciclohexano
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G107	3512	Fábrica de insecticidas de BPMC y MIPC
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G113	3512	Fertilizantes compuestos (NP)
G114	3512	Fertilizantes de nitrato amónico/nitrato cálcico-amónico
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G116	3512	Instalaciones para la mezcla de fertilizantes

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<u>Volumen I:</u>

H1	3529	Fábricas de cerillas
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H5	3529	Fábrica de dinamita
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H8	3529	Fábrica de papel sensible
H9	3529	Fábrica de adhesivos
H10	3529	Fábrica de cinta autoadhesiva
H11	3522	Síntesis de ácido ursodesoxicólico
H12	3522	Síntesis de tetrabutirato de riboflavina
H13	3522	Tecnología de síntesis de rifampicín
H14	3522	Fábrica de sacarina
H15	3522	Tecnología de síntesis de la amoxicilina
H16	3522	Tecnología de síntesis de la cefalotina
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H18	3529	Fábrica de cerillas
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H22	3521	Fábrica de pinturas y barnices
H23	3529	Producción de papel fotosensible
H24	3529	Fabricación de cola para el calzado
H25	3521	Revestimiento de paredes de ACPV (acetato de polivinilo)

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H26	3540	Planta de destilación de alquitrán de hulla
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J3	3559	Correas transportadoras de cable de acero
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K4	3560	Fábrica de envases de plástico
K5	3560	Fábrica de botones de poliéster
K6	3560	Fábrica de baldosas de CPV-asbesto
K7	3560	Fábrica de revestimientos de CPV para paredes
K8	3560	Fábrica de tuberías flexibles de CPV
K9	3560	Fábrica de sacos de polietileno dotados de cierre
K10	3560	Fabricación de envases de plástico mediante moldeo por soplado
K11	3560	Fábrica de hojas corrugadas de cloruro de polivinilo rígido
K12	3560	Instalaciones de moldeo de plastisol de CPV

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K13	3560	Fábrica de tuberías de CPV rígido
K14	3560	Fábrica de pavimentos de CPV
K15	3560	Fábrica de cascos balísticos de NRP

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K16	3560	Fábrica de películas de BOPP (polipropileno)
K17	3560	Termoformación rotatoria de plastómeros
K18	3560	Producción de botellas de plástico

Volumen IV:

K19	3560	Ventanas de CPV
K20	3560	Moldeo por inyección - proceso de fundición inyectada
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L5	3610	Varilla cerámicas para resistencias de carbón
L6	3620	Fábrica de fibra de vidrio aislante

Volumen III:

L7	3620	Fábrica de tubos y ampollas de vidrio
L8	3620	Fábrica de artículos de cristal
L9	3620	Fábrica de vidrio plano

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M3	3691	Fábrica de productos refractarios
M4	3699	Fábrica de postes y pilotes de hormigón
M5	3699	Fábrica de losas de yeso
M6	3699	Fábrica de tubos "Hume"
M7	3699	Instalación para áridos

Volumen II:

M8	3691	Fábrica de mosaicos
M9	3692	Fábrica de losetas a base de cemento
M10	3691	Fábrica de ladrillos refractarios
M11	3699	Fábrica de revestimientos de frenos
M12	3699	Fábrica de abrasivos sobre soportes flexibles
M13	3691	Fábrica de ladrillos de arcilla

Volumen III:

M14	3691	Fábrica de ladrillos
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M16	3691	Losetas y ladrillos cocidos
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N2	3710	Fábrica de tubos soldados en espiral
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O3	3819	Fábrica de conservas
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O5	3819	Fábrica de gabiones
O6	3819	Fábrica de accesorios para tubos
O7	3819	Fábrica de envases
O8	3819	Fábrica de tapones-corona
O9	3819	Fábrica de monedas
O10	3819	Fábrica de puntillas
O11	3819	Fábrica siderúrgica (fundición de hierro y elaboración de acero)
O12	3819	Taller de galvanoplastia
O13	3819	Planta punzonadora
O14	3819	Planta de resortes laminados
O15	3811	Instalaciones automáticas para hacer juegos de llaves
O16	3819	Fábrica de tapones-corona
O17	3819	Fábrica de envases
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O19	3819	Fábrica de alambre de acero chapado en cobre
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024	3819	Materiales de construcción de acero
025	3811	Producción de herramientas de mano
026	3813	Fabricación de tubos de conexión
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P6	3829	Planta de montaje de bombas
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P14	3824	Criba para materiales de construcción
P15	3829	Montaje de tractores de ruedas
P16	3823	Fabricación de soldadoras
P17	3823	Fábrica de piezas de repuesto para máquinas-herramientas
P18	3822	Fábrica de motocultivadores
P19	3829	Fábrica de bombas de riego
P20	3823	Fábrica de tornos de roscar
P21	3823	Fábrica de fresadoras de control numérico
P22	3823	Fábrica de taladradoras
P23	3823	Fábrica de prensas hidráulicas
P24	3823	Fábrica de tijeras mecánicas
P25	3823	Fábrica de plegadoras
P26	3823	Fábrica de sierras alternativas para metales

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P27	3823	Fábrica de soldadoras de gas
P28	3824	Fábrica de mezcladoras de hormigón
P29	3824	Fábrica de trituradoras
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Construcción de material de transporte, CIIU 384*

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Q3	3829	Fábrica de alambres y cables

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Q4	3831	Planta de reconstrucción de generadores y de motores de arranque
Q5	3843	Reconstrucción de bloques del motor, faros de locomotoras y bombas de riego
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Q7	3843	Planta de reconstrucción de carburadores y de bombas del combustible
Q8	3839	Conmutadores, enchufes machos y enchufes hembras eléctricos
Q9	3831	Planta de montaje de motores eléctricos
Q10	3832	Planta de montaje de teléfonos
Q11	3839	Fábrica de lámparas eléctricas
Q12	3831	Planta de montaje de transformadores
Q13	3833	Planta de mezclado
Q14	3833	Planta de montaje de ventiladores eléctricos
Q15	3832	Fábrica de tocadiscos estereofónicos
Q16	3832	Fábrica de sintonizadores televisivos
Q17	3832	Fábrica de bobinas de desviación
Q18	3839	Fábrica de redondos de carbón
Q19	3839	Reactancia electrónica para lámpara fluorescente
Q20	3831	Planta de montaje de motores V.S.
Q21	3839	Fábrica de faros para automóviles
Q22	3839	Fábrica de electrodos para soldadura por arco
Q23	3843	Fábrica de ejes delanteros y traseros
Q24	3843	Fábrica de amortiguadores
Q25	3843	Fábrica de cilindros del freno

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Q26	3843	Fábrica de discos de ruedas
Q27	3843	Fábrica de radiadores
Q28	3843	Fábrica de conjuntos de tapas de embrague
Q29	3843	Planta de transmisiones
Q30	3844	Planta de montaje de vehículos de dos ruedas

Volumen III:

Q31	3832	Planta de montaje de televisores
Q32	3833	Planta de montaje de aparatos para cocer el arroz
Q33	3839	Fábrica de pilas secas
Q34	3831	Planta de montaje de generadores de CA
Q35	3832	Fábrica de condensadores
Q36	3839	Fábrica de cable para líneas de comunicación
Q37	3843	Fábrica de radiadores de automóviles
Q38	3833	Cables y alambres eléctricos
Q39	3833	Fabricación de planchas para planchar
Q40	3833	Fábrica de calentadores de agua
Q41	3831	Fabricación de transformadores distribuidores
Q42	3831	Fabricación de interruptores
Q43	3839	Fabricación de fusibles 2 NVO
Q44	3839	Fabricación de accesorios eléctricos
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Q46	3843	Fábrica de refrigeradores de automóviles

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Q48	3831	Montaje de generadores de energía eólica

Parte R: Equipo profesional y científico, instrumentos de medida y de control, e instrumentos de óptica, CIIU 385*

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R1	3851	Fábrica de algodón hidrófilo
R2	3851	Fábrica de pañales
R3	3851	Fábrica de contadores del agua
R4	3851	Fábrica de termómetros/manómetros
R5	3851	Planta de montaje de vatiocontadores horarios
R6	3851	Fábrica de jeringuillas
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Parte S: Otras industrias manufactureras, CIIU 390*

Volumen I:

S1	3909	Fábrica de cintas de celofán
S2	3909	Fábrica de lápices
S3	3909	Fábrica de rotuladores
S4	3909	Fábrica de tiza
S5	3909	Fábrica de papel carbón
S6	3909	Fábrica de cepillos de dientes

Volumen II:

S7	3909	Fábrica de cremalleras abrochadoras de poliéster

Volumen III:

S8	3909	Fabricación de cremalleras abrochadoras de plástico

Volumen IV:

S9	3909	Lápices

Parte T: Servicios de reparación, CIIU 951*

Volumen I:

T1	9513	Planta de reparación de automóviles

Volumen IV:

T2	9513	Planta de construcción y reparación de chasis de automóviles

Parte U: Silvicultura y extracción de madera, CIIU 121* y 122*
Producción agropecuaria, CIIU 111*
Pesca CIIU 131*

Volumen II:

U1	1210	Producción de carbón vegetal en pequeña escala

Volumen IV:

U2	1110	Producción de huevos
U3	1302	Piscicultura y explotación de viveros o criaderos

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Parte V: Obras hidráulicas y suministro de agua, CIIU 420*

Volumen II:

V1	4200	Unidad de desalación solar

Parte W: Extracción de otros minerales, CIIU 290*

Volumen IV:

W1	2903	Planta de producción de sal
W2	2901	Instalaciones para el tratamiento de grava y arena
W3	2901	Canteras de materiales de construcción
W4	2903	Planta de refino de sal

Parte Z: Actividades no bien especificadas, CIIU 000*

Volumen IV:

Z1	0000	Planta de reciclaje de filtros de aceite y de otros materiales de desecho aceitosos

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A

How To Start Manufacturing Industries

Oral Rehydration Salts Production

Introduction

Acute diarrhoeal diseases are one of the leading causes of mortality in infants and young children in many countries. In most cases, death is caused by dehydration. Dehydration from diarrhoea can be treated simply, effectively, and cheaply in all age-groups and in all but the most severe cases by administering an adequate glucose-electrolyte solution orally.

This way of administering fluids to prevent or treat dehydration is called oral rehydration therapy (ORT). ORT, combined with guidance on appropriate feeding practices, is the main strategy recommended by the WHO Diarrhoeal Diseases Control (CDD) Programme to achieve a reduction in diarrhoea-related mortality and malnutrition in children.

Practical application: Oral rehydration therapy (ORT) can be introduced by village health workers and practised in the homes by mothers, who however need some guidance at first. ORT is therefore a method highly suited to the primary health care approach. Moreover, when given along with advice on proper feeding practices, ORT has been found to contribute to better weight gain and thus to reduce the ill effects of diarrhoea on the nutritional status.

ORT should begin at home with the use of available "household food" fluids or a home-prepared "sugar and salt" solution given early during the diarrhoea episode to prevent dehydration. Once a child becomes dehydrated, however, ORT should be provided in the form of a balanced and complete standard mixture of glucose and salts (ORS).

Composition of Oral Rehydration Salts: Oral Rehydration Salts (ORS) is the non-proprietary name for a balanced glucose-electrolyte mixture, approved and recommended by UNICEF and WHO. Two mixtures are referred to as "ORS-bicarbonate" and "ORS-citrate". They have the following compositions, to be dissolved in 1000 ml of potable water:

	grams/litre	*%*
ORS-bicarbonate		
Sodium chloride	3.5	12.73
Sodium bicarbonate (sodium hydrogen carbonate)	2.5	9.09
Potassium chloride	1.5	5.45
Glucose anhydrous	20.0	72.73
Total	27.5 g	100.00%
ORS-citrate		
Sodium chloride	3.5	12.55
Trisodium citrate	2.9	10.39
Potassium chloride	1.5	5.38
Glucose, anhydrous	20.0	71.68
Total	27.9 g	100.00%

The recommended formulations of ORS can be produced in three dosage forms: powder, tablets and liquid.

In view of the overriding need to make available an essential drug through the simplest and most appropriate technology at an affordable price, here only the production of ORS in powder form is described.

Integrated or independent ORS production: Generally, the most appropriate approach to ORS production is to integrate it into an existing pharmaceutical production facility, preferably into one that is producing other essential drugs, and in which ORS can be manufactured with existing equipment that is already used for other drugs in powder form.

Ideally, ORS should be integrated into a factory producing drugs, where the staff is familiar with the ingredients used for ORS, and where a well-equipped laboratory is available, assuring the essential quality control of raw material and finished product.

Process Description

Whether ORS is produced in a hospital on a very small scale, or industrially in large quantities, the basic procedure remains the same. The only differences are the space requirements, particularily for storing raw materials, and the method of packing ORS. The packing of large quantities of ORS is normally efficiently done by mechanical means using suitable equipment.

Identity Test

Raw materials arriving in the ORS production unit have to be analysed and released for production only with the approval of the laboratory department.

Drying

After long storage periods in hot and humid climates, the raw materials may have absorbed a substantial amount of moisture, so that the water content may exceed the indicated limits. The use of such ingredients for the manufacture of ORS-bicarbonate may result in accelerated decomposition. Therefore, if a raw material containing too much water is to be used for this particular composition, it is preferable to dry it at the recommended temperature of 105–130 °C.

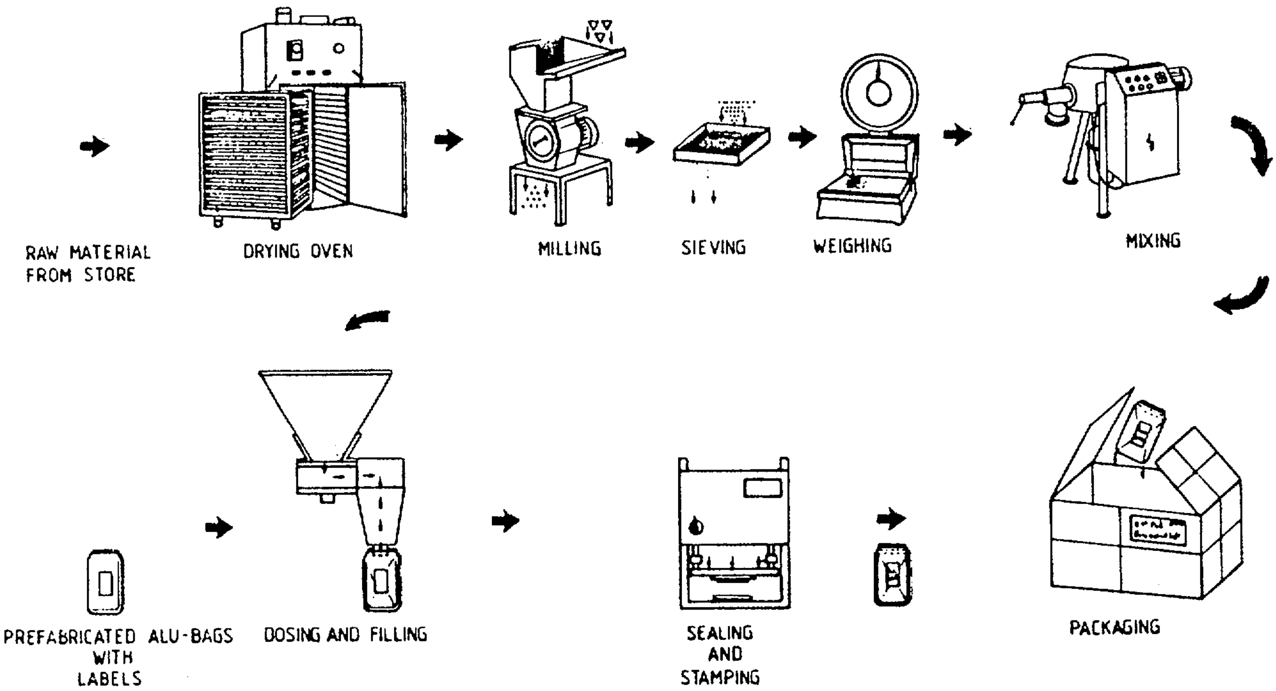
The time required for drying to the specified limit depend on the amount of water absorbed, but should not exceed 16 hours (overnight). In tropical countries, special attention must be paid to the temperature and relative humidity of the air to be used for drying. For example, outside air of 33 °C and 95% Rh (about 33 g water/m^3), heated up to 50 °C, has its relative humidity reduced to 40%, but the water content per m^3 is still 33 g. These conditions may not be sufficient for drying the raw material properly; in this case higher drying temperatures or pre-drying of the intake air will be required.

It is therefore important to compare the moisture content in the raw material both before and after the drying process, in order to ascertain the extent of water loss during drying. The condition of the intake air is less critical in countries with a cold and dry climate.

Grating/Sifting/Sieving

The imported raw materials may have been stacked for long periods, and thus may not have the same characteristics on arrival as when they left the factory (free-flowing). They may therefore need chopping and grating. The most suitable sizes of perforations on the grating drum are 3.0 mm and 6.0 mm. Shifting (or milling) may be required to obtain a uniform particle size, which is important for uniform mixing of the product. Sieving is recommended to screen off any foreign particles such as fibre, wood, paper, plastic, hairs, etc., thus ensuring an uncontaminated product. The recommended meshes for obtaining particle sizes between 1000 and 1500 microns are 1.0 mm and 1.5 mm (equivalent to mesh numbers B.S. 16 and 12, or A.S.T.M. 18 and 14).

Process Flow Diagram



Weighing

The ingredients are normally weighed in batches, whereby the size of a batch is determined by the capacity of the mixer. Whenever possible, and depending on the bulk density of the raw materials, the batch sizes can also be based on the standard bag containing 50 kg of glucose, giving for example the following proportions:

50.000 kg	glucose, anhydrous	71.68%
7.247 kg	trisodium citrate, dihydrate	10.39%
8.754 kg	sodium chloride	12.55%
3.753 kg	potassium chloride	5.38%
69.754 kg	total batch size	100.00%

The weighing of the ingredients should be done only when they are ready for mixing i.e. after drying, grating, and sieving. The containers from which the raw materials are taken and the containers or plastic bags into which the desired quantities are filled must be clearly marked with the name of the respective ingredient to avoid any error of weighing and incorrect mixing of ingredients.

Weighing the ingredients carefully and correctly is the most important step in the production of ORS!

All the weighed materials for each batch should therefore be double-checked and verified by a second person.

Mixing

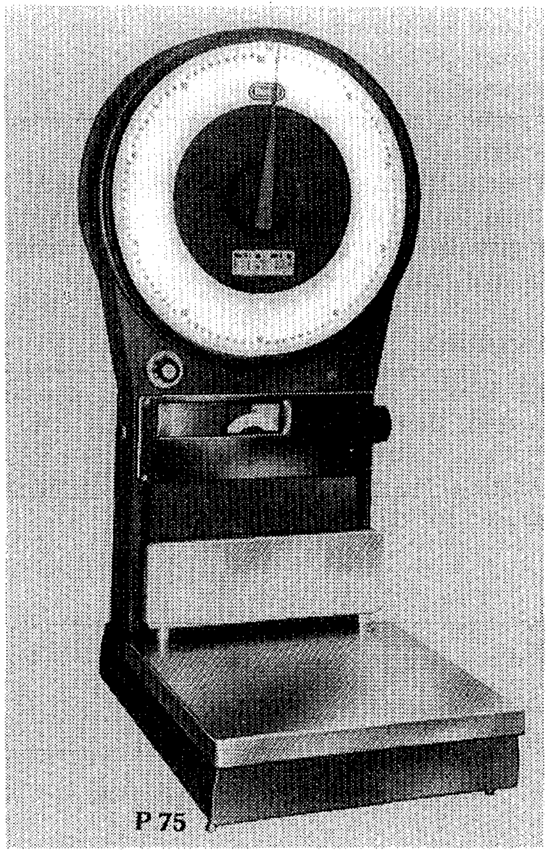
Mixing is not only the fundamental operation in ORS production, but one of the basic processes in pharmaceutical production in general.

Mixing may appear to be a very simple operation but in fact good and uniform blending can be rather demanding. The difficulty in mixing may be caused by the type of mixer, the mixing time and the different densities of the components, but is caused primarily by the differences in particle size of the four ingredients, which may produce a dispersing effect and unfavourable cohesive forces. All four ingredients should therefore be of the same medium or fine crystalline grade, a requirement which can be specified when the ingredients are ordered, but is in fact usually difficult to obtain. Therefore, milling, grinding, or sifting to the required uniform particle size may occasionally be required.

The mixing time is product-specific, and normally lies between 10 and 20 minutes.

Dosing/Filling/Sealing

A semi-automatic dosing-, filling- and sealing machine provides proper dosing and filling of prefabricated bags. To ensure the right filling quantity, the dosing must be controlled by weighing random samples at intervals of 10–15 minutes. The results are permanently recorded in order to evalute the production field and observe the performance of the machine in general.



Precision platform scale

Depending on the quality of the raw materials, particularly glucose, the handling of ORS on automatic equipment is normally accompanied by the development of dust, which can have negative influence on the sealing operation. The machines are normally equipped with a general dedusting system (vacuum cleaner). It should be possible to adjust each of the suction nozzles so that the sealing jaws can be kept clean; but the suction should not be so strong that all small particles are sucked up and the chemical composition is altered.

Leakage Test

The sachets must also be submitted to an air leakage test at intervals of 10–20 minutes.

Packing/Labelling

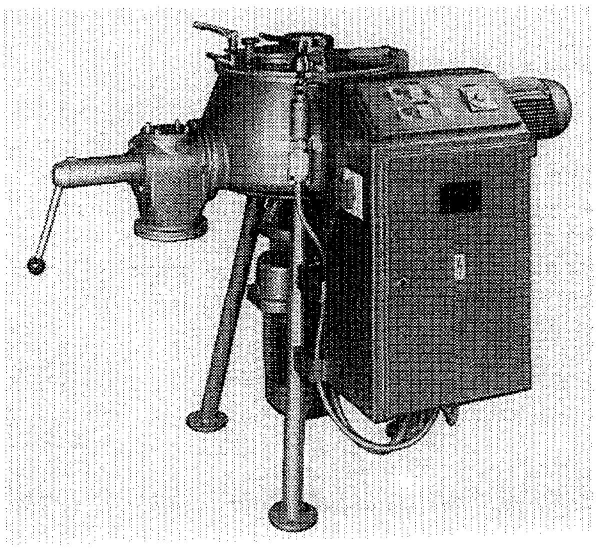
Once the ORS has been filled and sealed and the batch number has been printed or embossed on the sachets, the sachets are directly packed into collecting boxes, and then into cartons for transportation. The boxes and cartons must be provided with labels indicating the following:

- name of the product
- quantity
- batch number (date of manufacture)
- name of the manufacturer.

The batch number and the date of manufacture can be combined in a single code number; this code number should be stamped or written on to the printed label.

Quarantine

All batches are kept in a separate quarantine area until they have passed the quality control tests. Only when released by the quality control laboratory, the cartons can be moved to the storage area for dispatch.



Pharma mixer

Example of the Plant

Capacity: 4000 sachets/day based on 1 shift of 8 hours/day.

Required Machinery and Equipment

2 Scales
1 Drying oven*
1 Hammermill
1 Sieve
1 Mixer (capacity 100–200 l)
5 Steel drums, stainless steel (200 l capacity each)
1 Semi-automatic filling and sealing machine (capacity 500 sachets/h)
1 Vacuum device to suck off the dust
1 Packaging table
1 Semi-automatic labelling machine
1 Set of laboratory equipment**

Remarks:
* only necessary in countries with high humidity
** can be cancelled when the ORS production is planned as an extension of an existing pharmaceutical production plant.

Total FOB price (in 1986): approximately US$ 370,000.00

If the production is to be raised to 10,000 sachets per day, a fully automatic dosing-, filling- and sealing machine must be provided. In that case the total FOB price will be approx. US$ 550,000.00

Required Production Materials and Utilities per Day (4000 sachets, 1 litre solution each)

Example ORS-citate:	
Glucose, anhydrous	88 kg
Trisodium citrate, dihydrate	148 kg
Sodium chloride	15.4 kg
Potassium chloride	6.6 kg
Aluminium sachets sealed on three sides	4,200 sachets
Collecting boxes for 50 sachets	80 pcs
Cardboard boxes for collecting boxes	8 pcs
Labels	4,300 pcs
Electric power	65 kWh/day

Required Manpower (Semi-Automatic Operation) per Shift

Production supervision	1
Laboratory technician	1
Processors	2
Operators	2
Packer	1
Total	7

Required Plant Site Area

Total built-up area for production and storage: approx. 250 m^2

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File: A 38
ISIC CODE 3133

How To Start Manufacturing Industries

Malt Production

Introduction

Malt is to a substantial degree used as a raw material in the brewing process, necessitating as much as 10–17 kg malt to produce 1 hl beer based on 100% malt utilization and approx. 10–12 kg/hl beer with the addition of raw grain. It is also used as a component for patent food, baking auxiliary agents, and for other prepared foodstuffs.

The most common natural product as base material for industrial malting is barley, which is growing in many places of the world. Wheat, rye and sorghum are also used for malting. Barley, however, and especially the two-row spring barley (known as "brewer's barley") proved to be most suitable for the production of brewing malt in industrial scale.

The aim of malting is to produce enzymes, breaking down the protein of high molecular weight duing malting operation to low-molecular-weight protein for modification of cell walls between the starch cells in order to produce essential enzymes requisite for the brewing process.

Malting is a natural process performed to an optimum and within the shortest possible time when realized in industrial maltings with latest technology and parameter-related in view of

- oxygen
- addition of water and
- temperature.

Process Description

The parameters for brewer's barley are dictated by:

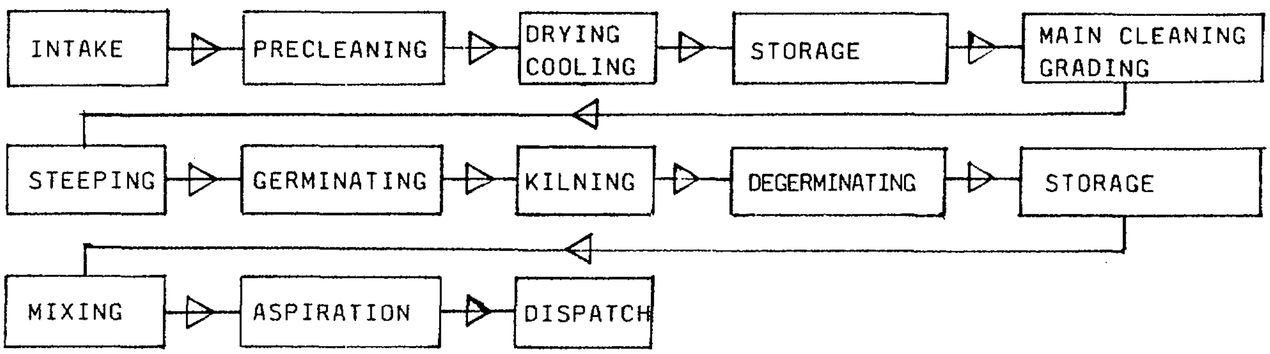
- moisture content: 12–13%
- 1000-grain weight: 35–48 g (air-dry)
- germinative power: not below 96%
- protein content: 9–11.5% (dry matter)
- full-barley contents: exceeding 85% (screen size 2.5 mm)

Barley Conditioning

The combine-harvested raw barley is relieved of coarse and fine impurities, carried to the weighers for weighing and subsequently stored in silo bins.

Conscientious care must be taken when storing barley with negative storage properties to retain the germinating power of the brewer's barley. Consequently, lots with a moisture content above 13% necessitate additional cooling and/or preservation by cooling. The barley is fed onto grading machines for grading in 2 or 3 grades to obtain uniform malting parameters. To counter the danger of infestation the stored barley is frequently fumigated with tablets which render the vermin inocuous and dissolve during storage.

Process Flow Sheet



Maltings

The malt processing mainly comprises three steps:

- steeping
- germinating
- kilning.

As a basis for subsequent germination the barley achieves a moisture pick-up of up to 48% during steeping. Moreover, the barley steeps provide for an intensive "wet washing" by simultaneously adding compressed-air. Carbon dioxide that builds up is removed during the so called "dry steeping phase", adding spray water at the same time.

The steeping period normally lasts approximately two days.

Germination is carried out in so-called "germinating boxes", the greater part of which are designed these days to the Saladin system. This enables the germinating stock to be individually loosened and turned when using screw turners (shown in the process flow diagram). Faultless aeration of the germinating stock (green malt) is ensured during the entire germination period, adding water from time to time to keep the product moisture constant.

The germinating process normally lasts five to six days.

Green malt is taken onto the kiln with a moisture content of approx. 45% and takes about 20 hours to reach a final moisture content of approx. 4%.

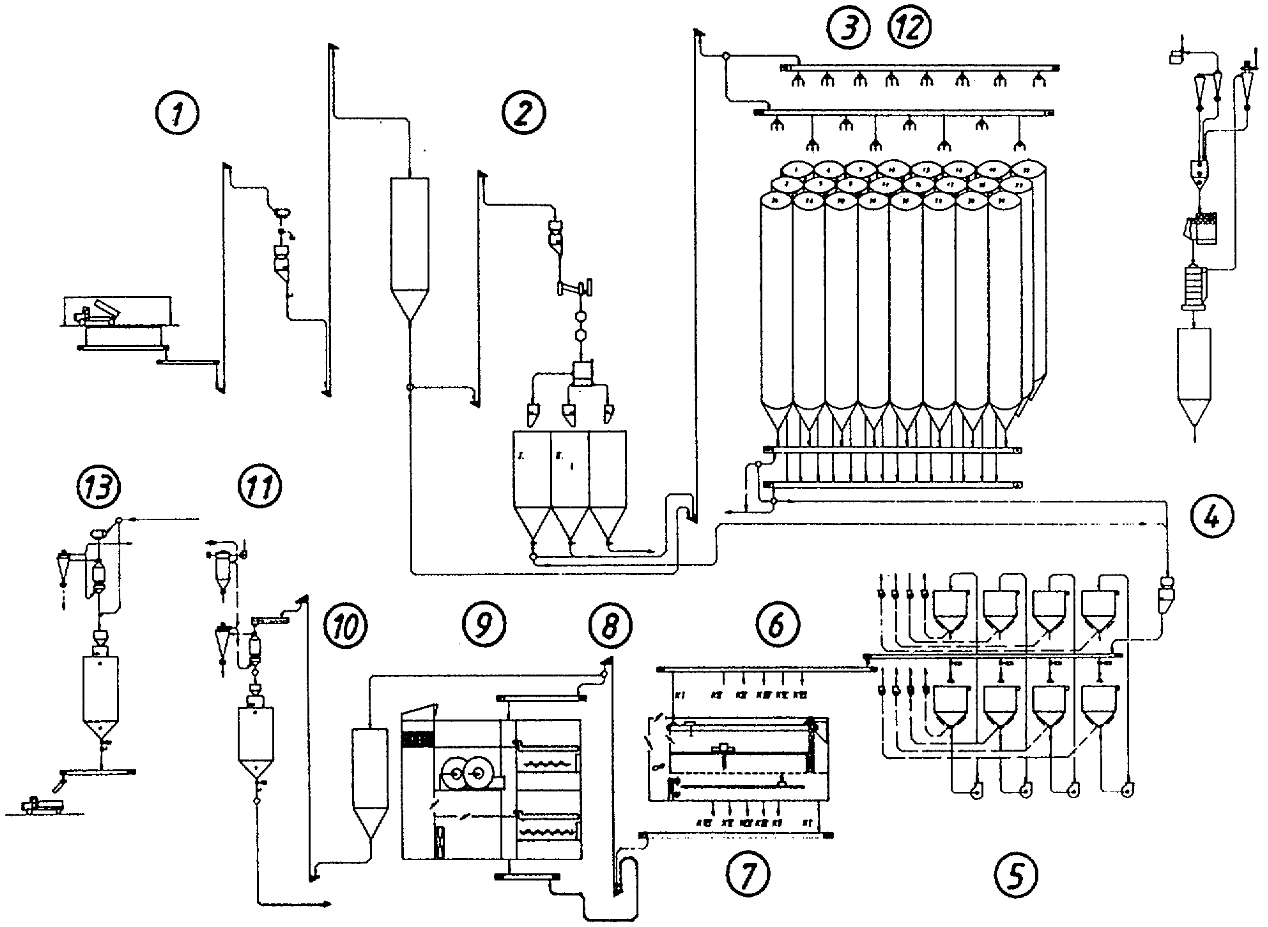
The kilning process is run in two steps. The so-called "withering period" is followed by the kiln-drying phase. Specific temperatures apply to either processing step to achieve the desired malt parameters. The so-called light "Pilsner Malt" is mainly produced on recently developed kilns, which have also proved suitable for the production of dark malts and other special malts.

Energy saving heat-recovery plants have been introduced successfully during the past few years, e.g. by glass tube heat exchangers and by two-floor kilns.

Malt Treatment

After completion of the kilning process the rootlets (approx. 3%) sticking to the malt are carefully separated by means of "whirling". They are utilized for producing animal feed. Subsequently, the malt is stored in silos. Mostly,

Process Flow Diagram



prior to reaching the consumers, it is guided to pass through an "air washing" step within the malt dispatch section.

The yield obtained by malting cleaned and graded brewer's barley rates at approx. 80%.

The process "steeping – germination – kilning" shall be one course without interruption. The plants are designed to suit one barley lot being processed as one batch.

Example of the Plant

Capacity: annual output of 10,000 tons of malt.

Required Machinery and Equipment

(The item numbers correspond with the indications made in the process flow diagram)

1	Barley intake and precleaning	20 t/h
2	Barley main cleaning and grading	10 t/h
3	Fittings for barley silo plant (concrete silos by customer)	6 × 500 t
4	Conveyors to steeping plant	20 t/h
5	Steeping plant with 2 conical steeps	2 × 40 t
6	Hydraulic conveyors for steeped product	100 m³/h
7	Germinating box plant with 6 germinating units	6 × 40 t
8	Mechanical green malt conveyors	40 t/h
9	One-floor circular kiln	40 t
10	Kiln-dried malt conveyors	60 t/h
11	Malt degermination	10 t/h
12	Fittings for malt silo plant (concrete silos by customer)	8 × 250 t
13	Malt dispatch	10 t/h
14	Germinating box cooling plant	
15	Electric switch and control plant	

The FOB price (in 1986) for the mechanical equipment amounts to approx. US$ 2,100,000.

Required Raw Materials and Utilities

The average daily requirement of raw materials amounts to approx. 38 to 40 tons (based on 330 operation days per year).

The utility consumption values per 1,000 kg processed malt amount to:

total water consumption:	approx. 8 m^3
waste water obtained:	approx. 2 m^3
total power consumption:	approx. 150 kWh
heat demand	1,000,000 kcal

(without heat-recovery, one-floor kiln)

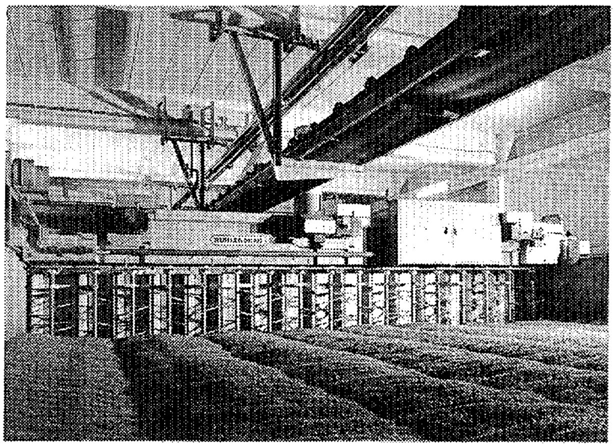
Required Man Power

one shift per day (8 hours):
- 3 Maltsters
- 2 Laboratory assistants
- 5 Silo workers
- 1 Electrician
- 1 Mechanic

plus two attendants each for two more shifts per 24 hours.

Required Plant Site Area

Production area including silos approx. 85 × 55 m	approx. 4,700 m^2
Open area	approx. 2,300 m^2
Total	approx. 7,000 m^2



Screw turner

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Kuskus Production

Introduction

Kuskus is a pre-cooked and dried product made of hard-wheat semolina, shaped by the agglomeration of two or more semolina granules. Its particle size ranges from 0.85 to 2.5 mm mesh.

The above definition of kuskus states that the final product is obtained through a process of agglomeration. This means that the raw materials must contain a certain amount of inherent gluten in the form of gluten proteins, in order to ensure optimum agglomeration during the production process. Thus any milling products of durum, hard wheat or soft wheat can be utilized, either in the form of flour, middlings or semolinas.

For products with no inherent gluten, including corn (maize), millet, barley, rice etc., a mechanical agglomeration process or the addition of an appropriate quantity of gluten proteins is required.

This basic food in the widest sense of the word is not only the staple diet of all North African Muslims, but is common with Islamic Africans far into Central Africa. It is now also increasingly accepted in European countries.

The historical background of kuskus and how it was traditionally produced, is described by an ethnology journal from about a hundred years ago. It shows us that kuskus is nothing new, but a product with a very long tradition. It also gives us an accurate account of the individual operations involved in the traditional process.

The account mentions the following sequence in the preparation of this food: Water is added to semolina, and the two ingredients are thoroughly mixed by hand; the resulting product is then rubbed between the palms of one's hand until small granules have been formed. Finally, in order to obtain the most uniform particle size possible, these granules are screened through one or several sieves and the appropriately sized particles are placed in a dish.

The other granules are treated in the same manner until they too have the desired shape. During summer, a stock of kuskus is worked up: it is spread on sacking or on a large cloth to be dried in the sun. Stored in pots or wooden vessels, this sun-dried kuskus has a long shelf life.

Process Description

The above described operations have been taken into account in the development of the new process and have been integrated in a modern, high-capacity, continuous system. This system can also be utilized for the production of instant flour and instant semolina.

Agglomeration

As in the traditional method of preparation, the new kuskus process too makes use of the principle of agglomeration in the first production phase.

Along with water, the starchy raw materials, which have the form of flour, middlings or semolina, are continuously metered by a feeder at exactly the required rate into the blender. Through the homogeneous intermixing of the semolina with the water, which produces a dough with a moisture content of 30%–40% (depending on raw ingredients), optimal agglomeration into coarse granules is achieved.

Detaching and Sifting

These damp, coarse granules obtained in the horizontal mixer are gravity-fed straight into a detacher. This detacher carriers out two important operations:

- Reduction of the oversized coarse granules
- Strengthening and shaping of the kuskus agglomerates.

The product is discharged from the detacher in the form of a freeflowing material and is separated by means of a traditional wet sifting process into kuskus granules, too fine and too coarse.

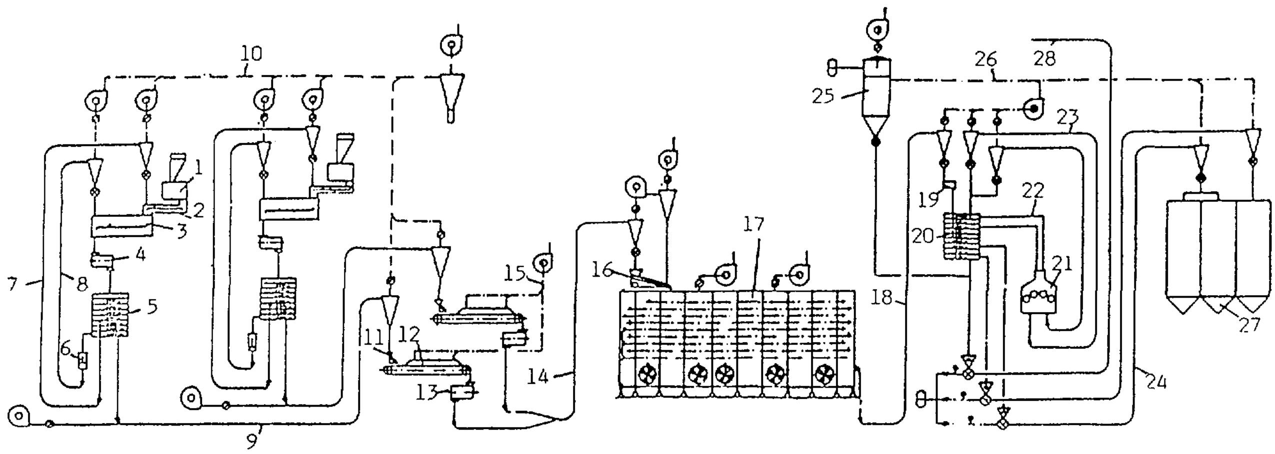
The wet fine particles are returned to the mixer, where they pass a second time through an agglomeration process. The too coarse agglomerates are reduced in a shredder and are transported pneumatically via a detacher to the sifter.

The wet kuskus granules, 1.2 to 4.0 mm in size, are fed by a pneumatic transport onto the steaming belt.

Steaming/Cooking

After the preparation of the granules follows the second stage, the steaming of the agglomer-

Process Flow Diagram



1 Feeder
2 High speedmixer
3 Mixer for agglomeration
4 Detacher
5 Wet sifter
6 Shredder
7 Pneumatic transport
8 Pneumatic transport
9 Pneumatic transport
10 Aspiration
11 Product distributor
12 Steaming belt
13 Detacher
14 Pneumatic transport
15 Steam aspiration
16 Product distributor
17 Belt dryer
18 Pneumatic transport
19 Magnet apparatus
20 Sifter
21 Four roller mill
22 Pneumatic transport
23 Pneumatic transport
24 Pneumatic transport
25 Filter
26 Aspiration
27 Storage
28 Return "to fine"

ates. The starch contained in the product is cooked or gelatinized respectively.

The gelatinization of the starch is dependent on such factors as temperature, moisture and time. To optimize these parameters an atmospheric cooker was designed in such a way that the steam is forced to flow through the material from the bottom to the top. As a result, direct cooking of the agglomerates by means of hot steam takes place in the bed of loose material. This allows a cooking process to be achieved in which the stock receives gentle thermal treatment within the shortest period.

Drying

The firm, precooked granules are detached in a detacher when leaving the steamer and are then directed in their free-flowing state to the drying process. To obtain an impeccable final product, the material must be conditioned and dried in shallow layers. Short-goods pasta dryers are successfully applied and have proved to be most appropriate.

Sifting/Size Reduction

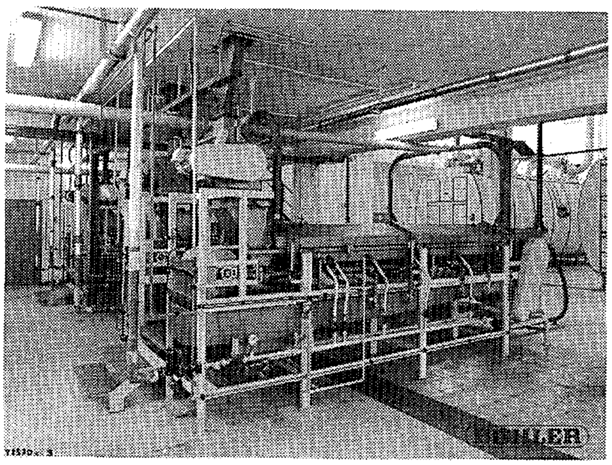
The kuskus granules, dried to a final moisture content of 10% to 12%, are sifted in a plansifter. The fractions which immediately tail over are the fine, medium and coarse kuskus separations. Undersize particles are recycled, being returned at a controlled rate to the manufacturing process. Oversized granules are crushed in a roller mill and then sifted. Tests and field experience have demonstrated that only a two-stage roller mill with the adequate corrugations (flutes) and the proper spiral will produce optimum results.

Packaging, Storage and Shipping

The final product is filled in packages or bags as common for cereals. Market requirements are determining kinds and sizes of packing as well as storage areas and facilities.

Example of the Plant

Capacity: 6,400 kg per 8 hours (production over 24 hours = 3 shifts, packaging and shipping over 2 shifts)



Steaming belt with detacher, inlet provided with distribution device and steam connections

Required Machinery and Equipment

- Handling system for raw material (semolina) incl. reception, silos, weighing/mixing, mixer feeding
- One complete kuskus production line (see process flow diagram)
- Packaging machines according to kind, quantities and other market requirements
- Laboratory equipment.

For individual items within the production line see process flow diagram.

The approximate FOB price (in 1986) amounts to US$ 1.55 million for the complete production line.

Requirement of Production Materials and Utilities per 8 Hours

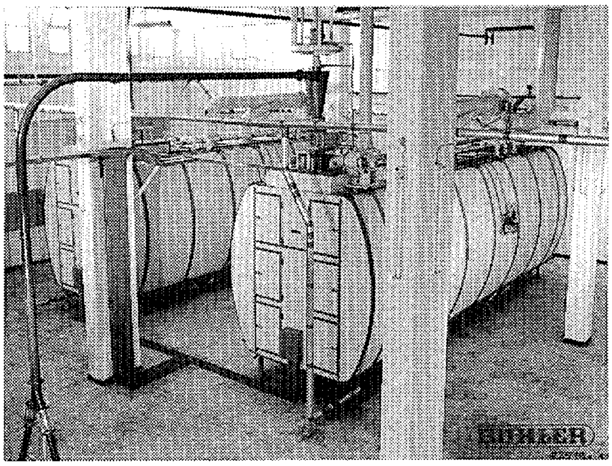
- Semolina with an approx. moisture content of 15%: approx. 6,500 kg
- Drinking water for moistening: approx. 1.5–2 m^3
- Electric power: approx. 900 kWh
- Steam: approx. 2,500 kg at 8 bar
- Heating: approx. 2,500,000 kcal
- Packaging materials acc. to market requirements, i.e. prefabricated bags, foils from rolls, carboard boxes etc.

Required Manpower per shift

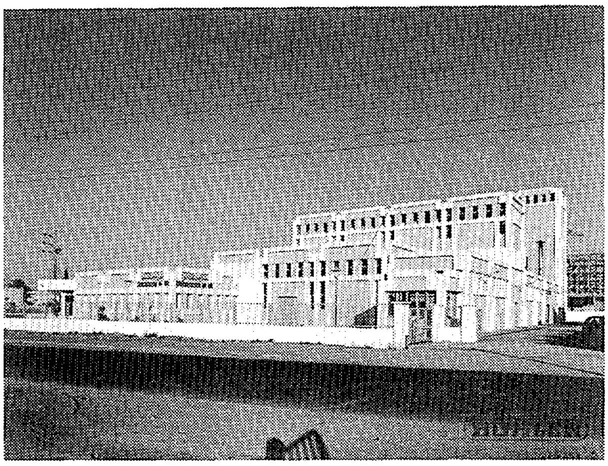
• Raw material handling	1	3-shift operation
• Production line	1	
• Packaging	3	2-shift operation
• Maintenance	2	
• Shipping	2	

Plant Site Requirements

Built up area	approx. 2,500 m^2
Open area	approx. 1,500 m^2
Total:	approx. 4,000 m^2



Dryers in a kuskus plant. Each dryer is equipped with an automatic climate control system.



Existing kuskus production plant (at Sfax, Tunisia)

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How To Start Manufacturing Industries

Cane Sugar Factory

Introduction

Sugar cane is the oldest and cheapest source for the production of sugar. The earliest record of sugar cane cultivation in Hindu literature is about 3000 years old. Sugar cane spread slowly to Persia and then to Egypt, where commercial production and refining of cane sugar was developed during the 9th century. Across Northern Africa and the Mediterranean area sugar cane came to Spain and the Canary Islands, from where Columbus introduced it to the New World.

In the Middle Ages, sugar was a luxury in Western Europe. Rising consumption levels and a growing population increased production requirements in cane sugar producing countries and influenced the start of sugar production from beet. By 1890, world sugar production was about 6 million tons (40% from cane, 60% from beet). World production increased to about 1000 million tons in 1983 with a portion of about 60% from cane.

The cane is the industry plays an important part in world economy, and for a number of coutries it is a most essential factor influencing their national economy.

Sugar cane is the world's most efficient crop. Cane sugar production employs millions of people worldwide in areas which have only few other alternative crops and often no other industry.

Process Description

The production process is essentially a combination of separation and concentration of sucrose, the significant component of the cane. The process comprises:

- Cane handling
- Extraction of juice from cane
- Clarification of juice
- Concentration of juice
- Crystallization of sugar
- Separation of crystal sugar
- Refining of raw sugar
- Handling of commercial sugar

Cane handling is to a great extent subject to cane supply arrangements from the fields and on local conditions. It includes weighing of incoming cane, sampling for sucrose determination, storage to allow for continuous supply to the extraction plant also during times when no cane is delivered. Prior to juice extraction the cane is comminuted by revolving knives and shredders. Special cane cleaning equipment is required depending on the grade of impurities of the incoming cane.

Extraction of juice is performed either with conventional multi-roller mill tandems by applying pressure and water to squeeze the juice out of the cane, or through diffusion by means of solid-liquid extraction by applying heat and water and squeezing the final bagasse.

With diffusion in general higher sucrose extraction is achieved under more economical conditions. The bagasse (exhausted cane) leaving the extraction plant in general serves as fuel for steam generation. It can also be utilized as raw material for the production of paper, board, furfural and other products.

Clarification of juice is performed to remove impurities by applying heat and chemicals to form a precipitate which can be separated by filtration.

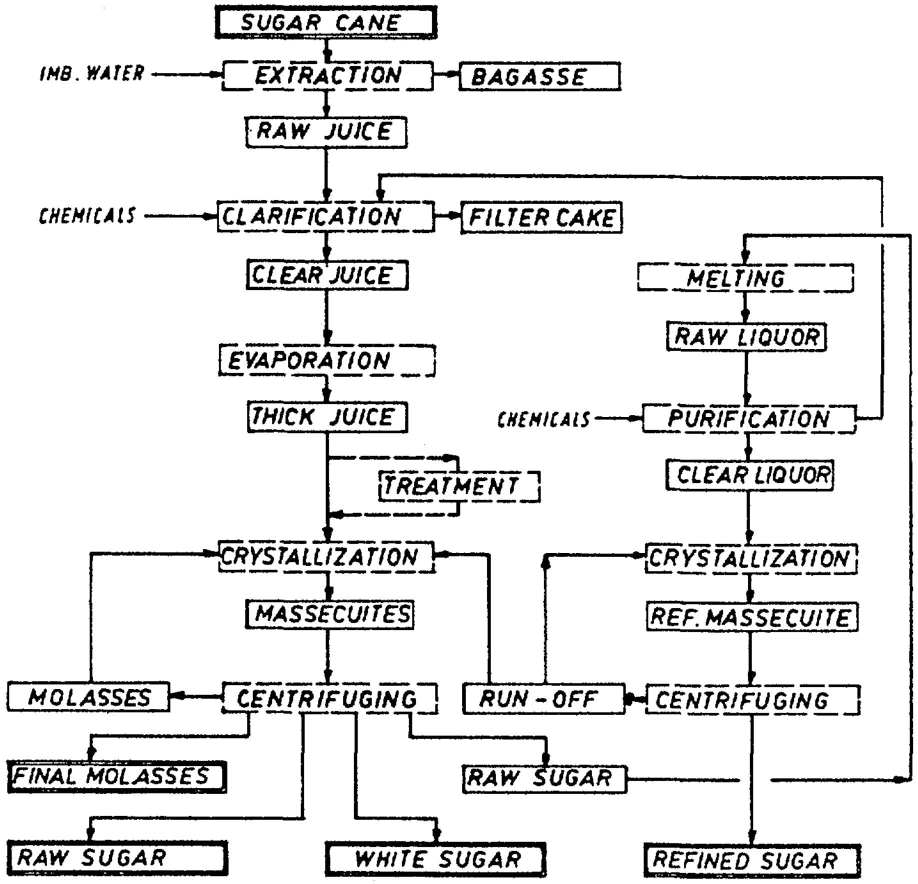
Subject to the required qualitiy of the final sugar produced, different clarification processes are employed:

- for *raw sugar* production the *defecation process*, using lime and heat;
- for *direct consumption white sugar* (i.e. "plantation white" or other sugar for consumption without refining) the *sulfitation process*, using SO_2-gas, lime and heat, or the carbonation process, using CO_2-gas, lime and heat.

A number of additives can be used as aids in the clarification process, such as soluble phosphates, polymer flocculants and others. Clarification processes for direct consumption sugar generally include thick juice treatment.

Concentration of juice (evaporation) is the first stage for separation of water from the clarified juice to obtain a final crystalline product. Concentration of juice is generally done in multiple-effect evaporator stations under vacuum with reduced boiling temperatures to prevent the destruction of sucrose and for improved thermal

Cane Sugar Manufacturing Process



economy. The vapours of the first effects are used for heating the following effects, juice heaters and vacuum pans. The vapour from the last effect is usually too cool for process heating and is condensed by direct contact with cold water in a barometric condenser.

The condensed heating steam or vapour (condensate) of each effect, juice heater and vacuum pan is collected, flashed and used as feed water for steam generation or as hot water in the process, subject to its purity (sugar content).

Crystallization of sugar is processed in two phases:

- massecuite boiling in a vacuum pan by further evaporation of water from thick juice and recirculated molasses to produce sugar crystals,
- massecuite cooling in a crystallizer to recover a maximum amount of sucrose in solution by increasing the crystal size.

Complete exhaustion in one single step of crystallization is not possible. The normal procedure in cane sugar production is to work in three steps (A, B, and C strikes). High juice purities only two steps may be sufficient to bring down the final molasses purity to standard level.

The appropriate boiling scheme must be selected according to the juice purity expected and the quality of commercial sugar desired.

Normally the commercial sugar is obtained from the first boiling (A-strike) and sugars from the following boilings are recirculated.

Vacuum pans are most commonly operated batchwise. Continuous operating systems have been available for a few years only.

To achieve uniform crystals and a narrow crystal size distribution, special attention has to be directed to seeding, circulation, and process control.

Determining factors for the deposition of sucrose on an existing grain are purity of the product, supersaturation and time, which is increasing with decreasing purity. Therefore, cooling crystallization is important for low-purity products.

Cooling crystallizers are operated batch-wise or continuously with mechanical agitators and water cooling systems.

Cooling crystallization has its limits where the viscosity of the massecuite increases to the extent that grain growing as well as mechanical agitation is barely possible.

To provide for good separation of sugar crystals from cooled massecuite, the viscosity has to be reduced by reheating for a short time prior to centrifugation.

Separation of crystal sugar in the massecuite from the surrounding molasses is performed by centrifugal force either in batch or continuous machines. Batch centrifugals should be used for high-quality commercial sugar. Continuous centrifugals, which have evident advantages, can be employed for all massecuites the recovered sugars of which are recirculated in the process.

The quality of sugar can be improved either by washing with water and steam inside the centrifugal or by minglin sugar coming from a centrifugal with liquid and purging the magma in a second centrifugal (double porging).

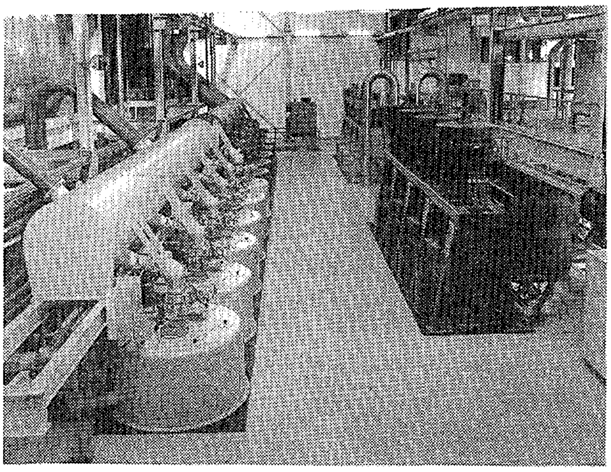
Handling of commercial sugar after centrifuging differs for raw sugar and white sugar handling. Raw sugar in general is stored and shipped in bulk. White sugar from centrifugals contains moisture and has to be dried and cooled before packing and storing. Subject to market requirements, the dry sugar has to be screened for the removal of dust and lumps.

Refining of raw sugar can be incorporated in a cane sugar factory. In this case the raw sugar is melted to liquor which is purified in processes similar to those applied for juice clarification or by phosphate-lime treatment. Subject to liquor quality decolorization is required prior to crystallization. Crystallization and centrifuging in the refinery is performed as described before.

In practical operation, the manufacturing process varies in almost every factory according to local conditions or traditional habits.

Essential aspects to be considered in general for the erection of a plant:

- Since large amounts of bulky cane are to be transported to the factory, it should be located near the centre of the cane growing area.



Continuous and batch centrifugals

- Cane transport and handling facilities must be well selected with a view to the prevailing local conditions (manual or mechanical harvesting, transport by road or rail, etc.).
- Transport facilities for raw materials and consumables to the factory and sugar, final molasses and waste from the factory are of great importance for smooth operation.
- Factory effluent disposal must ensure that pollution of the environment is kept within acceptable limits.

Example of the Plant

Daily capacity: approx. 400 tons of sugar (from appr. 4,000 tons of cane) per 24 hours.

Required Machinery and Equipment
(Main items of the individual sections)

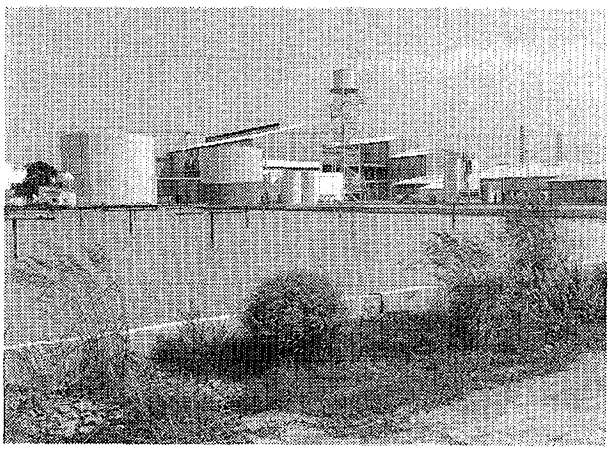
- Cane handling
  - 2 Feeding tables
  - 1 Primary knife with 370 kW drive
  - 1 Secondary knife with 600 kW drive
  - 1 Shredder with 1250 kW drive
- Juice extraction
  - Conventional mills:
  - 5 mills, 390 mm dia. × 2140 mm with 600 kW drives
- Solid-liquid extraction
  - 1 diffuser 5 m × 59.5 m
  - 1 dewatering mill 1180 mm dia. × 2360 with 1000 kW drive
- Clarification of juice (defecation process)
  - 2 Juice heaters, 280 m^2 heating area each
  - 2 Clarifiers, 240 m^2 capacity
  - 2 Vacuum filters, 40 m^2 filter area each
- Concentration of juice
  - 1 Quadruple effect, 5000 m^2 total heating area
- Crystallization (raw sugar, 3 products)
  - 5 Vacuum pans, 80 t massecuite cap. each
  - 6 Strike receivers, 100 t massecuite capacity each
  - 2 Cooling crystallizers, 230 t massecuite capacity each
- Separation of crystal sugar
  - 4 Batch centrifugals for a-product
  - 11 Continuous centrifugals for b- and c- product
- Refining of raw sugar
  - 1 Melting station for 25 t/h raw sugar
  - 1 Liquor purification plant for 40 t/h
  - 2 Vacuum pans, 60 t massecuite cap. each
  - 2 Strike receivers, 70 t massecuite cap. each
  - 4 Batch centrifugals for refined sugar
- Sugar handling
  - 1 Sugar dryer and cooler, 20 t/h cap.
  - 1 Sugar sifter
  - 3 Bagging scales

- Steam generation
  2 water tube boilers, 60 t/h steam (31 bar, 400 °C) production capacity each (bagasse is used as fuel)
- Power generation
  2 Turbo-alternators, 4000 kVA each
  1 Emergency diesel-alternator, 1850 kVA
- Water treatment (acc. to properties of available water)

Total weight of equipment:	12,000 t
Total weight of steel structure:	2,700 t

The FOB price (in 1986) amounts to approx. US$ 60 mill.

Subject to the industrial standard of a country up to 25% of this amount could be spent for local manufacture of equipment.



Cane sugar factory with cooling pond (Numan, Nigeria)

Utility Requirements

- Electric power per 100 tons of cane:
  approx. 3000 kWh
- Steam per 100 tons of cane:
  approx. 50 tons for raw sugar production
  approx. 70 tons for refined sugar production
- Water per 100 tons of cane:
  approx. 44 m^3 for the process
  approx. 150 m^3 for equipment cooling
  approx. 2500 m^3 for condenser injection

The water for equipment cooling and condenser injection can be recirculated in closed circuits via cooling towers or ponds.

Chemicals (for juice clarification, water treatment, cleaning of heat-exchangers and evaporators, etc.) per 100 tons of cane:

Hydrated lime	110 kg
Phosphoric acid	12 l
Flocculants	6 kg
Powered activated carbon	18 kg
Aluminium sulfate	8 kg
Chlorine	24 kg

Required Manpower (per shift)

Processing sections	168
Laboratory personnel	14
Maintenance and repair section	18
	200

Required Plant Site Area

approximately 300,000 m^2

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How To Start Manufacturing Industries

Date Processing and Packing

Introduction

Dates have been appreciated and cultivated since ancient times. For a number of countries dates are the only abundant crop and enjoy a high economic importance. Date palms survive the rigorous climate of sub-tropical deserts.

However, dates do not lend themselves easily to modern industrial processing. They are sticky and not always free-flowing and they are relatively small. On the other hand the increase of population and the ever rising wages demand an improvement of date processing in larger and more effective and productive plants. In view of this development reliable modern machinery was developed and adapted to the specific needs of the date packing industry. A date pitting machine with almond stuffing device has successfully solved the problem of pitting dates without damaging the fruit. A new rotary date press has solved the problem of high throughput under hygienic conditions with self-cleaning of the pressing station. So, with modern date processing machines it is now possible to produce a marketable product which can easily be handled, transported, stored and sold, packed in different attractive fashions.

Process Description

Primary Cleaning Line

The growers deliver the dates to the factory loose or in crates. Initially the dates are fed onto a vibratory screen conveyor designed to remove loose debris which drops directly onto a lower level debris collection belt. On the following multi-lane inspection and cleaning belt dates unsuitable for processing are discarded and debris too large to pass through the screen of the vibratory conveyor is separated and discharged by means of the debris collection belt into a rubish bin.

Parallel to the removal of debris and dates unsuitable for processing the empty crates are moved through a crate washer for thorough cleaning. These storage crates are then filled anew with dates qualified for processing and are moved to the palletising area where they are loaded on pallets for pallet-wise entrance into the fumigation plant and succeeding intermediate storage.

Vaccum Date Fumigation Plant

Prior to intermediate storage the dates are fumigated under sustained vacuum to kill any insects infesting the dates. The vacuum fumigation plant consists of one or more separate chambers each with an infeed and a discharge door at opposite ends to keep fumigated dates away from non-fumigated product thereby avoiding any possibility of recontamination.

Each chamber is designed to operate at a vacuum of approximately 95%. By removing most of the air from the chamber and from the dates stacked therein (high working vacuum) air pressure is highly decreased so that the gas can penetrate almost immediately into the interior of the dates. The removal of almost all oxygen increases the insecticidal effectiveness of the gas. A circulating system ensures an even gas distribution within the chamber.

Cycle time is thereby reduced to a maximum of 4 hours enabling 6 fumigations every 24 hours and this, in turn, allows use of relative small chambers, which leads to a sustantial decrease of initial investment.

Washing and Conditioning Line

The preliminary treatment line for dates is a cleaning line containing special date washing and conditioning equipment for optimum preparation of dates whether they are to be packaged in their natural state or to be processed further prior to packaging.

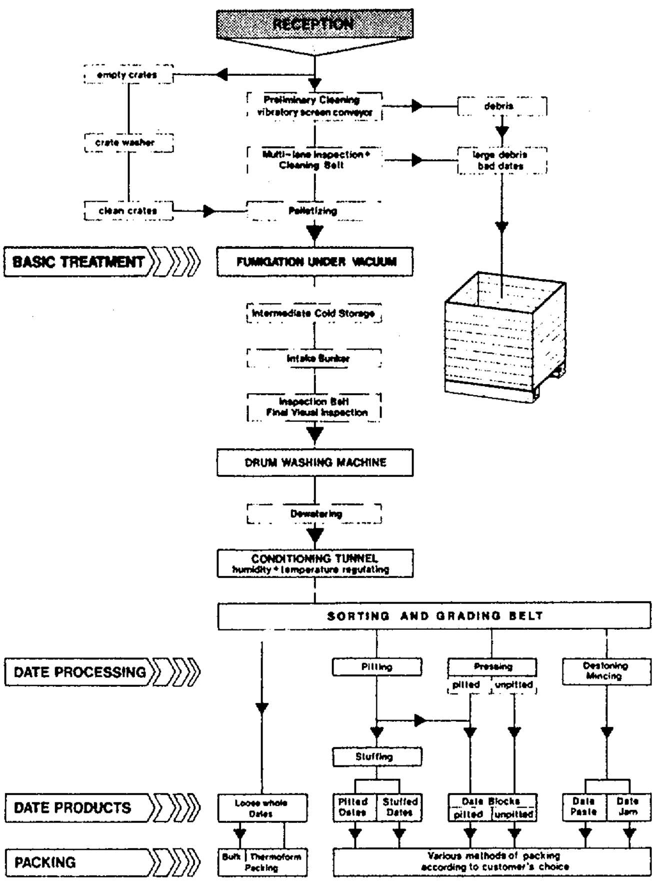
The dates after being fumigated are stored in a cold store room at a temperature of 5–7 °C. From there they are taken as required and transferred to the line intake bunker from where they are fed into the washing and conditioning line. The bunker is equipped with a separately driven metering system to assure uniform product flow. The succeeding inspection belt allows for a final visual inspection prior to washing and for a sorting of the dates into different size of quality classes for separate processing.

The dates which pass inspection are channelled to the drum washing machine where they undergo a unique multi-phase procedure which cleans them more efficiently as if water would be used only. From the washing machine the dates are conveyed further, remaining surface water is removed before they are subject to a humidity and temperature regulating process in the conditioning tunnel. The unique conditioning procedure has the special function of getting the dates into optimum prepacking or processing condition.

Processing Lines for Data Products

From the preliminary treatment line described above the dates are channelled to the various product handling and processing lines, i.e. installations for the packaging of dates in their natural state or the pitting of dates prior to packaging, the pressing of unpitted or pitted dates to rectangular blocks with subsequent packaging or the production of date paste and date jam.

Flow Chart of Date Processing Plant



Spraying of the dates with oil prior to further processing is recommended.

Packaging of Whole Dates

Whole dates can be packaged automatically without pressing in 250 g, 500 g, 1,000 g units or in larger weights from 5 kg to 20 kg (bulk packing). When packaging low weight units deep drawing vacuum packaging machines are recommended.

Cost saving packaging of dates in plastic bags of high weight units from 5 kg to 20 kg is achieved best by a semi-manually operated filler-weigher. The plastic bags rest in a bag holding device mounted on a weigh bridge with a circular weight indicator and are fed with dates from the preceding timing belt conveyor. Product infeed is automatically interrupted when the pre-set filling weight is achieved. Each filling procedure must be activated anew by actuating a foot or hand switch. Personnel is required at the filler-weigher to operate the filling switch and to attend the bag holding device.

The filled bags are transferred on a roller way to the semi-automatic sealing machine where the air is exhausted from the bags prior to sealing. Simultaneous injection of gas is possible. Here again, personnel is required to place the bags into and to take them from the vertical vacuum chamber.

Date Pitting and Stuffing

The special characteristic of the date pitting machine which can handle 9,000 to 10,000 dates/h is the careful and accurate opening and closing of the dates without destroying their form and appearance.

Before pitting the dates are graded manually in categories of 35–40 mm, 40–45 mm and 45–50 mm to fit the respective holding moulds. The machine accepts a tolerance of ± 3 mm in length. For reasons of flexibility it is recommended to keep different sets of moulds to be able to quickly adapt the machine to varying date sizes.

The dates to be pitted are placed manually in special holding forms arranged in six parallel lanes to keep the dates positioned as they pass through the pitting machine. The dates are slit open longitudinally by rotating circular knives and then widened apart. Fork-like fingers remove the date stones.

Process Flow Sheet

Immediately afterwards the dates are sprayed inside with water from jet nozzles to obtain a fine, clean product.

The pitting machine can include a gadget for the stuffing of almonds in place of the removed date stones. Devices for other insertions than almonds e.g. nuts or pistachios are also possible.

Prior to leaving the pitting machine, the dates are carefully closed again to restore their original appearance. A collecting discharge chute then drops the dates into the hopper of a discharge belt by which they are conveyed to the packaging station.

As for pitting and stuffing it should be mentioned that prior to this process the suitability of each sort of dates must be tested.

Pressing of Dates

For easier handling, transporting and storage but also to keep out air and insects dates are preferably pressed into blocks. A special rotary date press was developed with interchangeable weighing and shaping forms for blocks of 100 or 125 and 200 or 250 g. The larger the blocks the more exact is the weight content. The maximum capacity is achieved with blocks of 125 or 250 g yielding an hourly output of 450 kg. This capacity can be doubled by using a twin-press.

The rotary press consists of a weighing station, shaping forms, a pressing station and an automatic cleaning device which washes the shaping forms after each pressing. This is an important feature since it always keeps the machine clean. After pressing the date blocks are automatically transported to the following wrapping machine.

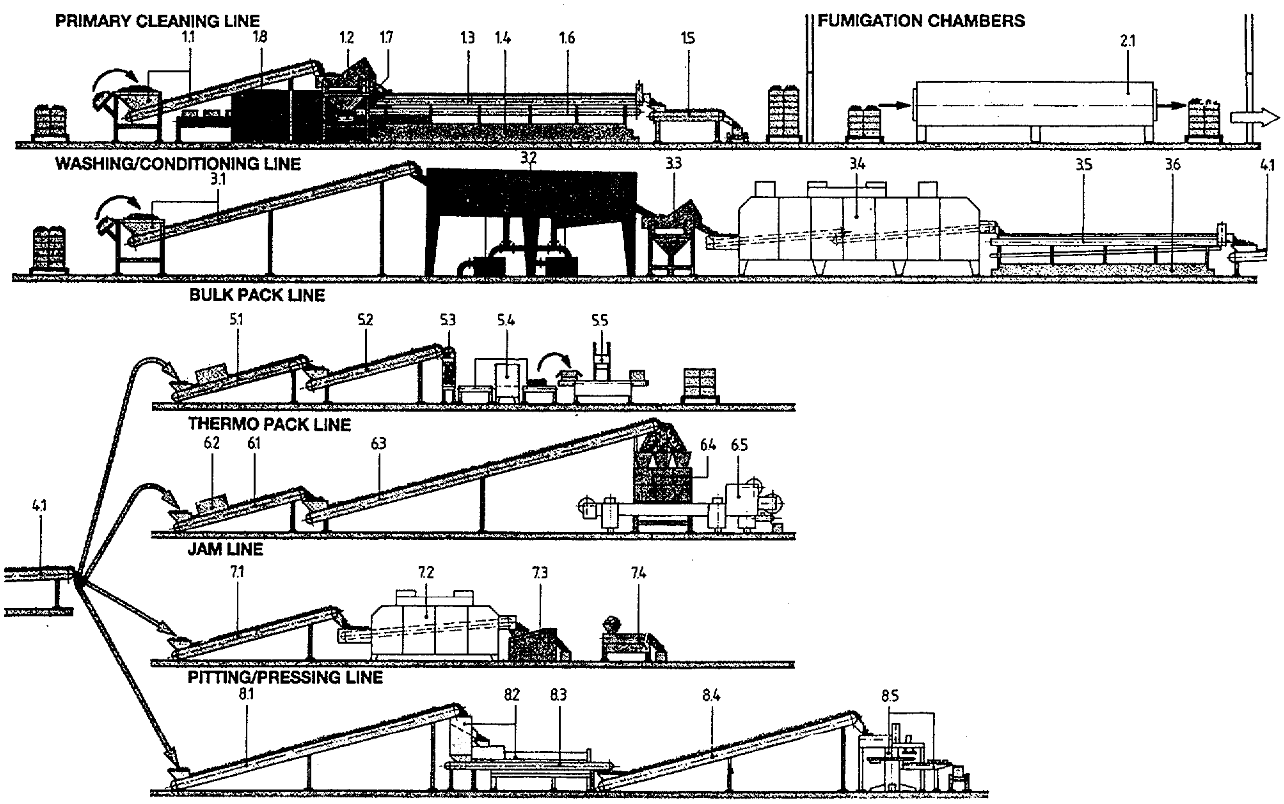
Wrapping and packaging can be done in different ways according to the customer's needs and ideas. Fancy and attractive packages can be used if required from a marketing aspects. There is a number of proposals for different ways of packaging.

Date Paste, Date Jam, Date Bars

Depending on market requirements it may be desirable to produce date paste and date jam. For this purpose dates of minor quality can be used which will be branched off at the sorting/grading belt.

Since for paste production it is not necessary to preserve the shape and appearance of the dates they can be destoned automatically without manual feeding by a simple destoning machine which crushes the dates after they were softened and pinches off the pits. Afterwards the destoned mass is minced to paste which can be used as date jam or be cast in bars of e.g. 50 g like the well-known Mars bars coated with chocolate.

Process flow sheet



Example of the Plant

Daily capacity approx. 16 tons of dates to be processed (2,000 kg/h).

Required Machinery and Equipment

(For section headings and item nos. refer to the process flow sheet)

1. Primary Cleaning Line

Line in-take bunker with flat discharge belt conveyor	1.1
Vibratory rod conveyor	1.2
Inspection/cleaning belt	1.3
Platform	1.4
Crate filling belt	1.5
Debris collection conveyor	1.6
Debris discharge conveyor	1.7
Crate washer	1.8

2. Fumigation Chambers

Two separate chambers	2.1

3. Washing/conditioning line

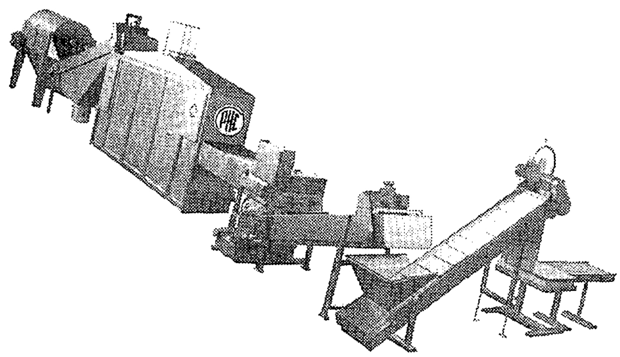
Line in-take bunker with flat discharge belt conveyor	3.1
Washing machine system with pump system	3.2
Vibration screen conveyor	3.3
Drying/conditioning tunnel	3.4
Inspection/sorting belt	3.5
Platform	3.6

4. Distribution

Conveyor belt to individual packaging lines	4.1

5. Bulk pack line

Wire conveying belt	5.1
Inclined flat timing belt conveyor	5.2
Semi-manually operated fillerweigher	5.3
Vacuum sealing machine with in-take and out-take rollerway	5.4
Case taping machine	5.5



Preliminary cleaning and semi-manual bulk packing

6. Thermo Pack Line

Wire conveying belt	6.1
Oil spraying device	6.2
Infeed belt conveyor	6.3
Tripleset of weighers	6.4
Thermoforming, filling and sealing machine	6.5

7. Jam Line

Infeed belt conveyor	7.1
Date heating tunnel	7.2
Date destoning and crushing machine	7.3
Date mincing machine	7.4

8. Pitting/Pressing Line

Infeed belt conveyor	8.1
Semi-automatic date pitting machine	8.2
By-pass belt conveyor	8.3
Transfer belt conveyor	8.4
Single date press	8.5

Other Requirements

Utilities, plant site area, manpower and approximate prices for the different sections are shown in the following table, based on the preparation lines (including the distribution belt) and the bulk pack line as the minium installation:

Requirements (per 8 hour shift)	*Section* 1.1 to 5.5	1.1 to 6.5	1.1 to 7.4	1.1 to 8.5
Manpower skilled	3	3	3	3
Manpower unskilled	22	26	28	32
Electric power kWh	1,000	1,025	1,600	1,650
Water consumption m³	100	105	105	120
FOB price Mill. US$ approx. amounts (1986)	1.0	1.4	1.5	1.8

The required site area for the total plant amounts to approx. 1,500 m^2.

The capacities of the single processing lines vary according to market conditions within certain ranges. By experience an outline version of the following features can be indicated:

Bulk line:	1,200 kg/h for 5 kg packages
Thermo line:	300 kg/h for 100 g packages
Jam line:	1,500 kg/h
Pitting/ press. line:	360 kg/h for 100 g packages

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How to Start Manufacturing Industries

Legume Processing

Introduction

Legumes have been known as foodplants, apart from cereals, for a long time. In many countries great importance is attached to pulses for human consumption, especially with a view to their richness in protein.

Beans, peas and lentils belong to the genus of legumes. A seed grain consists in particular of two cotyledons. The seed coat envelopes the cotyledons as well as the germ.

The various kinds of beans, peas and lentils differ considerably in grain size and shape as well as in thickness and strength of their husks. This fact must be given consideration when selecting equipment for a processing plant. Only mature seeds are used in industrial processing. Offals obtained are reprocessed for utilization as animal feed.

The aim of industrial processing of pulses is to prepare the agricultural produce for human consumption, i.e. promoting perfectly hygienic products of attractive appearance to market requirements, keeping a constantly high quality standard.

These food stuffs are either retailed by way of trade directly to the end consumer or delivered to the food industry for further processing, i.e. to produce tinned foods or any other refined ready-meals such as soups in bags, soupe-cubes etc.

Besides the principal aim of the mere processing, full consideration must be given to the storage of the material to serve as a "buffer" balancing between seasonal harvest-time and continuous consumption as well as to cater for an adequate reserve for periods of extraordinary need. Thus the storage capacity for raw and final products should be provided according to such requirements.

Storage facilities should also provide all-weather protection and measures against infestation by micro-organisms. The design must be such that pests, insects, birds and rodents cannot penetrate, and that trespassers have no access.

For delivery ex-factory the final products are packed in packages of 0.5 to 10 kg or in bags of 10 to 50 kg or they are loaded and transported as bulk commodity.

Process Description

After reception in the factory the raw material is prepared for storage, i.e. precleaned and, if necessary, also provisions are made for drying and fumigation. Normally, storage tanks or silos are in use, but also bag storage in sheds is applied.

The essential steps of the actual processing which are applied according to the sort of legume and the relevant quality requirements to be met are summarized as follows:

1. Cleaning and grading
2. Hulling (without/with splitting)
3. Glazing and/or polishing
4. Grinding and screening
5. Hydrothermal treatment

1. Cleaning and Grading

(see diagram 1) include the following functions:

- Removal of foreign matters contained in the raw material from harvesting or subsequent transportation. This concerns in particular:
  - coarse impurities
  - straws and stones
  - tramp iron
  - foreign seeds and weeds
  - other legume grades.
- Elimination of seeds which are damaged, discoloured, spoilt or infested and thus affecting the quality of the final product.
- Elimination of broken, split and partly or wholly hulled seeds for separate handling.
- Removal of dirt sticking to the seed surface.
- Classification by sizing to obtain a uniform end product, thus facilitating further handling and food preparation.

Special machines for this part of processing are: separator, aspiration channel, magnetic separator, indent cylinder, gravity separator, concentrator, dry destoner and drum grader.

These machines operate in a processing line subject to the different properties of the product handled and the material to be separated. Separation is effected with sieves to grain size, i.e. grading to grain length by means of indents and to floating characteristic when exposed to the air current in air sifters. Magnets are applied to separate iron particles.

The number of machines individually applied depends on the raw material to be handled and quality requirements to be met for the final products. Washing machines serve for special cases of application to clean the grain surface with water.

2. Hulling

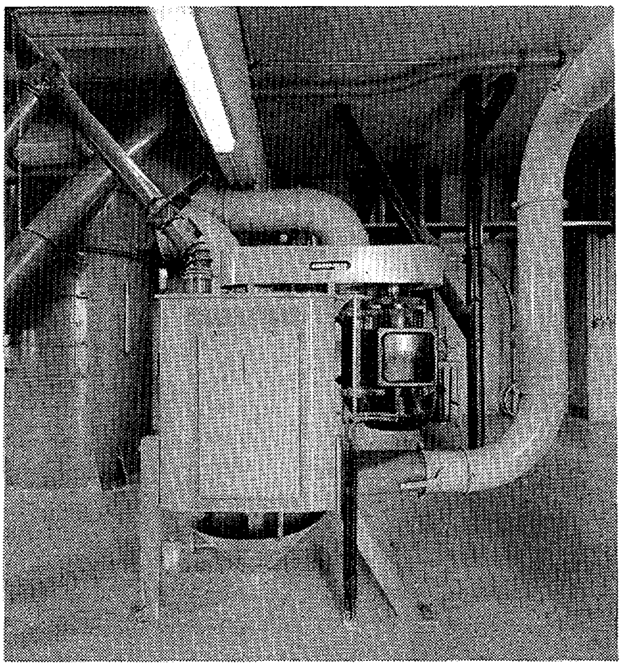
The indigestible coat is removed from the seeds by hulling. During this operation, lentils and peas are often also split or divided into the two cotyledons.

Removing the husk is facilitated through prior conditioning which differs in application for the various sorts of legume. During this conditioning the product is exposed to a hydrothermal treatment and subsequently tempered in tanks (see diagram 2). This measure favours loosening the husk and permits an easier treatment during the hulling operation and thus decreases the damage to the endosperm. The removed husks serve as additives for animal feed.

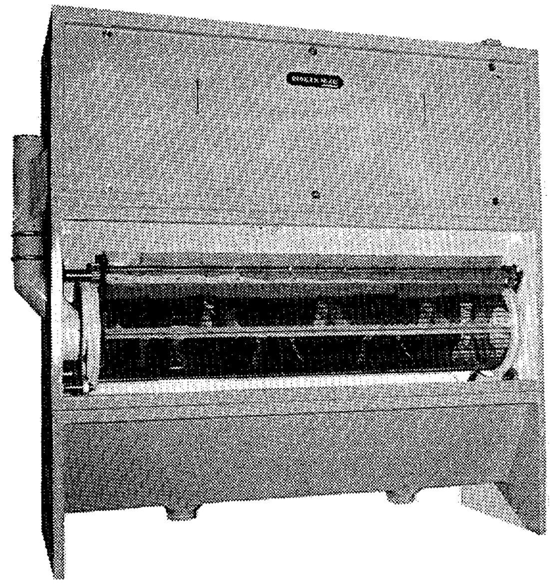
The bigger part of the material is split in the hulling phase – passing through the vertical whitener. Drum graders enable the split to be relieved of whole legumes by screening.

Whole legumes are guided – as long as an unsplit product is not requested – to pass through one or several passes for splitting. At the end of each splitting pass, the individual cotyledon halves are taken again onto the drum graders to be separated.

At this point, the split still contains coarse and fine brokens. These are guided to pass once



Vertical whitener-pearler



Drum grader

again through a drum grader with an adequate screen. Subsequently, the brokens thus obtained are forwarded to be separately handled, e.g. to produce flour. The dry destoner is applied to remove stones, which still may be in the material.

After hulling, the product is fed into round sifters for aspiration in order to remove husk particles and dust (see diagram 3).

3. Glazing and Polishing

Legumes are often exposed to an after-treatment to improve their appearance and storage stability. Therefore, hulled and split peas and lentils are dampened and guided to pass through a rotating glazing drum after adding a glucose solution. Thereafter all sticky split halves are sorted out in the drum grader and subsequently separated again by using the splitter.

4. Grinding and Screening

For the production of flour for human consumption both hulled and unhulled pulses are suitable to be processed.

Depending on the required fineness of the different kinds of flour either hammer mills or finegrind mills are used for the grinding operation. Subsequent screening through plansifters serves to eliminate coarse particles which may still be found in the flour. The retainings are returned to pass the mill once more.

5. Hydrothermal Treatment

This process represents a treatment with moisture and heat over a specific period, which allows the manufacture of special and easy-to-prepare food.

Process Flow Diagrams

Diagram 1:

LENTILS (RED/GREEN)
CLEANING AND GRADING

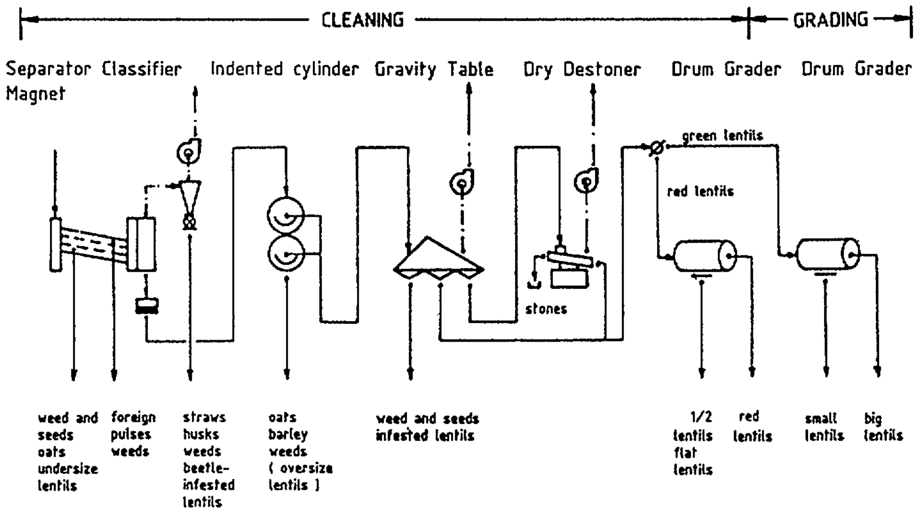


Diagram 2:

PRODUCING SPLIT PEAS

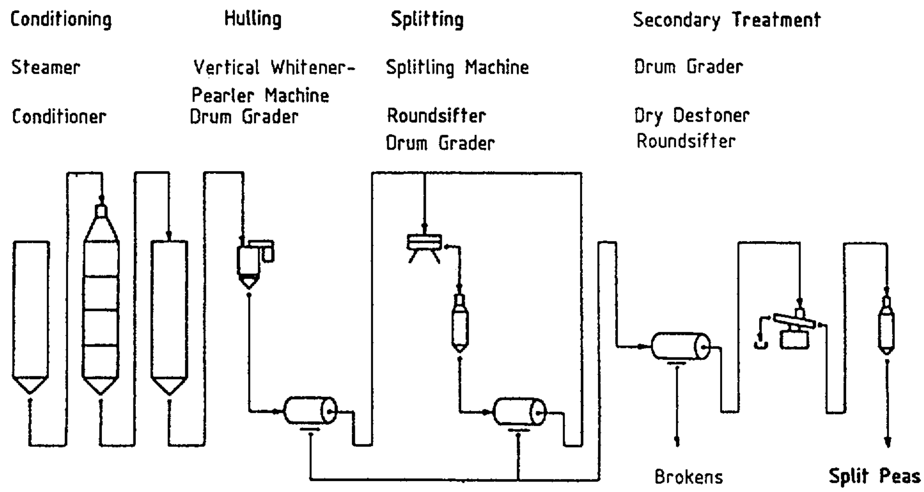
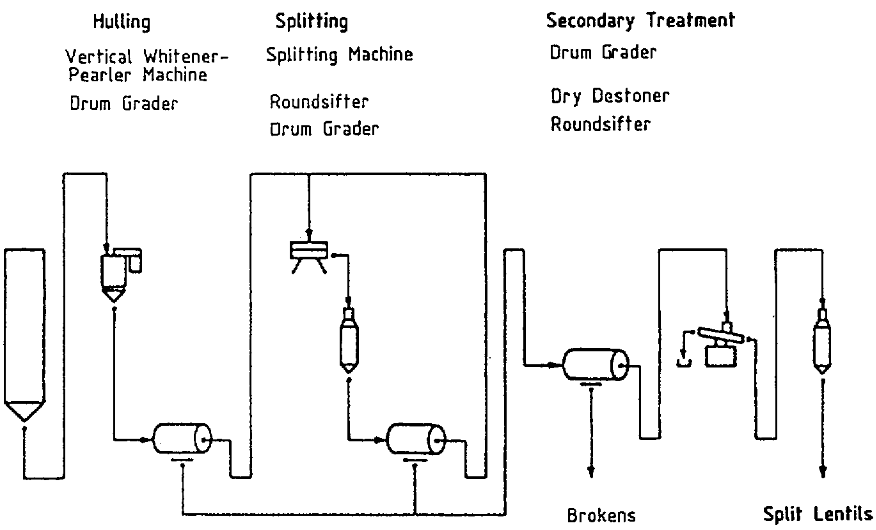


Diagram 3:

PRODUCING SPLIT LENTILS



Whole peas and lentils are soaked in water for 5 to 15 hours depending on the species, thus increasing their water content to 43–46%. Subsequently they are fed into autoclaves to be cooked to the stage of well done. The precooked legumes are then passed through a recycle-air drier for drying at low temperatures.

These special products, namely precooked whole peas and lentils as well as flours obtained therefrom, are – although common – an attractive and an easy-to-sell commodity, which facilitates the preparation of meals.

Example of the Plant

(related to a layout for cleaning, grading, hulling and splitting lentils)

Capacity: approx. 8,000 kg split lentils per day (8 hours)

Required Machinery and Equipment

Cleaning and Grading:
1 Separator
1 Magnetic separator
1 Indent cylinder unit with secondary separator
1 Gravity separator
1 Dry destoner
2 Drum graders with countersunk perforation

Hulling and Splitting:
1 vertical whitener-pearler
3 Drum graders
1 Splitter
2 Round sifters
1 Dry destoner

Sundry Equipment:
Intake chute
Elevators
Cyclones and fans
Spouts and aspiration ducts
Erection material
Switch cabinet with luminous wiring diagram
Pedestals and supporting framework

Approximate total FOB price in 1986: US$ 370,000.
(Not included is packaging machinery resp. bulk handling equipment, hoppers, silos, etc.)

Daily Required Production Materials and Utilities

Raw material: approx. 8,000 kg lentils (per 8 hours)
Electric power: 90 kWh per 1,000 kg raw material

Required Manpower

2 Shift workers
2 Store keepers

Plant Site Requirements

Building dimensions: 20 × 10 m, height: 10 m (2 floors) including 3 bins of approx. 8 m^3 capacity each serving as day bins, conditioning and bagging bins (erected in reinforced concrete or steel).

Total area: approx. 600 m^2

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How To Start Manufacturing Industries

Palm Oil Production

Introduction

Palm oil is a constituent of the fruit-pulp of oil palms and is used in the manufacture of soap, candles, and for colouring and scenting ointments. Bleached or slightly hardened it serves also as raw material for the production of margarine and baking fat.

The palm oil is produced by extraction from the reddish-to-orange pulp of the ovoid shaped fruits which grow on stalks in fresh fruit bunches (FFB) on the oil palms. Pure oil and kernel are the main final products besides minor quantities of solids which are used for animal feed and fertilizers. Shell and dry fibres are used within the palm oil processing line for fuelling the steam boiler.

An approximate quantification of the different components is shown in the typical fruit and production composition chart.

Process Description

Reception of Raw Material

The FFB are brought from the field to the mill by means of trailors or trucks which pass a weigh bridge (for quantity control of the incoming FFB and the outgoing products as well). After weighing the bunches are dumped on the storage area, which is either a concrete floor or a raised unloading ramp (in small scale plants). Depending on the type of sterilizer and the capacity of the plant filling of sterilizer baskets or cages is carried out by hand or by suitable systems (gravity, loaders, etc.). In large plants unloading hoppers or specially designed reception systems are applied.

Sterilizing

In this section the fruit bunches are submitted to direct steam at a pressure of approx. 3 bar over a period in the range of 30 to 60 minutes depending on the weight/size of the buches.

Objects of the sterilization are:

- Prevention of any further rise in F.F.A. (free fatty acid content) due to enzyme action by inactivation of these lipolytic.
- Facilitation of mechanical stripping. To loosen the fruits from the bunches, sufficient moist heat must penetrate to the point of attachment of the fruits to the stalk.
- Modification of the colloids of the pericarp and stalk in a way that de-oiling of the fruit solids is favoured in the following pressing phase. This applies both to the fibre solids and to the solids in the crude oil which are de-oiled in the clarification section.
- Pre-conditioning the nuts to minimize kernel breakage during both pressing and nut cracking. Adequate sterilization permits sufficient heat penetration to cause a high percentage of the kernels to become detached from the shell. (This process of loosening the kernels is continued in the nut silos and must be completed before the nuts are cracked if "split nuts" are to be avoided.)

There are vertical type sterilizers of limited volume for small scale plants and big horizontal type sterilizers for mills with higher capacities and continuous sterilizing process lines.

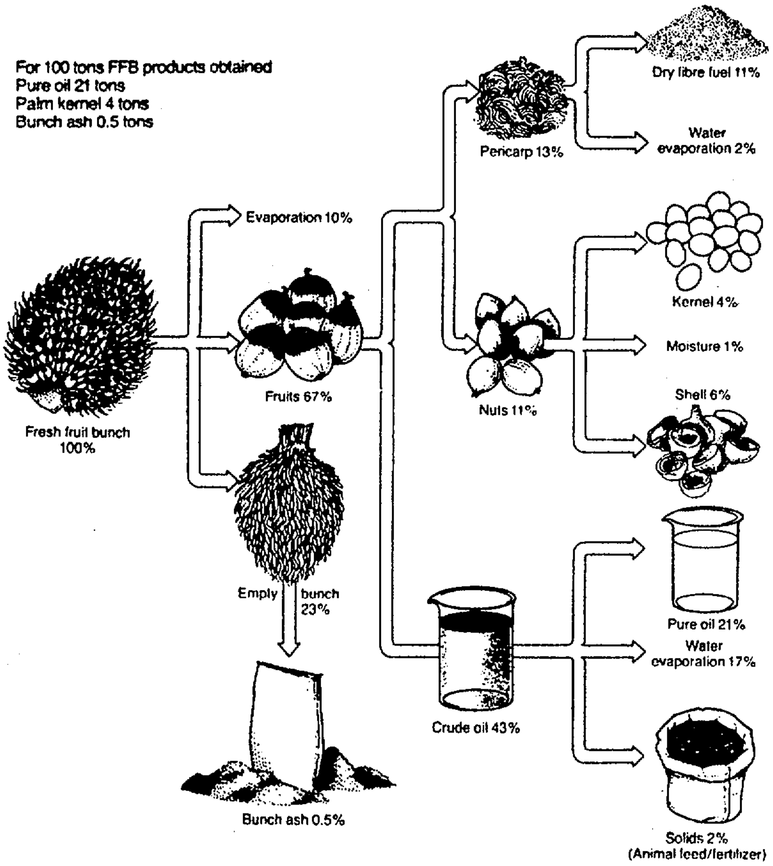
Stripping

After sterilization of the complete FFB, the fruits are separated from the bunch stalks in the stripping station.

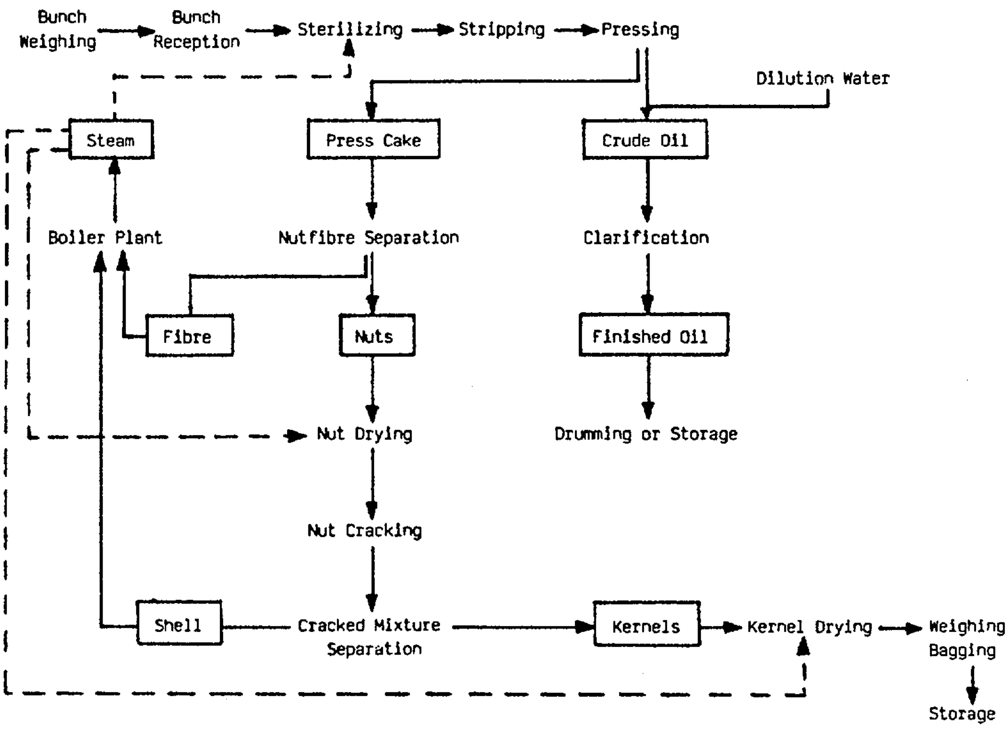
No palm oil is contained in the calyx leaves and the stalks of the FFB, but during sterilizing and stripping some oil is absorbed by them. As far as the calyx leaves are concerned the absorbed quantity is unimportant since they will be pressed together with the fruits. They could be screened off before, however their presence has been found helpful to improve the press fibre de-oiling. The bunch stalks, on the other hand, cannot be pressed and it is important, therefore, to keep the amount of oil transferred to them to a minimum and to care that no significant quantity of residual fruit remains attached.

Digesting

After the bunches have been stripped, the sterilized fruits are reheated together with the accompanying calyx leaves and thus the pericarp is loosened from the nuts and prepared for



Typical Fruit and Production Composition Chart



Synoptic Chart of Palm Oil and Kernel Production pressing. This is achieved in steam heated vessels (digesters) provided with a rotating shaft to which stirring arms are attached.

Pressing/Oil Extraction

Pressing is the most usual method of extracting crude palm oil from digested palm fruit. Other methods are centrifuging and the wet process.

Modern types of presses with highest efficiency are continuously operating double screw presses, in which two parallel screws are running side by side in a common perforated press cage. The position of a double cone is controlled hydraulically in order to achieve constant cone pressure applied to the fruits. Such presses can be rated for different throughputs at different screw speeds depending on the various types of fruits.

During the pressing operation, the press cylinder will be flushed with hot water the rate of which is determined by the rate of crude oil. Usually the oil to water ratio is 1 : 1.

Clarification and Storage

The crude oil extracted by pressing, centrifuging or by the wet process contains varying amounts of water together with impurities consisting of vegetable matter which is partly dissolved in the water and partly forms insoluble solids.

From the crude oil receptacle the oil is pumped through a direct steam heater to the continuous settling tank. Here it enters at the bottom, so the impurities and the sludges deposit quite rapidly in the lower part of the vessel while the oil rises to the higher level. The top oil flows from the continuous settling tank via an overflow into the clean oil settling tank, from which it is fed to the oil dehydrator.

The liquid sludges are continuously delivered to discontinuous settling tanks where the oil recovery is alternatively done in a static way. The oil obtained in these secondary tanks is recycled to the continuous settling tank.

The heavy sludges that sink to the bottom part of the settling tanks, have to be withdrawn regularly into an open groove. These heavy sludges are forwarded first to an inspection receptacle and from there to a concrete sludge pit.

The oil dehydrator reduces the water content to approx. 0.2%, before the final product reaches the pure oil storage tank. For delivery ex-works either drums or tank lorries are filled.

Nut-Fibre Separation

When digested fruit is pressed to extract the oil a cake consisting of nuts and fibre is produced, the composition of which varies consideralby, being dependent on the type of fruit and the kind of extraction process.

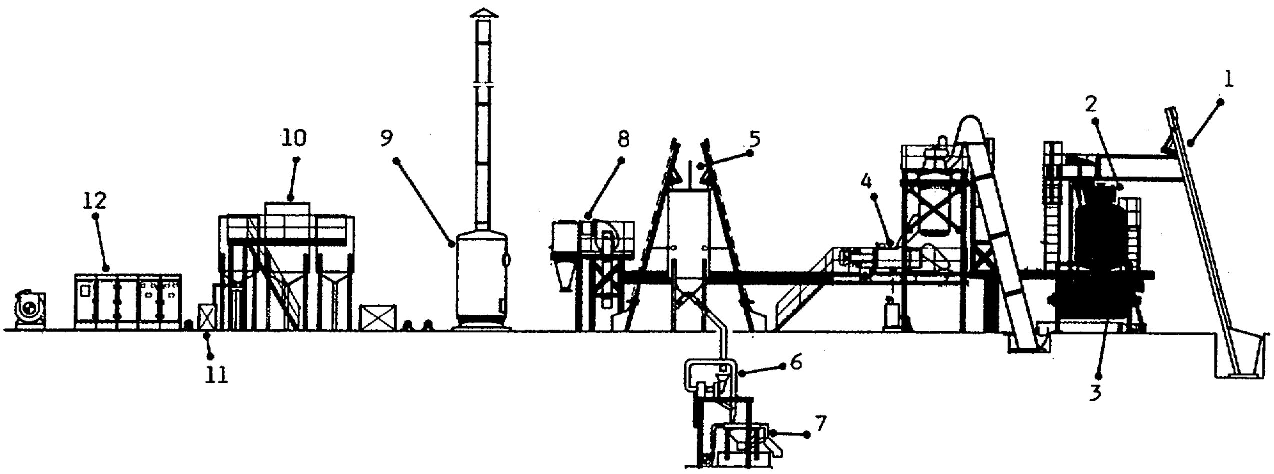
The cake is given a breaking and drying treatment before being fed into the nut-fibre separator which is operating either by mechanical means or by use of an air counterflow method.

The recovered fibres are used for fuelling the steam boiler.

The Kernel Recovery is composed of:

- nut drying (conditioning)
- nut cracking
- kernel separation and drying

Process Flow Sheet



1 Fruit bunch elevator
2 Sterilizing plant
3 Stripping plant
4 Pressing station
5 Nut/kernel drying
6 Cracking plant
7 Cracked misture separation
8 Nut/fibre separation
9 Boiler plant
10 Clarification
11 Drumming or oil storage
12 Power plant

Nut Drying (Conditioning)

After separation from the fibre, the fresh nuts must be treated to achieve a correct cracking. In a fresh nut the kernel is closely attached to the shell immediate cracking of which would give a split nut in which the shell would adhere to the kernel. The treatment or conditioning consists of loosening the kernel from the shell (the kernel starts in fact getting loose already during sterilizing) by reducing the moisture of the nuts from about 16% to between 10 and 12%, at which level the desiccation causes the kernel to shrink off the shell.

Whereas a simple sun-drying may be carried out in rural mills, larger factories are equipped with nut silo-dryers in which steam-heated air is circulating at constant temperature.

Nut Cracking

The nuts leaving the silo-dryers fulfil the conditions for a correct cracking i.e. recovering a maximum of whole kernels with a minimum of broken ones. Cracking is carried out by rotary centrifugal crackers, in which the nuts are hurled violently from a rotor to a circular casing. The correct cracking as mentioned before is achieved by adjusting the speed of the rotor.

Kernel Separation

The cracked mixture consists of free kernels, shell, unbroken nuts, partly cracked nuts, and dust (fibre, fine shell, bits of broken kernels).

Except for small plants where the investment is hardly justified, the dust is separated first. Among the various methods of separating the kernels from the cracked mixture, the following two methods are mentioned:

- Separation by means of suspension, utilizing the different specific gravities (kernels between 1.06 and 1.16, shell between 1.3 and 1.35) which make the kernels float while the shell fragments sink.
- Separation by hydrocyclones, based on a water stream rotating at high speed inside a cyclone.

Kernel drying

After separation the kernels have a moisture content of about 20%. Partial drying to approx. 7% is absolutely necessary for further handling.

The kernel dryer is part of the combined nut/kernel silo-dryer in which heated air is blown in order to dry the kernels to the desired moisture level.

Steam is required in the factory for sterilizing the bunches, reheating the fruit before pressing, heating the dilution water, and drying nuts and kernels. This steam is produced by vertical field type boilers which are simple in operation and maintenance for smallsize plants.

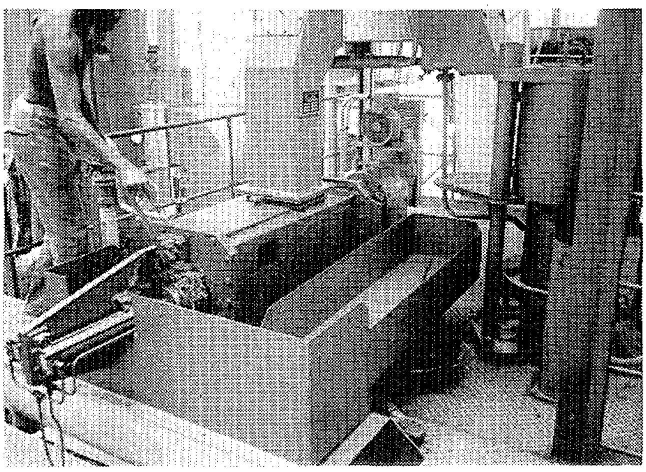
The power to drive the different electric motors is generated by a suitable power generating plant in case no reliable electric power can be supplied from the public network.

Example of the Plant

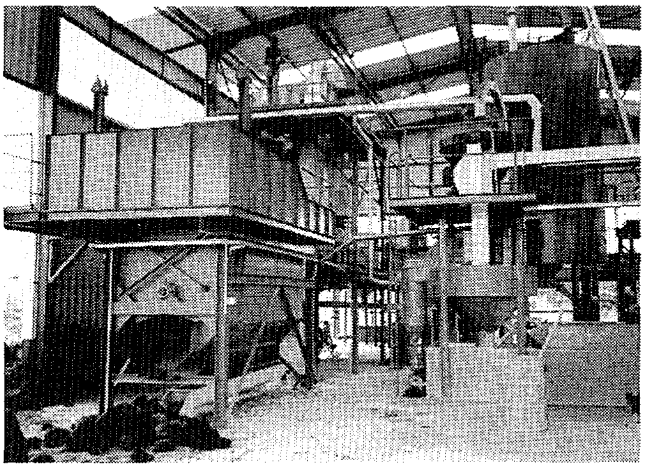
Capacity: 24 tons of FFB per day (8 hours)

Required Machinery and Equipment
(main items)

1 Weigh bridge
1 Fruit bunch elevator
1 Sterilizing plant (with 4 baskets)
1 Stripping plant incl. stalk incinerator
1 Extracting station incl. digester and screw press
1 Clarification plant incl. settling tanks and reheaters
1 Oil storage tank with drum and lorry-filling equipment
1 Kernel plant with equipment for:
nut/fibre separation



Twin-screw press



General view of stripping and kernel plant

nut/kernel drying
nut cracking
cracked mixture separation
kernel drying
weighing-bagging the product
1 Steam boiler
1 Power plant
Ancillary equipment such as
conveyors, elevators, pumps, etc.

The FOB price on 1986 basis amounts to appr.:
US$ 770,000.00

Utility Requirements per 8 Hours

Water:	approx.	40 m^3
Steam:	approx.	13,000 kg at approx. 3.5 bar
Electric power:	approx.	560 kWh

Required Manpower per Day

Skilled:	
Foreman	1
Reception	1
Sterilizing	1
Threshing (crane operator)	1
Extracion press operator)	1
Clarification	1
Boiler house	1
Power house	1
Unskilled:	
For bunch reception and handling	4
For cleaning/filling the drums, loading trucks etc.	1
For collecting fibre, nutshells for firing the boiler	1
Total:	14

Required Plant Site Area

Production plant (covered)	approx. 600 m^2
Free area	approx. 4,400 m^2
Total:	approx. 5,000 m^2

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How To Start Manufacturing Industries

Starch Derivatives Production

Introduction

For many years starch and starch containing materials have been converted by means of high temperatures in the presence of catalysts into soluble sweet products.

Early in the last century it was discovered that, if potato starch slurry is treated with acid, a sweet tasting syrup was produced, from which dextrose crystallized.

Since that time starch production from amylaceous raw materials and starch processing into high-quality starch derivatives has made enormous technological progress, especially over the past thirty years.

In general large amounts of starch are processed into starch sweeteners. Any purified starch extracted, for example, from maize (corn), millet, wheat, rice, potatoes, or from tropical roots such as manioc, tapioca, cassava and yucca, can be used for this purpose. It is hardly often that these raw materials are processed directly into starch sweeteners without starch as an intermediate.

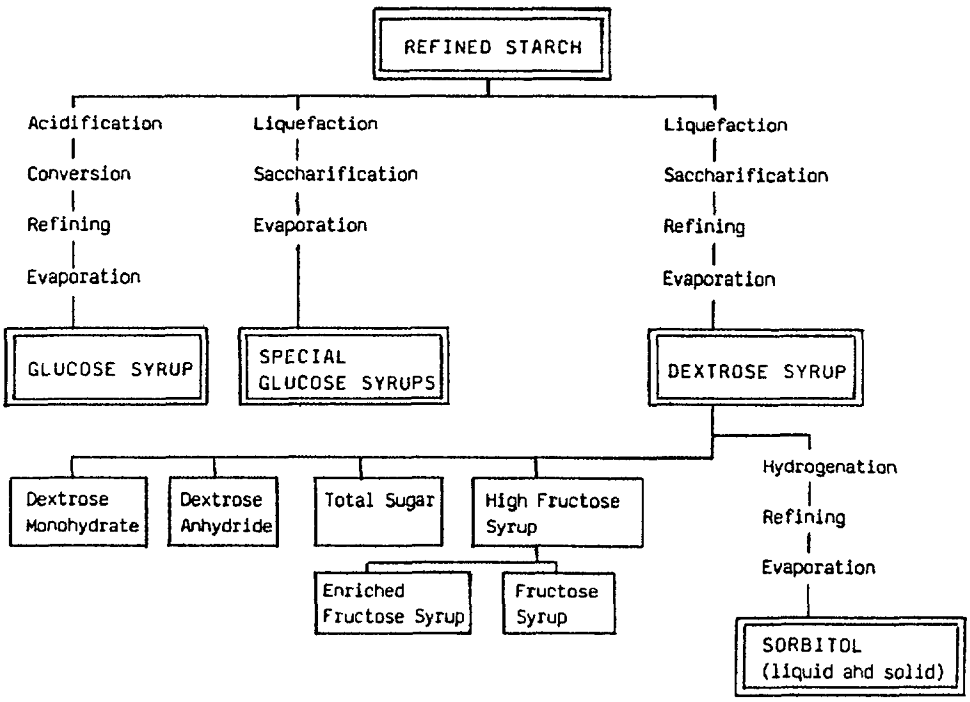
Starch sweeteners/derivatives are primarily subdivided into glucose syrup (including the "family" of special glucose syrups) and dextrose syrup (as base for subsequent forms of dextrose).

Process Description

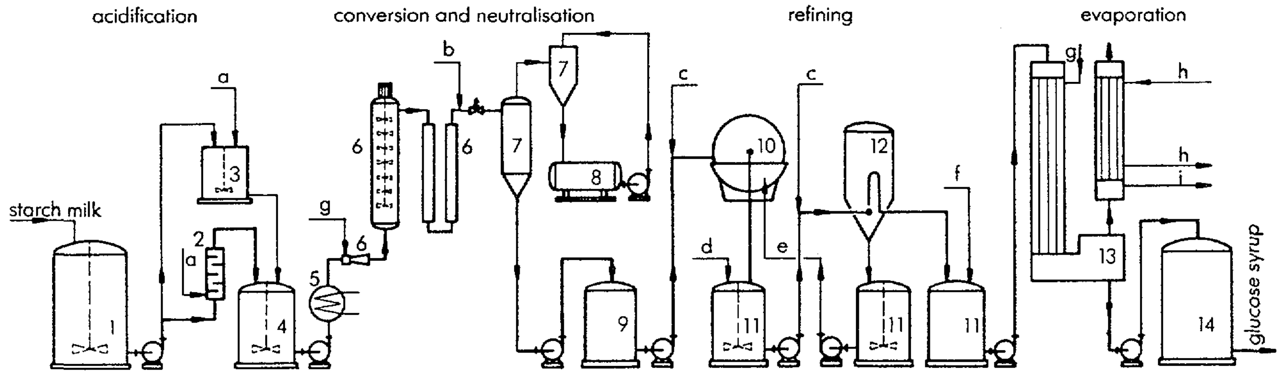
The process descriptions hereafter refer to the production of:

1. Glucose syrup
2. Special glucose syrups
3. Dextrose syrups
3. Sorbitol (one of the subsequent products out of dextrose syrup)

Synoptic Chart of Starch Derivatives



Process Flow Diagram for Glucose Syrup



1 starch milk tank	8 hot water aggregate	a HCl
2 continuous acidification	9 neutralisation tank	b Na_2CO_3
3 batch acidification	10 filter	c filter aid
4 acidified starch milk tank	11 tanks	d activated carbon
5 heat exchanger	12 candle filter	e used activated carbon
6 continuous converter	13 evaporator	f $NaHSO_3$
7 flash cooling	14 product tank	g steam
		h cooling water
		i vapour condensate

1. Glucose Syrup

Glucose syrup is used in the food industry not only because of its sweetness and its nutritive value, but in particular for its functional properties (stabilization of moisture, softening ability, build-up of texture, prevention of crystallization of other sugars, formation of film and body). In the first place it is used for sweets and confectionery, ice cream, pastries, preserves and liqueurs.

Glucose syrup is a sweet, colourless, highly concentrated solution of a mixture of easily digestible sugars. Glucose syrup produced by the standard method, i.e. single-stage hydrolysis of starch with acid, has a DE between 32% and 55%. A DE of approx. 42% (which is the most common syrup) goes with a constant sugar spectrum of about 19% glucose, about 14% maltose and about 67% oligosaccharides. This syrup is concentrated to 43–45% Baumé equalling 81–85% dry substance, and at 45% Bé it is a very viscous product.

To produce glucose by acid hydrolysis, purified starch milk is acidified (commonly in the presence of hydrochloric acid as a catalyst) to an acidity of 0.03 n HCl. In a converter the acidified starch is converted at high temperature into a mixture of glucose, maltose and higher saccharidies. With the aid of such process parameters as temperature, pH value, concentration and residence time (which have to be checked very carefully) it is possible to choose a degree of saccharification (DE) being equivalent to a defined sugar spectrum.

After hydrolysis, the hydrolysate is cooled down, and soda is added for neutralization in order that the impurities in the starch (protein, fat) flocculate can be removed by mechanical means, either by separators or by rotary precoat filters.

In general, decolourization of the hydrolysate proceeds in two stages in the presence of activated carbon. The filters (rotary filters, candle filters, filter presses) required to filter the juice and to separate the activated carbon are of the precoat type. If need be, ion exchangers can be employed to demineralize the glucose. Finally, the purified glucose is evaporated in a vacuum to the final concentration of 81% to 85% dry substance.

The starch generally used for acid hydrolysis is corn starch or root starch which has to be purified very thoroughly. Since starch to be hydrolyzed has to be suspended in water, a glucose factory quite often is combined with a starch factory so as to avoid the necessity of drying the

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* DE: Dextrose Equivalent, expressing the degree of hydrolysis (conversion) and, consequently, the breakdown of the glucose chains in the starch.
Since glucose and maltose-type sugars, unlike the starch molecule, have reducing aldehyde groups, this reducing property can be utilized to define the DE. The DE is the percentage of reducing sugars (in terms of glucose) in the dry substance of the product concerned. The DE of starch is 0% and that of pure glucose is 100%. The DE is just a measure of the number of reducing groups present, but does not disclose any details about the sugar spectrum, i.e. the percentages of glucose, maltose and higher saccharides.
The acid hydrolysis, acid-enzyme breakdown and double-enzyme process makes it possible to produce substances having different DEs and a different sugar spectrum.

starch first and then re-dissolving it in water. For another thing, the factory should be located in the centre of its market area in order to minimize syrup transport costs. For root starch which in most cases is produced in places far away from the centres of glucose consumption, it might therefore be expedient to use dry starch.

2. Special Glucose Syrups

Maltose syrup and high-DE glucose syrups can be produced by two-stage acid/enzyme or enzyme/enzyme saccharification. Though their DE is the same as that of standard glucose syrup, these syrups have a different sugar spectrum and, as a result, specific properties such as more sweetness, a better crystallization-inhibiting effect upon sucrose, and less hygroscopicity.

The applications of these syrups are the same as those of standard glucose syrup, and owing to their favourable properties they are being used to an increasing extent – in spite of the fact that their price is higher.

Generally speaking, low-DE syrup is highly viscous and imparts texture and body to the product; high-DE syrup is used for its sweetness. The principal fields of application of these glucose syrups are as follows:

- Low-DE syrup, 20–38 DE:
  Frozen dairy products, beer;
- Normal-DE syrup, 38–58 DE:
  Confectionery such as drops, gelatine and jelly sweets, chewing gum, marzipan, etc., beverages, frozen dairy products;
- High-DE syrup, 58–70 DE:
  Soft drinks, jams, pastries, ice cream.

Special glucose syrups can be produced at a normal glucose factory practicing the acid hydrolysis technology, provided the plant is supplemented by the equipment required for enzymatic saccharification.

Table of Typical Sugar Spectra of Glucose Syrups

DE	*Process*	*Sugar spectrum (%)* glucose	maltose	oligo-sacch.	*Glucose variety*
32	Acid	11	10	79	low-DE
42	Acid	19	14	67	normal-DE
55	Acid	31	18	51	normal-DE
47	Acid/ enzyme	12	50	38	maltose syrup
63	Acid/ enzyme	37	31	32	high-DE
97	Enzyme/ enzyme	96	3	1	dextrose syrup

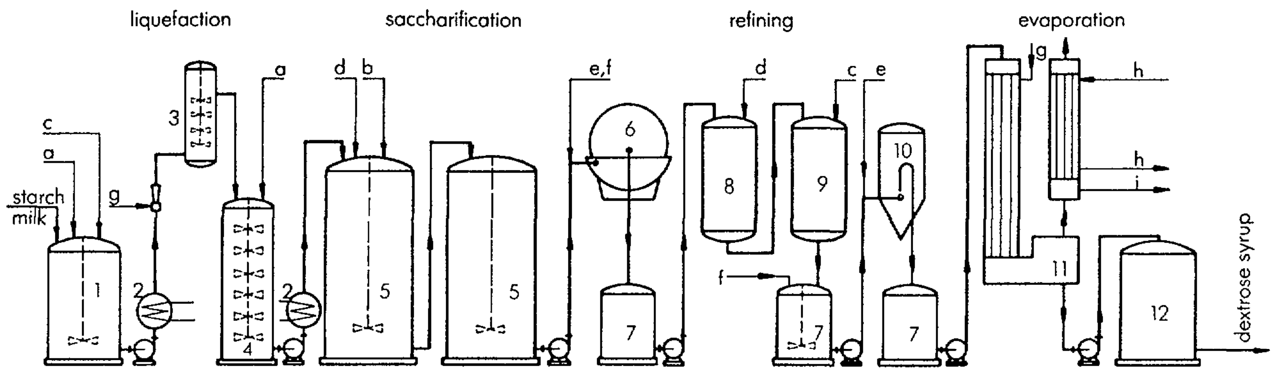
Some maltose syrup varieties are made by the enzyme-enzyme process, but this process requires the same equipment as dextrose syrup production.

3. Dextrose Syrup

Dextrose syrup is a sweet, colourless, concentrated solution having a DE of 97–89%, a typical sugar spectrum of 96% glucose and 4% maltose and oligosaccharides, and a concentration of 71% dry substance. It is made from starch milk by two-stage enzyme-enzyme liquefaction and saccharification.

Very high DE dextrose syrup is used for pastries, soft drinks, etc. In general, however, dextrose syrup is an intermediate which quite often the producer himself tranforms into high fructose syrup, dextrose monohydrate and sorbitol.

Process Flow Diagram for Dextrose Syrup

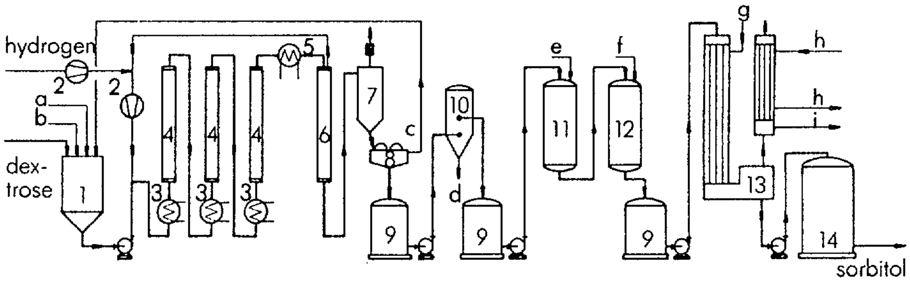


1 starch milk tank	7 tanks	a α-amylase	f activated carbon
2 heat exchanger	8 cation-exchanger	b amyloglucosidase	g steam
3 preliquefaction	9 anion-exchanger	c NaOH	h cooling water
4 liquefaction tank	10 candle filter	d HCl	i vapour condensate
5 saccharification tank	11 evaporator	e filter aid	
6 filter	12 product tank		

Examples for the Different Production Plants

Designation	Dimensions or Quantities	*Final Products* Glucose Syrup	Special Glucose Syrup	Dextrose Syrup	Sorbitol
Capacity min. approx.	t/d	5–10 t/d batch wise 10 t/d continuously	5–10 t/d batch wise 10 t/d continuously	5 t/d	5 t/d continuously
working time	h/d	24	24	24	24
Production equipment for process plants	see process flow diagrams				
Production material	kg per 1,000 kg DS final product	refined starch 1,000 kg DS	refined starch 1,000 kg DS	refined starch 967 kg DS	dextrose syrup 1.05 kg DS
Chemical and other additives	kg per 1,000 kg final product based on DS	Batch / Cont. HCl (30%) 7 / 7 Na_2CO_3 (100%) 2.5 / 2.5 filter aid 6 / 6 activated carbon 6 / 6 $NaHSO_3$ – / 0.18	Batch / Cont. 7 / 7 2.5 / 2.5 6 / 6 6 / 6 – / 0.18	-amylase 0.6 amyloglucosidase 0.8 NaOH 4 HCl (30%) 6 filter aid 3 activated carbon 3	catalyst 8.5 NH_3 3–4 HCl (30%) 38 NaOH 17 hydrogen H_2m^3 134
Approx. FOB price for the process plants	US$	5 t/d batch 0.7 Mill. 10 t/d cont. 0.9 Mill.		5 t/d 74% DS 1.0 Mill.	15 t/d cont. 70% DS 1.8 Mill.
Utilities for main production plants:	based on 1,000 kg DS	Batch / Cont.	Batch / Cont.		
Electrical power	kWh	120 / 70	120 / 70	110	155
Steam bar	kg/h	8 bars 1,000 / 1,200	1,000 / 1,200	10 bars 600	12 bars 3,200
Process water	m^3/h	0.25 / 0.25	0.25 / 0.25	1.2	2.8
Cooling water via cooling tower	m^3h	0.6 / 1.4	0.6 / 1.4	2.5	4
Manpower requirements	per shift	Batch / Cont.	Batch / Cont.		
Chemist		1 / 1	1 / 1	2	1
Foreman		1 / 1	1 / 1	2	1
Workers skilled		2 / 3	2 / 3	4	2
Workers skilled		4 / 4		6	2
Laborant		2 / 2		3	1
Space requirement (main prod. + aux. plants)	m^2	480 / 600 ÷800	480 / 600 ÷800	2,400	at 10–30 t/d production 1,200
Open area	m^2	depending on storage possibilities			

Process flow Diagram for Sorbitol



1 feed tank
2 HP-compressor
3 HP-heat exchanger
4 HP-reactor
5 HP-cooler
6 HP-gas/sorbitol separator
7 LP-gas/sorbitol separator
8 separator catalyst/sorbitol
9 tank
10 candle filter
11 cation-exchanger
12 anion-exchanger
13 evaporator
14 product tank

a catalyst
b NH_3
c recycled catalyst
d non-active catalyst
e HCl
f NaOH
g steam
h cooling water
i vapour condensate

This intermediate should contain a very high percentage of glucose and the least possible amount of other saccharides; this can be achieved by using enzymes specifically breaking the starch molecule in both liquefaction and saccharification.

Usually, starch liquefaction proceeds in two stages in the presence of thermostable alpha-amylase. In this case, part of the enzymes is added to the starch milk, and the starch is preliquefied in a steam-heated converter. Liquefaction to the required DE of approx. 12 then proceeds in a retention zone at a temperature of 95°C for a period of 90 to 120 minutes.

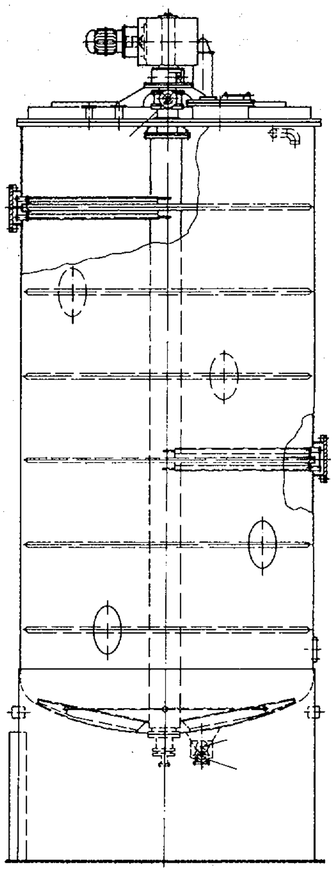
Starch liquefaction is followed by saccharification in the presence of amyloglucosidase. Saccharification is a slow process which takes about 48 to 72 hours. A larger amount of enzymes reduces the reaction period. Saccharification takes place in tandem-arranged tanks ensuring a continous flow. Prior to saccharification, the hydrolysate has to be cooled to approx. 60°C and set to a pH of 4.5.

This is followed by multi-stage purification of the thin dextrose juice to give the required product quality. The purification process comprises: separation of insolubles such as protein, fat, etc., decolourization with the aid of activated carbon, and elimination of all salts in ion exchangers. Finally, the demineralized product is evaporated in a multi-effect evaporator plant to the degree of concentration required for further processing.

4. Sorbitol

Sorbitol is a hexahydric alcohol (sugar alcohol) and is a resultant product of dextrose. It is available in liquid form containing 70% dry substance and in solid form (granular or powdered).

In the food industry sorbitol is used as a substitute of sugar for diabetics' food. Today sorbitol is the only raw material that permits econom-



Continuous Dextrose Crystallizer

ical production of ascorbic acid (vitamin C). In the cosmetics industry it is an essential consistency-stabilizing constituent of toothpastes and creams. Moreover, sorbitol is used for tobaccos and in the chemical industry for plastics, resins, adhesives and plasticizers (paper, leather, textiles).

Sorbitol is produced by catalytic hydrogenation of dextrose (glucose) at an increased temperature by the following empirical formula:

$$C_6H_{12}O_6 + H_2 \xrightarrow{\text{catalyst}} C_6H_8(OH)_6$$

For sorbitol production a continuous high-pressure hydrogenation process is applied, proceeding at 150 bar and 180°C, its special Raney nickel catalyst being continuously separated from the sorbitol solution after hydrogenation and being recycled.

After hydrogen removal, the sorbitol/catalyst mixture is reduced to normal pressure and the catalyst is separated from the sorbitol in such a way that the active particles only are recycled for re-use. The inactive particles are filtered off and can be regenerated.

The sorbitol is decolourized and demineralized in ion exchangers and then evaporated to a dry substance content of 70%.

Dry sorbitol can be produced from liquid sorbitol either by crystallization or by drying.

Either dextrose monohydrate dissolved in water or dextrose syrup may be used as a starting material. The syrup is mixed with the recycled catalyst and pumped into the high-pressure hydrogenation reactor with hydrogen gas being added at the same time. The heating and reaction processes proceed in several steps in order to prevent side reactions. When hydrogenation is finished, the mixture is cooled and the hydrogen gas is separated from the sorbitol/catalyst mixture.

Since the hydrogenation process requires hydrogen, this hydrogen has to be produced by electrolysis of water or has to be made available from another process source. A compressor keeps this gas and the recycled hydrogen at an operating pressure of 150 bar.

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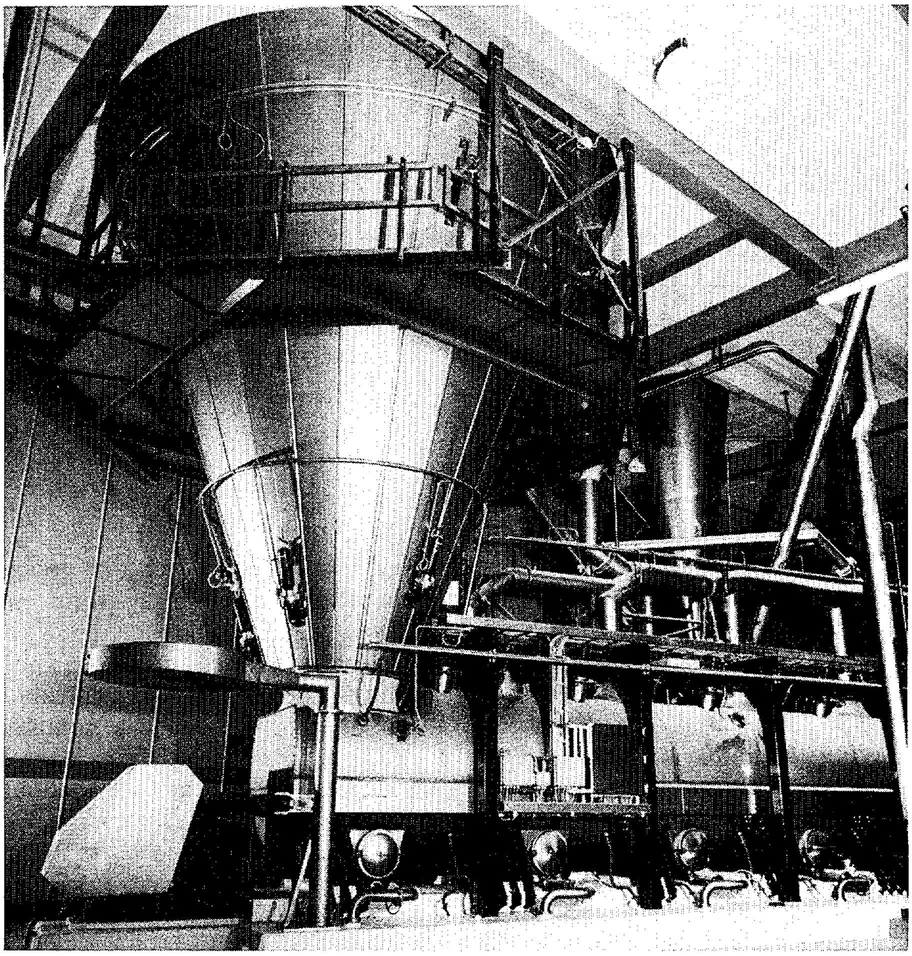
How To Start Manufacturing Industries

Milk Powder Production



Introduction

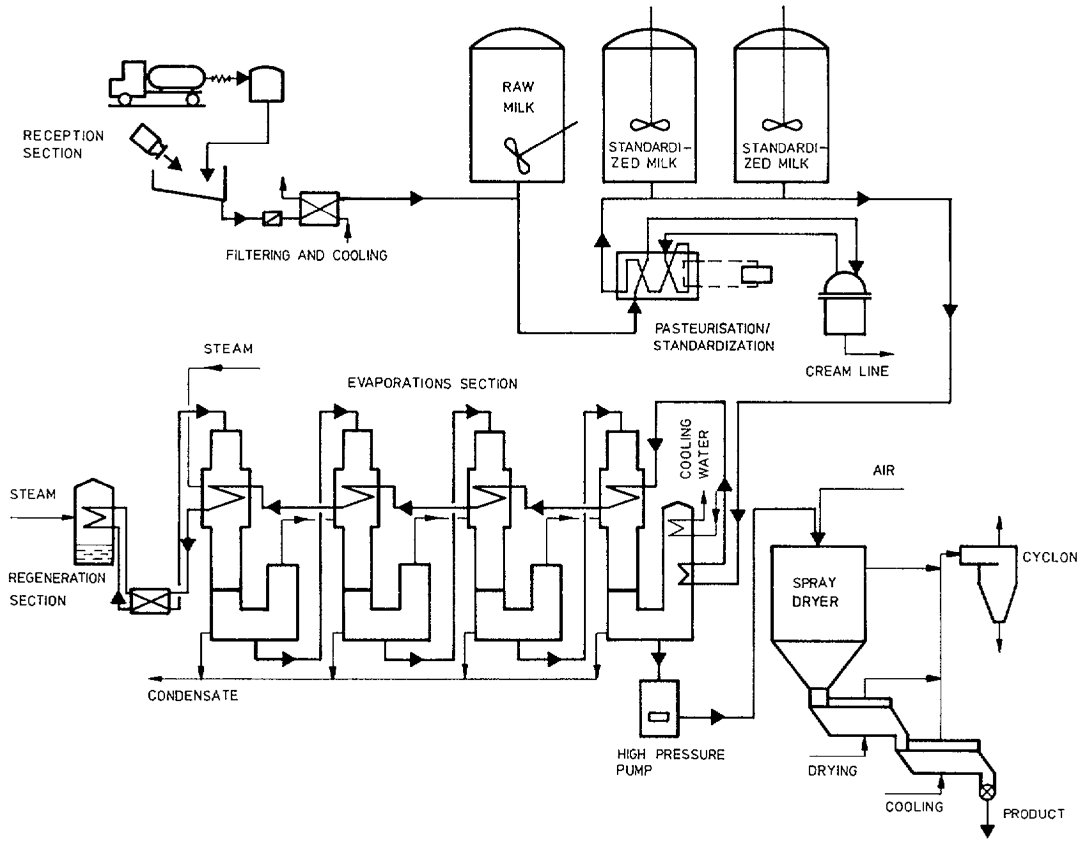
Milk powder contains all those components that make natural untreated milk such a "classic" for a healthy nutrition – proteins, carbohydrates, mineral salts. The production of milk powder offers a chain of advantages: the volume of the milk is reduced by which handling becomes much easier. That goes for milk powder being used as raw material in the industry as well as an additive to food in the ordinary household. Furthermore, when it is properly stored it keeps its quality for a nearly unlimited time.

The plant described here has a capacity of 1.2 t/hr milk powder. The fresh milk required for the process can be supplied either in cans or by road tankers.

Description of the Production Process

The plant is designed for both the reception of milk in cans as well as in road tankers. After reception, the milk is filtered and cooled down to 6 °C and stored in a raw milk storage tank. The milk, transported to the plant by means of road tankers is additionaly pulled through a degaser to remove air from the milk.

Process Flow Diagram



After completing the daily reception of milk, the reception system – as well as the following process steps – has to be cleaned. For this purpose a "Cleaning-In-Place Kitchen" is provided from where all equipment and product piping can be cleaned with caustic and acid solutions. From the storage tank the milk is transferred to the first section of a pasteurizer, to give the product the required temperature for standardizing and clarifying. The standardized milk is now returned to the pasteurizer for pasteurization and recooling. The product cooled to 6 °C is then stored in storage silos. On request sugar can be added to the silos. The silos are provided with high energy mixers to ensure that the sugar will be completely dissolved. By a transfer pump the standardized milk is then fed through preheaters, a regeneration section and a pasteurizer to the first effect of a four-effect falling film evaporator. In this section the milk is concentrated to 47% total solid or, when sugar is added, to about 52.5% t.s.

The concentrate is then filtered and by a high-pressure pump transferred to the atomizer nozzles of the spray dryer. The concentrate is atomized into hot drying air. The hot air evaporates the water contained in the atomized concentrate. The milk powder leaves the spray dryer to a two-stage fluid bed drying and cooling unit for the final drying. Between the two stages of the drying and cooling unit a lecithine dosing system is provided. The lecithine gives the milk powder the instant quality.

From the dryer and cooler the milk powder is conveyed to a packaging section. The milk powder is then packed by a volumetric-type filling machine into polyethylene bags or cans according to the requirement of the market.

Example of the Plant

Required Machinery and Equipment

Item	*Description*
1	Milk reception for milk cans
2	Milk reception for road tankers
3	Standardizing / skimming and pasteurization section
4	Evaporation section
5	Spray dryer
6	Shaking fluid beds
7	Cleaning in place kitchen
8	Packaging section
9	Piping and insulation
10	Instrumentation
11	Control panel
	FOB-price for machinery and equipment approx. US$ 4,000,000.00

Required Buildings

Production building (including storage and laboratory)	41 m × 18 m × 26 m
Administration building	12 m × 9 m × 3 m

Required Manpower

Management and administration	4
Technical factory manager engineer	1
Foremen	2
Skilled workers	4
Quality control	1
Mechanic technician for maintenance	1
Electrician for maintenance	1
Helpers	4
	18

Required Power and Utilities

1	Electrical power	195 kW
2	Steam	3,560 kg/hr
	Pressure	7.5 bar
3	Icewater closed system	47,550 kg/hr
	Temperature	3 °C
4	Warm water closed system	18,400 kg/hr
	Temperature	80 °C
5	Cooling water closed system	12,000 kg/hr
6	Compressed air	30 cu.m
	Pressure	7 bar

Technical Data

Raw material	12,500 kg/hr whole milk
Product	approx. 1,200 kg/hr milk powder

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How To Start Manufacturing Industries

Pineapple Processing and Canning

Introduction

Pineapples are an important export product in many countries and well liked as a delicacy in those countries that do not have a warm climate the year round and therefore are less fortunate in their fruit-supply. Pineapples are a favourite fruit anywhere and appreciated in many ways: for desserts, fruit salads, in cakes, certain dishes, dried and candied and as stimulating drinks.

The first commercial culture of pineapples began about 1850 on the Azores which still are one of the main producers of fresh fruits. Commercial canning was started in Florida, USA, in 1871, but the first real development along the line was in Malaya in 1898. Today 90 per cent of the total pineapple production is available on the market as canned fruit.

Description of the Production Process

The raw pineapples are unloaded into the washing basin and washed on the roll conveyor by means of a spraying system, to be picked up by the discharging elevator. There they are sprayed again and subsequently transported to the pineapple grader. They are calibrated according to sizes and subsequently fall on to conveyor belts.

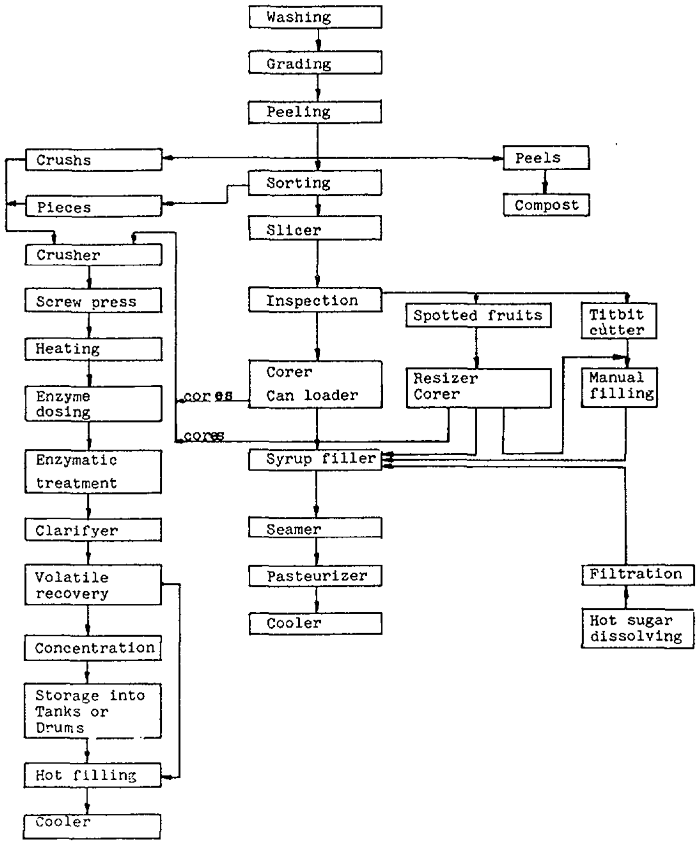
From this conveying system, the pineapples are conducted by chutes into the automatic pineapple peeler where the fruit peels are scraped out, with waste being removed by a belt conveyor. The fruit parts and the juice are transported to the juice line.

On the picking and sorting belts the peeled pineapple cylinders are inspected and cut into slices. The slices emerging from the slicing machine are picked again and sorted. The clean fruits are manually led to the coring and can-loading machine, while the spotted slices are manually taken to the resizer/corer/cutter machine on the opposite side of the belt and, if required, cut into pieces.

The slices are filled into cans. The filled cans are transported to the vacuums syruper and placed there on the feeding conveyor to be filled up with sugar solution and closed under vacuum and pasteurized.

If desired, the slices can be processed to titbits and canned in a special titbit filling line. The pineapple cores are conducted to the milling unit by means of a conveyor belt together with the crushed fruit parts and the juice from the peelers. After milling the mash is collected in a preliminary juice extraction vessel. The juice is pumped to the entry vessel of the tubular heater and cooler. The mash ismechanically pressed and the resulting juice collected in the entry vessel. From here, the juice flows to the tubular heater and is heated up to 90 °C for sterilizing purposes, then cooled down to 45 °C and treated enzymatically to reduce the pectine content. The treated juice is precleared by means of a centrifuge and conveyed to the concentration plant where it is concentrated to the final density required, normally 65° Brix. The concentrate is stored in tanks or shipped in drums.

Process Flow Diagram



Example of the Plant

Capacity:

Output abt. 4.5 t/h slices
abt. 3 t/h titbits
abt. 3 t/h juice

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Washing and Preparation	
	channel system for unloading and washing of pineapples	1
	discharging elevator	1
	graders	2
	belt conveyors	5
	chutes	2
	pineapple peelers	2
2	Slice line	
	single knife slicers	2
	corer and can loaders	4
	resizer/corer	2
	canloaders	2
	piece cutting machines	4
	vacuum filling machines	2
	seaming machines	2
	tunnel pasteurizers/coolers	2
	can dryers	2
	belt conveyors	3
3	Titbit line	
	rotary vibratory filling machine	1
	vacuum filling machine	1
	seaming machine	1
	tunnel pasteurizer/cooler	1
	can dryer	1
	belt conveyors	2
4	Juice line	
	desintegrator	1
	vessels	3
	pumps	3
	packing press	1
	tubular pre-heater	1
	separator	1
	vacuum filling machine	1
	seaming machine	1
	tunnel pasteurizer/cooler	1
	can dryer	1
	belt conveyors	2
5	Syrup line	1
6	Labelling and packing line	1
	FOB-price for machinery and equipment approx.	US$ 3,500,000.00

Required Area

Production building	1,700 sq.m
Storage	800 sq.m
Facilities	500 sq.m
	3,000 sq.m

Required Manpower

Management and administration	8
Foremen	4
Skilled workers	12
Unskilled workers	54
	78

Required Power and Utilities

1.	Electrical power AC 380 V, 50 c/s, 3-phase	abt. 350 kW
2.	Cooling-washing water	abt. 50 cu.m/h
3.	Processing water	abt. 12 cu.m/h

Required Raw Materials

1.	Fresh pineapple	15 t/h
2.	Cans	
	a) slices (can sizes 84–115 mm)	5,100 cans/h
	b) titbits (can sizes 99–119 mm)	5,625 cans/h
	c) juice (can sizes 84–115 mm)	5,625 cans/h
3.	Sugar	
	a) slices	266 kg/h
	b) titbits	440 kg/h

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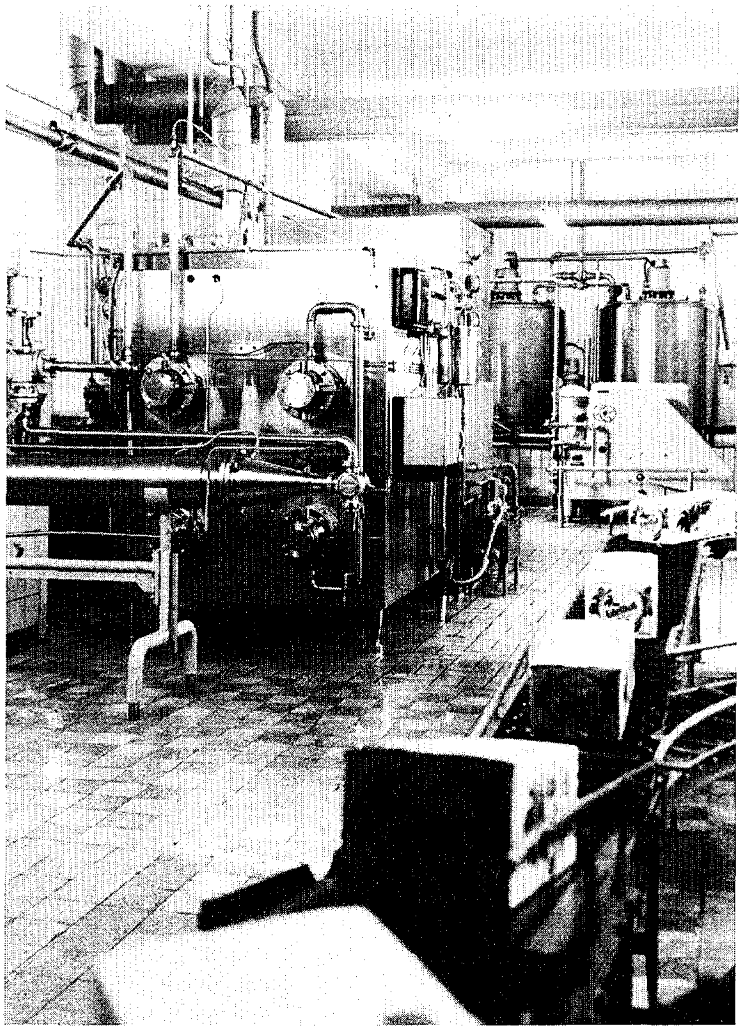
File: A 47
ISIC CODE 3115

How To Start Manufacturing Industries

Margarine



Introduction

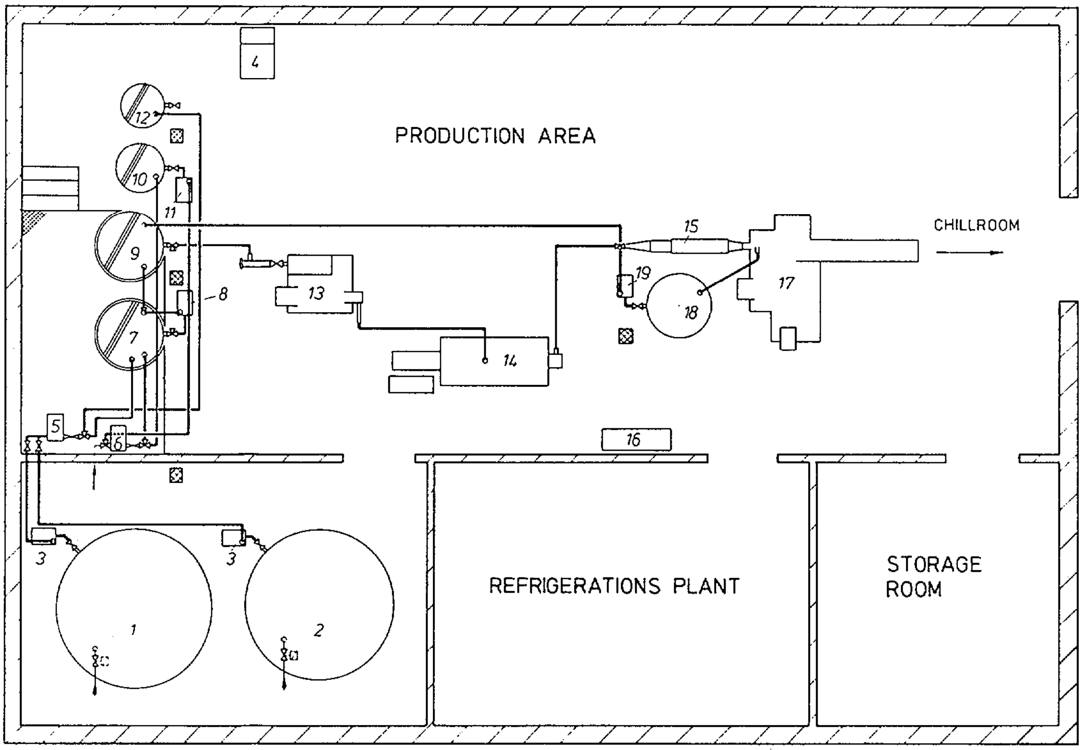
In the course of the past 50 years margarine has been developing steadily into a nutrient fat of high dietetic value that in many cases is even preferable to butter. It is spreadable, an emulsion of certain oils and fats. For oil, soya oil, cotton-seed oil, sunflower oil or peanut oil are the main ingredients; cocoa fat, palmoil or palm-kernel fat the main fats. Apart from these vegetable raw materials, high-value oils from mammals or fish can also be used for the production.

Margarine contains polyunsaturated fats which contribute to the reduction of the cholesterine level thus also reducing the risk of degeneration of arteries and coronary vessels, which is one of the main reasons for heart-attacks and apoplexy of the brain.

Hence margarine also has become an important component of a healthy diet increasing its appeal to all those who want 'to lead a healthy life'.

The described plant has been designed for the production of table margarine with a capacity of 500 kg/hour.

Layout of the Production Plant



Description of the Production Process

Oils and fats in the required quantities are conveyed from the storage tanks 1+2 via the volumetric meter 5 into the stirring vessels by means of centrifugal pumps 3. Whilst in the stirring vessel 7 the margarine consisting of oil, hydrogenated fats, emulsifier, lecithin, water, salt and other ingredients, is formed. The stirring vessel 9 is used as buffer vessel. The emulsifier/lecithin phase is formed in the stirring vessel 12 and manually led to the stirring vessel 7. The water/salt phase is formed in the stirring vessel 10. The necessary water quantity for the batch is added via the volumetric meter 6. By means of the centrifugal pump 11 and again via the volumetric meter 6 the water/salt phase is led into the stirring vessel 7. Until the margarine emulsion is pumped into the buffer vessel 9 by means of the centrifugal pump 8, the emulsion is kept circulating in the stirring vessel 7 by the same pump to guarantee a steady and continuous mixing procedure.

A gear pump 13 pumps the margarine emulsion to the Kombinator. This Kombinator is a permanently operating heat-exchanger in which internally rotating knives keep on scraping the product from a cylindrical heat transmission surface. From the Kombinator the product is conveyed via the resting implement 15 to the packing station 17.

In case of any faults in the production the margarine can be conveyed to the remelting vessel 18 to be liquefied again and conveyed back to the buffer vessel 9 by the centrifugal pump 19.

In the packing station the final product is automatically filled into the containers.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Storage tank, heatable	1
2	Storage tank, non heatable	1
3	Centrifugal pumps	2
4	Balance for ingredients	1
5	Volumetric meter (heatable)	1
6	Volumetric meter (non heatable)	1
7	Fat blend tank (mixing)	1
8	Centrifugal pump	1
9	Fat blend tank (buffering)	1
10	Stirring vessel	1
11	Centrifugal pump	1
12	Stirring vessel	1
13	Gear pump	1
14	Kombinator	1
15	Resting implement	1
16	Electrical control panel	1
17	Packing machine for cups	1
18	Remelting vessel	1
19	Centrifugal pump	1
20	Refrigeration plant for Kombinator	1
21	Refrigeration plant for the cooling chamber	1
22	Piping system	1
	FOB-price for machinery and equipment approx.	US$ 450,000.00

Required Area

Production building	150 sq.m
Cold storage building	100 sq.m
Facilities	100 sq.m
	350 sq.m

Required Power and Utilities

1.	Electrical Power	55 kW
2.	Steam	250 kg/h at 10 bar
3.	Water	1 cu.m/h

Required Manpower

Management and administration	4
Technical manager engineer	1
Foremen	2
Skilled workers	3
Quality control	1
Mechanic technician for maintenance	1
Eletrician for maintenance	1
Helpers	5
	18

Required Raw Material

Base recipe margarine	
Oils and fats (separated or composition)	78–80%
Emulsifier	0.3%
Lecithin	0.2%
Beta carotene	0.1%
Salt	0.5%
Sorbic acid	0.15–0.3%
H_2O	16–20%

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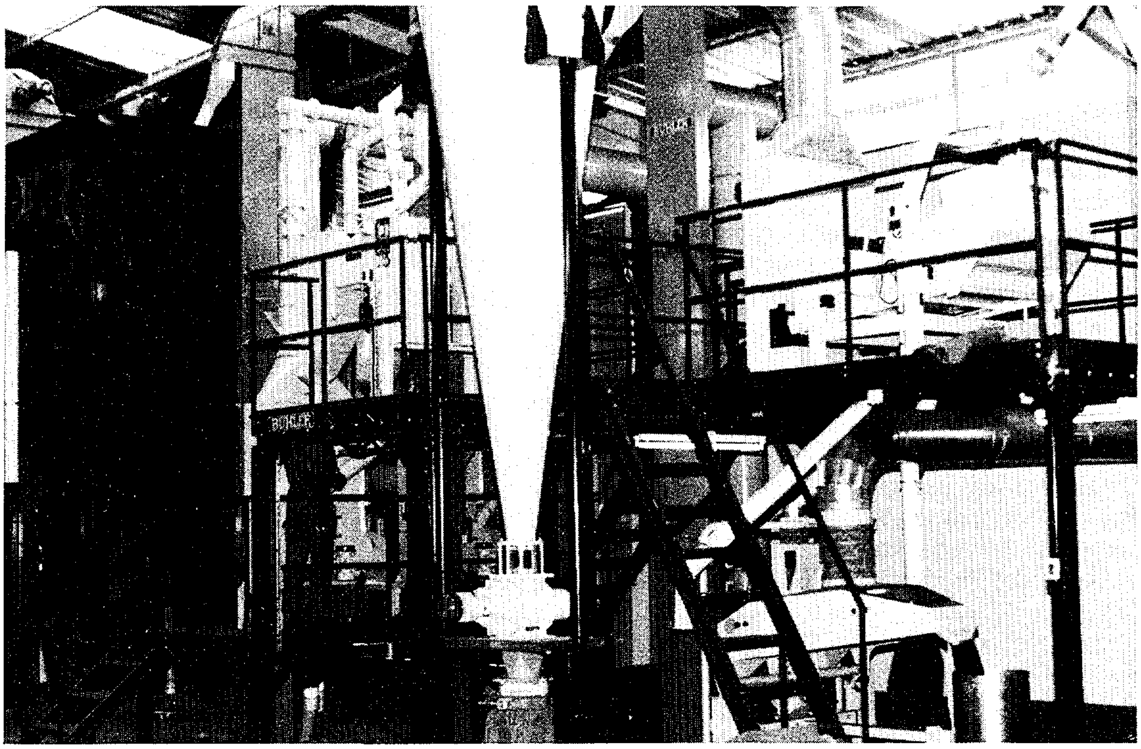
How To Start Manufacturing Industries

Coffee Processing



Introduction

Generally coffee processing is separated into processing in the producer countries and processing in the consumer countries. In the producing countries the coffee is grown and prepared for export as green coffee beans. Two procedures are in use: the "wet process" and the "dry process". Their application depends on local customs and availability of water. It also depends on the variety of coffee grown, i.e. whether Arabica or Robusta coffee is to be processed.

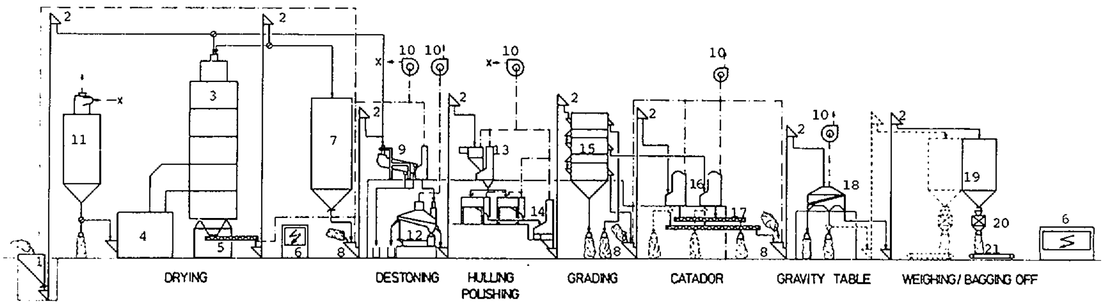
In the consumer countries the green coffee beans usually arrive in bags and are then processed into instant coffee which is filled in glasses with screw-tops or into roast coffee beans or ground roast coffee filled in bags of various sizes.

The enclosed plant example shows the processing of Robusta coffee cherries (dry process) into green coffee beans in a producer country. The plant has a capacity of approx. 2 t/h green coffee.

Description of the Production Process

The bags containing parchment coffee are opened by hand. The contents are fed to an intake hopper with dosing and conveyed via a bucket elevator to a drier which is supplied with hot air by a hot air generator burning parchments husk, wood, oil or other materials. The parchment coffee flow through the drier can be controlled by a discharge screw conveyor. The entire drier group is supervised by an electric control panel. An elevator lifts the product

Process Flow Diagram



either for re-circulation or into the intermediate silo, from which the coffee can be fed to an elevator which takes it to the cleaner elevator. There the coarse or fine impurities (lumps or sand) are removed and collected. The attached separation channel separates all kinds of light-weight particles such as husks, strings and dust. Fans blow them to the husk silo where the air is separated by a cyclone. The husks may be bagged off or automatically fed into the burner of the hot-air generator.

The cleaned parchment is destoned in the destoner – an important step in coffee-processing. A fan ensures dust-free operation.

Clean, destoned parchment is elevated and fed into the low temperature impact huller and polisher with attached husk separators for the removal of hulls. The husks are blown to the silo by a fan.

The raw green coffee passes an elevator and a grading system composed of a flat screen grader or drum sieve for accurate classifying by size.

Compact catadors separate the defective, infested or broken beans. Direct feeding from the sieve is the ordinary way of operation; however the catadors can also be fed by hand. A fan is installed to ensure dust-free and efficient operation.

Screw-conveyors collect beans and feed them by elevator into a gravity separator for the separation of light-weight or unhulled beans. A fan aspirates the gravity separator.

The finished green coffee is lifted by a bucket-elevator and taken to the intermediate silo. Finally it is weighed and bagged.

The whole plant is controlled by a central main control panel.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1.	Intake Hopper	1
2.	Bucket Elevator	8
3.	Dryer	1
4.	Hot Air Generator	1
5.	Discharge Screw Conveyor	1
6.	Electric Control Panel	2
7.	Intermediate Silo	1
8.	Feed Hopper	3
9.	Cleaner Separator	1
10.	Fan	5
11.	Husk Separator and Silo	1
12.	Destoner	1
13.	Parchment Huller/Separator	1
14.	Polisher/Separator	1
15.	Grader	1
16.	Catador	2
17.	Screw Conveyor	2
18.	Gravity Table	1
19.	Storage Bin	1
20.	Bagging-off Scale	1
21.	Belt	1
	FOB-price for machinery and equipment approx.	US$ 820,000.00

Required Buildings

Production building	400 sq.m
Storage building	600 sq.m
Facilities	400 sq.m

Required Manpower

Management and Administration	6
Supervisors, Foremen, Specialists	8
Quality control	2
Workers	20
	36

Required Energy		Raw Material and Product Data	
Electricity	150 kW	100% Green Coffee Cherries	66–70% H_2O
Fuel Parchment Husks	200 kg/h	95% Red Coffee Cheries	60–65% H_2O
or Cherry Husks	200 kg/h	37% Dry Cherries black	
or Oil	80 kg/h	18% Raw Green Coffee	
		16.5% Clean Green Coffee	

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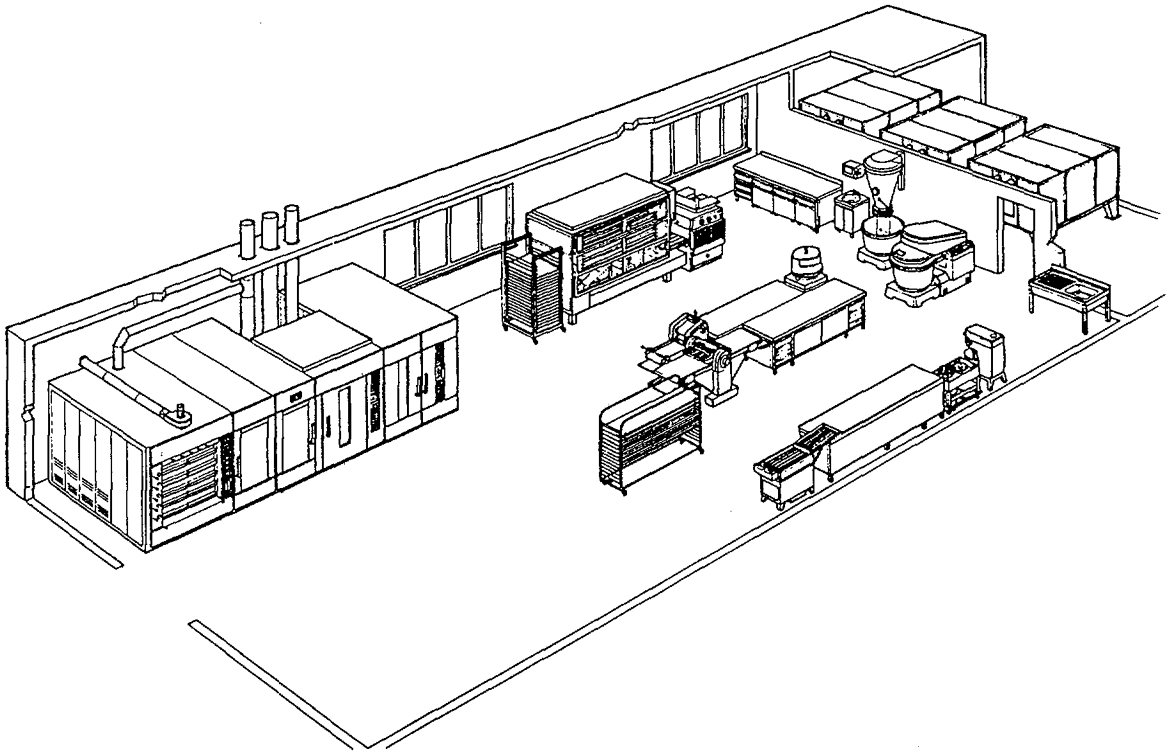
File: A 49
ISIC CODE 3117

How To Start Manufacturing Industries

Bread and Confectionery



Introduction

From the early times of mankind bread has been a basic food in many parts of the world. When people started to turn their backs to labourious farmlife and started instead life in settlements that were to develop into cities, it was the baker's trade that provided them with bread. Nowadays the manufacture of various sorts of bread – there are more than 200 sorts of bread available on the market in Germany for instance – is only one of the activities in a modern bakery, and the manufacture of confectionery is just as important.

To produce high-quality products in great numbers at costs as low as possible, is a maxim that nowadays also applies to a craftman's business. Prerequisites are that the machinery he uses is adapted to his market's requirements and that the sequence of manufacture is economical. The bakery described in this paper is laid out to manufacture both various sorts of bread and confectionery, as is shown at the examples of Danish pastry and French baguettes.

Process Description

Production of Baguettes

From a storage silo, flour is conveyed to a spiral mixer. Simultaneously salt, yeast, malt and water are added. These ingredients have been weighed manually. The spiral mixer operates in two phases. In the first phase the ingredients are mixed. In the second phase, the spiral mixer operates at high speed, the dough is warmed and air worked in. These procedures take about 2 + 6 minutes.

Now the dough must undergo a rest-pause of approx. 15 minutes. The rest-pause over, the baguettes are weighed and pre-shaped. The final backing-shape of the dough-pieces is achieved in the French stick moulder. The next step is the fermentation of the dough-pieces. The average fermentation period in the so-called proofer at a relative air-humidity of 75% is approx. 45 minutes. Simultaneously with this procedure, the oven must have reached the baking temperature of 230 °C, since the dough-pieces must be baked rightaway after the fermentation. When the pieces are put into the oven, steam is blown in to prevent the crust from getting too hard and dark. After a baking time of approx. 30 minutes the baguettes are finished and ready for sale.

Danish Pastry

The dough is made in a way similar to the dough for baguettes. The main ingredients are sugar, salt, water and flour. When the batch has left the spiral mixer, it must rest for approx. 15 minutes. The next step is to add butter to the dough by means of the rolling-out device, whereby a multiple-layer formation dough – butter is achieved. This is periodically interrupted by rest-pauses. The aim is the fermentation of the dough and to make the pastry light.

Finally the dough can be cut into pieces and filled with cottage cheese, fruit, jam, nut or seed fillings, even with sausages or cheese, according to the customers' likings. After an average 20 minutes' baking time at a temperature of 220 °C and the application of icing, the Danish pastry is ready for sale.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Multi-deck backing oven	1
2	Proofer unit	1
3	Spiral mixer	1
4	Dividing and moulding machine	1
5	Working table	1
6	Trolleys	3
7	French stick moulder	1
8	Dough scale	1
9	Varimixer	1
10	Pastry brake	1
11	Bread slicing machine	1
12	Hot air baking oven	1
	FOB-price for machinery and equipment approx.	US$ 150,000.00

Required Building

Raw material storage	15 sq.m
Bakery production area	53 sq.m
Packing and dispatch area	15 sq.m
Shop	9 sq.m
Facilities	5 sq.m

Required Manpower

Skilled baker	1
Assistant in dough handling section	1
Assistant in proofing and baking section	1
Assistant for various types of bread	1
	4

Required energy	16.2 kW
Fuel oil for baking oven	231,000 kJ

Production Data (Example)

Bread Specification		Sand-wich	Samuly	Baguette
Weight				
Dough-weight	g	75	180	320
Bread-weight	g	60	150	250
Dimensions				
Diameter ∅	mm	40	60	60
Length	mm	130	240	550
Production Data				
Kneading time	min.	12	12	15
Dough-rest	min.	30	30	30
Intermediate-proof	min.	10	10	10
Final proof	min.	50	50	50
Baking time	min.	15	20	25
Capacity in 8 hours				
Bread	kg	737	768	512

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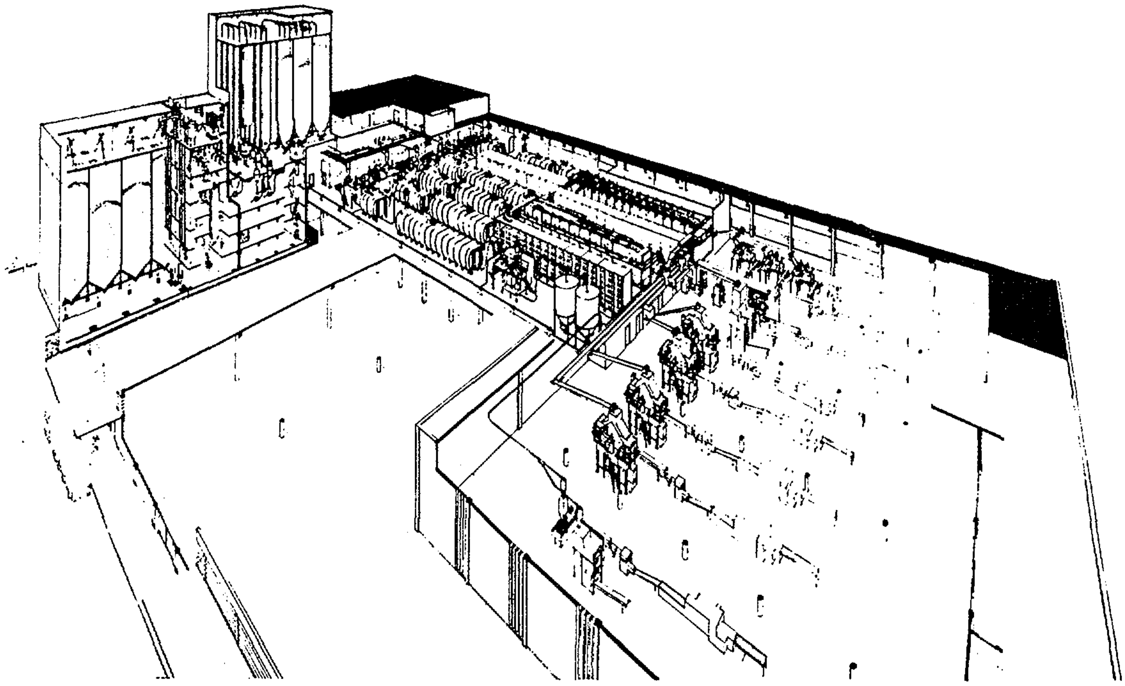
File: A 50
ISIC CODE 3117

How To Start Manufacturing Industries

Pasta Production



Introduction

Pasta can best be defined as the generic term for a class of products made by forming unleavened dough into a variety of shapes and drying them from 28–30% to 12–13% moisture.

Pasta products have been known in Europe for a long time but are also popular now in the United States, South America and other countries. Today, there are more than 250 types of pasta products of various shapes and sizes on the world market. In some countries such as Italy, pasta products have become a staple food. Pasta can be used as a side dish instead of rice or potatoes or as a main course e. g. spaghetti.

While Italy is the country in which pasta products have attained their greatest popularity, it appears that their manufacture and use may have originated in China.

It was in the 12th century that the Italians first made pasta. The climate of Italy, especially in the vicinity of Naples, was ideal for the drying of the product as well as for the cultivation of the hard wheat from which the raw material, the semolina, is milled. This combination was responsible for producing rich and tasty pasta.

Real industrial production of "pasta" is relatively new, but has developed in the past few decades to a highly sophisticated, technical industry. The introduction of the continuous operating screw extruders in the 1930's was the first giant step towards fully automated processing lines. First, hand-made products, then spindle presses and later large hydraulic driven piston presses were the steps to today's efficient and sanitary extruders, operating at capacities of 500 kg/hr up to 3,000 kg/hr.

Description of the Production Process

The basic raw materials are milled wheat products, such as semolina and flour, which are mixed with water into a homogeneous dough.

For special products, materials like eggs, proteins, vegetables, etc., can be added.

The raw material semolina is usually delivered by a mill and stored in silos, before it is pneumatically transported to the press.

The first machine in the manufacturing process is the press with doser, where solid and liquid raw materials are mixed together in the exact desired proportions. This mixture passes through a vacuum chamber, where the air is extracted in order to get a firm product, and is then extruded through a die at a pressure of approx. 120 bar and thus formed into shapes.

The next step is the drying process, where the extruded pasta is dried in stages from 28–30% coming out of the press to 12–13% final moisture. Because of the high drying temperatures, a cooling zone at the end of the drying line is necessary.

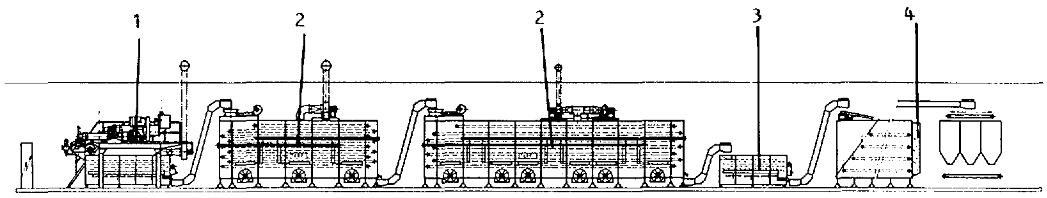
After drying, the finished products are usually stored before packing. Since the production lines are operating for 24 hours /day while packaging is normally only in operation for 8–16 hours, an intermediate storage is indispensable. The products are packed in bags or boxes, in some cases bulk for further use.

The basic technological process for all the pasta shapes is the same. However, the mechanical process is different and can be divided into three groups:

Short Goods

Short goods, such as elbows, noodles, short macaroni etc. are extruded through a round die and cut when leaving the die. They pass through a shaker-predryer first and are then dried in drum- or belt-dryers. The finished product is stored in silos or belt stackers.

Flow sheet: Short Goods Line

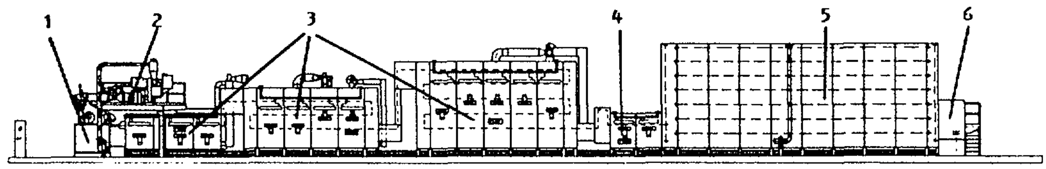


1 press
2 dryers
3 cooler
4 storage

Long Goods

Long goods, such as spaghetti, are extruded through a rectangular die. The extruded strands are automatically spread on sticks and cut to an even length. The loaded sticks pass through the dryers and into the stacker. When ready for packing the dry product is stripped off the sticks and cut into the desired length. In come cases, the product is stripped and cut after drying and stored in a bucket storage system.

Flow sheet: Long Goods Line



1 spreader
2 press
3 dryers
4 cooler
5 storage
6 stripper/cutter

Twisted Goods

Twisted goods or nests are extruded through a rectangular die. The extruded strands are shaped automatically into the twists or nests and placed on special trays, which then pass through dryers. After drying, the product slides off the tray and can be stored in a belt stacker.

Example of the Plant

Required Machinery and Equipment for the Production of 1 t/hr Short Goods

Item	*Description*
1	Raw material handling system raw material reception silos weighing and mixing device press-feeding regrind equipment
2	Short goods production line press dryer cooler storage
3	Packaging equipment
	FOB-price for machinery and equipment approx. US$ 1,440,000.00

Required Buildings and Areas

Production building	360 sq.m
Final product storage	120 sq.m
Raw material storage	90 sq.m
Laboratory	54 sq.m
Facilities	120 sq.m

Required Manpower

Administration	3
Foremen	2
Skilled workers	4
Unskilled workers	6
Laboratory	2
	17

Required Power and Utilities

Heating energy	240,000 kcal/hr
Electric energy	120 kW
Cooling energy	25,000 kcal/hr

Steam is only required during start-up and shut-down of the production line.

Required Raw Materials

Semolina or flour with a moisture of 15%	1,000 kg/hr
Drinking water	150 l/hr
Eggs	according to the regulations of each country

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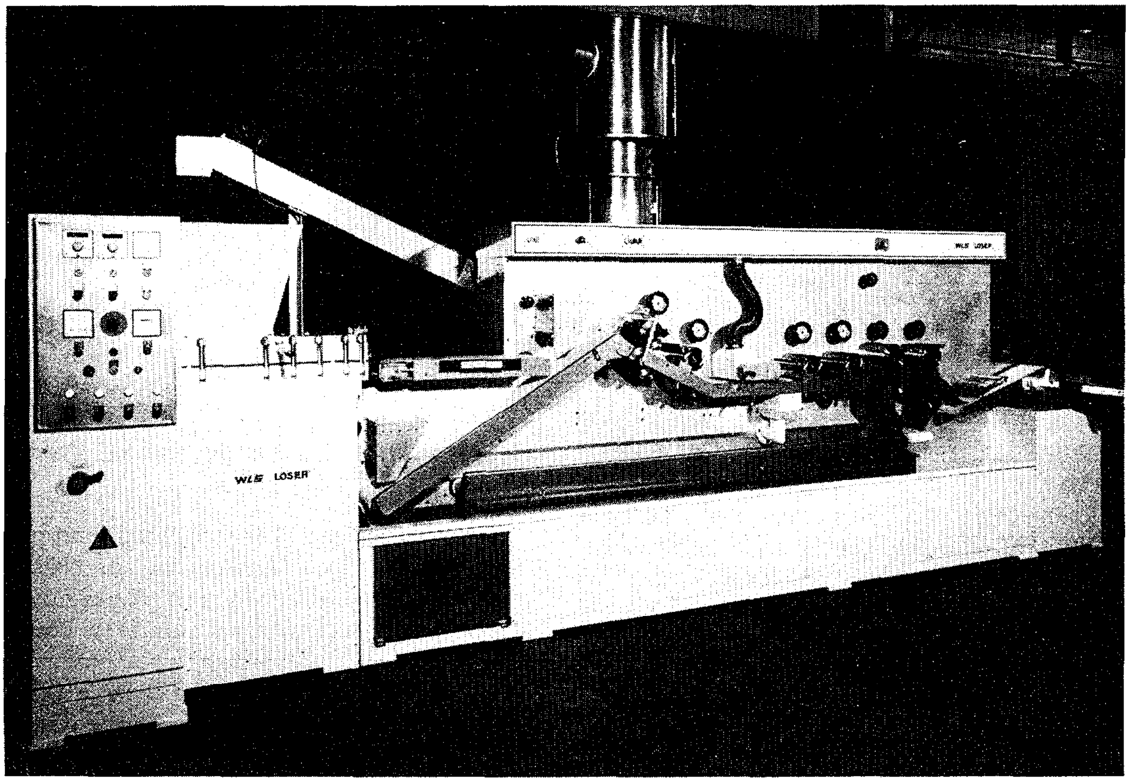
File: A 51
ISIC CODE 3119

How To Start Manufacturing Industries

Chewing Gum



Introduction

The production of chewing gum dates back as far as to the first years of the 19th century. The pioneers Thomas Adams and William Wrigly founded the first worthwhile industrial production in the second half of that century. Since then chewing gum has developed from a mere sweet to an article of manifold uses. Nowadays even dentists recommend sugar-free chewing gum and also use it as an anaesthetic for local pains. Pharmacy, too, offers chewing gum preparations on a sugar-free basis, for instance to the general relief from pain or for the treatment of oral inflammations or angina. Some products serve as an aid to a slimming diet, others are vitamin-carriers or enticing medicines for children.

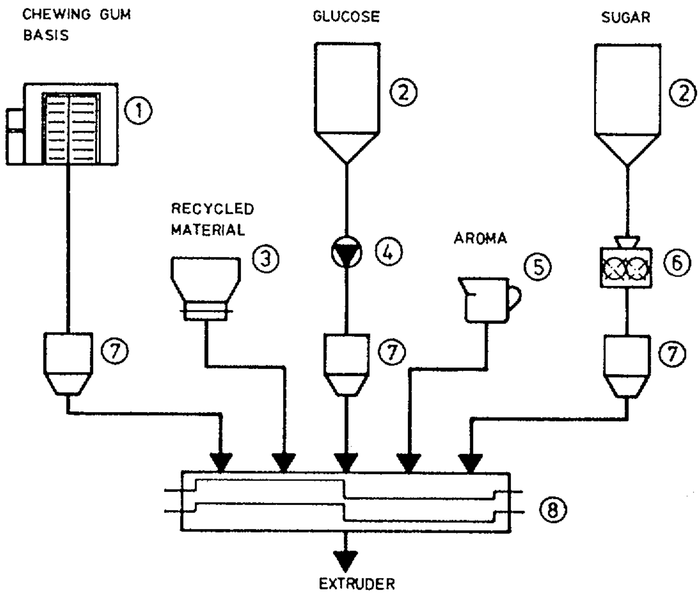
The plant described here is laid out for a capacity of 240–270 kg/hr stick-gum.

Process Description

Description of the Production of Chewing Gum Sticks

A kneading device takes approx. 20 minutes to mix and knead the preheated chewing gum base, glucose, powdered sugar and flavours. This mass is divided into portions which are conveyed to a pre-extruder. This device extrudes an endless strip of chewing gum which, cut into plates, is conveyed to another extruder via a conveying belt. While being transported, the product cools down and stabilizes. The second extruder discharges an endless strip which is powdered with powder-sugar on both sides. A roller system presses the powder-sugar onto the strip, and a second roller system reduces the thickness of the chewing gum strip.

Flow sheet: Production of Chewing Gum Mass



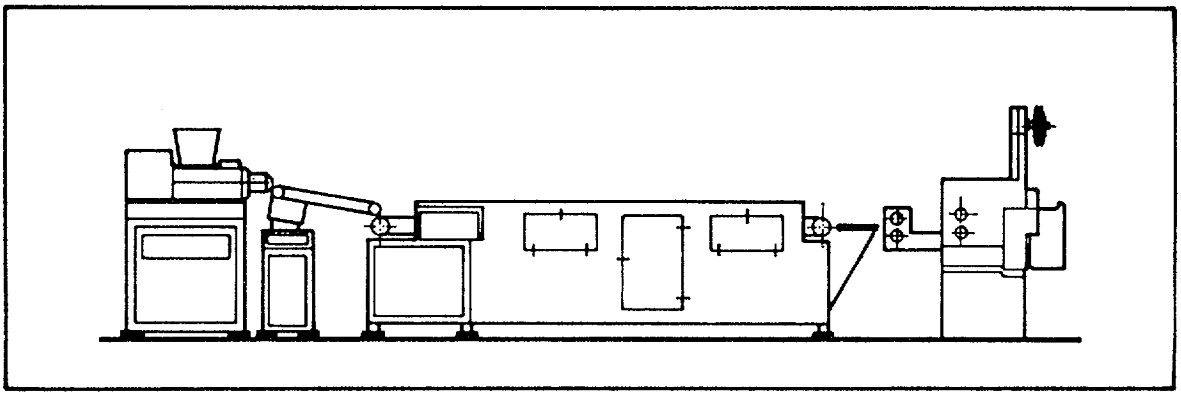
A brushing device removes the loose powder-sugar from the strip. This sugar is collected in bags by means of a suction device, and can be used again. The chewing gum strip passes two more roller stations to achieve its final thickness of 1.8 mm for sticks or 4 mm for chiclets. Longitudinal and transversal cutting rollers groove the strip and cut it into plates. The grooved plates are stacked on trays by means of a discharging device and stored for approx. 20 hours in air-conditioned rooms. A cutter cuts the chewing gum plates to size; then they are conveyed to the packaging unit.

Description of the Production of Bubble Gum

The preparation of the chewing gum mass follows exactly the same pattern as that of the sticks. The second production phase, however, is altogether different since this is a continuous process.

The extruder forms of the mass a thick rope the profile of which already has the form of the final product. The rope passes through a cooling tunnel. The cooled rope is led through a cut-and-wrap machine which sizes, egalizes, cuts it and packs or wraps the individual pieces.

Production line for Bubble Gum



Example of the Plant

Required Machinery and Equipment

Production of Stick Gum

Item	Description	Pieces
1	Sugar mill	1
2	Pre-heating cabinet for gum-base	1
3	Mixing and kneading machine	1
4	Automatic extruding, rolling and scoring machine	1
5	Dust-absorbing unit	1
6	Packaging machine	1
7	Trolleys, trays and tray carriages	misc.
	FOB-price for machinery and equipment approx.	US$ 575,000.00

Production of Bubble Gum

Item	Description	Pieces
1	Sugar mill	1
2	Pre-heating cabinet for gum base	1
3	Mixing and kneading machine	1
4	Extruder	1
5	Cooling tunnel	1
6	Cooling aggregate	1
7	Cutting and wrapping machine	1
	FOB-price for machinery and equipment approx.	US$ 425,000.00

Required Buildings and Areas

Administration	30 sq.m
Production	140 sq.m
Storage	60 sq.m

Required Manpower

Production of	*Stick gum*	*Bubble gum*
Manager	1	1
Secretary	1	1
Skilled workers	6	4
Helpers	4	3
	12	9

Required Power and Utilities

Production of	*Stick gum*	*Bubble gum*
1. Electrical power AC 380 V, 50 c/s, 3-phase	60 kW	80 kW
2. Cooling water consumption approx.	1.5 cu.m/hr	2.5 cu.m/hr
3. Compressed air consumption approx.	8 cu.m/hr	10 cu.m/hr

Standard Recipes	*Stick gum*	*Bubble gum*
Gum base	20%	17%
Powdered sugar	60%	60%
Glucose	19%	22%
Flavour	0.5%	0.5%
Other ingredients		
Glycerine	0.5%	0.25%
H_2O	–	0.25%

The recipes may vary if local taste and demand require it.

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How To Start Manufacturing Industries

Cocoa Processing and Chocolate

Introduction

Cocoa and chocolate are favourites all over the world and full of nutritional value. Obtained from cacao, a tree of the tropics, the cocoa-beans contain most of the substances required for human nutrition: approx. 50% fat, 20 to 25% carbohydrates, 15 to 20% proteins and the rest are moisture and certain minerals. Originally the cocoa was native to coastal Mexico, Central America and South America. Nowadays Ghana and Brazil are the largest cocoa-bean growers and exporters and the product is in large demand everywhere.

The described plant is of the smallest possible economical capacity. It processes 0.4–0.5 t/h of raw cocoa-beans and manufactures 1.0 t/h of finished milk and dark chocolate in proportion of 50 : 50%.

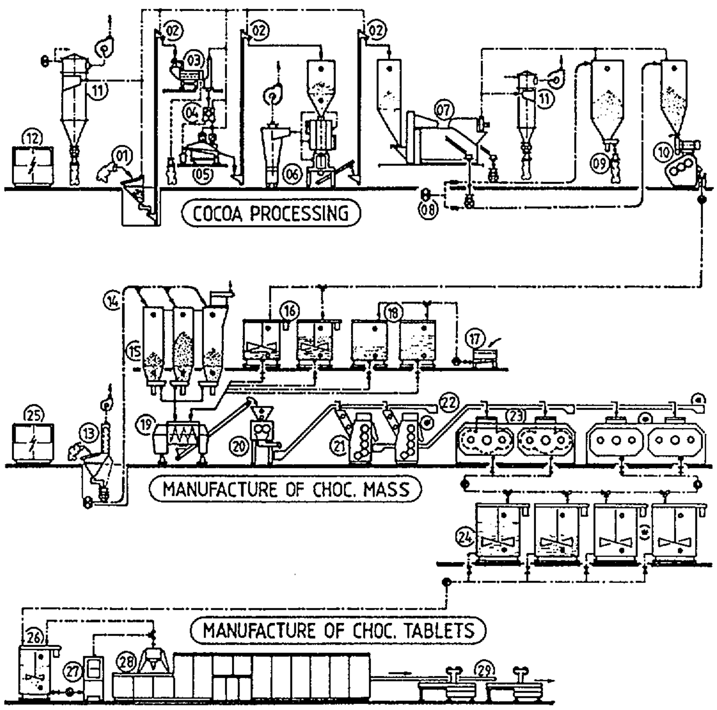
Process Description

A. Cocoa Processing

The cocoa-beans are fed to the cleaning equipment: the cleaner separator 03 to remove coarse and fine impurieties such as wood, sand etc., the aspiration channel 11 to separate light-weight particles such as shells, strings and dust, the magnetic apparatus 04 to remove iron parts and the dry destoner 05 to separate stones, glass etc. Via the pre-silo they reach the continuous roaster 06 with fresh air system and steam heating with a cyclone cleaning the exhaust air.

After having passed through another pre-silo, the winnowing silo, the substance is crushed and winnowed 07. A double pneumatic transport system 08 conveys the shells to a silo with discharge and bagging device 09, the nibs to the pre-hop-

Process Flow Diagram



per of the cocoa grinding unit 10 with pre-grinder, three-roll mills and liquefier. The resulting mass is pumped to two cocoa-mass storage tanks 16 above the chocolate mixer.

B. Manufacture of Chocolate Mass

Sugar and milk powder are fed to the three storage silos 15 equipped with dischargers with coarse and fine feeding. Cocoa butter/fat is melted in the melter 17 and pumped to two storage tanks 18. Pipings take the ingredients from the storage tanks to the chocolate mixer 19 mounted on an accurate scale. After the mixing process the mixture is conveyed by belt conveyors to a two-roll pre-refiner with feeding hopper and outlet screw homogenizer and a five-roll final refiner with feeding and discharge apron 21. When the refining is achieved 2 double overbeating conches 23 in tandem arrangement conch the chocolate mass for an adjustable number of hours (8–24 hours) until it can be pumped into 2 storage tanks 24.

C. Manufacture of Chocolate Tablets

From the chocolate-mass storage tanks 24 the intermediate tank 26 is fed and in turn discharged to the tempering unit 27 for the pre-crystallization of the chocolate mass. It passes the moulding plant 28 which consists of chocolate depositor, shaker, cooling zone, twisting device and conveyor for solidified tablets. After passing the 2 wrapping machines 29 the product is taken to the finished products storage.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1.	Intake hopper for cocoa-beans	1
2.	Bucket elevators	3
3.	Cleaner separator	1
4.	Magnetic drum separator	1
5.	Dry-destoner	1
6.	Continuous drier/roaster	1
7.	Crusher/winnower	1
8.	Fluidlift pneumatic transport	1
9.	Shell silo with bagging station	1
10.	Grinding unit	1
11.	Aspiration systems	2
12.	Electric plant control	1
13.	Intake hopper for sugar/milk	1
14.	Fluidlift pneumatic transport	1
15.	Ingredients silos with dischargers	3
16.	Storage tanks for cocoa mass	2
17.	Melter for cocoa butter/fat	1
18.	Storage tanks for cocoa butter/ fat	2
19.	Chocolate mixer on a scale	1
20.	Two roll pre-refiner	1
21.	Five roll final-refiner	1
22.	Belt conveyors	3
23.	Conches in tandem arrangement	2
24.	Storage tanks for chocolate mass	2
25.	Electric plant control	1
26.	Intermediate tank	1
27.	Chocolate tempering unit	1
28.	Moulding plant for chocolate tablets	1
29.	Wrapping machines	2
	FOB-price for machinery and equipment approx.	US$ 3,400,000.00

Required Manpower

Management and administration (managers, clerks, secretaries)	10
Supervisors and foremen	8
Quality control (Laboratory)	2
Skilled workers	10
Unskilled workers	12
	42

Required Area

Production area	2,000 sq.m
Storage	1,800 sq.m
Facilities	900 sq.m
	4,700 sq.m

Required Power and Utilities

1.	Electrical power AC 380 V, 50 c/s, 3-phase	700 kW
2.	Steam	300 kg/h
3.	Compressed air	5 N cu.m/h
4.	Cooling water	8 cu.m/h*
5.	Warm water 60 °C	12 cu.m/h*

* circulating

Required Raw Materials
(2,000 h/y, 1 shift)

Cocoa-beans	750 t/year
Cocoa butter/fat	200 t/year
Granulated sugar	1,000 t/year
Milk powder	200 t/year

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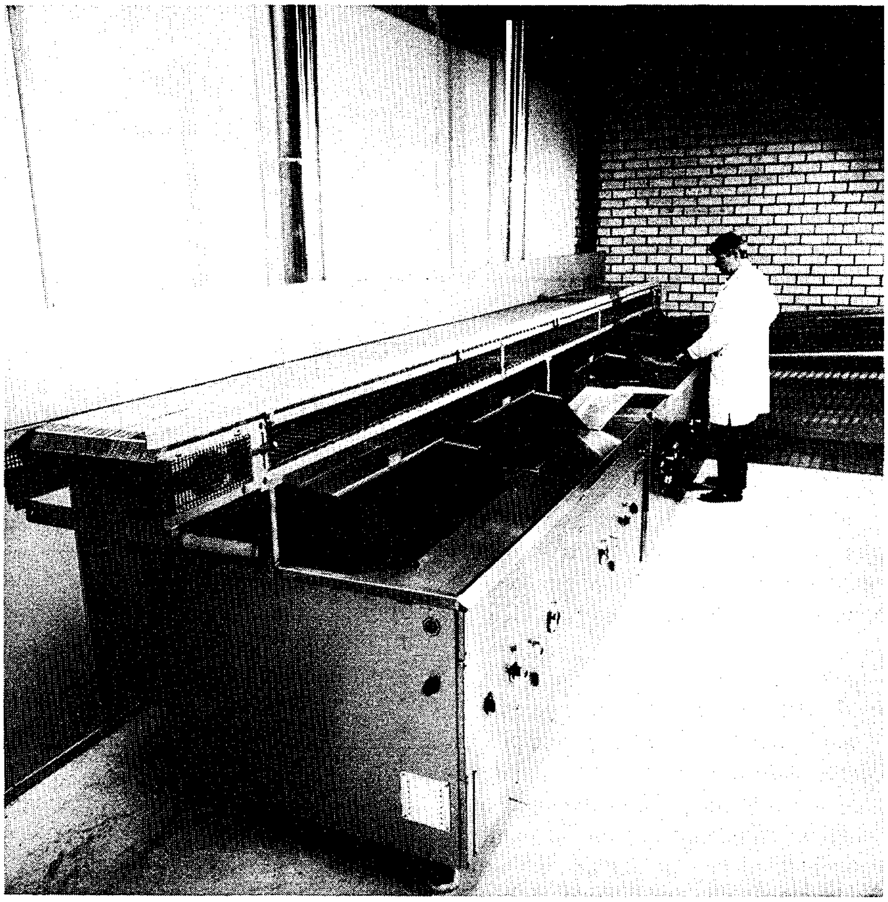
File: A 53
ISIC CODE 3121

How To Start Manufacturing Industries

Potato Crisps



Introduction

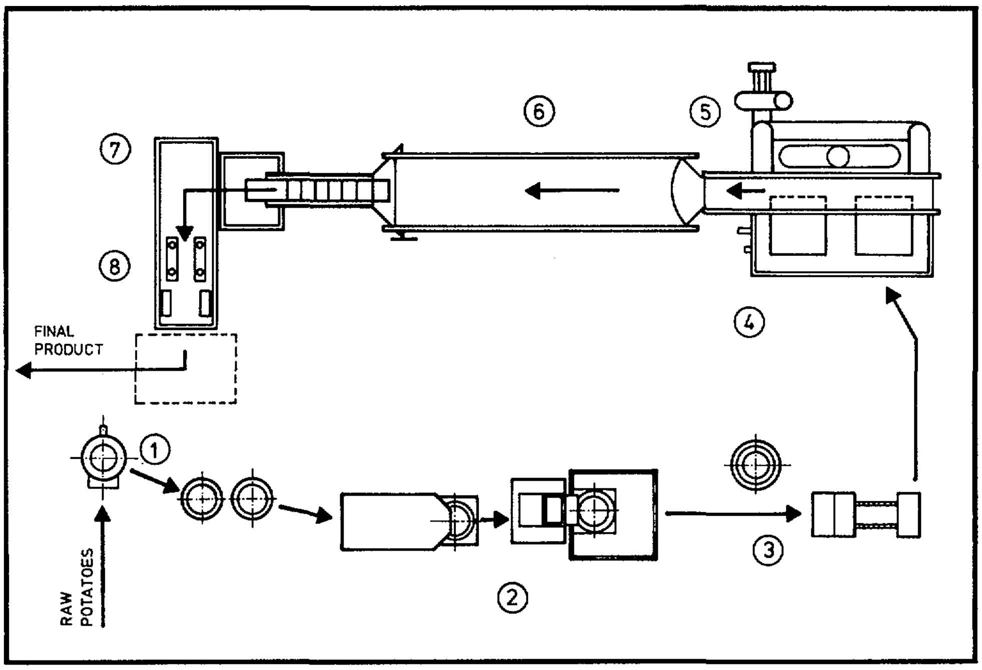
The potato originates from the South American Andes where numerous wild forms of it can be found even today. In the middle of the 16th century the first red-skinned potatoes were brought to Europe. First a delicacy for the rich, the potato developed into a staple food for all. But the way to eat potatoes has considerably changed. Formerly they had been a basic food and usually made up the main part of a meal, but nowadays they are at best just one part of it or they are consumed as a so-called refined product.

The production of such a refined product, namely the potato crisp, is described in this profile. The plant shown here is a semi-automatic plant with a capacity of 40 kg finished product per hour.

Description of the Production Process

The potatoes supplied can be stored either in sacks, on pallets or in standard boxes of approx. 1,000 kg. Depending on the delivery possibilities of potatoes, which can considerably vary from

Process Flow Diagram



place to place, the producer must determine the number of production days for which the required potatoes should be stored, thus avoiding production breaks due to lack of potatoes. In case potatoes are to be stored for a longer period, it may be recommendable to have air conditioning installed.

The first step in the processing is to peel the potatoes. As to guarantee good quality, the peeled potatoes are inspected and manually cleaned and peeled where this might still be required. In bins or baskets they are conveyed to the cutting and slicing machine which can cut the potatoes either into slices or sticks. These pieces again are washed by hand and dehydrated in a centrifuge. The next step, the so-called deep-frying, is done in the oven that has been developed especially for such processing. It is laid out with two frying vats and can be heated both by propane gas and natural gas. Via a cooling belt conveyor the potato crisps are manually seasoned and then conveyed to the packaging plant.

There they are packed into printed plastic bags of 50 or 100 g contents. The final product should be protected from heat and sunlight. In case of prolonged storage the room temperature should not exceed 20 °C to avoid that the oil in the crisps gets rancid.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Potato peeling machine	1
2	Cutting and slicing machine	1
3	Centrifuge	1
4	Frying oven	1
5	Fat-drip and transport belt	1
6	Cooling belt conveyor	1
7	Packaging devices	2
8	Sealing devices	2
9	Baskets, bins, containers	misc.
	FOB-price for machinery and equipment approx.	US$ 60,000.00

Required Buildings and Areas

Production	160 sq.m
Storage	80 sq.m

Required Manpower

Manager	1
Foreman	1
Workers	4
	6

Required Power and Utilities

Gas	140,000 kcal/hr
Water	3.5 cu.m/hr
Electric power	15 kW

Required Raw Materials

Raw potatoes	1,400 kg/shift; for 1 kg final product 4 to 4.5 kg raw potatoes are required
Oil	130 kg/shift; for the production of potato crisps the use of peanut oil is recommended
Spices and salt	according to market requirements

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How To Start Manufacturing Industries

Cassava Starch

Introduction

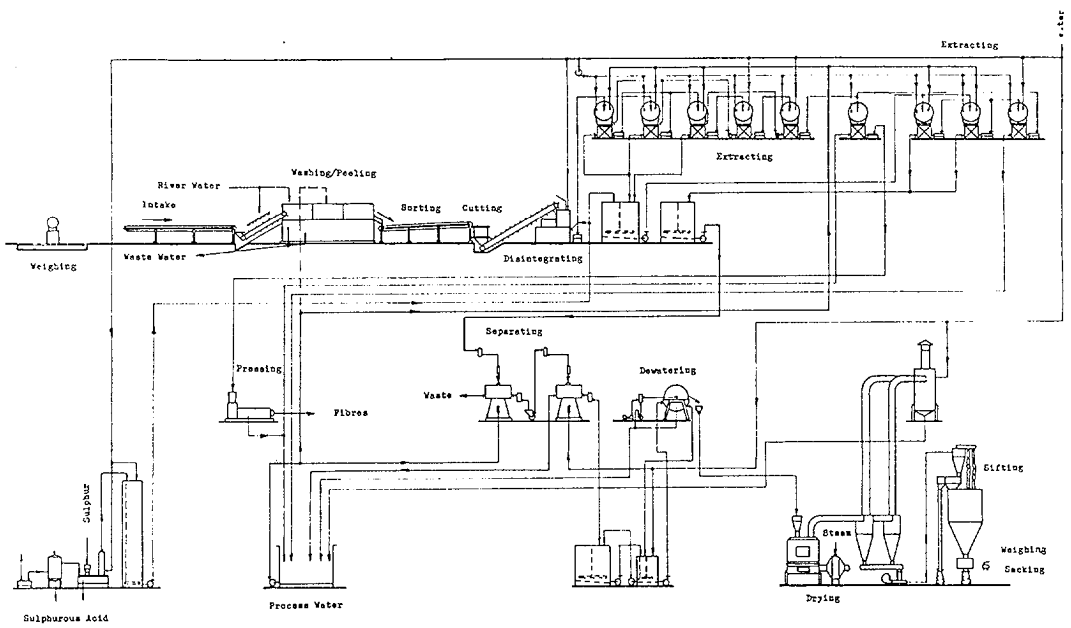
Cassava starch is extensively used in the textile and paper industries and also to make cassava dextrin. Dextrin is well suited for use as an adhesive for postage and other stamps, gummed envelopes, tape, stickers, etc. It is also used in laundries and for the manufacture of plywood and veneer adhesives. Small quantities are turned into plastics that largely consist of starch acetate. Because of its low protein content cassava starch is exceptionally well suited to be processed into glucose or for the production of 'pearl tapioca' (pearl sago).

Description of the Production Process

The harvested cassava roots are delivered by trucks and unloaded at a storage place. Root bundles are split, wooden ends and stalks cut, before the processing begins. An inclined belt conveyor evenly feeds the roots to the washing and peeling machine. The pre-washed and peeled roots are thrown on a sorting belt for inspection with regard to ingrown stones or damage by parasites. The refuse is eliminated by hand. A cutting machine and a disintegrator cut the roots into pieces. The resulting pulp is collected in a hopper connected to an eccentric worm pump. It pumps the pulp to a two-stage extraction unit for intense washing of the coarse fibre, feeding the first extractor.The outgoing fibre is pumped to a second extractor for the final washing process. The crude starch-milk leaving the extraction section is collected in the container equipped with agitator. A pump transports the crude starch-milk to the extraction unit for the fine-fibre removal. This extraction unit comprises two stages. The treated starch-milk is collected in a container equipped with agitator. The coarse and fine fibres are leaving the respective final extractors and can be used to feed the pigs.

A pump transports the crude starch-milk to the separator where it is concentrated and washed after having passed the filter pot. The separated fruit-water which still contains protein leaves the factory or is partially transported back to the process water basin with pump and

Process Flow Diagram



filter pot. In order to ensure a high-quality starch two separators are installed in series.

The concentrated starch-milk passes through a container equipped with agitator and from there is pumped to a vacuum drum filter for mechanical dewatering. The resulting starch has a moisture content of approx. 42%. Via a special feeding device the moist starch enters the drier where the moisture content is reduced to 12% standard or to a higher content according to customer's choice.

The dry starch is fed to a sifting machine for quality control. It is equipped with a bag-spout for the sacking of the final product with scales controlling the weight of the filled sacks.

The production of first-class starch requires the use of sulphurous acid in the course of the process, which also achieves a sterilization effect. The bleaching process gives the starch its white colour and also renders the separation of protein easier.

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Belt conveyor	1
2	Washing and peeling machine	1
3	Sorting belt	1
4	Cutting machine	1
5	Belt conveyor	1
6	Disintegrating unit	1
7	Feeding unit	1
8	Two-stage extraction unit	1
9	Feeding unit	1
10	Separator	2
11	Feeding unit	1
12	Vacuum drum filter	1
13	Rapid starch dryer	1
14	Automatic bagging scale	1
15	Sifting machine	1
16	Sulphurous acid production unit	1
17	Filter dewatering unit	1
18	Steam boiler	1
19	Diesel generating set	2
	FOB-price for machinery and equipment approx.	US$ 2,000,000.00

Example of the Plant

Design data

Cassava yield starch per ha	30 t
Starch yield per ha	7.5 t
Raw material	100 t/24 h cassava roots moisture content 65% H_2O
Product	25 t/24 h commercial starch moisture content 12–13% H_2O 17 t/24 h wet fibre pig-feed moisture content 70% H_2O

Required Manpower

Management	5
Engineers	3
Quality control	3
Skilled workers	6
Unskilled workers	25
Fitters	3
Electricians	3
	48

Required Area

Production area	250 sq.m
Storage	200 sq.m
Facilities	100 sq.m
	450 sq.m

Required Power and Utilities

Electricity	200 kW
Process water	20 cu.m/h
Wash water	25 cu.m/h
Steam	17 t/h
Sulphur	5 kg/h

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How To Start Manufacturing Industries

Maize Starch

Introduction

Like other commercial starches, maize starch has a great many uses. They include domestic use as food in puddings, soup and gravy thickeners, as cold or hot water laundry starch, as a preferential water absorber in baking powder, in the manufacture of confectionery, in sizing and finishing textiles and papers, as a binding agent in papers, in making adhesive pastes, in conversion to dextrins which are the bases of many adhesives, in syrup and sugars, as a binding and diluting agent in the preparation of pharmaceutical products such as pills and tablets, in cosmetics etc. Moreover, the production of maize starch yields some by-products that have a high commercial value.

Description of the Production Process

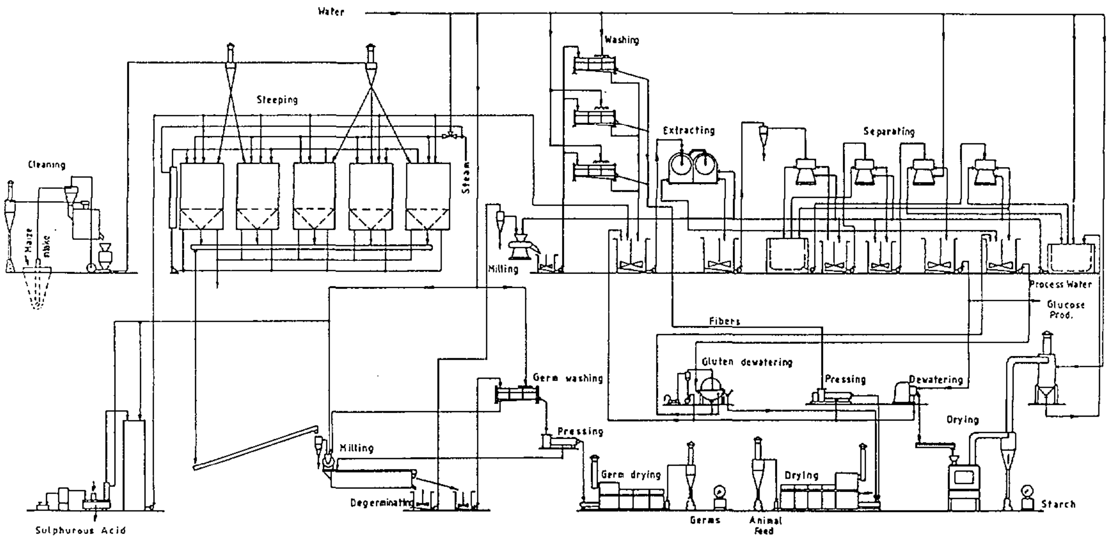
The maize is cleaned and by means of a pneumatic conveying blower transported into the steeping vats. The steeping water has a temperature of max. 52 °C which is maintained by circulation via a heat-exchanger. To facilitate the gluten separation 0.2 to 0.3% sulphurous acid is added. Apart from the sterilization effect this additive also bleaches the starch.

After draining off the steeping water, the steeped maize is discharged by screw conveyors to the degerminating mill. It breaks up the maize kernels and sets the germs free without damaging them. The maize slurry drops into the germ separator where the fat-containing germs are separated from the slurry and flow into a container. They are pumped into a washing machine and a dewatering press. After this dewatering the germs are dried in the germ drier. Then they are ready for storage. Having a high-value edible oil content of approx. 45% they can be used for oil extraction.

The maize slurry flows into the container and is pumped to the refiner mill. The maize slurry pump delivers it to the extraction section for coarse fibre washing. The starch milk is collected in raw milk vessels equipped with stirrers.

The husks, shells and coarse fibres are conducted to the dewatering press where they are mechanically dewatered. The crude starch milk is pumped to the extraction section for fine fibre washing. From the extractors the starch-milk flows to the container. From there the pump conveys it into the first separator via a filtering device. In this separator the gluten is separated from the starch milk. The milk is washed again in a second and third separator or hydro-cyclone plant and concentrated. The gluten water is

Process Flow Diagram



collected in a container and then pumped to the concentrator. The concentrated gluten flows into the container to be mixed with the pre-dewatered fine fibres coming from the extraction section and directly dewatered by a vacuum filter. By means of a screw conveyor the gluten, the pressed fibres and husks are fed into a dryer. The resulting product is a high quality animal feed.

The starch milk that has been collected in the pure starch milk container is pumped to the centrifuge. The scraped starch is transported by a screw conveyor to the starch dryer to reduce the water content. The dried starch is collected in a cyclone. Via rotary discharge sluice and sacking scale the product is sacked-off.

The resulting starch is of high quality and corresponds to international standards.

Example of the Plant

Required Machinery and Equipment

Item	*Description*
1	Cleaning device
2	Steeping device
3	Screw conveyors
4	Germ separation unit
5	Germ washing unit
6	Dewatering press
7	Germ dryer
8	Germ packing unit
9	Maize slurry mill
10	Washing unit
11	Extraction unit
12	Starch milk filtry device
13	Multi hydro-cyclone plant
14	Dewatering unit
15	Gluten concentrator
16	Vacuum filter
17	Dryer
18	Packaging unit
19	Centrifuge
20	Rapid starch drying unit
21	Packing unit
22	Steam boiler
23	Compressed air system
24	Diesel generating set
	FOB-price for machinery and equipment approx. US$ 4,000,000.00

Required Manpower

Management	5
Engineers	3
Quality control	3
Skilled workers	6
Unskilled workers	20
Fitter	3
Electrician	3
	43

Design data

Maize yield per ha	7 t
Starch yield per ha	4.55 t
Raw material	50 t/24 h maize moisture content 14% H_2O
Product	32.5 t commercial starch moisture content 13–14% H_2O 10 t animal feed 10–12% H_2O 3.5 t germs moisture content 2–3% H_2O

Required Area

Production area	400 sq.m
Storage area	250 sq.m
Facilities	95 sq.m
	745 sq.m

Required Power and Utilities

Electricity	350 kW
Water	14 cu.m/h
Steam	2.8 t/h
Sulphur	·12 kg/h

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File: A 56
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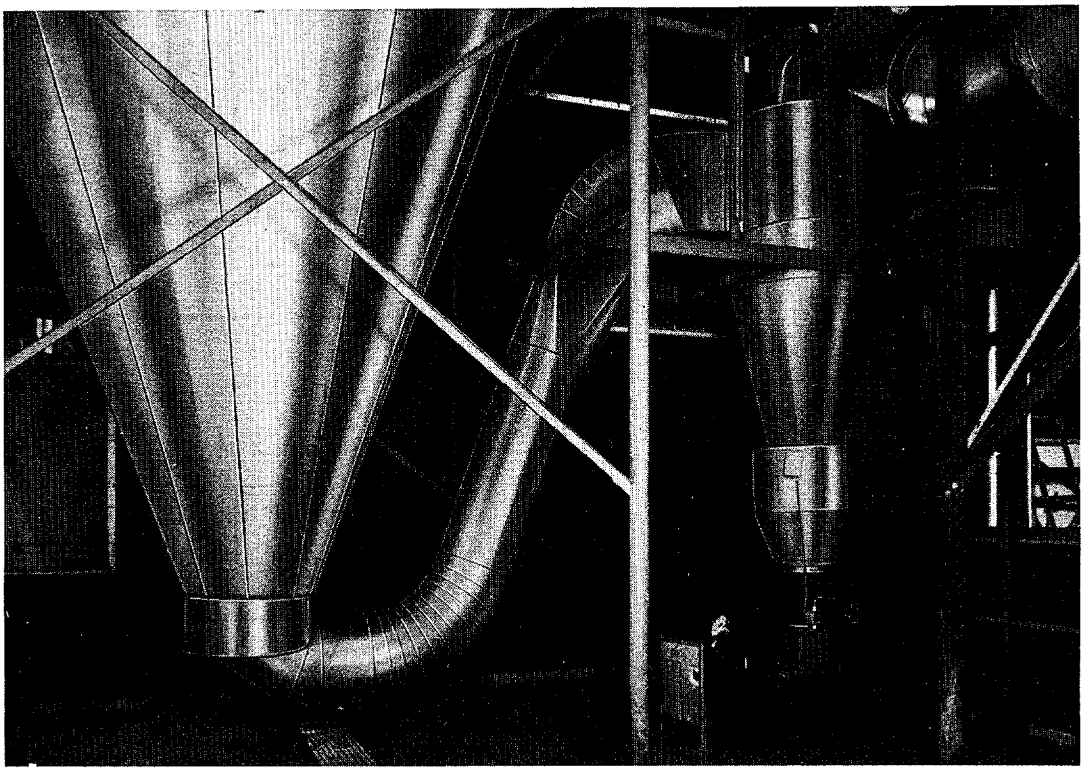
How To Start Manufacturing Industries

Dried Egg Powder



Introduction

The egg is one of the most nutritious natural products that we know of. They are rich in protein, vitamins and minerals. In their natural state, however, they suffer from certain disadvantages. The shell containing the eggs is somewhat brittle, and the storage life is limited. The industrial processing of eggs has the main objective of eliminating the disadvantages whilst at the same time conserving the advantages of the egg.

From the quality standpoint important advances have been made in recent years in the processing of eggs on an industrial scale. The end products have a high nutritive value and the loss of organoleptic characteristics is very slight. Spray drying especially of whole egg, egg white and yolks, with or without the addition of sugar has developed very rapidly and has become a thoroughly modern production process, both from the point of view of food technology and of the process technology involved.

Process Description

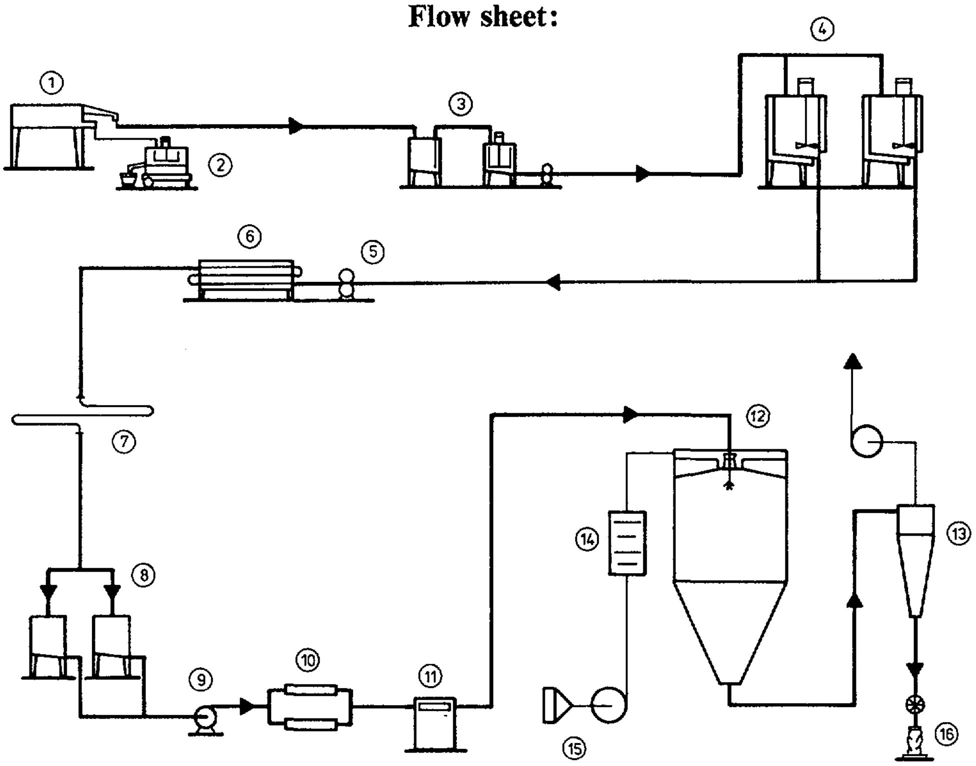
The below described plant is designed for a capacity of 48,000 eggs per day. The operation time per day is 12 hours for the breaking section and 20 hours for the pasteurizing/drying plant.

The eggs are manually fed to a conventional cup breaking system. After breaking and separation of the egg and shell the whole egg is discharged into the filtration system of the process. The shells are deposited in a centrifuge where the residual liquid egg and shell are separated. After the special filtration process the egg is fed to storage tanks where it is cooled down to 4 °C by means of the chilled water jackets. Slow speed agitation is provided with these storage vessels.

From the storage tanks the egg is fed by a positive displacement pump to the tubular heater. This tubular heater is heated by hot water. The egg temperature is raised to 65 °C. After heating the product is held at 65 °C for 6 minutes. This holding at 65 °C for 6 minutes gives sufficient pasteurization of the product for most situations and errs on the side of safety. Shorter holding times at 65 °C are acceptable if the incoming egg quality allows this.

The warm egg from the holding tube is fed to one of the two dryer balance tanks and then to the high pressure pump by a centrifugal feeding pump. From the high pressure pump the egg is fed to the atomizing nozzles via a high pressure line. The spray dryer is cylindrical with a conical outlet for air and powder. The filtered drying air is heated by steam and then introduced to the drying chamber by a specially designed venturi. Placed in this venturi are the atomizing nozzle lances. The product is finally atomized into the hot inlet air. Due to flash drying the hot air rapidly reduces in temperature, thus giving minimum product damage. The dry powder and drying air leave the chamber at the bottom of the cone and are transported to a cyclone where the powder is separated from the air. The powder is then cooled and filled into a container.

Flow sheet:



Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Piece*
1	Egg breaker	1
2	Centrifuge	1
3	Filter	2
4	Storage tank	2
5	Feed pump	1
6	Tubular heater	1
7	Holding tube	1
8	Balance tank	2
9	Feed pump	1
10	Filter	2
11	High pressure pump	1
12	High pressure spray dryer	1
13	Cyclone with exhaust and fan	1
14	Heater	1
15	Fan	1
16	Packing unit	1

FOB-price for machinery and equipment approx. US$ 600,000.00

Required Buildings

Production building	144 sq.m
Production building drying section	36 sq.m
Laboratory	18 sq.m
Storage	36 sq.m
Facilities	72 sq.m

Required Manpower

Commercial manager	1
Technical factory manager engineer	1
Secretary	1
Foremen	4
Skilled workers	9
Quality control	1
Mechanic technician for maintenance	1
Electrician for maintenance	1
Helpers	9
	28

Required Power and Utilities

1. Electrical power	
Production line	15 kW
2. Steam	
Consumption	198 kg/hr
Pressure	15 bar
3. Hot water closed system	
Consumption	750 l/hr
Temperature	70 °C
4. Ice water (closed system)	
Consumption	6.500 l/hr
Temperature	1 °C
5. Compressed air	
Consumption	30 cu.m/hr
Pressure	6 bar

Technical Data

1. Raw material	48,000 fresh eggs/day
Average weight	60 g/egg
Average composition:	
egg white	54%
egg yolk	31%
shell	12%
waste	3%
2. Product	30.5 kg/h egg powder
Moisture content	4%
3. Mode of operation	
preparation section	2 shifts
drying section	3 shifts

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How To Start Manufacturing Industries

Brewery

Introduction

Beer is a carbonated alcoholic beverage that is well liked all over the world. Its production developed over the centuries from home-type brewing facilities to industrial manufacturing.

Today's beer production plants – breweries – are based on a highly developed brewing technology as well as adequate modern processing equipment.

The capacity of breweries ranges from 1,000 hl to 3 million hl per annum and even more.

Description of the Brewing Process

Principally beer is manufactured from four ingredients: malt (germinated barley), water, hops and yeast. Brewing is done in the following stages

Wort Production

Wort is prepared in the brewhouse, starting with the mashing process where crushed malt is mixed with brewing liquor (treated water). The mash is stirred and heated up to a temperature where malt-enzymes are active.

The mash contains husks and solid particles from the malt; they are separated in such a way that the liquid is strained through the settled grain-bed.

The liquid which is called wort is then boiled under addition of hops. This boiling process achieves a stabilization of the wort.

After the hot trub (protein particles) has been removed, the wort is cooled. Before the now cold wort is pumped to the fermentation tank, oxygen – by injection of sterile air – and yeast have to be added.

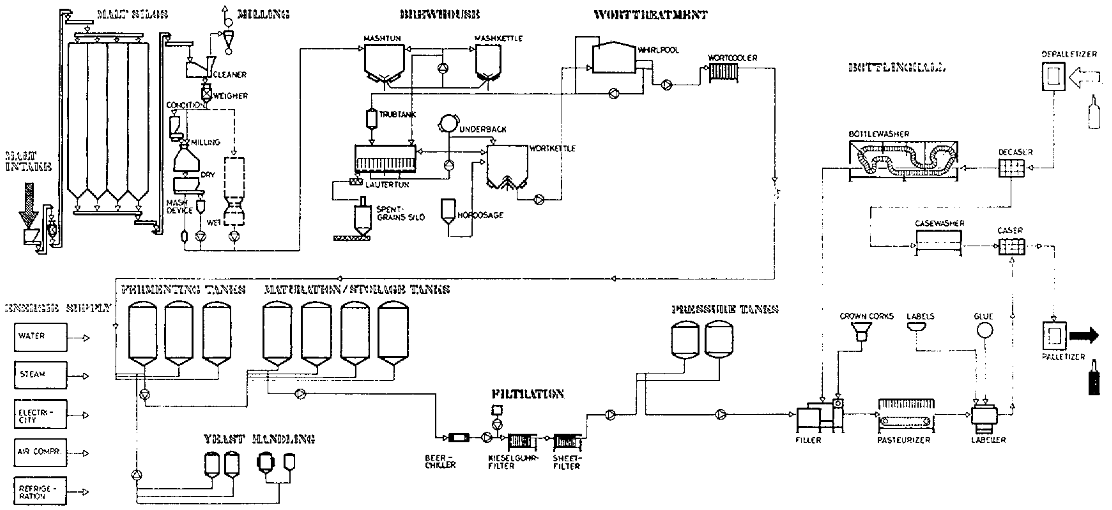
Wort Fermentation

During the fermentation process the yeast converts the fermentable sugar of the wort into alcohol and carbon dioxide.

Since the fermentation is a thermal process, the wort temperature rises. In the range of 9 to 11 centigrades the temperature has to be kept constant by means of controlled cooling.

After a 5 to 6 days' period most of the fermentable sugar is converted, the yeast is settling and

Process Flow Diagram



fermentation stops. The fermented product called green beer is cooled down and the yeast separated. The green beer is pumped into maturation and storage tanks.

Beer Maturation and Storage

During the maturation process most of the remaining yeast and other substances must be sedimented and unwanted flavours eliminated. Carbon dioxide has to be added in case of insufficient saturation during storage. According to the type of beer even a secondary fermentation may be induced at the first stage of maturation.

The temperature of beer during maturation and storage is lowered to freezing point by cooling facilities.

Beer Filtration

As the matured and stored beer still contains yeast, protein particles and certain bacteria, it has to be clarified by a filtering process prior to bottle filling or kegging.

A two-step filtration with kieselgur-filter and sheet filter can be regarded as the common filtration process. It results in a bright and clear beer which is pumped into bright beer tanks.

Beer Packaging – Bottling, Canning, Kegging

Finished beer is filled into suitable containers like glass-bottles, metal cans and metal kegs.

The conventional beer container is the glass-bottle. The utilisation of can- or keg-filling facilities depends on the actual market conditions.

In order to achieve a biological stability of the beer which means a long shelf-life, beer has to be prevented from contact with oxygen (air) and micro organisms must be inactivated. At the filling process carbon dioxide gas will be used instead of air for setting up the counter-pressure, and either in line or in the containers the beer will be pasteurized.

Brewery by-products

By-products of the beer manufacturing process like spent grains from the brewhouse, surplus yeast and carbon dioxide from the fermentation can be sold. Spent grains and surplus yeast will serve as animal fodder. Both products can be dried separately or together by means of drying installations.

Carbon dioxide gas collected from the fermentation tanks is purified, compressed and liquefied and can then be filled into steel cylinders serving for various industrial purposes.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	
1.	Malt- (adjuncts) storage and handling plant	
2.	Brewhouse plant incl. brewing liquor tanks	
3.	Spent grains silo and drying plant	
4.	Wort treatment plant	
5.	Yeast handling plant	
6.	Fermentation tanks	
7.	Beer maturation and storage tanks	
8.	Beer filtration and bright beer tanks	
9.	Beer packaging plant	
10.	Tank/pipework sanitizing plant	
11.	Laboratory	
12.	Water treatment plant	
13.	Refrigeration plant	
14.	Carbon dioxide gas recuperation plant	
15.	Compressed air system	
16.	Steam boiler plant	
17.	Piping system	
18.	Emergency Diesel generator	
	FOB-price for machinery and equipment, based on a brewery plant with a capacity of 100,000 hl/year approx.	US$ 6,000,000.00

Required Buildings

Production building	1,800 sq.m
Bottling plant and storage	2,700 sq.m
Administration building	400 sq.m
Facilities	300 sq.m

Required Manpower

Management and administration personnel	30
Personnel for production and bottling	90
	120

Required Power and Utilities

Water	8–10 hl/hl beer
Refrigeration energy	30,000 kJ/hl beer
Thermal energy	180,000 kJ/hl beer
Electricity	10 kWh/hl beer

Technical Data

1. Raw material:

Malt/adjuncts	7,500 kg/day
Hops (based on natural composition)	100 kg/day
Yeast	6 x 1 l/yr

2. Process data:

Brewhouse production	450 hl hot wort
Fermenting period	7–8 days
Maturation and storage period	18–20 days

3. Product:

Finished beer 1 hl = 100 litres	100.00 hl/yr

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File: A 58
ISIC CODE 3134

How To Start Manufacturing Industries

Soft Drinks

Introduction

Principally, soft drink processing is a mixing procedure with essential components of raw materials, i.e. sugar, water flavour, acid and carbon dioxide. The secret of a recipe basis lies in harmonizing the raw materials in such a way that the finished product has a refreshing, stimulating character. A continuous quality control must ascertain that only perfect raw material is processed, that the bottled product is unobjectionable regarding its hygienic condition, and that it is microbiologically and chemically stable.

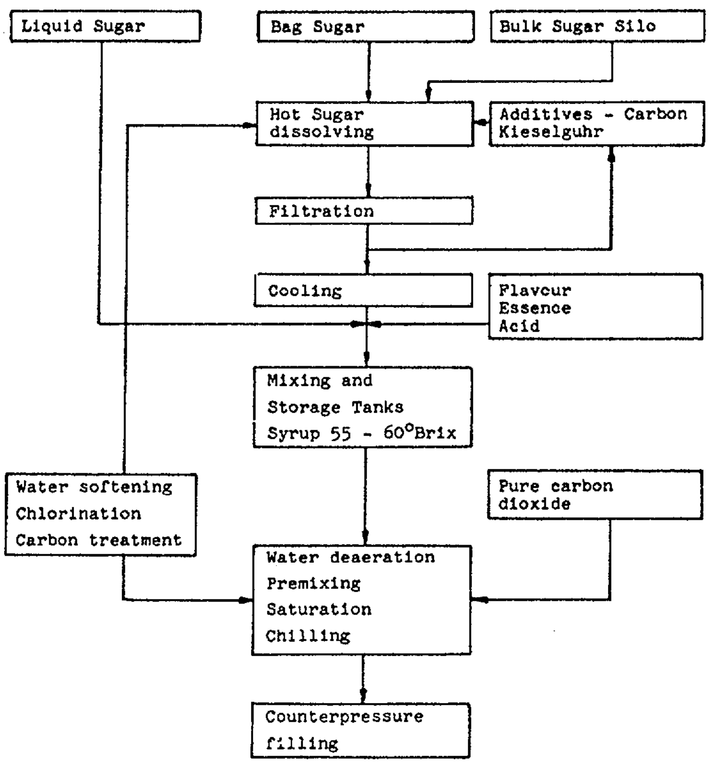
There are various processing methods for the production of soft drinks. The described admixing process where the mixture of water and lemonade syrup is carbonated before bottling, corresponds with those of the licencers of brands like Coca-Cola, Pepsi-Cola, Seven-Up, Canada Dry, etc.

Description of the Production Process

Sugar is delivered either in hopper cars with pneumatic discharge or in bags of 50 kgs. For reasons of micro-biological stabilization, the sugar syrup is produced in a hot dissolving process. The sugar is admixed by means of conveying elevators. In case the sugar is dirty or slightly brown, the application of active carbon is indispensable. For heating purposes and for maintaining a constant dissolving temperature of 85 °C, the sugar dissolving tanks have either a heating jacket or are equipped with an interior heating spiral.

Exact weighing is essential in this process. It is done by a pressure gauge with a large-scale reading instrument. The entire dissolving process takes about one hour. After that the mixture is filtered, cooled by the plate cooler, and from there the product flows directly into the mixing

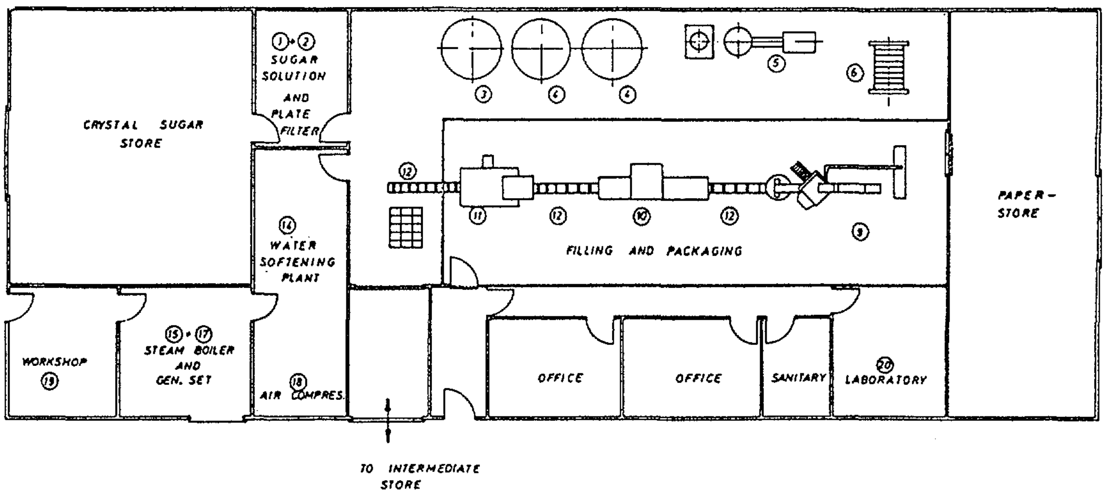
Process Flow Diagram



and storing vessels. The raw materials and essences are stored in a cool-room at approx. 4 °C. They are either pumped into the concentrate preparing vessel by a barrel pump or they are manually added. Citric acid is dissolved in a separate vessel. In order to obtain a homogeneous final syrup, the mixture should be stirred for another 15 minutes in the mixing vessel. During this time the measuring of Brix content should be done that correction can be made, if necessary. Then the syrup is transported to the pre-mixer by means of a pump. There the beverage is deaerated, dosed, cooled and carbonated. In a vacuum tank the treated water is deaerated and cooled down in a multiple stage plate cooler to approx. 8 °C in a first step, and then conveyed to the jet apparatus, where, according to the Venturi-principle, syrup and water are mixed.

In the carbonating department CO_2 is added to the mixed drink by means of a jetting apparatus, and thereafter the product is conveyed to the storage tank. From this tank a discharge is made out for further cooling in the second stage of the plate cooler at approx. 3–4 °C. Without mechanical help the product is conveyed to the filling machine. The filling and sealing unit works according to the single-chamber counter-pressure-principle and guarantees a quality-preserving bottling of drinks with highest microbiological security.

Plant Layout



Example of the Plant

Design Data

1.	Capacity of the plant Output	27,600 hectolitres/year
2.	Working days	300/year
3.	Shift per day	1

Required Machinery and Equipment

Item	Description	Pieces
1	Sugar solution plant	1
2	Plate filter	1
3	Syrup tank	1
4	Mixing tanks	2
5	Homogenizing and deaeration plant	1
6	Plate heat exchanger	1
7	Cleaning-in-place plant	1
8	Filling machine	1
9	Tray plant	1
10	Shrink wrapping machine	1
11	Set of conveyors	1
12	Electrical equipment	–
13	Water softening plant	1
14	Generating set	1
15	Armatures and pipes	1
16	Steam automat	–
17	Air compressor	1
18	Workshop equipment	–
19	Laboratory equipment	–
	FOB-Price for machinery and equipment approx.	US$ 2,000,000.00

Required Manpower

Administration	3
Foreman	1/shift
Quality control	1
Skilled workers	3/shift
Unskilled workers	6/shift
Maintenance	2
	16

Required Area

Production area	320 sq.m
Storage	400 sq.m
Facilities	180 sq.m

Required Power and Utilities

1.	Electrical power AC 380 V, 50 c/s, 3-phase	120 kW
2.	Water	2 cu.m/h
3.	Compressed air	60 cu.m/h
4.	Cooling water	5 cu.m/h
5.	Steam	400 kg/h

Required Raw Materials

1.	Concentrate	75 t/year
2.	Sugar	330 t/year
3.	Water	2,800 cu.m/year
4.	Carbon dioxide	18 t/year

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File: A 59
ISIC CODE 3113

How To Start Manufacturing Industries

Combined Can Factory and Cannery

Introduction

Experts take the view that the earth produces enough food-stuff to nourish the population on this earth if we succeed to prevent the losses of more than 50% caused for instance by the effects of climate, vermin and other causes. Also the continuing urbanization and the thus resulting increase of the distance between production site and place of consumption will increase these losses even further in the future. Almost all food-stuff can be protected by preservation, i.e. canning and packaging in suitable receptacles. This fact makes it possible to process locally the riches of the countries in form of natural produce and agricultural goods and make them available to the consumer without any losses. Furthermore this makes the countries able to participate in world trade and earn foreign exchange instead of spending it on expensive food.

If we take into account the particularly difficult climatic conditions and stress at storage, transportation and distribution, the tinplate can offers itself as one of the most suitable packaging. The properties of the packaging material steel in combination with a production technology which is based on many years of experience, but which nonetheless is supermodern, offer a maximum of safety:

- tinplate cans are shock-resistant and impact-proof;
- they are immune against highest and lowest temperatures;
- tinplate produced according to the latest production methods offer protection against corrosion for all kinds of filled-in goods;
- they are suited to can a large number of foodstuffs, e.g. fruit and vegetables, meat, fish, dairy products, beverages, dry food, etc.;
- no energy-intensive cooling system is needed for the storage of canned food;
- long-term storage is possible;
- the tinplate for the production of these cans is produced in large quantities in the whole world and therefore available anywhere at any time.

The plant described here has a capacity of 50,000,000 cans per year which is based on a one-shift operation with a production of 120 cans per minute.

Process Description

Can Factory

The factory uses tinplate sheet blanks, which means that the body blanks are purchased ready-made. On this installation round open-top cans with a diameter of 52 to 108 and a section of 65 to 280 mm can be produced.

The steps of manufacturing are:

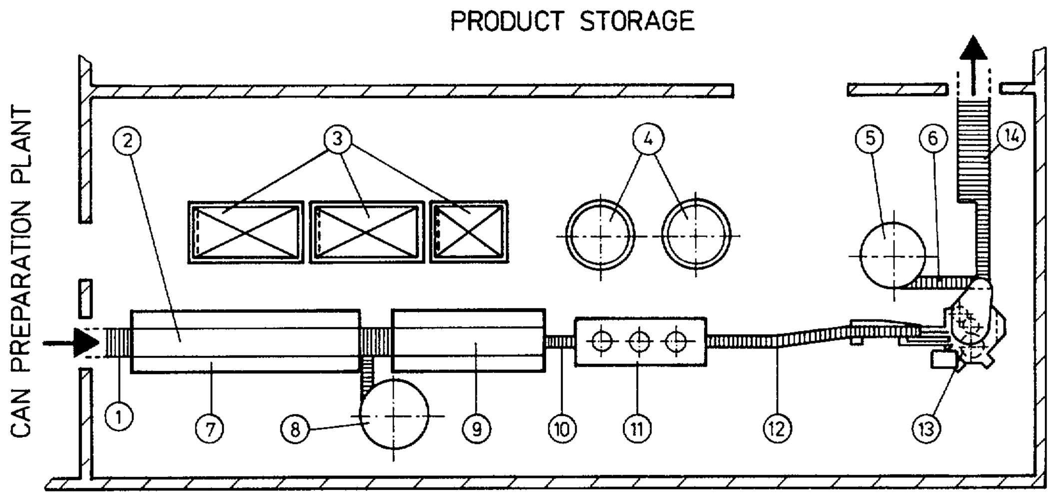
1. automatic body welding machine
2. inside roller coating system
3. outside roller coating system
4. lacquer coating unit
5. flanging machine
6. seaming unit

The cannery is designed for universal uses, i.e. for processing fruit, vegetables, meat and fish.

Filling and seaming

The first step is to wash (by machine), clean and sort the product to be packed. The further processing work is done by unskilled workers on a cleaning line. The raw material is conveyed to a filling table. It is spread on filling plates by means of a distribution conveyor whilst the empty cans are brought by means of a V-belt and filled by hand. In order to densify particularly bulky goods a vibration device is installed. Finally the cans are seamed by a seaming machine.

Layout: Filling and seaming machine



1 Elevator
2 Conveyor
3 Cooking boiler
4 Cauldron with agitator
5 Buffer disk
6 Conveyor
7 Cleaning and assorting table
8 Buffer disk
9 Filling table
10 Current conveyor
11 Overflow-topping machine
12 Conveyor
13 Seaming machine
14 Conveyor

Pasteurization/Sterilization

Canned products of a pH-value less than 4.5 are pasteurized to preserve them. For this purpose a continuous pasteurizer is used. The cans are transported by means of an endless chain type carrier through a hot-water bath. The water bath is followed by a cooling zone in which the cans are cooled by a coldwater spraying system.

Products that must be heated to more than 100° C for preservation are sterilized in autoclaves.

Description of the Production Process

The production plant consists of the following units that include the preparation of raw products:

- can manufacturing unit
- filling and seaming
- pasteurization and sterilization
- labelling and packing

Labelling and Packing

In the last step of production, the cans are labelled and manually packed into cartons by unskilled workers.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1.	Can factory	1
1.1	Automatic body welding machine	1
1.2	Inside roller coating system	1
1.3	Outside roller coating system	1
1.4	Lacquer curing unit	1
1.5	Flanging machine	1
1.6	Seaming machine	1
2.	Cannery	
2.1	Processing table	1
2.2	Cleaning table	1
2.3	Rotary disk	1
2.4	Filling table	1
2.5	Topping machine	1
3.	Pasteurizer	1
4.	Sterilizer	1
5.	Labelling and packing device	1

FOB-price for machinery and equipment approx. US$ 1,500,000.00

Required Buildings and Areas

Administration	60 sq.m
Production	300 sq.m
Storage	240 sq.m

Required Power and Utilities

Electric power	approx. 47 kW
Water	1,000 l /hr
Diesel oil	62.5 l /hr
Propane gas	5.6 kg/hr

Required Manpower

Administration	3
Skilled labour	8
Unskilled labour	55
Maintenance	3
	69

Required Raw Materials

Tinplate demand: for 1,000 cans of 99 mm diameter and 119 mm height	120 kg tinplate
Raw produce demand for these 1,000 cans: for instance pineapple	650 kg pineapple

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B

How To Start Manufacturing Industries

Fishing Net

Introduction

A typical fishing net, with diamond-shape openings, can be manufactured according to different techniques by different machines.

Depending on the fish-size, the opening size and the thickness of the mesh-bars are designed to hold the catch.

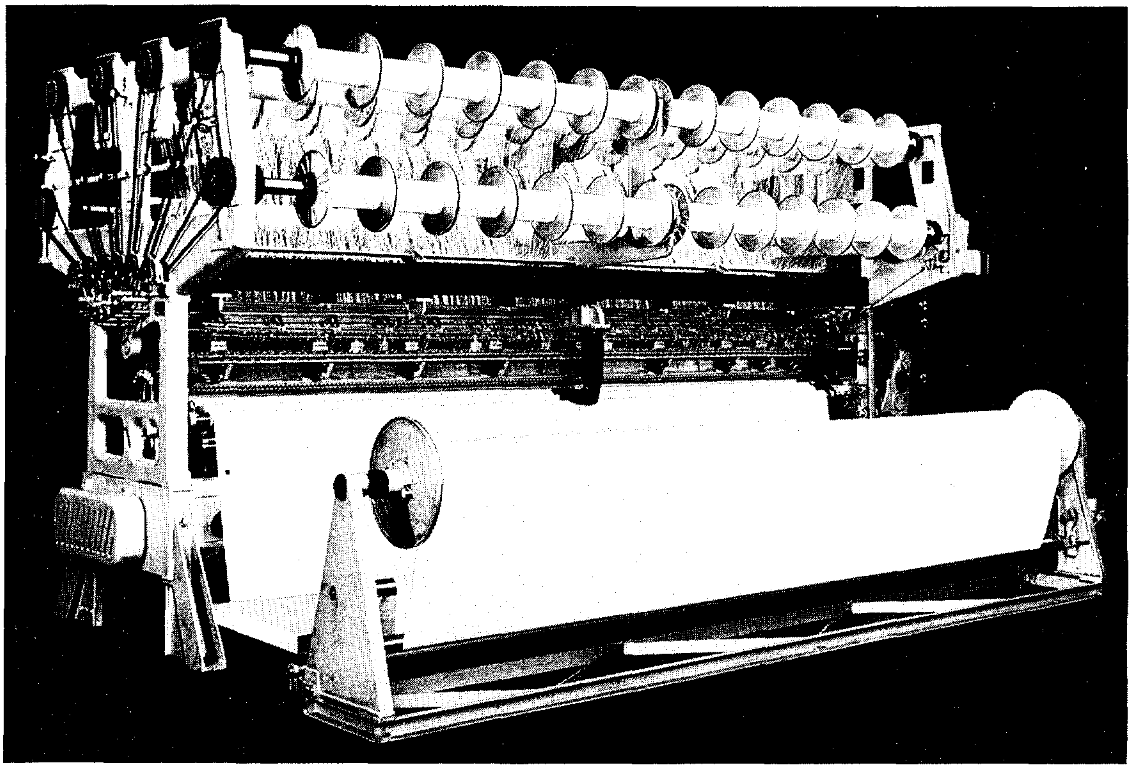
Traditionally nets were hand-knotted and later machine knotted which are both slow processes with many disadvantages.The mesh-bars are made of one yarn which must be twisted to prevent filamentation, the structure and particularly the knots are not strong, the net is very vulnerable on account of the protruding knots and, in some cases, the knots even loosen when immersed in the water.

Braiding techniques in which the yarns are twisted together to form the mesh, are even more sensitive to slippage and the net openings are changed and distorted under load stress.

The most modern, productive, profitable and technologically suitable method for fishing-net production is warp knitting as executed on the specially developed 8-guide bar high-speed Raschel machine.

The mesh bars produced on a Raschel maschine are made of loop chains and the flat connections are made by pulling the pillars together.

To improve the tenacity of the mesh bars and the connections, inlay yarns are made to follow the pillars of the loops and take part in the binding of every two mesh bars. Those inlaid yarns are almost straight in their structure and thus do-



Raschel Machine

nate great strength both ways, to the mesh bars and the connections. Usually those yarns are heavier than the knitting yarns which are used as the binding media.

Raschel machines are built in 7 to 16 needles per inch and with 6 to 8 guide bars to allow the following possibilities:

- Fine-gauge machines produce – with fine yarns – fine net structures, while the heavy-gauge machines produce the heavy-duty nets that are capable of catching and holding big fish. In those heavy net structures the inlaid and knitting yarns in each mesh bar can amount to 80,000 dtex and more.
- 6-guide bar machines produce the standard type of fishnet, while the 8-guide bar machine can produce especially reinforced structures or special selvedges on both sides of the net fabric.
- Machine widths of 105 to 190 inches can produce – according to the opening size – extremely wide net fabrics. It must be borne in mind that with every needle producing a mesh bar, the structure when stretched to open diamond openings will be many times wider than the knitting machine.

Plant Description

Raw material for fish nets is filament synthetic yarn of polyamid or polyester type. The yarn count depends on the wanted mesh size and stitches per cu.cm. Average range is 500 to 4,000 dtex.

The plant consists of a beaming arrangement (warping machine and warping creel) and one Raschel machine.

The total number of filament yarns processed on the Raschel machine has to be wound on several sectional beams of 21″ flange diameter and 21″ width. Winding of beams is done on the warping machine. The individual filament yarns are fed to the warping machine from a creel with approx. 600 running off positions for yarn cones.

The sectional yarn beams are fed to the Raschel knitting machine. The finished net material is again batched on beams to be supplied to the making-up department. Making-up of nets to sizes and fixing of ropes and hooks is done manually.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Direct sectional warping machine for beams 21 x 21″ with pressure roller, yarn storage device, levelling roller, yarn oiling device, static eliminator, intermediate reed, end break detector	1
2	Warping creel for 608 ends with tension regulator, end break detection	1
3	Raschel knitting machine of E 9 or E 12 gauge, 130-inch working width with warp let-off device, pattern drive, fabric take-up batching device	1
4	Sectional beams	50
5	Beam lifting and transport trolley	1
6	Weighing equipment	1
7	Yarn testing equipment	1
8	Hand-tools for making-up department	1
9	Air-humidifying equipment	1
	FOB-price for machinery and equipment approx.	US$ 350,000.00

Required Buildings and Areas

Store rooms	300 sq.m
Production room	250 sq.m
Facilities	150 sq.m

Manpower at 2-shift operation

Manager	1
Administration and stores	7
Technicians	2
Skilled operators	3
Unskilled helpers	4
	17

Required Power and Utilities

Required power	35 kW
No water, no oil required for production purposes	

Required Raw Materials

5.1 Example 1

Knitting stitches	8.6/cm
Weight	500 g/sq.m
Efficiency	80%
Production	approx. 28 running m/h
Width	3 m
Total weight per hour	28 × 3 × 0.5 = 42 kg
Waste	3%
Raw material per day of 2 shifts	42 × 16 × 1,03 = approx. 700 kg

5.2. Example 2

Knitting stiches	4.8/cm
Weight	1,080 g/sq.m
Efficiency	80%
Production	approx. 50 running m/h
Width	3 m
Total weight per hour	50 × 3 × 1.08 = 162 kg
Waste	3%
Raw material per day of 2 shifts	162 × 16 × 1.03 = approx. 2,670 kg

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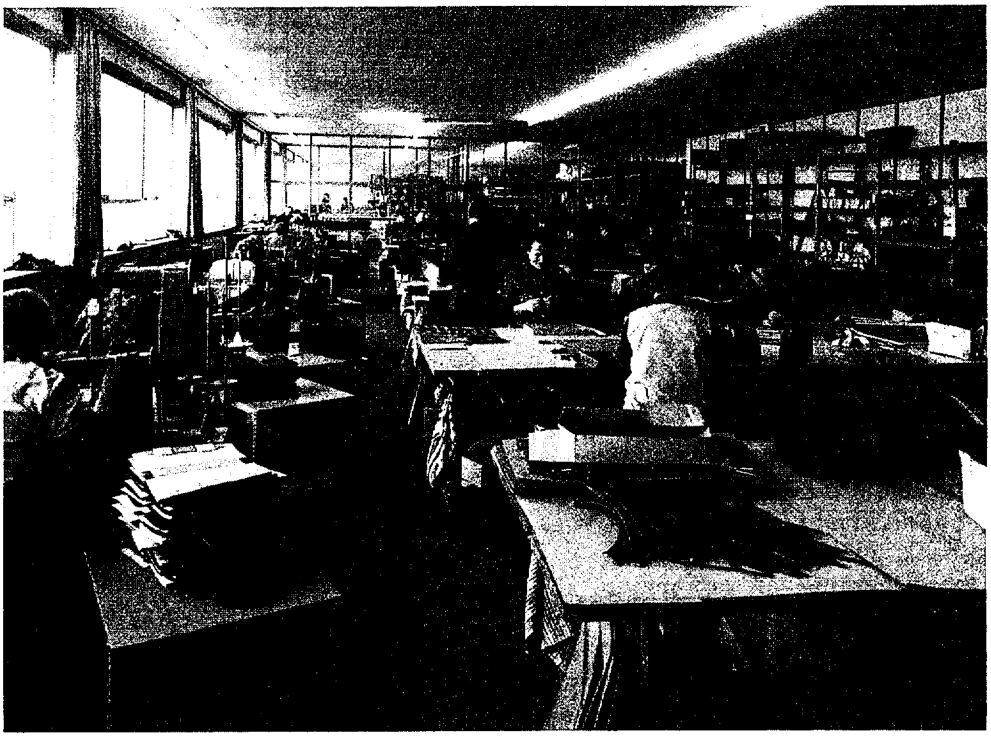
C

File: C 13
ISIC CODE 3233

How To Start Manufacturing Industries

Leather Bags



Introduction

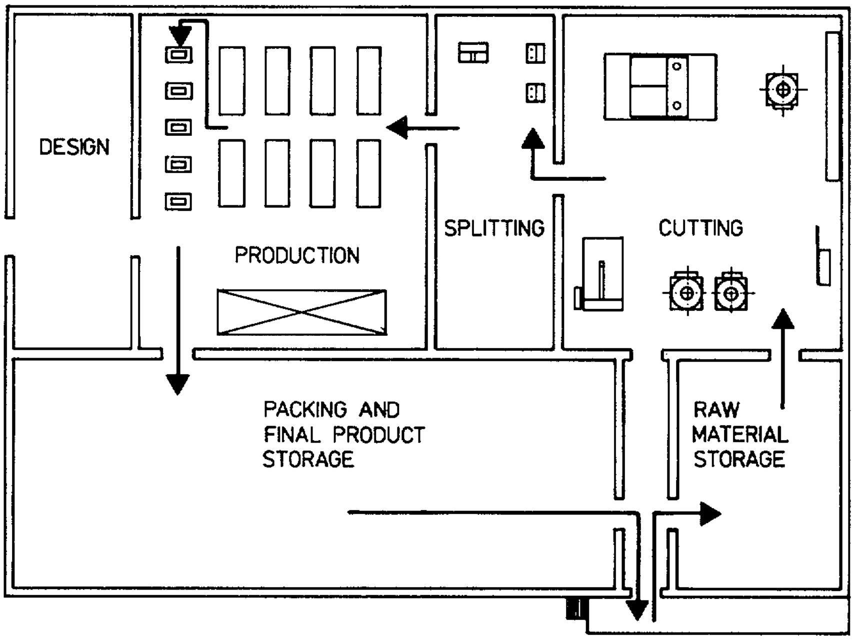
From the earliest times of mankind bags from the hides of wild and later domesticated animals have been manufactured to be used for collecting and carrying fruit or game or whatever there was collected or killed. Nowadays it is mainly the hides or skins of cows, sheep, goats, horses, pigs, some kinds of fishes and reptiles that are used for the production.

In former times its intended use determined form, shape and kind of material of a bag, whereas nowadays fashion is the main factor in its design.

The production of bags is a craft requiring certain numbers of skilled staff who are trained in careful and precise working and have developed a feeling for form and material.

The described production plant has been laid out for the average production of 1,000 bags per week.

Plant Layout:



Description of the Production Process

The production of a new bag begins with a design-study carried out by the designer. The fashion trend will determine design and choice of materials. Drawings are made and sample bags manufactured from paper. When a bag is selected, its paper parts are used to prepare punching tools. In the actual production process these will punch the individual parts of the bag, such as fronts and back, gussets or lining.

Prior to the beginning of production, the leather hides to be used, must undergo a careful inspection and classification. Usually there are three leather-categories: The best quality – mainly the back part of a hide – is exclusively used for fronts, the second best turned into backs, gussets, straps or handles. Tears, scars or even insect bites considerably impair a leather, and this third-rate quality may be used for small leather goods, the production of which is not gone into in this description.

When the parts of a bags have been punched out, the leather is split and ground. Where the parts are to be sewn, they are folded in and glued. Sewing is done with the parts turned inside out, and in this position the lining is sewn in, too. Then the bag is turned again, now presenting itself from the "right side", the outside. According to the design, frame, rivets or fittings are applied.

All finished bags must pass a strict quality control. This is followed by a careful cleaning. Finally every bag is stuffed with tissue paper and packed for dispatch.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Punching machines	6
2	Quilting machine	1
3	Saw	1
4	Grinding machines	2
5	Splitting machine	1
6	Riveting machine	1
7	Cutting machine	1
8	Folding machines	2
9	Hand tools	20 sets
10	Sewing machines	15
	FOB-price for machinery and equipment approx.	US$ 600,000.00

Required Buildings and Areas

Administration	300 sq.m
Production	800 sq.m
Storage raw material/final product	800 sq.m

Required Manpower

Management	2
Administration	8
Foremen	2
Quality control	2
Skilled workers	30
Unskilled workers	6
	50

Required Power and Utilities

Electricity	80 kW

Required Raw Materials
for the manufacture of 1,000 leather bags

1. Leather	450 sq.m
2. Adhesive	8 kg
3. Yarn	3,000 m
4. Lining	350 sq.m
5. Accessories zips, buckles, bolts, buttons, etc.	according to design

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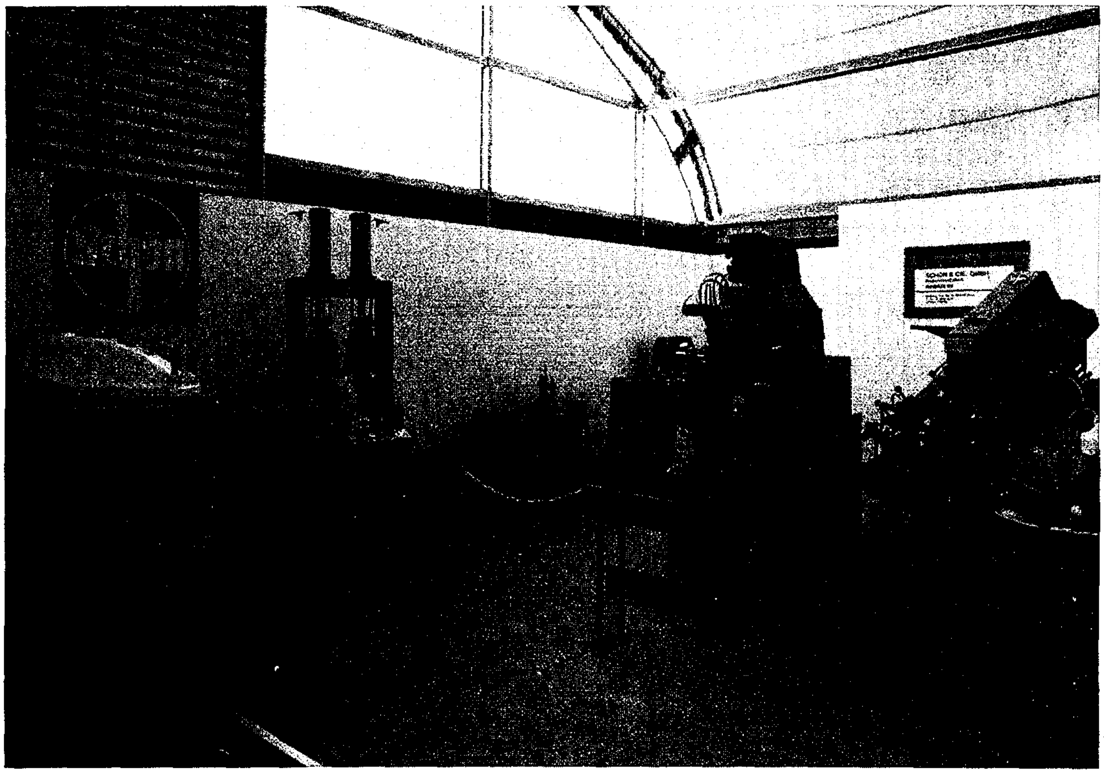
File: C 14
ISIC CODE 3240

How To Start Manufacturing Industries

Leather Shoes



Introduction

Right up to the first half of the 19th century, shoes were exclusively made by hand with tools such as curved awls, hammers, chisel-like knives, scapers, spoke-shaves and drawknives – tools that had been in use as early as 1,300 B.C., as excavations have proved. The first real step toward the mechanization of shoe production was the invention of a "rolling machine" in 1845. That machine was used to soften leather and improve its wearing qualities. In the following year an invention by no means confined in its effects to the shoe industry, proved to be a milestone in the production-line manufacture of shoes: the first functioning sewing machine. Its successful adaptation marked the beginning of a rapid series of inventions and improvements in the shoe production that has continued up to the present day.

The production plant described on the following pages is laid out for the production of 500 pairs of shoes in 8 hours.

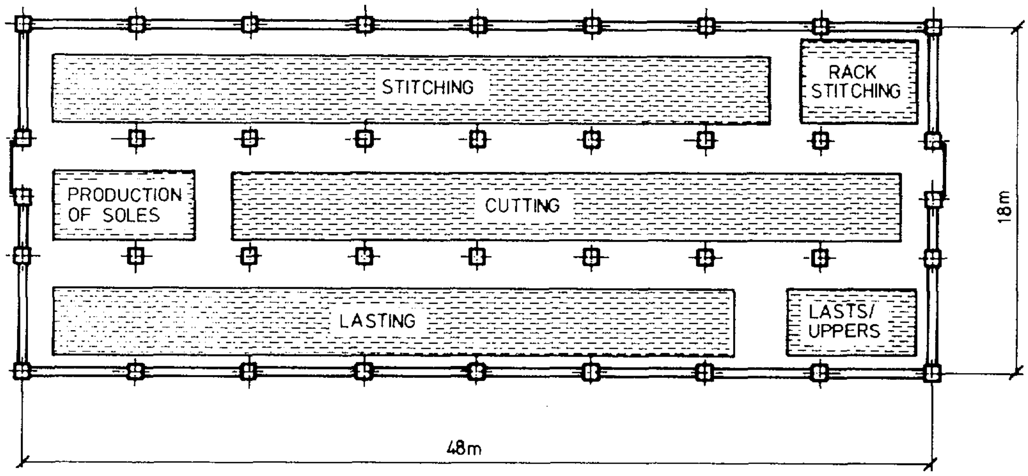
Description of Production

Production begins with the sorting and grading of the tanned leather. Leather for uppers is sent to the cutting room where the separate parts of uppers and the lining are cut out. Upper parts are taken to the fitting room where they are assembled and stitched to form completed shoe uppers. In addition to that, several operations are performed in this department: the stitching of the various parts of uppers and lining in their proper sequence, cementing and folding or finishing the edges of vamps, quarters, tips and other parts, the insertion of eyelets and application of buckles, etc., just as the design specifies.

Meanwhile the other required commponents such as insoles and outsoles have to be manufactured. The next step is to bind the outsole, the upper and the insole. The upper is formed over the last and temporarily fastened to the insole by means of staples, tacks or cement. Before the permanent-bond cement is applied, the surface must be roughened. The cement is applied to the surface and activated by heat. The shoes are clamped into a sole-attaching machine. Bonding is accomplished by hydraulic pressure.

Final operations are the cleaning, ironing and polishing of the finished shoes. They undergo a final quality control before they are taken to the packing department.

Plant Layout



Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Upper cutting and preparation section	1
2	Closing section	1
3	Bottom cutting and preparation section	1
4	Fastening and finishing section	1
5	PVC injection machine with cooling unit and moulds	1
6	Auxiliary equipment	
	plastic lasts	200 pairs
	insole and outsole knives, upper cutting knives and knives for smaller parts	6 sets
	FOB-price for machinery and equipment approx.	US$ 450,000.00

Required Buildings and Areas

Administration	50 sq.m
Production	380 sq.m
Storage	76 sq.m
Workshop	16 sq.m

Required Manpower

Administration	3
Production manager	1
Senior foremen	2
Mechanic	2
Storekeepers	3
Skilled workers (production)	25
Unskilled workers (production)	35
	71

Required Power and Utilities

Electric power, installed	58 kW

Required Raw Material
(basis: 1 pair of shoes)

Upper leather	2.2 sq.f.
Lining leather	1 sq.f.
PVC soles	0.250 kg
Insoles	0.150 kg
Sewing thread	25 m
Adhesive	0.025 kg
Eyelets	12 pieces
Tacks	0.008 kg
Counters and toe puffs	0.080 kg

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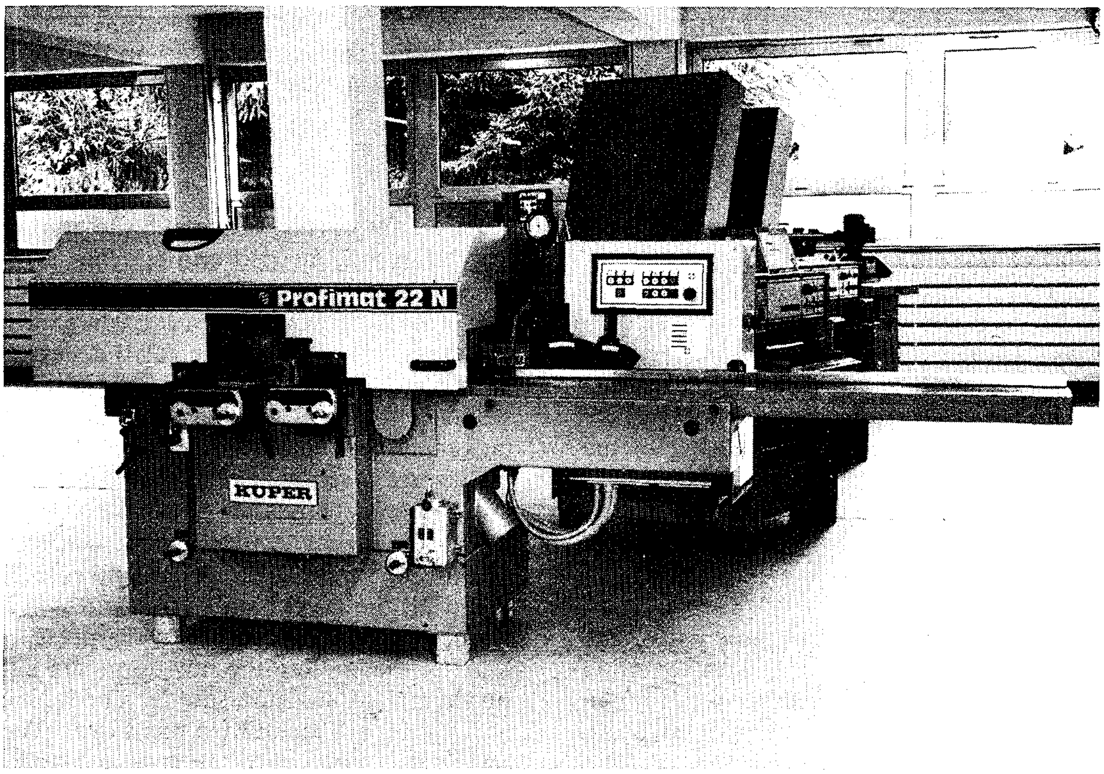
D

File: D 8
ISIC CODE 3311

How To Start Manufacturing Industries

Window and Door Production



Introduction

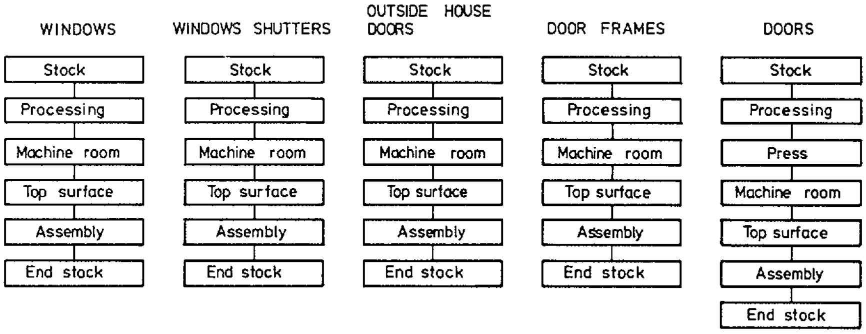
Doors and windows are important building elements, and it is a great advantage for the building industry when these elements are produced on an industrial scale. Manufacture in small workshops means rather expensive products, whereas the use of special machinery in larger plants reduces production costs and supplies the market with well priced elements. The plant described here is of medium size. Its daily output of 50 windows, 50 pairs of folding shutters, 5 house doors, 50 door frames and 50 room doors will be sufficient to provide 5 new houses with those essential elements.

Descriptions of the Production Processes

Windows

After the drying process the wood is cut into lengths 2, divided and cut into rails 3. It is planed on the foursided moulder 10, on the surface planer 8 and thicknesser 9. The rails go to the mortising, tenoning and length profiling and also to the sanding sections. The holes are mortised for the middle frame rails 15, and the fitting holes are drilled. The frames are glued 16, the wings go to the outer profiling 14 and with the frames for surface treatment are transported

Production flow



to be dipped and dried. Finally the fittings are mounted 27, 28.

Window shutters

After the drying process 1 the wood is cut into lengths 2, divided and cut into rails 3. They are planed on the four-sided moulder 10. The wood frames and slats are cut lengthwise to exact measures 6 and go on to be mortised and tenoned on the moulder 13. The frames for the slats are grooved 11, and the slat ends are squeezed on both sides 12 for better fitting into the grooves.

The window shutters are glued in the frame press 17 and dipped and dried 30 for surface treatment. The last step is the mounting of the fittings 28.

Outside house doors

The working sequence is the same as for the window shutters up to mortising and tenoning on the moulder 13. The mortising on the longitudinal frame pieces is carried out with the chain mortiser 15. The solid filling is glued 17 after pre-planing 9 and joining 8. It is cut to size 23, fine-planed 9, profiled 13, sanded 19 and goes together with the frame parts on to the glueing section 17. Surface treatment 30 and end assembly 27, 28 conclude the process.

Door Frames

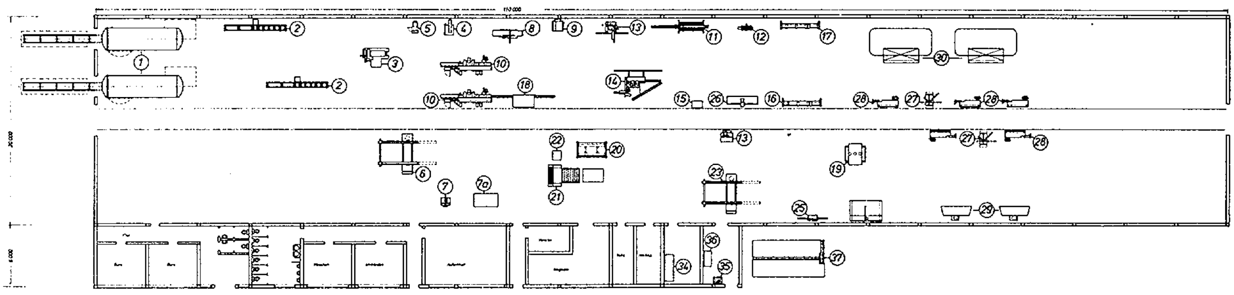
The working sequence is the same as for the window shutters up to the section where the upright frame parts are rebated on the moulder 13. After being sanded 19 and painted the parts are assembled 28.

Doors

After the drying process 1 the timber is cut into lengths 2, divided and cut into rails 3. The air grooves 6 are made on the cross rails when they are cut to exact measures. They move on to the cross grooving section for the slats 7. These are lengthwise cut 6 out of fibre board or plywood 3. A tacker joins frame and slats on the tacker table. There also the lock and hinge blocks are inserted. The plywood or fibre board cross bands are passed on to the press 20 after having been cut to size 6. The stapled frames also move to the press. After one side has been glued 21, the cross bands are composed with the frames and glued together in the press.

After the cooling the raw doors are cut to size on the twin dimension saw 23. The lock holes 25 and hinges are made by a hand drill. The glazed panels are made with the special glazing moulder 24. The doors are sanded 19 and the final coat of paint is applied 29. The locks and hinges must be mounted 27, 28 and the glass strips fitted before the doors are transported into the stock.

Plant Layout



Example of the Plant

Required Machinery and Equipment

Item	Description	Pieces
1.	Solid wood processing	
	Drying chambers	2
	Cross-cut saw	2
	Multiple saw	1
2.	Machine room Moulding machines	2
	Sanding machine	1
	Surface planer	1
	Thicknessing machine	1
	Moulder	1
	Tenoning and shaping profiler	1
3.	Shutter finishing	
	Slitting cutter	1
	Upsetting machine	1
	Press	1
4.	Window finishing	
	Mortiser	1
	Drill	1
	Press	1
5.	Top surface, assembly, solid wood parts	
	Dipping pools with overhead hoist	2
	Carpenter's benches	2
	Mitre circular saw	1
6.	Door finishing	
	Twin dimension saws	2
	Radial saw	1
	Tacker table	1
	Press	1
	Moulder	1
	Lock insertion machine	1
	Glazing moulder	1
	Sanding machine	1
	Spraying walls	2
	Carpenter's benches	2
	Mitre saw	1
7.	Tool maintenance	
	Sharpening machine	1
	Working bench	1
	FOB-price for machinery and equipment approx.	US$ 1,100,000.00

Required Manpower

Commercial Manager	1
Technical factory manager engineer	1
Secretary	1
Foremen	2
Skilled workers	35
Unskilled workers	10
Fitter and tool service man	1
Electrician	1
	52

Required Area

Production area	approx. 2,200 sq.m
Storage	
Raw material	200 sq.m
Finished parts	210 sq.m
Facilities	375 sq.m

Required Power and Utilities

Electrical power	530 kW

Required Raw Materials (1 month)

1.	Solid wood	200 cu.m
2.	Hard board panels/plywood	10,000 cu.m

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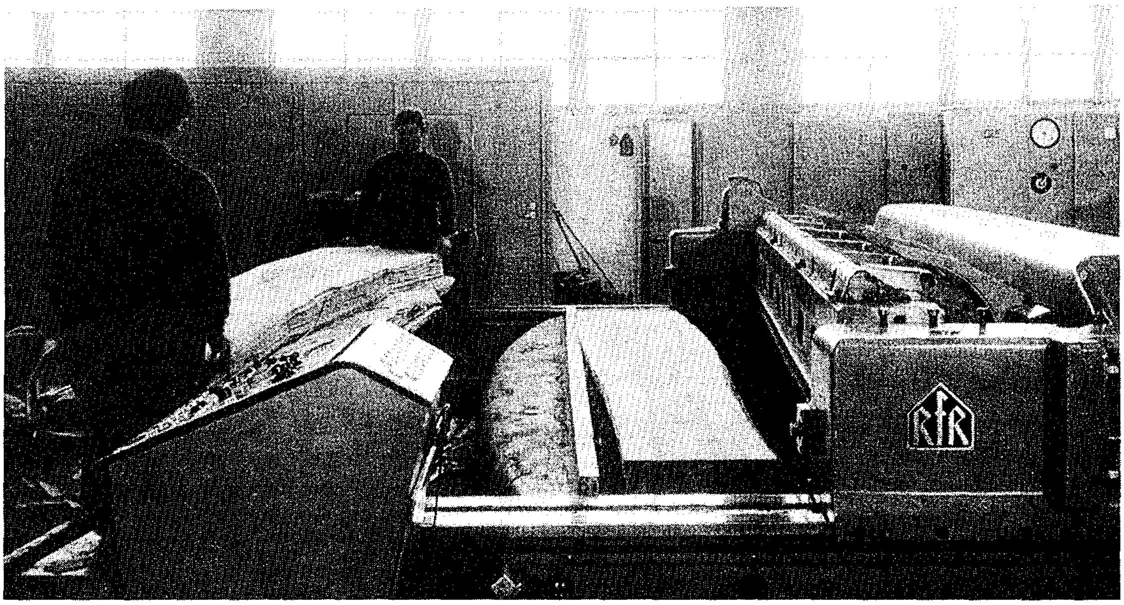
File: D 9
ISIC CODE 3311

How To Start Manufacturing Industries

Veneer Manufacturing



Introduction

Although nowadays the use of veneer has spread all over the world to an extraordinary extent and the production of veneer developed into a significant industrial branch, the first beginnings of this craft date back as far as to the early history of man. When the sepulchral chamber of Tut Anch Amon of the 18th Dynasty of Egypt was disclosed, evidence was found that the artisans of the time of 1350 B.C. had mastered the craft of veneering. We also know masterpieces of the Hellenic times of Greeks and Romans.

However, up to modern times veneering as inlaid work was a mere craft. It was the technical development of the 19th century that also brought immense progress to the production of veneer. The ever-increasing demand of large parts of the population for a refined style of living and the possibilities offered by a technology that developed in leaps and bounds, also opened vast chances for the establishment of an industry that produced veneer.

The various uses of veneer had also multiplied in the course of time in accordance with the development of industrial manufacture of furniture, interior design, decoration, cars and vehicles, ships, aircraft. Decisive for this breakthrough of industrially manufactured veneer were the low price, relatively easy handling and the scarceness of luxury- or hardwood. The described production line consisting of the machine units slicer, veneer drier and clipper, are laid out to handle 20 cubic meters per shift.

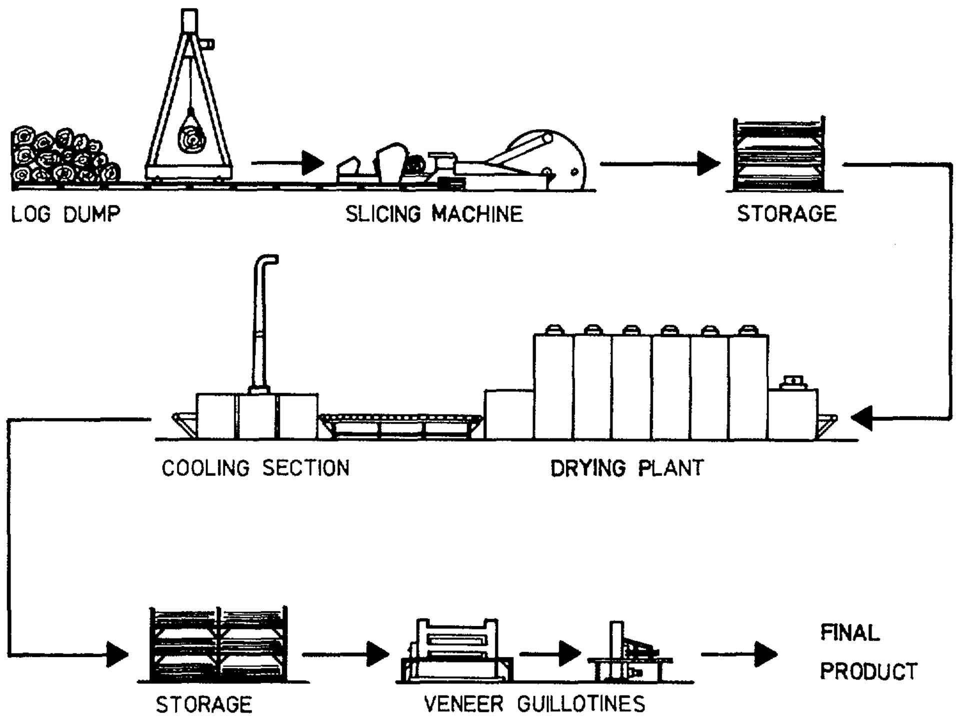
Description of the Manufacturing Process

For the production of luxury-wood veneer mainly hardwood of fine colouring and interesting grain is used.

These are the kinds of wood that are most frequently used for veneering:

in Europe	oak, maple, ash, birch, nutwood, pear, plum, cherry
overseas	mahogany, teak, macoré, jacaranda, and others

Process Flow Diagram



Contrary to metal, wood is a living material following its own laws, and its processing requires specific knowledge on how to prepare the wood and set the tools and machinery.

The first step of manufacture is done at a so-called slicer. This machine is laid out for a cut-length of up to 4 m at a veneer thickness of 5.2 mm at most. The block to be measured is clamped down by a clamp activated by an electric motor. The maximum cutting capacity is 60 cuts per minute. The product is discharged by a discharging device which also prevents ruptures. The cut sheets of veneer must have the following properties:

- they must not show the slightest irregularities;
- the product must be free of nodges;
- it must have a smooth silky surface;
- the sheets of veneer must be unstained.

The drying and cutting play an important part in every veneering plant. The classic drier for luxury wood is a jet aerated belt drier. The jet aereation is achieved by radial fans with the jets guaranteeing a high speed and even distribution of the air over the entire surface of the veneer. Apart from the drying of the product and simultaneously with the drying, a so-called ironing effect is achieved, which actually means a straightening of the veneer.

Despite all rationalization, the processing of high-quality veneer remains a predominantly manual procedure. The simultaneous cutting of the veneer packages and judging their quality by the personnel is the main factor for the optimum evaluation of the veneer. Longitudinal and cross-cut guillotines have been foreseen in the plant to keep the process flow smooth and disturbance-free.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Veneer slicing machine	1
2	Veneer drier	1
3	Cross-cut guillotine	1
4	Longitudinal cut guillotine	1
	FOB-price for machinery and equipment approx.	US$ 775,000.00

Required Manpower

Commercial manager	1
Technical factory manager	1
Secretary	1
Foreman	1
Quality control	1
Workers	7
Helpers	5
	17

Required Area

Production area	1,240 sq.m
Storage	520 sq.m
Facilities	260 sq.m

Required Power and Utilities		Required Raw Material	
Electrical power	approx. 100 kW	Round timber	20 slid metres/shift
Compressed air	approx. 10 cu.m/hr		
Steam at 16 bar	approx. 1,100 kg/hr		

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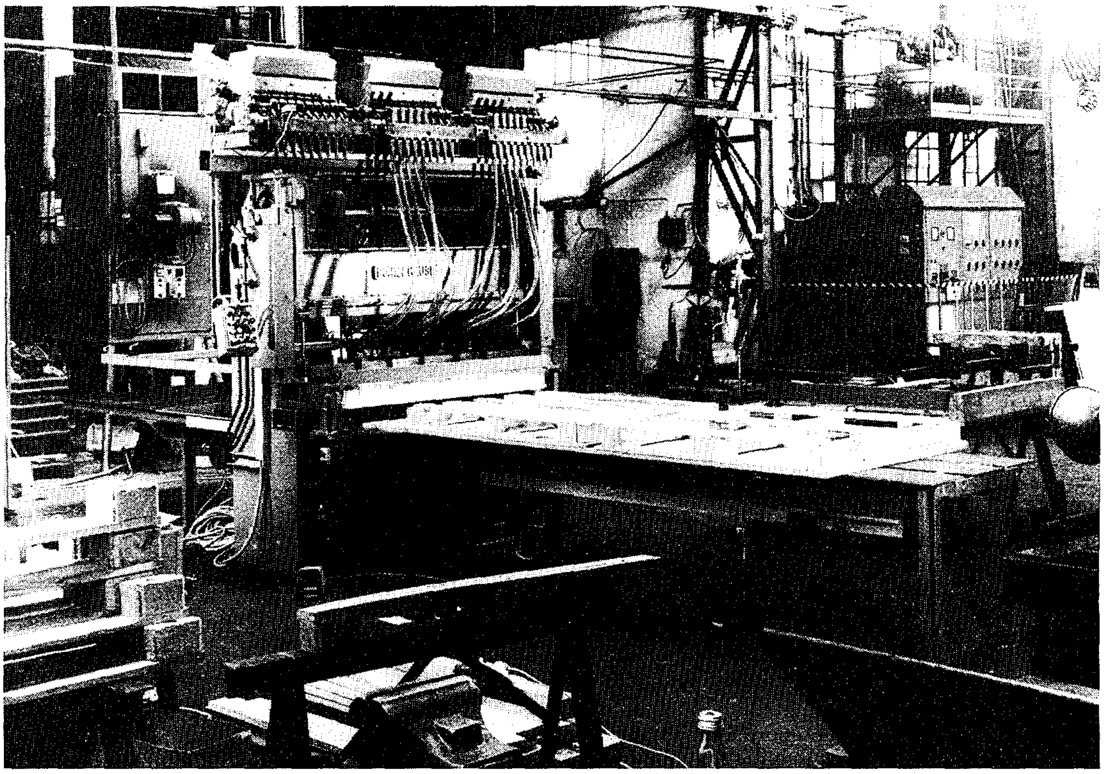
File: D 10
ISIC CODE 3319

How To Start Manufacturing Industries

Pallet Manufacture



Introduction

A pallet is a portable platform which allows the collection of different or uniform packages to form a unit for transport or storage.

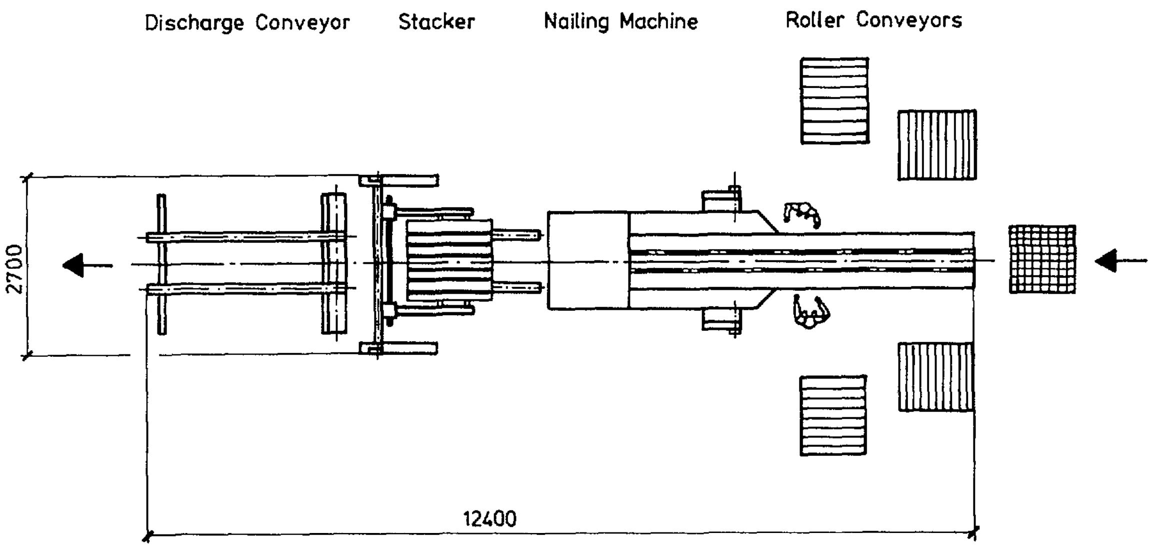
First of all pallets are used for handling by forklift trucks, but they can also be turned over by cranes or lifting tables. The pallet is the ideal transport medium for internal and outside use. It is assembled from boards, blocks or bearers, so that the forks can either enter from all sides (four-way entry block pallet) or from two sides only (two-way entry bearer pallet).

The boards, bearers or blocks in correct sizes are obtained from a sawmill. They can be cut from materials of minor quality which otherwise cannot be used for high-quality articles (furniture, building, flooring, etc.).

Description of the Process

A forklift truck transports on pallets the timber which has been cut to size, to roller conveyors from where an operator feeds the jigs with the required number and sizes of boards. Every jig has a box form of the exact international measurements corresponding with the size of the pallet. It is placed on an infeed roller conveyor to be manually moved into the nailing machine. This machine uses wire nails or screw nails/spiral nails. They are thrown into the hoppers which by their constant up-and-down movement assort the nail in the guiding rails from which they are taken off one after the other. They fall into the hammer box which is the actual nailing unit, and are pressed into the timber by the hammer rod. The precise downward movement of

Plant Layout:



the hammer guarantees that the nails are driven in to an even depth. The driving depth of the nail head is adjustable.

When nailing is completed, the jig is moved back and the semi-nailed part is turned upside-down. Once more it is placed on the conveyor to have the second layer of boards fixed without the jig.

In the case of the four-way entry pallets, the blocks, crossboards and deckboards are laid into the jig and nailed, which procedure is followed by the second operation to fix the bottom boards.

Nailing finished, the pallet moves on to be received by the stacker which stacks the pallets to a pre-selected height. When it is reached the stack is transported to a discharge roller conveyor.

This is the simplest type that is used for non-returnable pallets and two- or four-way entry pallets made of softwood where no pre-drilling for nail holes is required.

When pre-drilling is necessary as to prevent the splitting of the wood by nailing, a multi-spindle boring machine is placed between the infeed roller conveyor and the nailing machine.

This system of semi-automatic manually influenced production can be turned into a fully automatic and continuously operating one in such a way that the machine is fitted with a chain drive for the automatic movement of the jigs and a return line added in parallel to the machine-line.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1.	Fork lift trucks	1
2.	Roller conveyors for storing raw materials on pallets	6
3.	Pallet nailing machine	1
4.	Jig, adjustable	2
5.	Pallet stacker	1
6.	Discharge conveyor	1
7.	Discharge roller conveyor	1
	FOB-price for machinery and equipment approx. US$	110,000.00

Required Manpower

Manager	1
Secretary	1
Foreman	1
Skilled worker	2
Unskilled worker	2
Driver for fork lift truck	1
	8

Required Area

Production Area	180 sq.m
Storage	150 sq.m
Facilities	50 sq.m

Required Power and Utilities		Required Raw Material	
Electrical power AC 380 V, 50 c/s, 3-phase	40 kW	for 21 pallets with basis having dimensions of 1,200 × 800 mm	
		1. Wooden material	1 cu.m
		2. Nails	1,600 pcs.

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File: D 11
ISIC CODE 3320

How To Start Manufacturing Industries

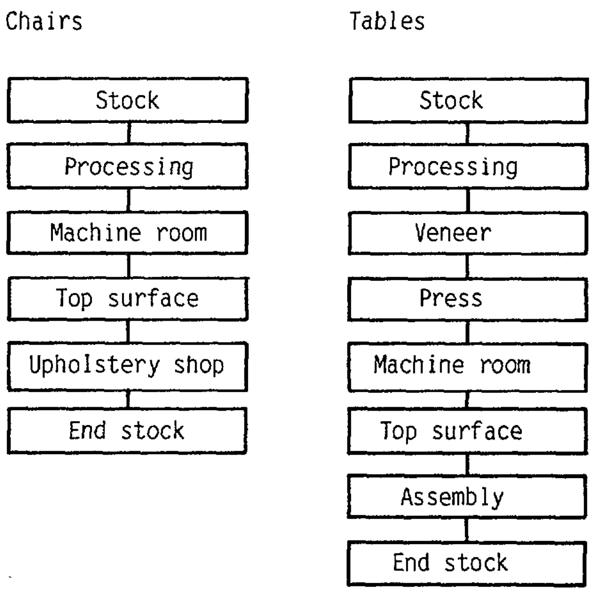
Chair and Table Manufacturing

Introduction

It is needless to say that chairs and tables are essentials even in modestly furnished living quarters which means that there will always be an open market for these goods. Industrial production means high production figures and low selling prices compared to those articles that are manufactured in workshops. The kind of wood that is to be used for the production can be chosen according to the wishes and likings of the customership and also to those sorts of timber that are grown in the country.

The factory described herein has a medium output, namely 50 chairs and 20 tables per day.

Production Flow-sheet:



Description of the Production Process

Chairs

After the drying process (1) the wood is cut into lengths (2) and then separated (3) or cut into form on the belt saw (13). The straight parts are planed on the four-sided planer (7) and profiled. The shaped parts, back legs and backrests pass through the surface planer (3) and the thicknesser (4), are cut into lengths (7) and transported to the twin moulder (11) for form moulding or they are moulded on the moulder (10). According to design, the cross profiler (12) gives the pieces their required shape. When round parts are required they will be turned on the lathe (9). The frames and backrests get their ends finished on the cutting – moulding – drill – and dowel fitting machine (14). The dowel hole borings in the rails are made by the multiple spindle drilling machine (15). Sanding operations on surfaces, edges and round parts are carried out on the sanders (16, 17, 18, 19). The next step is glueing, done on the frame press (20). From there the chairs are transported to be surface-treated and stained, furthermore they get their painting, intermediate sanding and top-coat painting (21, 22, 23). For the upholstery the chair seat panels are cut (30), notched on the moulder (9), and they get their edges fitted before the actual seating upholstery is made at the working spaces.

The finished chairs are taken to the storage.

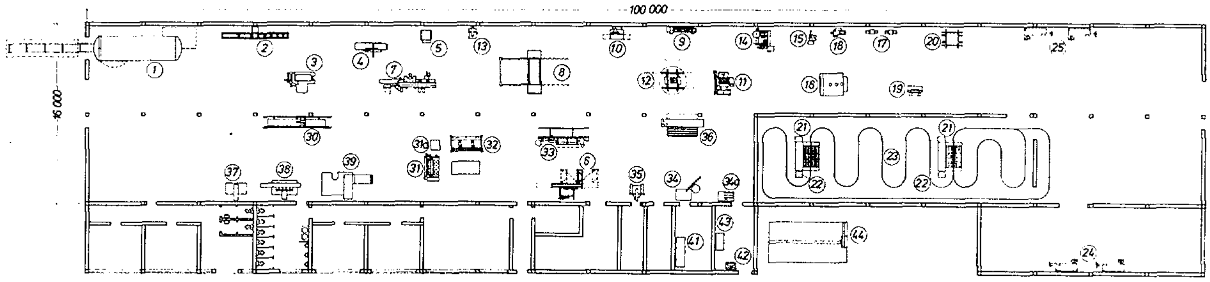
Tables

The table legs and frames follow the same working procedure as the chair parts (1 – 23). The table tops are manufactured in the following manner: They are cut out (30). The veneer is cut into lengths (37), jointed (38), joined (39) and pressed onto the carrier panels in the press (31, 32). The panels are cut to size (5, 7). Glue edging (33) is the next step. For round tops the form is moulded on the surface moulder (35) and the edges are glued on in the edge glueing machine (34) and trimmed on the trimming machine (34a).

All forms of table tops are sanded off (36) before they undergo the final surface treatment: staining, primer painting (21), intermediate sanding and top-coat painting (21).

Finally the tables are assembled (25) and transported to the storage.

Plant Layout:



Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1.	Solid wood processing	
	drying chamber	1
	cross cut saw	1
	multiple saw	1
2.	Machine room	
	moulding machine	1
	surface planer	1
	thicknesser	1
	bandsaw	1
	twin dimension saw	1
	moulder	1
	turning lathe	1
	cross moulder	1
	twin cross moulder	1
	cutting moulding dowel hole borer	1
	multi-spindle dowel hole borer	1
	wide belt sanding machine	1
	curve sanding machine	1
	profile sanding machine	2
	edge sanding machine	1
3.	Chair finishing	
	frame press	1
4.	Top surface	
	lacquer device	2
	airless units	2
	overhead rail	1
5.	Upholstery	
	carpenter's benches	2
6.	Board finishing/Table finishing	
	board dividing saw	1
	veneer cross cutter	1
	veneer joining machine	1
	glue applicator	1
	hydraulic press	1
	sizing saw	1
	edge glueing machine	1
	routing cutter	1
	glueing machine for round edges	1
	edge routing machine	1
	belt sander	1
7.	Assembly	
	carpenters' benches	2
8.	Tool maintenance	
	sharpening machine	1
	workbench	1
	FOB-price for machinery and equipment approx.	US$ 820,000.00

Required Manpower

Commercial manager	1
Technical factory manager engineer	1
Secretary	1
Foremen	2
Skilled workers	20
Labourers	8
Fitter and tool service man	1
Electrician	1
	35

Required Area

Production area	approx.	1,720 sq.m
Storage		
raw material		160 sq.m
finish material		160 sq.m
Facilities		360 sq.m

Required Power and Utilities

Electrical power	370 kW

Required Raw Materials (1 month)

1. Solid wood	50 cu.m
2. Particle boards	850 sq.m
3. Veneer	1,800 sq.m

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E

How To Start Manufacturing Industries

Roofing Felt Production

Introduction

Roofing felt and torching felt based on bitumen stand out as excellent materials to cover concrete or wooden roofs with different slopes. Unusual slopes, roof sizes and very large areas on halls, shed-roofs, dome-shaped roofs, building sealings, bridges and tunnels, too, can be permanently covered or sealed by this bitumen product. It must be emphasized that this product allows easy handling and represents a low-weight covering at low cost.

Product Description

The product is delivered in rolls of 10 – 15 – 20 m lengths and 1 m width geared to market requirements.

The weight ranges from 1 kg/sq.m to 6 kg/sq.m dependent on the thickness of the sheet which can be 1.5 mm to 5.0 mm.

The material is heat-resistant at temperatures of up to + 85 °C and resistant to cold down to approx. – 10 °C.

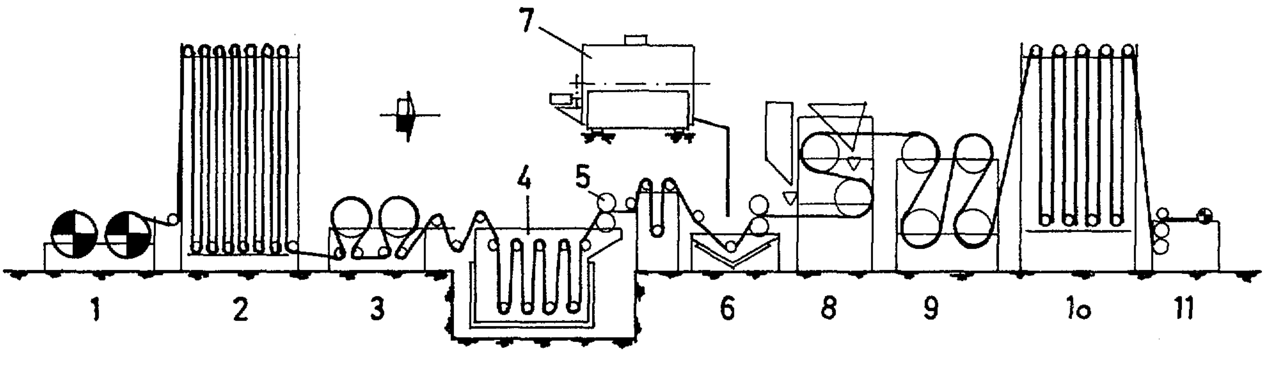
The described plant is designed for a capacity of 500 to 800 sq.m per hour.

Description of the Process

Roofing felt and torching felt are produced on a continuous production line in the following steps. The reel-off stand (item 1) carries the rolls of carrier materials such as:

- rack felt made of wastepaper and waste wool, weight 300 to 600 g/sq.m, roll weight 300 to 600 kg;
- jute, length of roll approx. 600 m;
- glass-vleece made of glass fibre fixed with synthetic resin, roll length 1,000 m with a weight of 50 g/sq.m;
- woven glass, length of roll 1,000 m and weight 170 g/sq.m to 220 g/sq.m; this material is impregnated in order to reduce capillary absorption.

Flow Sheet: Roofing Felt Production line



At this station the rolls are spliced in order to keep the line in trouble-free continuous running which requires a raw material looper (item 2). It contains such quantities of raw materials as are needed in the time that splicing is achieved. As the carrier material, especially rack-felt and woven glass, contains moisture, it must be heated by means of heated cylinders in the pre-heating unit (item 3) which effects the sheet pulling as well.

The rack-felt carrier, and only this kind of material, must be impregnated by bitumen as to prevent rotting. The bitumen used must have a penetration of 50 to 200 1/10 mm and a softening point of 80 to 100 °C. It is kept at a temperature of approx. 200 °C by means of heat transfer-oil which is circulating in a double shell system at the impregnating unit (item 4).

As the sheet comes out of the bitumen bath, it passes through the impregnating calender (item 5) in order to squeeze off the amount of bitumen which cannot be absorbed by the carrier material. After having passed a short cooling section, the sheet is pulled through a coating bath (item 6) to coat both sides of the sheet with coating bitumen. The thickness of the sheet and quantity of bitumen on leaving the bath depend on the type of finished material which is made in reference to the standards of the country. The coating bitumen is prepared in the mixer (item 7) where bitumen is mixed together with filler to raise the softening point and stabilize the coating. For the filler a mineral powder is used which will not swell or dissolve in water.

After the coating bath the sheet must be covered by sand, slate or talcum to prevent sticking of the sheet when it is rolled up. This is done by the mineralizer (item 8) which applies the covering material on both sides of the sheet. According to the type of product, there can be the same quantities of mineral on both sides or they can differ. This covering also protects from ultraviolet radiation and weather effects. The sand is applied in grain sizes from 0.2 to 0.6 mm and slate in platelets of 0.6 to 1.2 mm. After the mineralizer the product is pulled through the cooling unit (item 9) where water-cooled rolls with large-diameter cool the product down from coating temperature of approx. 160 °C to handling temperatures of approx. 30 °C.

Since the product is reeled up with a discontinuously working machine it is fed into a finish felt looper (item 10) with the same function as item 2. After this station the sheet reaches the reeling machine (item 11) which reels the product up in rolls of the required length. This device is semi-automatic.

Example of the Plant

Required Machinery and Equipment

Description	*Piece*
Production line (items 1 – 11) capacity 500 to 800 sq.m/h	1
Oil heating plant and pipe work, 700 kWm light or heavy heating oil	1
Bitumen storage, 50 sq.m each, heated	2
Bitumen pump, heated	
cap. 30 cu.m/h	1
cap. 10 cu.m/h	1
Bitumen melting tank, heated, 10 cu.m only required if bitumen is supplied in solid	1
Bitumen pipe work DN 80 (4″), heated	1
Cooling water pump and pipe work, 25 cu.m/h together with a water recooling system if necessary, to supply water of 12 to 15 °C	1

FOB-price of machinery and equipment approx. US$ 220,000.00

Required Buildings and Areas

Administration	150 sq.m
Production	400 sq.m
Raw and finished material storage, tanks	1,500 sq.m
Laboratory	20 sq.m
Others	40 sq.m

Required Manpower

Management	1
Foreman	1
Laboratory	1
Workers	8 (10)
Helpers	2
	13

Required Power and Utilities

Electrical power	80 kW without water recooling
Fuel	30 kg to 60 kg/h
Water	25 cu.m/h at 12 to 15 °C

Required Raw Materials

Carrier material	1,200,000 sq.m/year
Impregnating bitumen	500 t/year
Coating bitumen	2,500 t/year
Filler	800 t/year
Surface material	800 t/year

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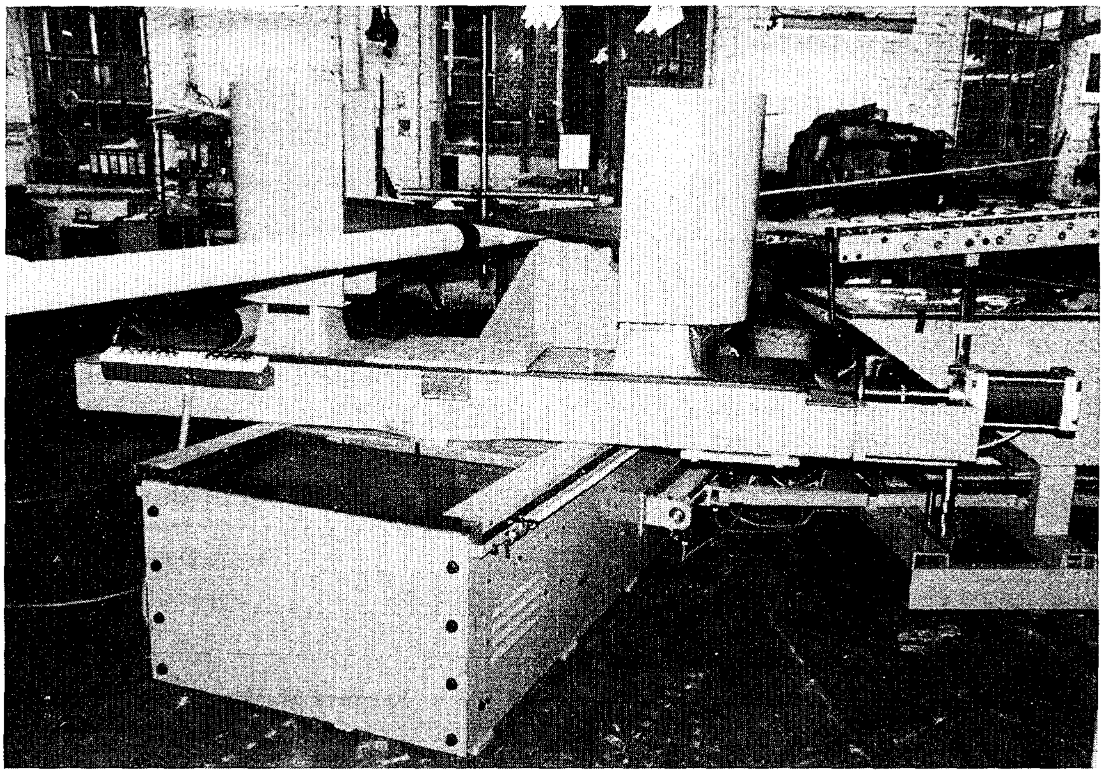
How To Start Manufacturing Industries

Paper Bobbins and Tubes



Introduction

More than 100 years ago the first tube winding machine was designed. However, convolute tube winding was very slow and could produce one tube only at a time. Hence a process had to be found to run this intermittent procedure continuously, for which a plastic extruder is an excellent example. A further advantage of such a method is that the tube can be supplied of practically endless lengths instead of one set length. The tube is cut off according to need.

The solution is called 'Spiral winding'.

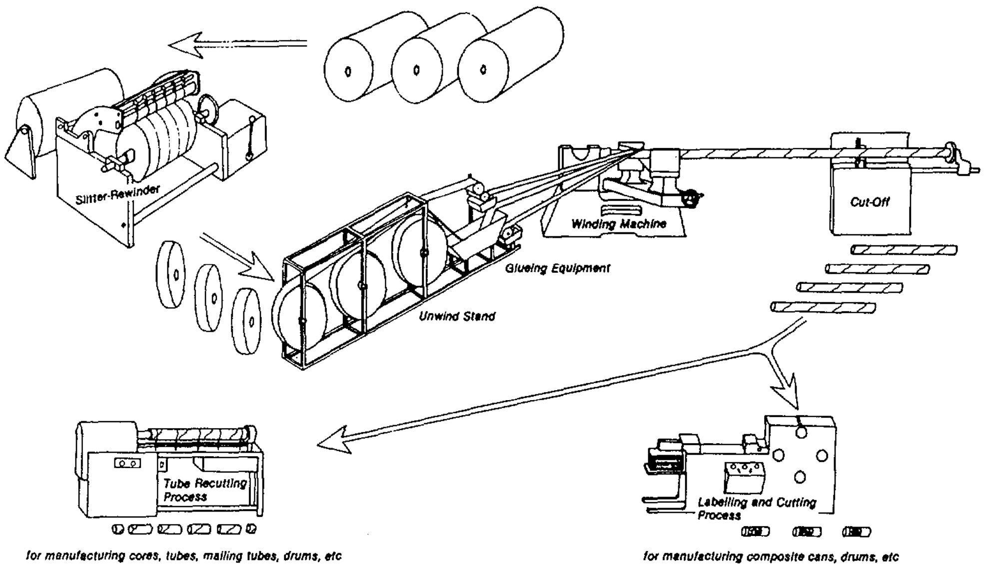
Small tubes of a few millimetres in diameter as well as large volumed barrels can be manufactured on spiral winding machines. There are tubes with only two paper layers, but some with 25 mm of wall thickness as well. The cut-off length can be 10 mm as for a roll of cellophane type, or eight metres as for winding cores needed in paper mills.

Description of the Production Process

The narrow paper webs which are necessary for tube winding, are cut on the slitter/rewinder. It is not advantageous to purchase these rolls from outside sources since the web width often changes due to tube diameter, wall thickness, etc. An additional advantage is that it is possible to buy low-price remnants trim rolls.

The webs for the winder are drawn from an unwind-stand. The paper rolls are mounted one after the other. The webs run over guides through the glueing equipment to the winding

Method of Procedure



machine. In this manner the frequency of roll changes is considerably reduced. The individual unwind sections have spare rolls that make it possible to splice rolls, while the machine is running. The inside paper webs are glued in a glue bath, while the bottom web and the cover web are either glued in single glueing units or kept dry. The glue bath can apply glue on both sides by dipping into a glue tank or one side cascade glue tank.

The essential element of tube manufacturing is the spiral winding machine. Here the glued strips are led onto a fixed mandrel. The angle between the winding belt and the mandrel is adjustable as it depends on web width, tube diameter and pitch of the spiral seam. When a second, third etc. paper web is wound over the first web and glued, a hard cardboard is the result. A winding belt wraps itself one turning round the mandrel and rotates the mounted webs helically around the mandrel.

The tube is cut to the desired lengths by a forward-moving saw or score-cut knife. During cut-off procedure the saw-head moves synchronically with the same speed as the tube until cut-off has been achieved. The tube now has the preset length. As shorter tubes are needed for various purposes, it is necessary to cut the tubes on another machine. On these tube-recutters the tube is pushed onto the mandrel where it is split by a circular score-cut knife or several knives. The tubes can be provided with a label.

After a long cardboard tube has been cut off on the spiral tube winding machine, the tube will be taken to a combined labelling and cutting machine. There it will first be wrapped with a multi-pattern picture label and then cut into the required number of tubes by means of several cutting knives.

Example of the Plant

Design Data

Output: approx. 2,000 m of core/shift
Core dia. 76/106 mm

Required Machinery and Equipment

Item	*Description*	*Pieces*
1.	Slitter rewinder	1
2.	Unwinding stand with glueing equipment	1
3.	Cut-off device	1
4.	Tube re-cutting machine	1
	FOB-price for machinery and equipment approx.	US$ 300,000.00

Required Manpower

Commercial manager	1
Technical factory manager engineer	1
Secretary	1
Skilled workers	8
Helpers	6
	17

Required Area

Production area	400 sq.m
Storage	300 sq.m
Facilities	150 sq.m

Required Power and Utilities

1. Electrical power: AC 380 V 50 c/s, 3-phase	50 kW
2. Compressed air: Consumption approx.	300 l/min

Required Raw Materials

core size, id. 76, od. 106 mm, 2,000 m/shift

1. Recycled or kraft paper	6,000 t
2. Glue	1.5 t

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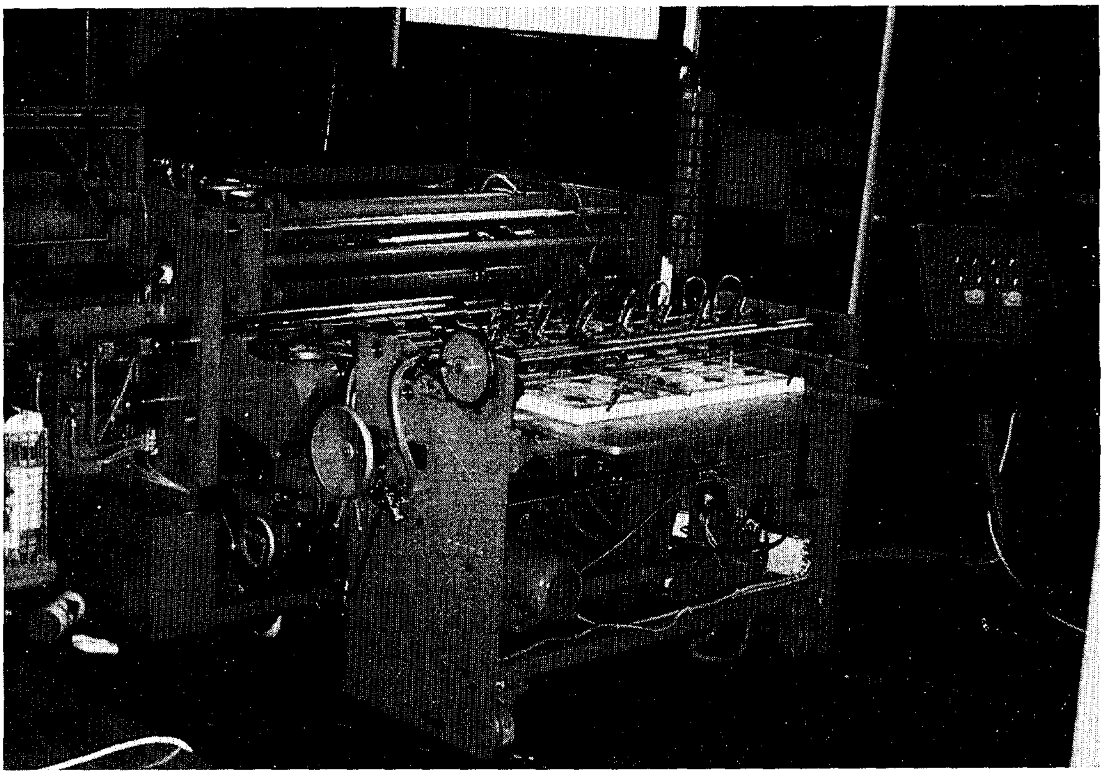
File: E 7
ISIC CODE 3412

How To Start Manufacturing Industries

Composite Container



Introduction

Composite containers sometimes are also called fibre cans or paper cans. They are considered as one-way packages that are used for filling materials having a shelf life of up to one year maximum. Their main raw material is paper or cardboard (mostly recycled paper). In other words: only few irretrievable resources will be used. This results in a price advantage of 10 to 20% compared with tinplate cans or similar packaging materials. The disposal of these containers after use does not present any problem either, since they can be burnt in incineration plants or handled by baling presses and stored in refuse pits or dumps for biological decomposition.

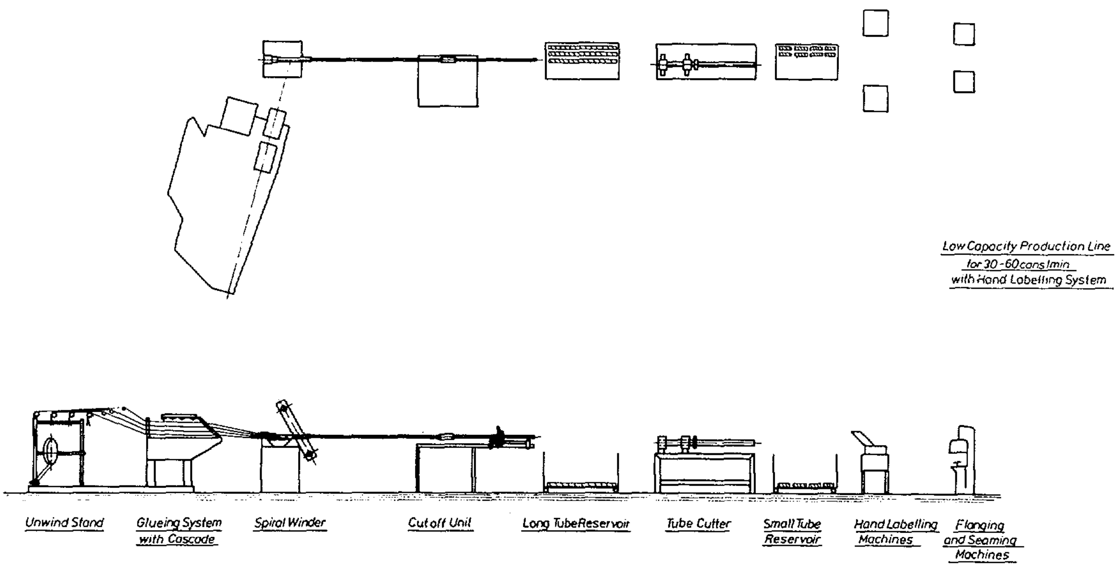
The manufacture of composite containers involves a noise-level substantially lower than the manufacture of tinplate or glass packaging for instance. Transportation, too, has its advantages where composite containers are concerned because of their considerably lower weight.

Description of the Production Process

Composite containers are made of narrow cardboard strips. The cardboard strip width should be equivalent to about 1.5 to 2.2 times the diameter of the container. For this reason the manufacturers of such containers usually have a slitter/rewinder of their own in order to be able to cut themselves the narrow rolls to size in case of need.

The paper rolls are mounted on an unwinding stand from where the cardboard strips including the inside layer are coated with glue and supplied to the spiral tube winding machine. There they are helically wound around a mandrel to

Plant Layout:



produce a spiral tube. A lubricant is applied to the inside layer to reduce friction. For the production of liquid-, water-, vapour and gas tight container bodies the inside layer is sealed at the overlapping seam by means of a hot-melt or a heat-sealing device.

Then the cardboard tube thus produced is cut into short or longer tube sections by means of one or several cutting knives. The tube sections are taken to a combined labelling and cutting machine in which the tube is first wrapped with a multi-pattern picture label and then cut into the required number of container bodies by means of several cutting knives.These container bodies are finally ejected from the machine.

The labelled container bodies are closed on one side by means of a lid or bottom in a separate machine. In most cases the lid is placed first. Such cans will be filled through the bottom which is then sealed for instance by means of combined filling and closing machines.

The plant described herein produces such containers with metal closing. This is the fasted method and done on conventional seaming machines. Here both container sides are flanged and the metal lid or bottom is fixed in position during the seaming operation. Flanging dies and seaming rollers of special design are used depending on the thickness of the container wall and the profile of the metal and curl.

However, there are other ways to close the containers, such as:

Bottoms or lids made of cardboard are fixed by means of a special machine. The lid/bottom is stamped from a cardboard strip, i. e. deep-drawn if desired and then attached to the container body.

Closing by means of plastic lids or bottoms can also be done on a special machine. In this instance the lids/bottoms are contained in a large hopper. They are assorted, supplied and fixed in the container or can body one after the other. Many cans have an aluminium membrane underneath the plastic lids and this membrance is positioned on the same sealing machine. In this case the membrance material will be coming from a roll where it is paid off, punched to shape and heat-sealed onto the container end.

The composite containers coming from the closing machine are frequently passed through a cleaning machine as well for the removal of paper dust before they are packed.

Example of the Plant

Design Data

Output approx. 6,000 cans/shift

Required Machinery and Equipment

Item	*Description*	*Pieces*
1.	Unwinding stand	1
2.	Glueing system	1
3.	Sprial winder	1
4.	Cut-off unit	1
5.	Long tube reservoir	1
6.	Tube cutter	1
7.	Small tube reservoir	1
8.	Hand labelling machines	1
9.	Flanging and seaming machine	1
	FOB for machinery and equipment approx.	US$ 250,000.00

Required Manpower

Manager	1
Secretary	1
Skilled workers	6
Helpers	4
	12

Required Area

Production area	350 sq.m
Storage	250 sq.m
Facilities	100 sq.m

Required Power and Utilities

1. Electrical power	
AC 380 V 50 c/s, 3-phase	20 kW
2. Compressed air:	
Consumption approx.	200 l/min

Required Raw Materials

per 1,000 composite containers, size 73x130 mm, closed by a metal end

1. Inside lining	32 sq.m
2. Winding paper	20 kg
3. Label paper	31 sq.m
4. Glue	3.4 kg
5. Lids	1,000 pcs.

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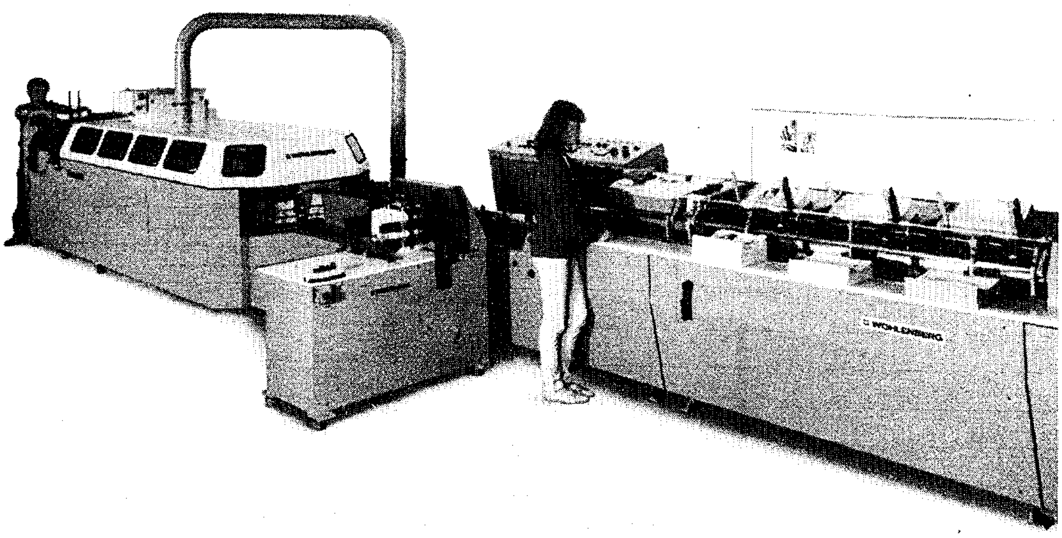
F

File: F 2
ISIC CODE 3420

How To Start Manufacturing Industries

Automatic Bookbinding



Introduction

By comparison with other media of communication, the written or printed word is a uniquely independent conveyor of culture, opinion, and information, as the content is not influenced by any advertiser or sponsor, and its physical production requires a relatively low capital investment only.

When a printed product consists of several pages, it has to be bound and finished in some way. Apart from the development of today's printing procedures, automatic bookbinding is the basis of a modern and cost-saving print-media landscape.

The plant described here is able – starting from the printed sheet – to bind pocket books, magazines or brochures.

Description of the Automatic Binding Process

The printed sheets are delivered on pallets. When books are to be bound, one has to distinguish between the cover which is printed on carton, and the printed paper sheets which will make up the book body.

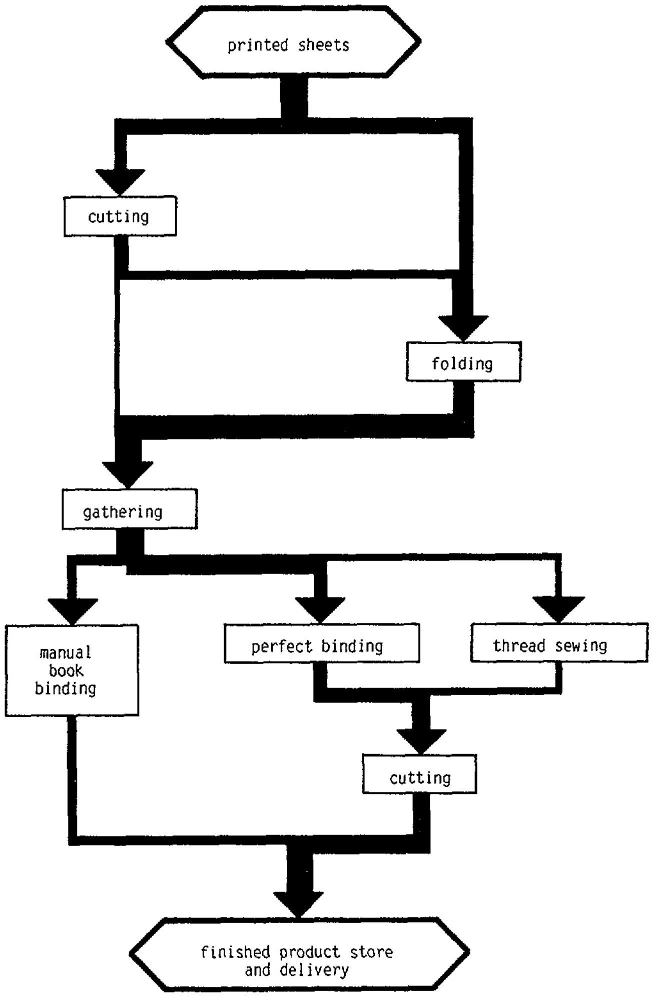
A certain number of covers and sheets that are going to make up a book, are cut. The next step is to fold the sheets. Depending on their size, pocket books or ordinary books consist of a certain, greater or smaller number of signatures.

By means of a gathering machine the signatures are brought into the correct order, and jogged. Secured in clamps with the spine downwards, they are moved on. At this stage the gathered product can be taken out if it is to be sewn.

The signatures are automatically transported from the gathering machine to the perfect binding machine. The spine is vouted and glued. The cut cover is scored, glued and fitted around book blocks automatically. The book is simultaneously transported to the three-knife trimmer and dried. The books are piled until they reach a maximum height of 100 mm.

Then the one long and the two short sides are cut. The cut books are automatically moved on to a foil wrapping machine. Finally they are manually stored on pallets.

Process Flow Diagram



Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1.	Guillotine	1
2.	Folding machine	3
3.	Perfect binding line	1
3.1	Perfect binder	1
3.2	Cooling line	1
3.3	Flow line three-knife trimmer	1
4.	Foil wrapping machine	1
5.	Thread sewing machine	1
6.	Card board cutter	1
7.	Book press	1
8.	Work tables	8
	FOB-price for machinery and equipment approx.	US$ 600,000.00

Required Buildings

Production building	180 sq.m
Storage	140 sq.m
Facilities	80 sq.m

Required Manpower

Managing director	1
Technical director	1
Skilled workers	6
Trained workers	11
	19

Required Power and Utilities

Electrical power	105 kW
Compressed air	48 cu.m/h

Required Raw Material

based on an annual output of 2.5 to 3 million books.

1.	Glue	8-11,000 kg/yr
2.	End paper	180,000 sheets, 75 x 100 cm
3.	Linen on reels	reel length 36,000 m reel width 30 cm
4.	Carbon	100,000 sheets 75 x 100 cm

File: F 2

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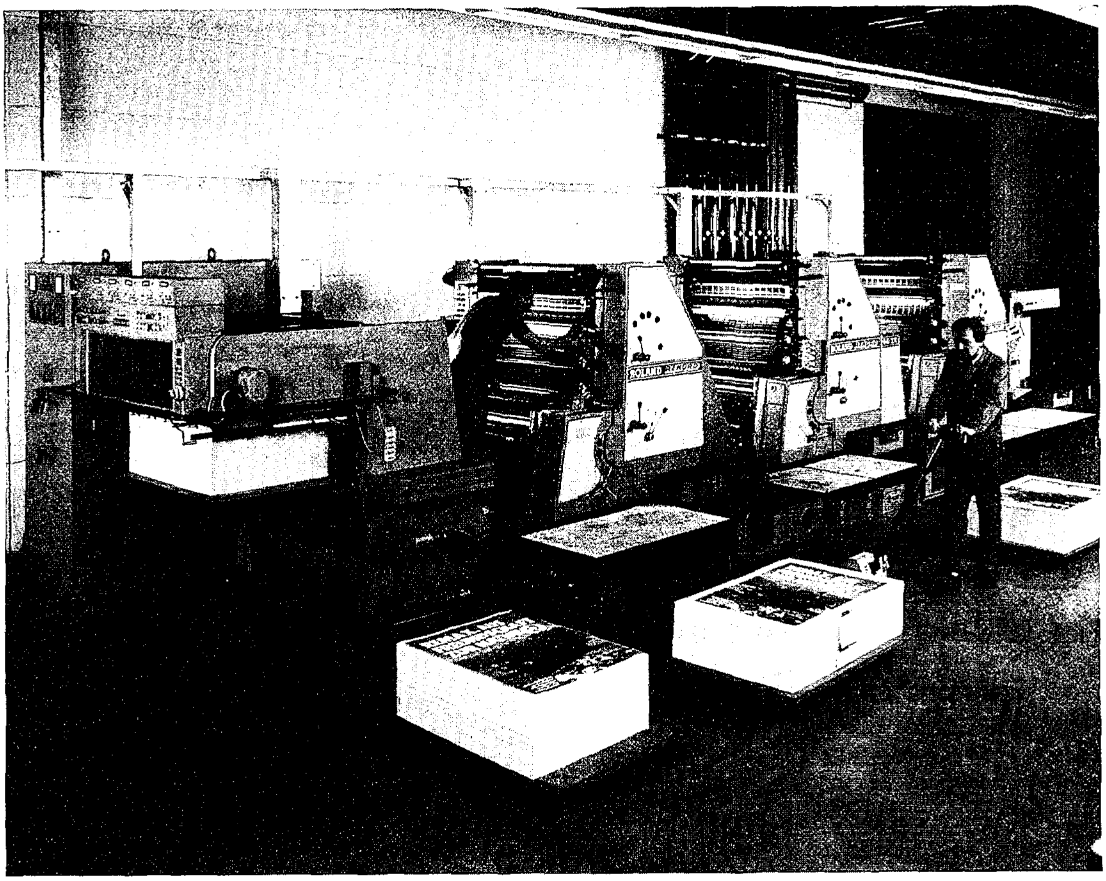
File: F 3
ISIC CODE 3420

How To Start Manufacturing Industries

Printing Plant



Introduction

Printed matter is one of the most popular media. It is the basic means of information and education. Its wide use – ranging from high-quality books and newspapers to admission tickets – reaches every area of civilization.

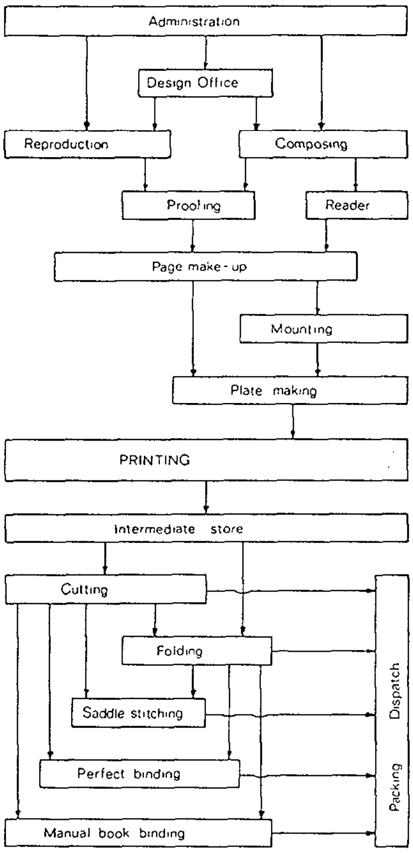
Education and information are unthinkable without school- and textbooks. In any society communication largely depends on the availability of newspapers and magazines. Variety and quantity of the printed matter available are an indicator for the level of technology and socio-culture a society has achieved.

Not all countries, however, have a satisfactory domestic supply of printed information. In recent years, efforts have increased to close this gap between demand and supply.

The major aim in this process is to secure overall supply of the public, expand those areas of industry that are already established, and gain independence of imports.

In the following, a printing plant will be described which actually exists. It only meets part of the overall demand, as everything exceeding production capacity and available quality is produced abroad and imported. The emphasis in production is the printing of books and magazines.

Process Flow Diagram:



Description of the Printing Plant

The printing plant combines different compartments for each individual production step in order to be able to manufacture the complete product. The design office is the entry to production. The future product is analyzed and the work structured according to production steps with the help of samples and drawings, the determination of headlines and layout design.

Photo-composing in the composing department supplies the basic text manuscript. Setting is done with positive or negative films that are exposed and developed. Parallel to this process, the negatives for black/white or colour pictures are developed in the production department.

According to paste-up and drawings, text parts and negatives are mounted to form the complete page. Mounted pages may consist of several film parts. The cut edges of the film parts cause a light-flash in the copying process which affects quality. That is why mounted pages are usually recopied before they are sheetmounted.

In the mounting department, the 'print sheets' are put up according to imposition layout. They are exposed in the printing down frame and copied onto a printing plate. Mostly these are positive plates. During this process the exposed parts are hardened. Non-exposed parts are washed out during the developing process. The printing plate is gummed to prevent oxidation. With the completion of the plate the preliminary printing stage is finished.

Production in the printing area is mostly carried out with the aid of multi-colour web offsets; besides, letter-presses do part of the printing and punching. After the printed sheet has been completed in the various printing stages, it is transferred to the third stage, to the finishing department. According to order, the sheets are cut, folded, glued, saddlestitched and sewn. The final product – magazines or books -is prepared for delivery.

Example of the Plant

Required Machineery and Equipment

Item	*Description*	*Pieces*
1	Photo-composing input units	4
2	Exposure	1
3	Film-processor	1
4	Horizontal camera	1
5	Vertical camera	1
6	Contact printer	1
7	Processor	1
8	Contact printer	1
9	Illumination tables	8
10	Contact printing frames	2
11	Plate processor	1
12	Burning-in oven	1
13	Four-colour printing machine	1
14	Two-colour printing machines	2
15	One-colour printing machines	2
16	Roller washing machine	1
17	Pile turner	1
18	Guillotine	1
19	Folding machines	2
20	Saddle stitching	1
21	Perfect binding	1
22	Collator	1
23	Jugging tables	2
24	Book presses	2

FOB-price for machinery and equipment approx. US$ 1,350,000.00

Required Manpower

Administration	7
Preparation	16
Printing	14
Finishing	15
Store	2
Others	4
	58

Required Area and Buildings

Administration	100 sq.m
Preparation	300 sq.m
Printing	600 sq.m
Finishing	600 sq.m
Storage	700 sq.m

Required Power

Electrical power	180 kW

Required Raw Material (per month)

Paper	720 x 1,020 mm	1,300,000 sheets
Carton/board		5,000 sheets
Ink		400 kg
Film	140 x 180 mm	5,000 sheets
Offset-plate	720 x 1,020 mm	350 sheets
Offset-plate	360 x 520 mm	100 sheets
Glue		400 kg

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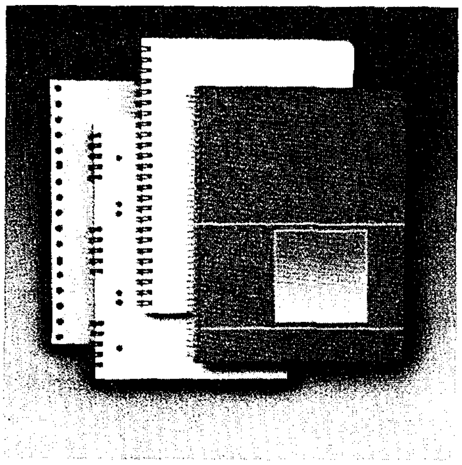
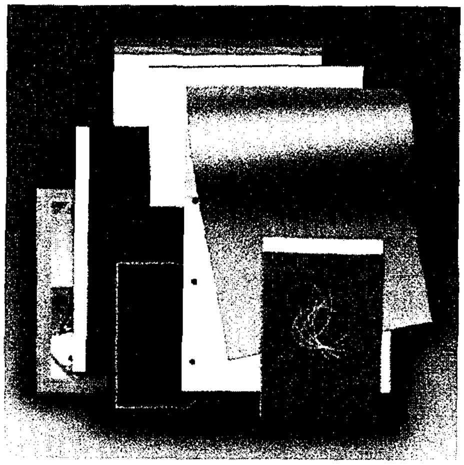
File: F 4
ISIC CODE 3420

How To Start Manufacturing Industries

Exercise Books and Notebooks





Introduction

At all times any significant dates, facts and figures, events and ideas have been taken down in writing, and materials of all kinds served to contain what was to survive the short-lived human memory.

Nowadays, the knowledge of writing is no more limited to the privileged classes. Education is a significant prerequisite of progress and as such enjoys top priority especially in developing countries. Learning means writing, and writing requires exercise books and notebooks to write facts down.

In the end there is a direct connection between the social and economic development of a nation, and a country is well off to have a production of exercise and notebooks of its own.

Description of the Production Process

The production plant described in the following, is laid out as a fully automatic unit for the production of 200 to 400 exercise books per minute. Suitable raw materials are all current paper weights from 40 g/sq.m to 250 g/sq.m.

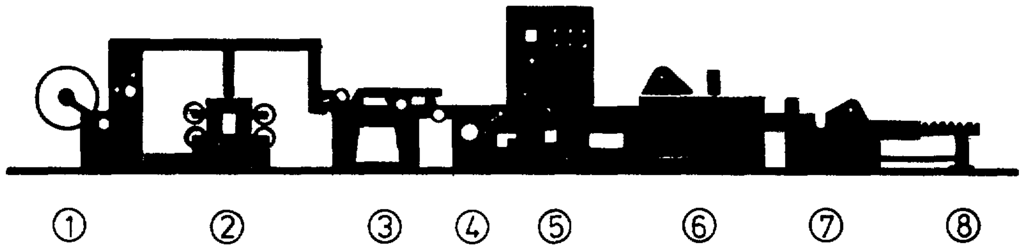
An endless ribbon is conveyed via an unwinding unit into a printing and ruling machine. There the paper, if necessary, is lined. Number and arrangement of lines can be determined according to the later use – for instance as a writing or as an arithmetic book. According to the width of the envisaged book the endless ribbon is cut into sheet layers by means of a rotary cross cutter. These sheet layers are counted and stacked.

In parallel to that procedure the covers are automatically conveyed to the production flow. Sheet layers and covers are stapled, folded and pressed.

The prefabricated exercise books still have a longitudinal size equal to the width of the paper ribbon minimum 350 mm, maximum 720 mm. Now a cutting unit cuts them down to their regular size.

The last step is the stacking and packaging of the finished exercise books or notebooks in certain numbers. This done, they are ready for dispatch.

Production line



1 Unwinding unit
2 Printing and ruling machine
3 Rotary cross cutter
4 Counting and collecting unit
5 Stack sheet feeder
6 Wire stitching, folding and spine squaring unit
7 Separation unit
8 Collecting and discharge unit

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Unwinding unit	1
2	Printing and ruling machine	1
3	Rotary cross cutter	1
4	Counting and collecting unit	1
5	Stack sheet feeder	1
6	Wire stitching, folding and spine squaring unit	1
7	Separation unit	1
8	Collecting and discharge unit	1
	FOB-price for equipment and machinery approx.	US$ 1,125,000.00

Required Buildings and Areas

Administration	60 sq.m
Production	180 sq.m
Storage	120 sq.m

Required Manpower

Administration	3
Production manager	1
Skilled workers	6
Unskilled workers	8
Maintenance	1
	19

Required Power

Electricity 60 kW

Required Raw Material

- Printing ink
- Paper — Paper weight max. 250 g/sq.m, min. 40 g/sq.m
- Coversheets — Cover weight max. 300 g/sq.m, min. 60 g/sq.m
- Wire clips — Length of clips 18 mm

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G

File: G 111
ISIC 3512

How to Start Manufacturing Industries

Compound Fertilizer DAP Plant – Pipe Reactor Process

(Diammonium Phosphate)

Introduction

Main nutrients for crops are Nitrogen, Phosphorous, Potassium and Calcium. These among others must be made available continuously and in correct proportions by the soil.

The individual effect of each of these nutrients is the following:

Nitrogen promotes:

- plant growth-speeds development both above and below ground, influencing the size, weight and colour of the plant yield, e.g. grain, tuber or fruit
- the synthesis of amino acids, protein and lipids, thus contributing in large part to the nutritional value of vegetable foodstuffs
- technical characteristics dependent on the protein content, e.g. the baking properties of wheat

Phosphorus promotes:

- the synthesis of organic phosphorus compounds in the plant organism e.g. phosphoric lipids, nucleic acids, and enzymes necessary for the formation of proteins, carbohydrates and other lipids and enzymes
- the plant's reproductive phase, e.g. the ripeness and quality of seeds and fruit
- the mineral content of plants used in foodstuffs and animal feed

Potassium promotes:

- nearly all metabolic processes leading to the synthesis of valuable components such as proteins and carbohydrates
- the vitamin and mineral content (especially of fruit and vegetables)
- technical properties dependent on the carbohydrate content (e.g. the processing properties of potatoes or the malting properties of barley)
- the development of strong plant tissue
- resistance to cold, drought, pests and disease

Calcium promotes:

- the intake of nutrients and transpiration and metabolism in the plant

Soils which are subjected to intensive agricultural usage especially after application of pure nitrogenous fertilizers over long periods such as ammonium nitrate or urea show a deficiency and unbalance in nutrients. This can be leveled by applying compound fertilizers. They offer the following main advantages:

- Compound fertilizers can be produced with different nutrient contents. It is thus possible to provide a fertilizer with optimum nutrient properties taking into account the needs of the crop, the soil conditions and the climate.
- The nutrient components can be dispensed in one operation only.
- Uniform distribution of the nutrients in the soil, since the main nutrient components are present in the desired ratio in every fertilizer granule.
- Separate calcium fertilizing is unnecessary, since many of the available fertilizer types contain calcium.
- Improvement of plant growth by using fertilizer types containing trace nutrients like Mg, Cu, Mn, Fe, Zn, B, Mo, Co as an additional component.

The nutrient content of compound fertilizers is quoted in
% by wt. N
for the nitrogen content
% by wt. P_2O_5
for the phosphate content
% by wt. K_2O
for the potassium content.

Fertilizers with only 2 main nutrients (NP types) – namely nitrogen and phosphate – are monoammonium phosphate, diammonium phosphate. Fertilizer with elevated nitrogen content are urea phosphates and the nitrophosphate fertilizers. NPK fertilizers are produced by adding potassium compounds in the form of potassium chloride (KCl) or potassium sulphate (K_2SO_4).

Several processes are available to produce NP(K) fertilizers. The optimum process can be selected taking into account the availability of raw materials, the prevailing soil and climatic conditions and the type of crop whether the immediate effect or an expanded effect or a combination of both is desired.

Nitrogen in form of nitrate is of immediate effect as well as phosphorus in a water soluble form (mono- or diammonium phosphate and monocalcium phosphate).

Nitrogen in form of ammonium is of expanded effect as well as phosphate in form of dicalcium phosphate, the latter being citrate soluble.

The use of fertilizers with maximum water solubility of the P_2O_5 is recommendable for neutral soils and for plants with a short growth period.

The raw material phosphate rock is available and mined in many places of the world. The rock contains phosphorus in form of tricalcium phosphate which is water insoluble. The phosphorous has therefore to be transformed to a water and/or citrate soluble form, by "attack" with mineral acids such as sulfuric acid and/or nitric acid and/or phosphoric acid. In case sulfuric acid is used, a suspension of gypsum crystals in phosphoric acid is achieved. This process can be described by the following formula:

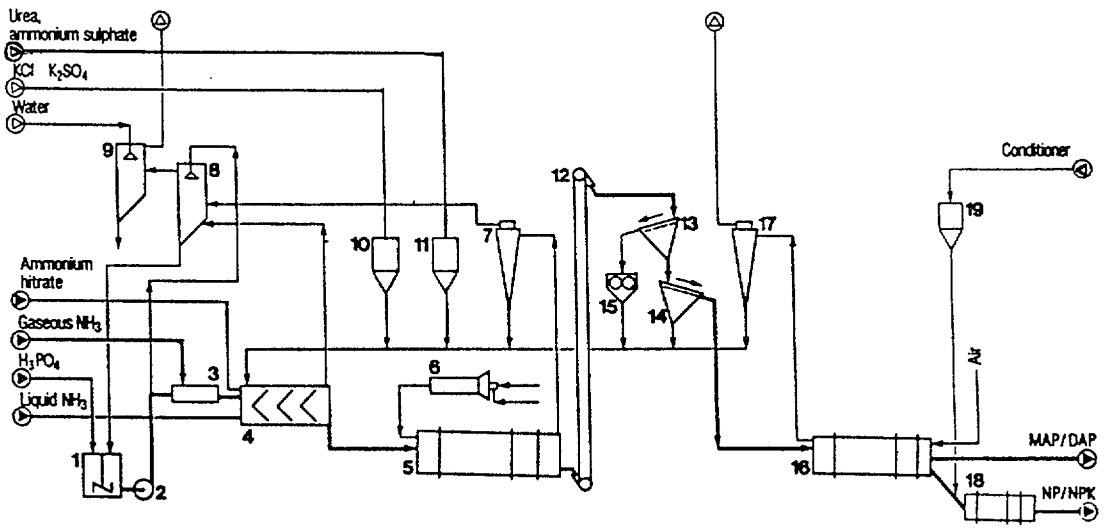
$$Ca_3(PO_4)_2 + 3\ H_2SO_4 + 6\ H_2O$$
$$\rightarrow 2\ H_3PO_4 + 3\ CaSO_4 + 2\ H_2O$$

The gypsum is separated by means of filtration to produce phosphoric acid which is an intermediate product for mono-/diammonium-phosphate (MAP/DAP)

MAP again is normally used as an intermediate in the production of fertilizer, whereas DAP can be applied as a fertilizer as such.

MAP/DAP can be produced by different processes. Most common are the "Preneutralizer Process" and the "Pipe Reactor Process". The latter is presented here due to its merits in low capital investment and low energy cost.

Process Flow Diagram
Pipe Reactor Process



1. Mixing vessel
2. Reactor feed pump
3. Pipe reactor
4. Ammoniator/granulator
5. Drying drum
6. Air heater
7. Dust removal facilities
8. Ammonia scrubber
9. Water scrubber
10. KCl/K_2SO_4 bin
11. Urea/AS bin
12. Bucket elevator
13. Coarse screen
14. Fine screen
15. Crusher
16. Cooling drum
17. Dust removal facilities
18. Coating drum
19. Conditioner bin

Process Description

To obtain MAP phosporic acid is ammoniated in the pipe reactor with ammonia to a molar NH_3/H_3PO_4 ratio of approx. 0.6.

The heat of reaction causes most of the water introduced with the phosphoric acid to evaporate at the outlet of the pipe reactor, resulting in a highly concentrated ammonium phosphate melt. This melt is sprayed onto the return material in the drum granulator and granulated.

By introducing ammonia into the granulation bed, further ammoniation to a molar NH_3/H_3PO_4 ratio of about 1.0 takes place. The reaction heat evaporates a further portion of the water introduced with the phosphoric acid.

The granules formed are then dried and cooled in a drum.

Depending on the concentration of the phosphoric acid, the drying will either proceed autothermally or with the aid of hot air.

The product is then classified. The fines, the crushed oversize and the dust removed from the waste air are returned to the drum granulator.

The on-size material is further cooled in a fluidized bed cooler or in a cooling drum and conveyed to product storage.

The exhaust gases from the drying drum and cooling facilities are passed through dust removal systems. The exhaust gases from the drying drum and drum granulator are then jointly scrubbed with phosphoric acid to recover ammonia. By subsequent water scrubbing fluorine is eliminated.

To obtain DAP, a molar NH_3/H_3PO_4 ratio of approx. 1.35 is adjusted in the pipe reactor and this will be raised to about 1.8 in the granulator. Due to the larger reaction energy, the drying normally proceeds autothermally.

To produce a NP fertilizer with a higher nitrogen content, an additional nitrogen component, such as urea, ammonium sulphate or ammonium nitrate is admixed to the return material and granulated jointly with the ammonium phosphate melt in the drum granulator.

For the production of fertilizer containing potash, potassium chloride or potassium sulphate is admixed in the granulator.

The product can be bagged ex bulk storage or directly. Bags at 50 kg weight are normally used.

Plant Features

(Example of the Plant for 2 Different Capacities)

- Raw materials: Phosphoric acid, Ammonia, Potassium Chloride
- Consumption figures per metric ton of product DAP ($N:P_2O_5$ = 18:46):

Phosphoric acid (45% P_2O_5)	1,035.2 kg P_2O_5
Ammonia (100% NH_3)	221.9 kg (100% NH_3)
Steam (LP)	–
Electr. Energy	35 KWh
Cooling Water	–
Oil/Gas	–
Process Water	0.005 m^3

Plant capacity	300 MTPD	1,000 MTPD
• Budgetary investment cost for the process plant under West European conditions in 1986 fob: Licence, know-how, engineering and equipment	US $ 4.4 Mill.	US $ 6.9 Mill.
• Required area for plant site	900 m^2	1,800 m^2

- Manpower
  - Operating staff: 1 foreman + 2 skilled workers/shift
  - Other technical staff: Engineers: 1; Chemist: 1; Maintenance: 2

The necessary production machinery and equipment is itemized in the Process Flow Diagram.

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File: G 112
ISIC CODE 3512

How to Start Manufacturing Industries

Compound Fertilizer NPK Plant – Phosphonitric Process

(Nitrogen, Phosphate and Potash)

Introduction

Main nutrients for crops are Nitrogen, Phosphorous, Potassium and Calcium. These among others must be made available continuously and in correct proportions by the soil.

The individual effect of each of these nutrients is the following:

Nitrogen promotes:

- plant growth-speeds development both above and below ground, influencing the size, weight and colour of the plant yield, e. g. grain, tuber or fruit
- the synthesis of amino acids, protein and lipids, thus contributing in large part to the nutritional value of vegetable foodstuffs
- technical characteristics dependent on the protein content, e. g. the baking properties of wheat

Phosphorus promotes:

- the synthesis of organic phosphorus compounds in the plant organism e. g. phosphoric lipids, nucleic acids, and enzymes necessary for the formation of proteins, carbohydrates and other lipids and enzymes
- the plant's reproductive phase, e. g. the ripeness and quality of seeds and fruit
- the mineral content of plants used in foodstuffs and animal feed

Potassium promotes

- nearly all metabolic processes leading to the synthesis of valuable components such as proteins and carbohydrates
- the vitamin and mineral content (especially of fruit and vegetables)
- technical properties dependent on the carbohydrate content (e. g. the processing properties of potatoes or the malting properties of barley)
- the development of strong plant tissue
- resistance to cold, drought, pests and disease

Calcium promotes:

- the intake of nutrients and transpiration and metabolism in the plant

Soils which are subjected to intensive agricultural usage especially after application of pure nitrogenous fertilizers over long periods such as ammonium nitrate or urea show a deficiency and unbalance in nutrients. This can be leveled by applying compound fertilizers. They offer the following main advantages:

- Compound fertilizers can be produced with different nutrient contents. It is thus possible to provide a fertilizer with optimum nutrient properties taking into account the needs of the crop, the soil conditions and the climate.
- The nutrient components can be dispensed in one operation only.
- Uniform distribution of the nutrients in the soil, since the main nutrient components are present in the desired ratio in every fertilizer granule.
- Separate calcium fertilizing is unnecessary, since many of the available fertilizer types contain calcium.
- Improvement of plant growth by using fertilizer types containing trace nutrients like Mg, Cu, Mn, Fe, Zn, B, Mo, Co as an additional component.

The nutrient content of compound fertilizers is quoted in
% by wt. N
for the nitrogen content
% by wt. P_2O_5
for the phosphate content
% by wt. K_2O
for the potassium content.

Fertilizers with only 2 main nutrients (NP types) – namely nitrogen and phosphate – are monoammonium phosphate, diammonium phosphate. Fertilizer with elevated nitrogen content are urea phosphates and the nitrophosphate fertilizers. NPK fertilizers are produced by adding potassium compounds in the form of potassium chloride (KCl) or potassium sulphate (K_2SO_4).

Several processes are available to produce NP(K) fertilizers. The optimum process can be selected taking into account the availability of raw materials, the prevailing soil and climatic conditions and the type of crop whether the immediate effect or an expanded effect or a combination of both is desired.

Nitrogen in form of nitrate is of immediate effect as well as phosphorus in a water soluble form (mono-or diammonium phosphate and monocalcium phosphate).

Nitrogen in form of ammonium is of expanded effect as well as phosphate in form of dicalcium phosphate, the latter being citrate soluble.

The use of fertilizers with maximum water solubility of the P_2O_5 is recommendable for neutral soils and for plants with a short growth period.

The raw material phosphate rock is available and mined in many places of the world. The rock contains phosphorus in form of tricalcium phosphate which is water insoluble. The phosphorous has therefore to be transformed to a water and/or citrate soluble form, by "attack" with mineral acids such as sulfuric acid and/or nitric acid and/or phosphoric acid.

The Phosphonitric Process

This process is an application of nitric acid and phosporic acid. The fertilizer thus produced always contains a citrate soluble phosphorous portion. Reasonably this process is applied up to a maximum desired water soluble phosphorous portion of 50%.

Capital investment costs are relatively low.

Process Description

"Attack" takes place in an agitator tank. It can be described by the following formula:

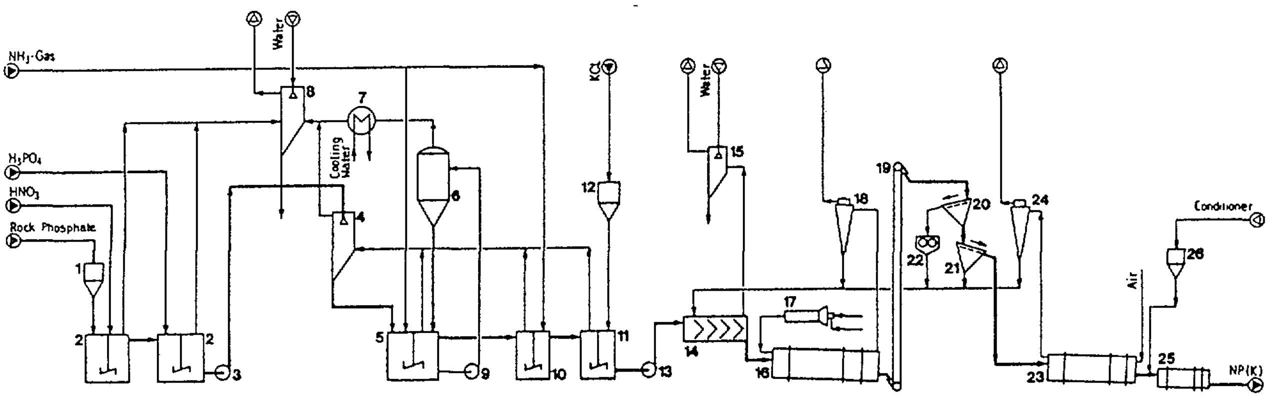
$$Ca_3(PO_4)_2 + 6\,HNO_3 \rightarrow 3\,Ca(NO_3)_2 + 2\,H_3PO_4$$

Phosporic acid is then added to the digestion solution. $Ca_3(PO_4)_2 + 2\,H_3PO_4 \rightarrow 2\,CaHPO_4 + Ca(H_2PO_4)_2$. The quantity depends on the required portion of water-soluble P_2O_5 in the final product. This solution is neutralized with gaseous ammonia in a two-stage neutralization section, thereby producing a mixture of mainly mono- and diammoniumphosphate, dicalciumphosphate and ammoniumnitrate.

The NP solution from the first neutralization stage is recirculated through a vacuum separator, in which the vapours are removed and condensed in a downstream surface condenser. The

Process Flow Diagram

Phosphonitric Process



1. Phosphate rock bin
2. Digester
3. Pump
4. Scrubber
5. Neutralizer
6. Separator
7. Condenser
8. Scrubber
9. NP melt pump
10. Final neutralizer
11. Melt mixing vessel
12. KCl bin
13. Melt pump
14. Granulator
15. Scrubber
16. Drying drum
17. Air heater
18. Dust removal facilities
19. Bucket elevator
20. Coarse screen
21. Fine screen
22. Crusher
23. Cooler
24. Dust removal facilities
25. Coating drum
26. Conditioner bin

ammonia-bearing exhaust gases from the neutralization section are withdrawn and scrubbed with the digestion solution to recover the ammonia. Thereafter, these gases and the exhaust gases from the digester are scrubbed with water.

For the production of fertilizer containing potash, potassium chloride or potassium sulphate is admixed in an agitator tank.

In the granulator, the NPK slurry is granulated.

The granules are dried by means of hot air and then classified. The fines, the crushed oversize and the dust removed from waste air are returned to the granulator. The onsize material is cooled in a fluidized-bed cooler or in a cooling drum, coated with conditioner and conveyed to the product storage.

The exhaust gases from the drying drum, cooling and conditioning equipment are cleaned in the dust removal facilities.

The product can be bagged ex-bulk storage or directly after conditioning. Bags at 50 kg weight are normally used.

Plant Features

(Example of the Plant for 3 Different Capacities)

- Raw materials: Rock phosphate, Jordan 73 BPL; Nitric acid. 60% HNO_3; Phosphoric acid, 53% HNO_3; (Sulfuric acid); Ammonia; Potassium Chloride

- Consumption figures per metric ton of product NPK 15:15:15:

Rock phosphate	197.8 kg
Phosphoric acid (53% P_2O_5)	160.0 kg
Ammonia	67.4 kg (as 100% HNO_3)
Nitric acid (60% HNO_3)	369.5 kg (as 100% HNO_3)
Ammonium nitrate*	
Steam (LP)	0.02 kg
Electr. Energy	50.0 KWh
Cooling Water	–
Oil/Gas	$1.0 \bullet 10^{-5}$ kcal
Process Water	–
Scrubbing water	0.5 m^3

* The addition of ammonium nitrate is only required at a ratio of $N:P_2O_5$ higher than 0.7.

Plant capacity		300 MTPD	800 MTPD	1,200 MTPD
• Budgetary investment cost under West European conditions in 1986 fob for the process plant: Licence, know-how, engineering and equipment	US-$	5.5 Mill.	7.8 Mill.	9.4 Mill.
• Required area for plant size		900 m^2	1,400 m^2	2,000 m^2

- Manpower
  - Operating staff: 1 foreman + 2 skilled workers/shift
  - Other technical staff: Engineers: 1; Chemist: 1; Maintenance: 2

The necessary production machinery and equipment is itemized in the Process Flow Diagram.

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ISIC 3512

How to Start Manufacturing Industries

Compound Fertilizer NP Plant – Odda-Process (Nitrogen and Phosphate)

Introduction

Main nutrients for crops are Nitrogen, Phosphorous, Potassium and Calcium. These among others must be made available continuously and in correct proportions by the soil.

The individual effect of each of these nutrients is the following:

Nitrogen promotes:
- plant growth-speeds development both above and below ground, influencing the size, weight and colour of the plant yield, e.g. grain, tuber or fruit
- the synthesis of amino acids, protein and lipids, thus contributing in large part to the nutritional value of vegetable foodstuffs
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Phosphorus promotes:
- the synthesis of organic phosphorus compounds in the plant organism e.g. phosphoric lipids, nucleic acids, and enzymes necessary for the formation of proteins, carbohydrates and other lipids and enzymes
- the plant's reproductive phase, e.g. the ripeness and quality of seeds and fruit
- the mineral content of plants used in foodstuffs and animal feed

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Calcium promotes:
- the intake of nutrients and transpiration and metabolism in the plant

Soils which are subjected to intensive agricultural usage especially after application of pure nitrogenous fertilizers over long periods such as ammonium nitrate or urea show a deficiency and unbalance in nutrients. This can be leveled by applying compound fertilizers. They offer the following main advantages:
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- Uniform distribution of the nutrients in the soil, since the main nutrient components are present in the desired ratio in every fertilizer granule.
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Several processes are available to produce NP(K) fertilizers. The optimum process can be selected taking into account the availability of raw materials, the prevailing soil and climatic conditions and the type of crop whether the immediate effect or an expanded effect or a combination of both is desired.

Nitrogen in form of nitrate is of immediate effect as well as phosphorus in a water soluble form (mono- or diammonium phosphate and monocalcium phosphate).

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The use of fertilizers with maximum water solubility of the P_2O_5 is recommendable for neutral soils and for plants with a short growth period.

The raw material phosphate rock is available and mined in many places of the world. The rock contains phosphorus in form of tricalcium phosphate which is water insoluble. The phosphorous has therefore to be transformed to a water and/or citrate soluble form, by "attack" with mineral acids such as sulfuric acid and/or nitric acid and/or phosphoric acid.

In cases of local availablility of natural gas or other suitable fossil energy sources being raw materials for the production of ammonia which in turn is the raw material for nitric acid and if sulphur or pyrites, the raw materials for sulphuric acid are not available locally then the attack by nitric acid can be the most economical choice.

The process applying this principle is worldwide known as "Odda-Process".

Process Description

Phosphate rock is attacked by nitric acid in the digester according to the main reaction equation:

$$Ca_3(PO_4)_2 + 6\,HNO_3 \rightarrow 3Ca(NO_2)_2 + 2\,H_3PO_4$$

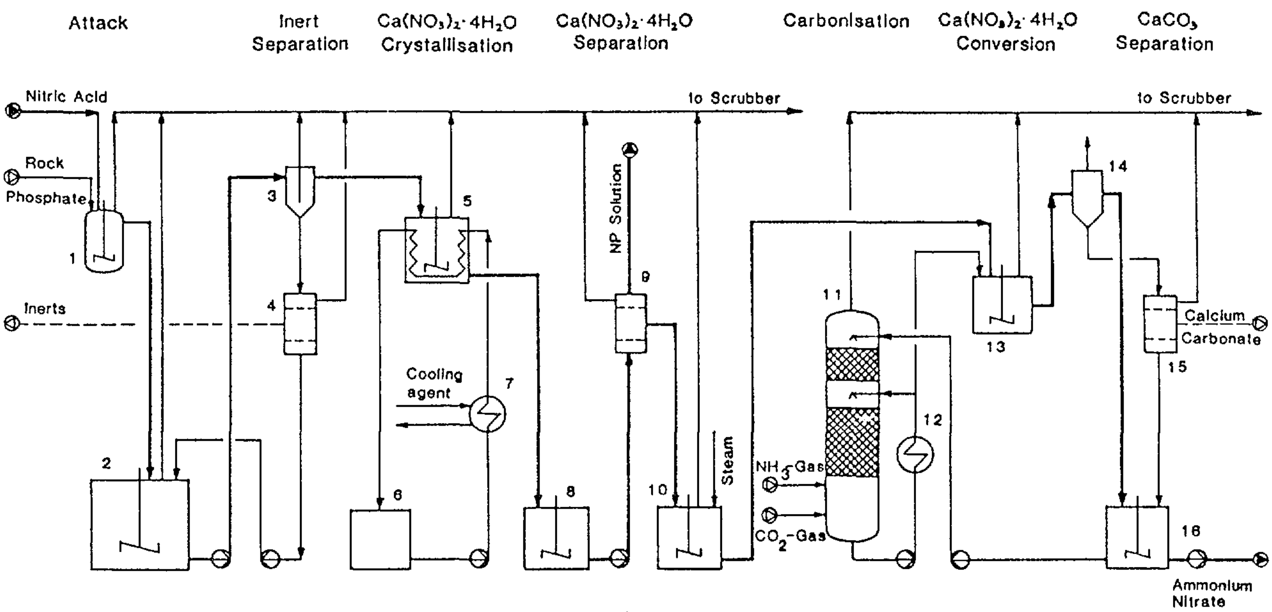
The waste gases containing F, NO_x and CO_2 are scrubbed with water.

By cooling the solution, part of the calcium nitrate crystallizes to calcium nitrate tetrahydrate. The cooling temperature and, consequently, the degree of crystallization is determined by the desired water solubility of the P_2O_5 in the final product.

By this process a water solubility of the phosphorous content of over 80% can be achieved. The remaining portion is present in form of dicalciumphosphate.

The calcium nitrate tetrahydrate crystals are separated. The remaining solution is then neutralized with gaseous ammonia according to the following main reaction equations:

Process Flow Diagram



1. Premixer
2. Digester
3. Thickener
4. Calcium Nitrate Separator
5. Crystallizer
6. Brine Tank
7. Brine Cooler
8. Pump Tank
9. Separator
10. Calcium Nitrate Dissolving Tank
11. Carbonation Tower
12. Cooler
13. Conversion Vessel
14. Settling Tank
15. Calcium Carbonate Separator
16. Ammonium Nitrate Solution Tank

1. $HNO_3 + NH_3 \rightarrow NH_4NO_3$
2. $CA(NO_3)_2 + H_3PO_4 + 2\ NH_3 \rightarrow CaHPO_4 + 2NH_4NO_3$
3. $H_3PO_4 + NH_3 \rightarrow NH_4H_2PO_4$
4. $H_3PO_4 + 2NH_3 \rightarrow (NH_4)_2HPO_4$

The nitrogen content can be increased by adding ammonium nitrate or nitric acid. The phosphate portion can be increased by adding phosphoric acid, DAP or MAP.

Part of the water introduced with the nitric acid is evaporated during neutralization by the heat of reaction.

The NP melt is granulated jointly with return material in a granulator.

The granules are then dried in a drum and subsequently classified. The fines, crushed oversize and the dust removed from waste air are returned to the granulator.

The on-size material is cooled. The storage properties are improved by conditioning, e.g. with an oil amine mixture.

The exhaust gases from the drying drum and cooling facilities are cleaned in the dust removal facilities.

The product can be bagged ex-bulk storage or directly.

Bags at 50 kg weight are normally used.

To obtain NPK fertilizers, potassium salt is admixed to the NP slurry prior to granulation.

Calcium nitrate conversion:

The by-product calcium nitrate crystals obtained in the ODDA process is converted to ammonium nitrate and calcium carbonate.

The crystals are dissolved in hot ammonium nitrate solution.

Further ammonium nitrate solution in which CO_2 and ammonia is dissolved is added in an agitator tank. Then the conversion reaction according to the following formula takes place:

$$Ca(NO_3)_2 + 2NH_3 + CO_2 + H_2O \rightarrow CaCO_3 + 2NH_4NO_3$$

The precipitate calcium carbonate is filtered off the ammonium nitrate solution. The latter is concentrated to about 95% and under addition of calcium carbonate further processed to calcium ammonium nitrate fertilizer.

The production of NP(K) fertilizers using phosphoric acid as intermediate raw material causes in most cases environmental problems, since high amounts of gypsum, the by-product of phosphoric acid, have to be disposed of. This problem does not arise in case of the Odda-process.

Crystallisation, Calcium Nitrate Separation and Conversion

Odda Process Plant
BASF, Antwerp/Belgium

Plant Features

(Example of the Plant for 3 Different Capacities)

- Raw materials: Rock phosphate, Nitric Acid, Ammonia
- Consumption figures per metric ton of product ($N:P_2O_5:K_2O$ = 22,0:22,0:0, rel. wat. sol. 80%)

Rock phosphate (Jordan 73 BPL)	681 kg
Nitric acid (60% HNO_3)	785 kg (as 100% HNO_3)
Ammonia	253 kg (as 100% NH_3)
CO_2	300 kg (as 100% CO_2)
Steam (LP)	0.3 kg
Electr. Energy	140 KWh
Cooling Water	60 m^3
Oil/Gas	–
Process Water	1.1 m^3
By product Ammonium nitrate	440 kg

Plant capacity	300 MTPD	800 MTPD	1,000 MTPD
• Budgetary investment cost for the process plant under West European conditions in 1986 FOB: Licence, know-how, engineering and equipment	US \$ 40.4 Mill.	62.0 Mill.	80.0 Mill.
• Required area for plant site	1,500 m^2	2,000 m^2	2,400 m^2

- Manpower
  Operating staff: 2 foreman + 8 skilled workers/shift
  Other technical staff: Engineers: 2, Chemist: 1, Maintenance: 3

The necessary production machinery and equipment is itemized in the Process Flow Diagram.

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How to Start Manufacturing Industries

Ammonium Nitrate/ Calcium Ammonium Nitrate Fertilizer

Introduction

Soils subjected to modern agricultural intensive usage require the frequent addition of a number of mineral nutrients.

Nitrogen is the most important among them.

Ammonium Nitrate (AN) is a pure nitrogenous fertilizer having a nitrogen (N) content of about 35%. 50% of the N is immediately available to the plants in form of nitrate. The other 50% being ammonium is made available by the soil bacteria. This means that the immediate effect of fertilizing after spreading as well as an expanded effect are achieved.

Nitric acid is an intermediate product in the production of AN.

As early as 1905 Friedrich Uhde, in cooperation with Prof. Oswald, both pioneers in the development of fertilizers, designed and constructed a pilot plant for the production of nitric acid by burning ammonia with air in the presence of a catalyst.

This invention is the basis of the worldwide use of AN in all agriculturally developed areas. The world's consumption in 1985 is estimated to be 70 million metric tons.

Soils, especially grass land, will become acidic after intensive utilization under application of nitrogenous fertilizers. A countermeasure is the addition of limestone meal ($CaCO_3$) to the AN thereby producing Calcium Ammonium Nitrate (CAN). Furthermore, the lime itself is also a nutrient for the plant.

Nitric acid other than ammonia is usually not shipped and stored in big quantities.

Therefore, nitric acid plants are installed together with AN-plants. Both plants are advantageously connected process-wise.

For the production of nitric acid various processes are available. These are mainly:

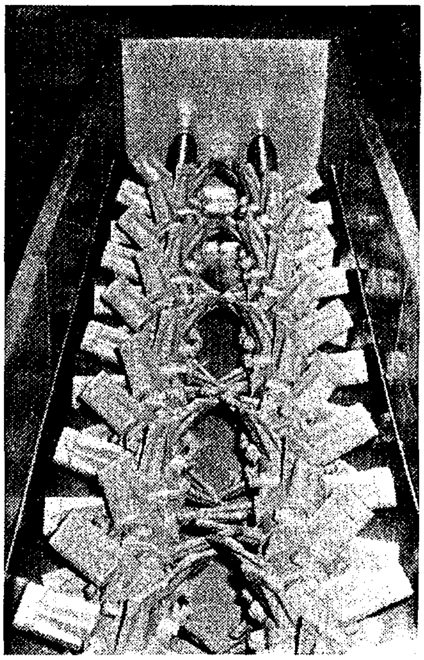
- the mono medium pressure process (4–6 bar),
- the mono high pressure process (7–10 bar) and
- the dual pressure process which employs 4–6 bar for the ammonia combustion section and 9–14 bar for the nitric acid absorption section.

The optimum process is selected taking into account the cost of raw materials and catalyst, energy cost, capital investment cost and requirements of the local authorities for emissions. The dual pressure process is presented herein.

The production of AN and CAN is performed in two process steps:

1. Neutralization of nitric acid by ammonia to achieve AN and the concentration of the AN solution,
2. Conversion of the AN melt to solids.

Neutralization, the first process step takes place:



Pugmill

- under atmospheric pressure,
- under vacuum or
- under elevated pressure.

The optimum pressure for neutralization is selected considering local energy and investment cost.

For the second process step:

- the pugmill,
- the fluidized bed granulator,
- the pan granulation,
- the prilling tower

are alternatively employed. However, the prilling tower requires high investment cost for purification of gaseous effluents. It is therefore applied only in special cases.

For the production of CAN lime meal is added to the granulator.

The pressure neutralization in combination with pugmill granulation is presented herein.

Process Description

Nitric Acid

Nitric acid is produced from ammonia which is oxidized by combustion with air in the presence of noblemetal catalyst.

A platinum-rhodium alloy (9 : 1 composition) has proved to be the most economical catalyst for this purpose.

The production of nitric acid takes place in 3 process steps according to the following equations:

1. Ammonia combustion
   $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O + 905\ kJ$
2. Oxidation of the nitric oxide
   $2\ NO + O_2 \rightarrow 2\ NO_2 + 113\ kJ$
3. Absorption of the nitrogen dioxide in water
   $4NO_2 + O_2 + 2H_2O \rightarrow 4HNO_3 + 343\ kJ$

These three process steps can be carried out under different conditions, resulting in several nitric acid processes as mentioned above.

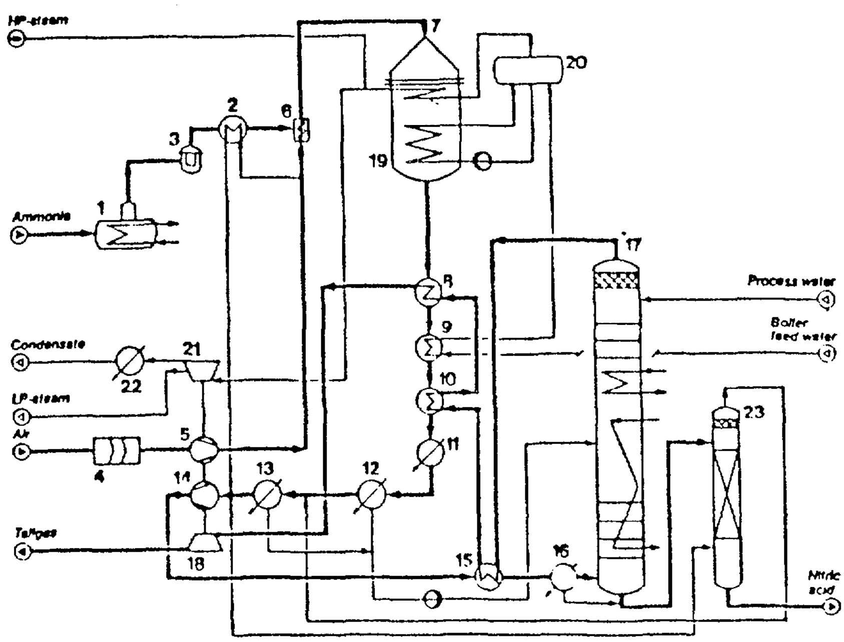
The dual-pressure process employs the medium pressure of 4–6 bar for ammonia combustion and a high pressure of 9–14 bar for nitric acid absorption.

The dual-pressure process was developed with a particular view to the ever more stringent environmental pollution control requirements.

Depending on the plant capacity, the process air is compressed by either a radial or an axial compressor to a final pressure of p abs. = 4–6 bar.

The combustion gases are cooled in a waste heat boiler, then passed through heat exchangers

Process Flow Diagram
Dual-Pressure Plant including Heat Recovery



1. NH_3 evaporation
2. NH_3 gas preheater
3. NH_3 gas filter
4. Air filter
5. Air compressor
6. NH_3/air mixer
7. NH_3 burner
8. Tailgas heater III
9. Economizer
10. Tailgas heater II
11. Feed water preheater
12. Cooler condenser I
13. Cooler condenser II
14. NO compressor
15. Tailgas heater I
16. Cooler condenser III
17. Absorption tower
18. Tailgas expans. turbine
19. La Mont waste heat boiler
20. Steam drum
21. Condensing turbine with extract. steam
22. Steam turbine condenser
23. Bleaching tower

for further cooling and finally compressed to p abs. = 9–14 bar.

The final pressure is selected such that the absorption section is optimized for the specified NO_x content of the tailgas (100 to 200 ppm) and that the compressor, driven by a condensing steam turbine, can be operated using only the steam generated in the waste heat boiler, while ensuring that some excess steam will always be available in order to guarantee steady operating conditions at all times.

Plant capacities of 1,500 tpd HNO_3 100% can be achieved in one single train (1 burner and 1 absorption tower).

The nitrogen yield in a plant of this type is 96.8% at a NO_x content in the waste gas of less than 200 ppm.

Acid concentrations of up to 70% can be achieved. Two or more product streams with different concentrations are also possible.

Production and Consumption per metric ton of HNO_3 100%

Acid concentration	60% HNO_3
Operating pressure	4.5/11 bar
Ammonia	279 kg
Electric power	9.0 kWh
Platinum	0.11 g
Cooling water (Δ t = 10 °C)	130 t
Process water	0.3 t
LP heating steam	0.1 t
HP excess steam	
25 bar, 400 °C	0.75 t
NO_x in tail gas	< 200 ppm

Ammonium Nitrate/Calcium Ammonium Nitrate (Neutralization under Pressure)

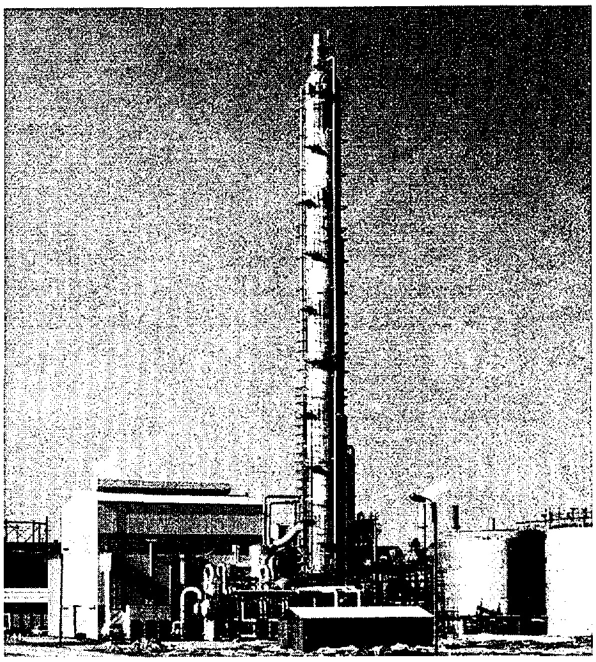
In the reactor ammonium nitrate is formed from gaseous ammonia and aqueous nitric acid; the reaction takes place as follows:

$$NH_3 + HNO_3 \quad NH_4NO_3; \; Q \text{ (kJ)}$$

Besides using pure gaseous NH_3, it is also possible to admit ammonia-bearing gas, for example carbamate gas from an urea plant. Simple design and moderate dimensions of the reactor have resulted in a reduction of capital and fabrication cost.

Ammonium nitrate solution passes through the reactor by natural or forced circulation. Depending on the concentration of the feed acid, the ammonium nitrate solution reaches a concentration of approx. 93%–94%.

For more efficient utilization of the process steam, the neutralization takes place under elevated pressure. Ideally, the pressure in the flash evaportor should be between 1.0 and 3.5 bar (abs.).



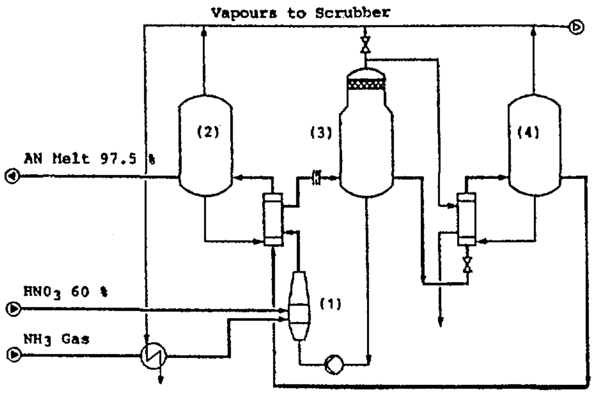
Dual-Pressure Process Nitric Acid Plant,
Capacity: 540 MTPD (100% HNO_3)
Acid Concentration: 60/68% HNO_3
Tailgas: 150 ppm NO_x
BASF/Antwerp, Belgium

Using 60% HNO_3 and a system pressure of 1.0–3.5 bar for neutralization, the concentration at the outlet of the neutralization section will be in the order of 70%.

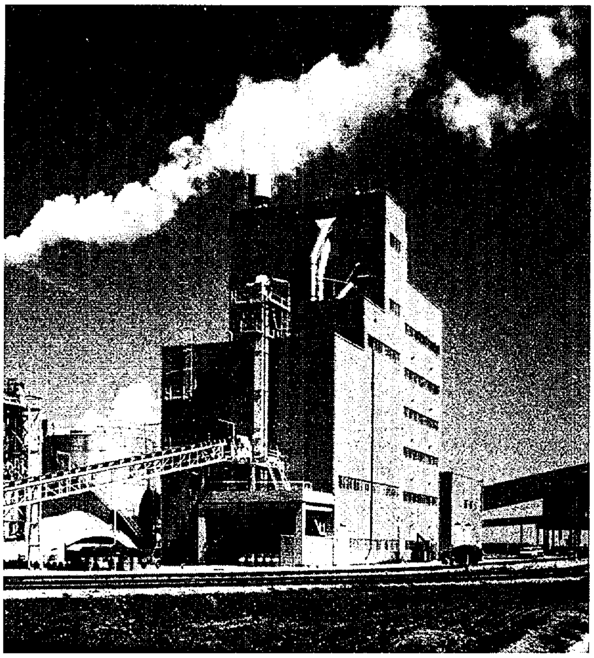
Vapours which are contaminated with AN are used for further concentration of the AN melt to 96.5%–97.5%. This is applicable for CAN and AN granulation.

Process Flow Diagram

Neutralization under pressure using contaminated vapours for concentration of the AN solution.



1. Reactor
2. 2nd Concentrator
3. Flash Evaporator
4. Ist Concentrator



Calcium Ammonium Nitrate Plant,
Capacity: 1,500 MTPD of CAN (26% N)
Process: Pugmill Granulation

Production and Consumption per metric ton of AN (97.5%)

Pressure	3.5 bar abs.
NH_3	213 kg
NHO_3 100% as acid with 60% HNO_3	789 kg
Cooling water $\Delta t = 10\ ^\circ C$	18.9 m^3
Electric power	3.5 kWh
Concentration of AN-solution	97.5%

Granulation

The concentrated ammonium nitrate solution is fed through a metering station into the pugmill. Recycle material is added from the screening and crushing equipment and from the dust collecting facilities.

For the alternative granulating of calcium nitrate (CAN) the components fed into the granulator are supplemented by powdered lime.

From the pugmill, the hot granules are fed to the drying drum for drying by hot combustion gases or hot air.

The dried granules are screened and classified; the temperature of the normal grain size fraction is reduced by cooled air in a fluidized bed cooler to a level which permits storage of the product in bulk. The exhaust air from the cooler is vented through cyclones or filters for dust removal. The fines, the crusher oversize, and the dust from the dust removal facilities are sent back as recycle material to the granulator. The cooled final product is fed to a coating drum for conditioning to prevent caking of the granules and, consequently, to improve the storage properties of the product.

The product can be bagged ex bulk storage or directly after conditioning. Bags at 50 kg weight are normally used.

Plant Features

(Example of the Plant for 3 different Capacities)

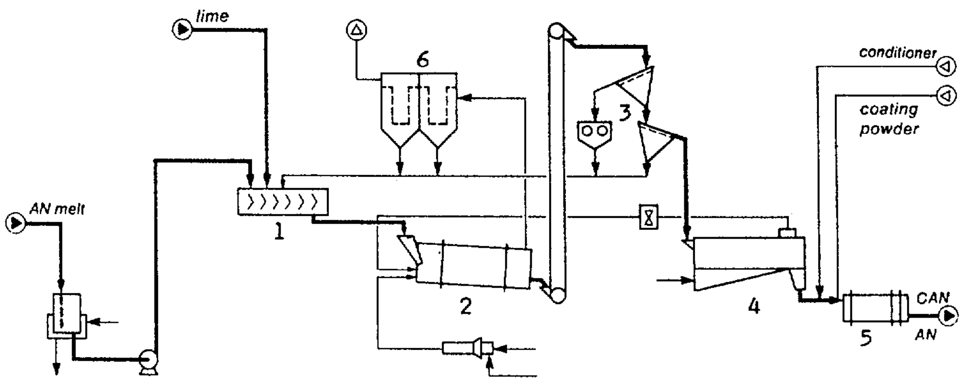
Raw materials:	Ammonia, Limestone
Intermediate product:	Nitric Acid
Economical plant capacities:	300 to 2,000 MTPD

Consumption figures per metric ton of product

	AN – 33.5% N	CAN 28% N	
Ammonia	417.7	348.9	kg
Cooling water	117	98	m^3
Additive	12	–	kg
Electric power	34.6	32.6	kWh
Lime meal	26	196	kg

Process Flow Diagram

Granulation of AN/CAN



1. Pugmill
2. Drying Drum
3. Screening and Crushing
4. Fluidized Bed Cooler
5. Coating Drum
6. Cyclones/Filter

Budgetory investment cost under Western European conditions in 1986 fob for the process plants (AN/CAN incl. HNO_3)

Plant capacity, CAN/AN	300/180 MTPD	1,000/600 MTPD	2,000/1,200 MTPD
Licence, know-how, engineering and equipment:	US-$ 18 Mill.	US-$ 58 Mill.	US-$ 85 Mill.
Required area for plant site:	1,100 m^2	1,800 m^2	3,500 m^2

Man power:
Operating staff:
HNO_3-Plant: 1 foreman + 1 skilled worker/shift
AN/CAN-Plant: 1 foreman + 4 skilled workers/shift.

Other technical staff: Engineers: 2
Chemist: 1
Maintenance: 4

The necessary production equipment and machinery are itemized in the process flow diagrams.

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File: G 115
ISIC CODE 3512

How to Start Manufacturing Industries

Polyester Spinfibre and Filament

Introduction

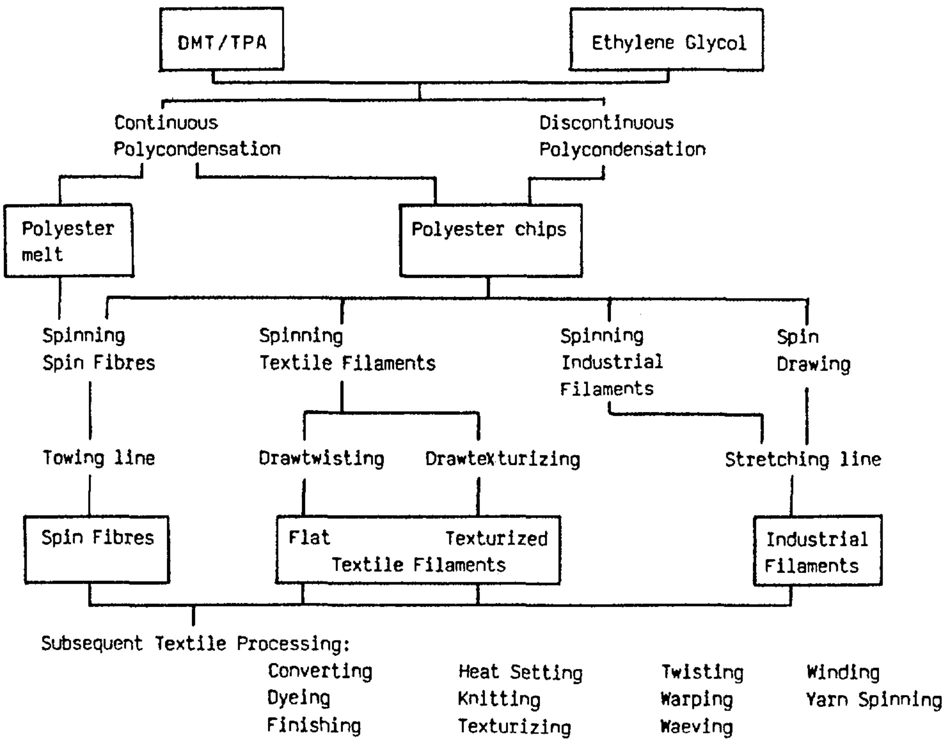
The demand of textiles for different use, i.e. clothing, home-textiles and technical purposes, is steadily increasing world wide and can not be met by the natural fibres wool and cotton. Therefore the production of synthetic fibres as an alternative to natural fibres becomes more and more necessary. Moreover, synthetic fibres cannot be considered as a mere supplementary product. They are far more important because of such outstanding properties as adaptability according to special requirements, high strength, good processing and shrinking properties, rot resistance, easy-care properties, resistance to light and chemicals, etc.

Besides polyamides and polyacrylnitrile, especially the products of polyethylene-terephthalate (Polyester) are expected to become predominant in the field of synthetic fibres.

There is already a great number of synthetic fibre types in the market, which have to meet a large scale of applications, in opposition to the limited types of natural fibres. In addition to the numerous basic types, characterized by selection of raw materials and their modifications, many special types with special properties are required.

In future, consequently the mere production of polyester fibres and filaments is not sufficient, without taking into consideration the required processing steps, the field of application, necessary quality and last not least economical aspects too.

Synoptic Chart of Polyester Production Process



The world production of synthetic fibres in 1985 amounted to 12.5 million tons which are divided into the following portions:

Polyester	52%
Polyamide	23%
Polyacrylnitrile	20%
Other synthetics	5%

Features of the Products

Polyester Spin Fibres

The production programme includes cotton and wool types which are dull or bright with varying shrinkage, cross-section and affinity to dyes, as well as low-pilling and spun-dyed fibres and types for special purposes.

Polyester Filaments (Textile) Flat and Texturized

The titre programme of the textile polyester filaments ranges from 30 to 350 dtex where the filament cross sections are: round (bright, semi-dull, and deep dull) and profiled; sewing threads have up to 280 dtex.

Polyester Filaments (Industrial)

Industrial polyester filaments are preferably produced with titres from 550 to 1,600 dtex, they are also flat-twisted depending on the various uses (as V-belts, flat belts, coating fabrics, etc.).

Subsequent Textile Processing

For the subsequent processing the fibres and filaments are delivered to other manufacturing plants, such as converting, dyeing, twisting plants and plants for the manufacture of sectional beams for warp knitting machines and plants for the manufacture of warp beams for weaving machines, etc.

Process Description

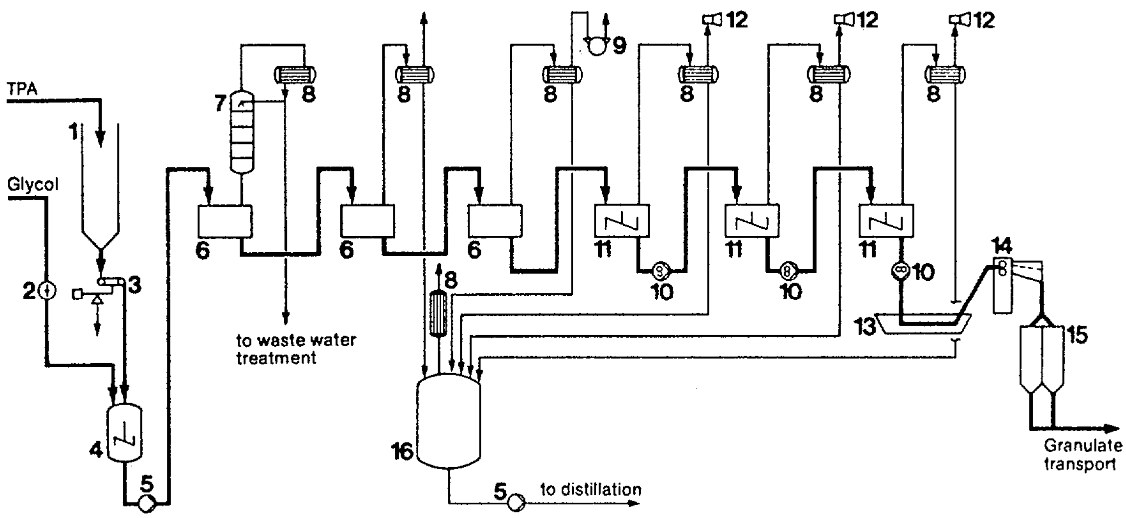
Feedstock: Terephthalic acid (TPA) or Dimethylterephthalat (DMT) and Ethylene glycol (EG)

Continuous Polycondensation

In this process, transesterification and polycondensation are carried out continuously in succession. In the first reaction step, DMT is transesterified with glycol to diglycol terephtalate. After an intermediate step for stripping the excessive glycol, polycondensation is effected in two or three steps with the vacuum set accordingly.

Thus, when using TPA and glycol, transesterification and polycondensation are carried out continuously in succession. The polyester is discharged through a nozzle, cooled and granulated. If certain requirements are met regarding the size of the plant to be constructed and in particular the process steps subsequent to polycon-

Process Flow Diagram: Continuous TPA-Polycondensation



1 TPA bin
2 Batching counter for glycol
3 Weight-batcher for TPA
4 Mixing vessel
5 Feed pump
6 Transesterifier
7 Water-glycol column
8 Condenser
9 Vacuum pump
10 Geared pump
11 Polycondenser
12 Vacuum pump
13 Cooling section
14 Slicer-dicer
15 Granulate collecting vessel
16 Crude glycol vessel

densation, the process steps of continuous polycondensation and melt spinning can be combined to one single process step, the so-called "direct spinning process".

By circumventing the intermediate step of granulate production, the melt obtained from polyconcentration is conveyed directly into the melt collector and spun. This procedure is of economic advantage, as investment and production costs for granulation, granulate transport, granulate drying and re-melting can be saved. A certain minimum size of the plant is necessary, however, to make this process economically viable.

Spin Fibres

As already mentioned, either the classic process with granulate as intermediate product or the direct spinning process with the melt directly obtained from polycondensation can be chosen, depending on the size of the plant to be constructed and the flexibility required for the production programme.

a) Spinning process using granulate:
   The polyester granulate is dried continuously and melted in an extruder.

b) Direct spinning process:
   The polyester melt is conveyed from a continuous polycondensation unit directly via a melt line into the spinning unit.

In both processes, the melt is fed in metered quantities through the spinnerets by means of spinning pumps. The resulting filaments are cooled in an air stream. After application of a textile finishing agent, the filament ends from the spinnerets of a spinning machine are plied into tows, drawn off and laid into spin cans such that proper running of the tows is ensured during subsequent stretching. The spin cans may be changed automatically.

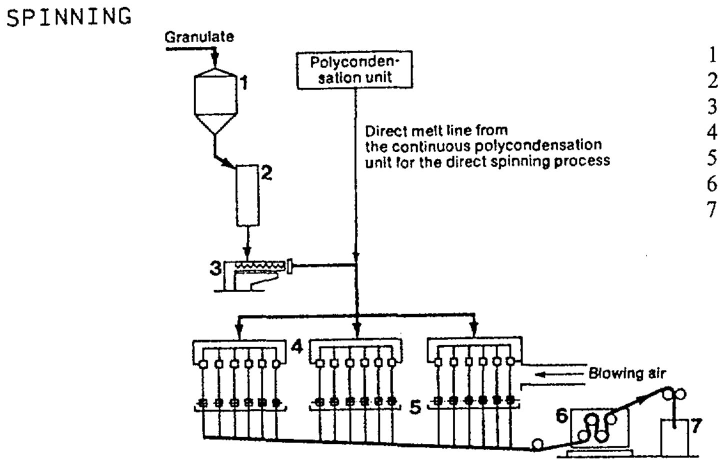
For stretching, several ends of tow are joined to form a wide tow, which is conveyed to the towing line. The tows are treated with textile finish agent, heated, drawn, crimped, and heat-set in one process step. By varying the processing conditions in the individual sections, those textile properties are obtained that are desired for the various fibre types.

Then the tows are either cut into staple fibres and baled or laid uncut as converter tows into suitable boxes.

Fields of application:

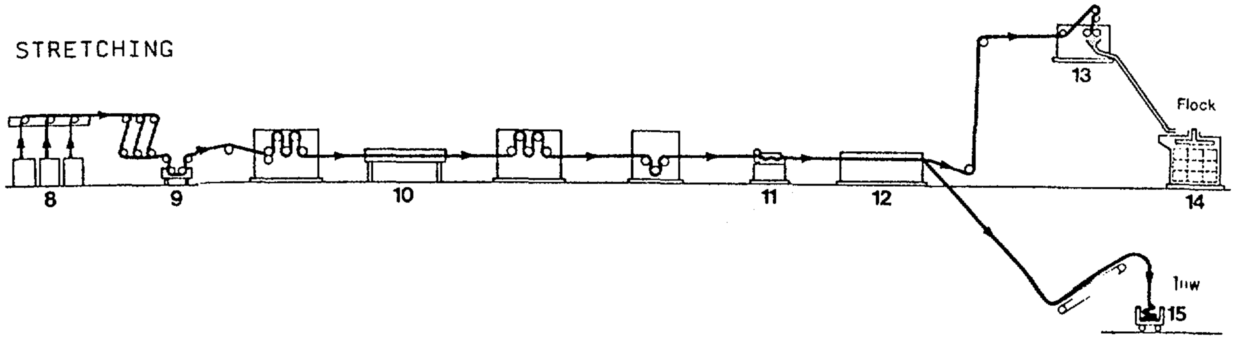
Polyester spin fibres are spun to yarn either on their own or blended with natural fibres and

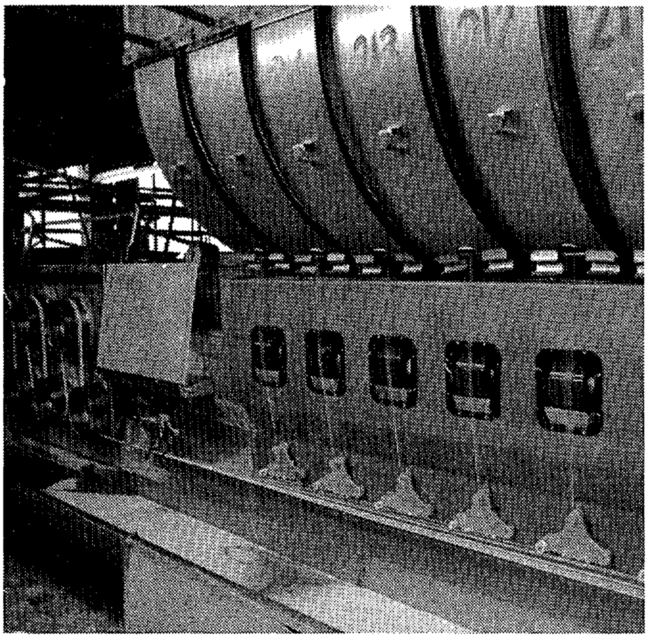
Process Flow Diagram: Polyester Spinfibres



1 Granulate feed vessel
2 Dryer
3 Extruder
4 Spinning heads
5 Textile-finish panel
6 Take-off roller set
7 Laying of undrawn tows

8 Feed creel
9 Textile finish
10 Stretching
11 Crimping
12 Heat-setting
13 Cutter
14 Baling press
15 Laying of drawn endless tows





other man-made fibres. The properties required for blending and the intended use of the yarn, i.e. titre, staple length, tensile strength, elongation at break and shrinkage, are imparted to the fibre in the production process. The spin fibres are “tailor-made”.

Articles made from polyester spin fibre blended yarns are distinguished by high quality, durability, good wear and easy-care properties. That is why they have found a ready market in all clothing sectors, e.g. for men’s and women’s outerwear, blouses, shirts, underwear and work clothes.

The home textile sector has already become another important field of application for the spin fibre yarns, e.g. the sector of floor coverings and wall decorations.

Textile Filaments

The polyester granulate is continuously dried and then melted in an extruder. The melt is metered by means of precision spinning pumps and pressed through spinnerets. The filaments, which are first in molten and then in plastic state, are cooled to stiffness, given a textile finish and wound up. Investment costs can be saved by simultaneously winding several filaments on a bobbin.

In order to exploit this process, special requirements with regard to a uniform quality of the feed yarn and its degree of preorientation (POY-yarn) have to be met.

Modern rapid spinning processes fulfil these requirements.

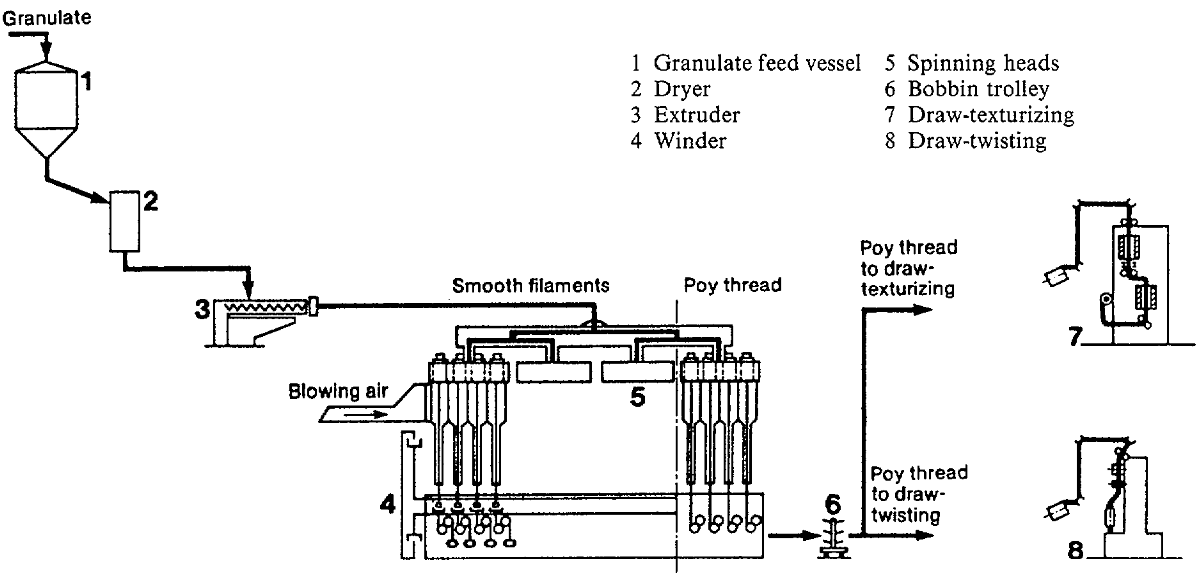
The next processing step for POY-yarn is the draw-texturizing or draw-twisting process. Final products are texturized yarn or flat yarn (textile filaments).

Fields of application:

The properties of the polyester filament yarns can be adapted to the most varying requirements of textile application. High strength in comparison with fibre yarns and natural fibres, good heatsetting properties and shape retention impart excellent wear and care properties to the products obtained from polyester filaments. In conjunction with a great variety of specially developed disperse dyestuffs, bright colours are achieved on polyester yarns which are demanded e.g. for the production of neckties. The good resistance to light and the easy-care properties of polyester filaments are an advantage for their wide application in the curtain sector.

Texturized polyester filaments are also distinguished by their bulky properties and pleasant full-bodied feel. They are processed on their own or blended with other yarns and are thus

Process Flow Diagram: Polyester Filament

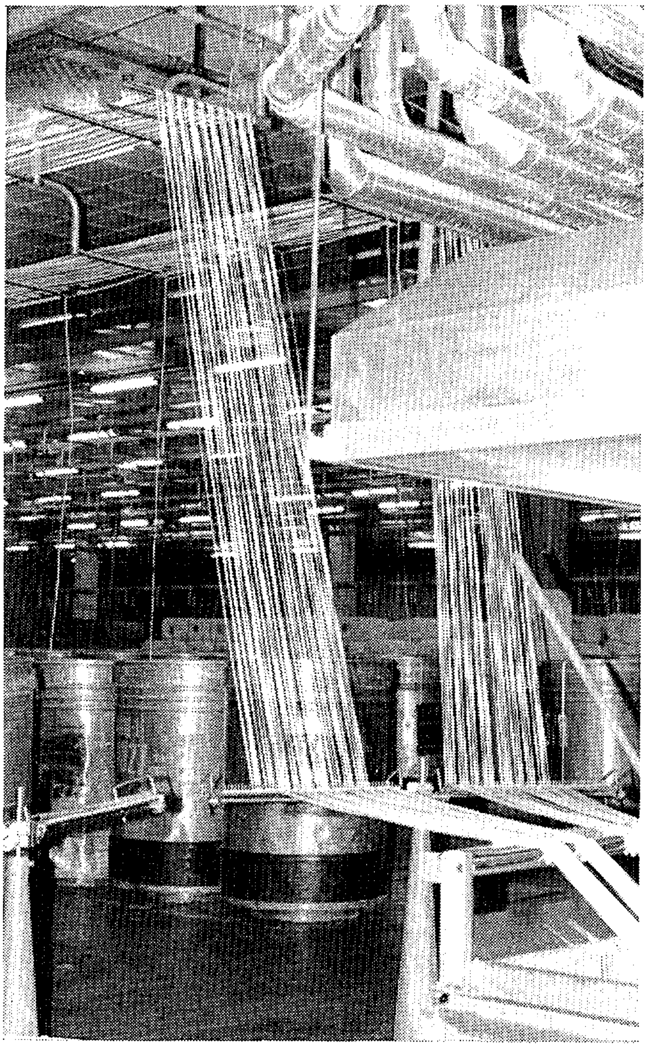


Examples of the Different Types of Plants

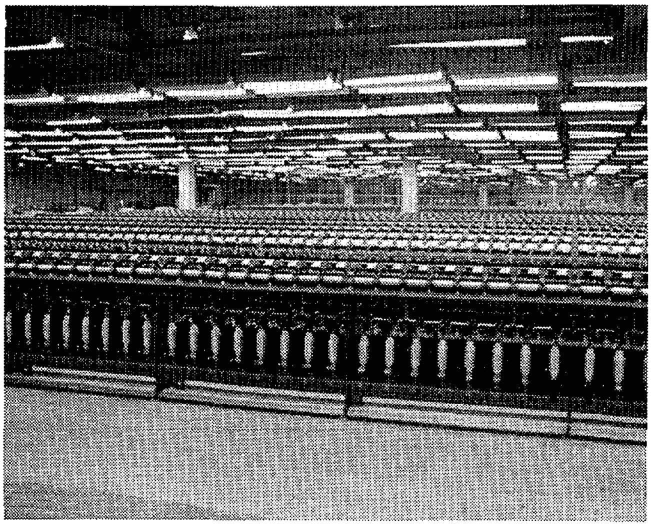
Item	Designation	Dimension	Discontinuous Polycondensation Plant	Continuous Polycondensation Plant	Direct Spin Fibres Plant: spinning line	Direct Spin Fibres Plant: drawing line	Textile filament Spinning plant
1.	final product	–	polyester granulate semi-dull	polyester melt semi-dull	polyester staple fibres cotton type 1.7 dtex		polyester POY spin bobbins for textile filaments, 110 dtex
2.	feedstock	–	DMT/EG	TPA (fibre grade) and EG	polyester melt		polyester granulate semi-dull
2.1	consumption	kg/ 1,000 kg final product	DMT: 1,040 EG: 380[1])	TPA: 870 EG: 350	1,047		1,042
3.	capacity[2]						
	min. approx.	ts/d	5.21	38.2	18 (38,000 dtex)	36.5 (2 x 0.9 Mill. dtex)	5.0 (110 dtex)
3.1	working time	h/d	24	24	24	24	24
4.	utilities for main production plants						
4.1	electrical power	kWh	33[3] (150)[4]	215	50	550	200
4.2	steam 20 bar	kg/h	44 (200)	–	–	1,500	–
4.3	steam 6 bar	kg/h	174 (800)	398	–	1,000	–
4.4	cooling water	m^3/h	33 (150)	26	–	6	0.7
4.5	chilled water	m^3/h	– –	16	–	–	–
4.6	demineralized water	m^3/h	0.01 (0.02)	–	0.5		0.8
4.7	compressed air 7 bar incl. instrument air	Nm^3/h	24 (110)	48	10	50	320
4.8	heat transfer agent (Dowtherm)	GJ/h	0.9 4.1	4.3	0.1	–	–
5.	personnel requirements						
5.1	chemist	day	1	1	1		1
5.2	foreman	shift	1	1	1	1	1
5.3	workers skilled	shift	1	2	2	2	2
5.4	workers unskilled	shift	2	2	1	2	1
5.5	laborants	shift	1	1	2		2
		day	1	1	1		1
6.	space requirements (main production and auxiliary plants)	m	24 x 12	36 x 24	36 x 192		24 x 18
6.1	height	m	24	24	24	6	24
6.2	floors	m	4	4	4	–	4
7.	*air conditions*						
7.1	process area						
	temperature	°C	–	–	20–28	20–28	22
	rel. humidity	%	–	–	30–50	30–50	65
8.	main production equipment for process plants		– esterinterchange reactor – polycondensation reactor – glycol/methanol column – noodle granulator – multicell bin for chips mixing	– 3 esterification reactors – glycol column – 2 polycondensation reactors – connection for direct spinning	– spinning line with 12 positions – quenching system – take up wall with finishing system – take up device – tow laying device – spinning can changing system	– drawing line with can creel – drawing system – heat setting – crimping – staple cutting – baling press	– dryer with crystallizer – spinning extruder, 90 mm – melt distribution – spinning line with 64 pos. – quenching system with finishing device – take up system with 16 four foldtake up heads
9.	Budgetory investment costs under West European conditions in 1986 fob for the process plants	US-$ x 1,000	2,700	11,850	2,750	4,150	4,100

remarks: 1 = for the consumption figure of EG a recycling of EG is considered.
2 = the capacity is depending from the individual production program and can be adjusted accordingly.
3 = the consumption figures of the discontinuous polycondensation plant are average values.
4 = consumption per 1,000 kg polyester granulate

General: all figures are approximate values.



Fibre Stretching Line, Inlet



Twisting Plant for Textile Filaments

used for the manufacture of knit fabrics and woven goods, women's and men's outerwear, clothes for sports and leisure wear as well as in the underwear sector. The texturized polyester filament yarns prove their worth when used for all articles that have to have such properties as shape retention, crease resistance and sometimes also elasticity. Flat polyester filaments are also used for curtains, neck-ties, lining fabrics and pile goods. In home textiles, too, such as carpets and upholstery fabrics, polyester filament yarns have found ready acceptance.

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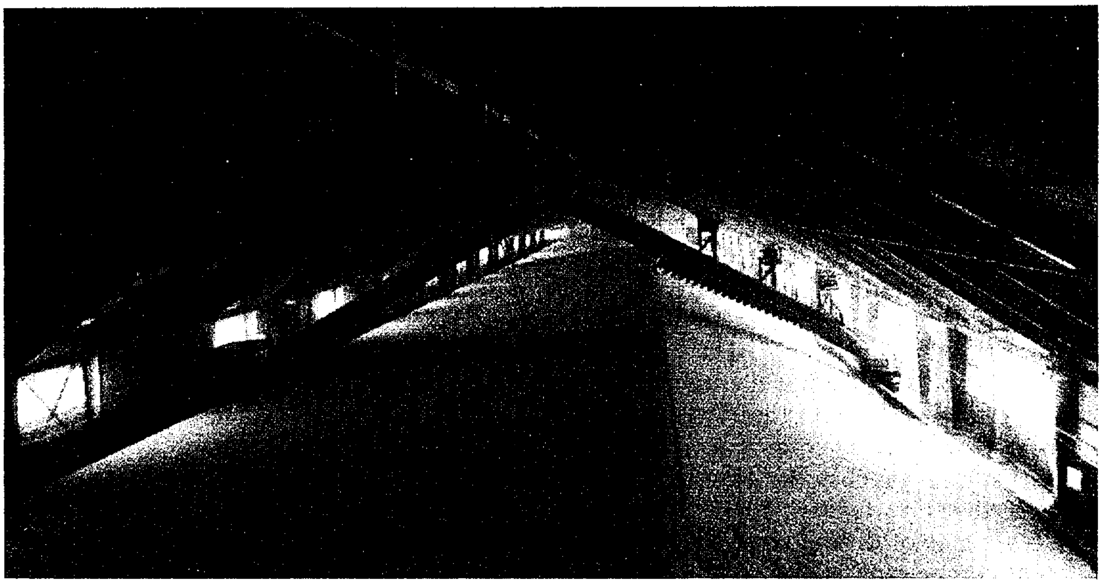
How To Start Manufacturing Industries

Fertilizer Blending Plant

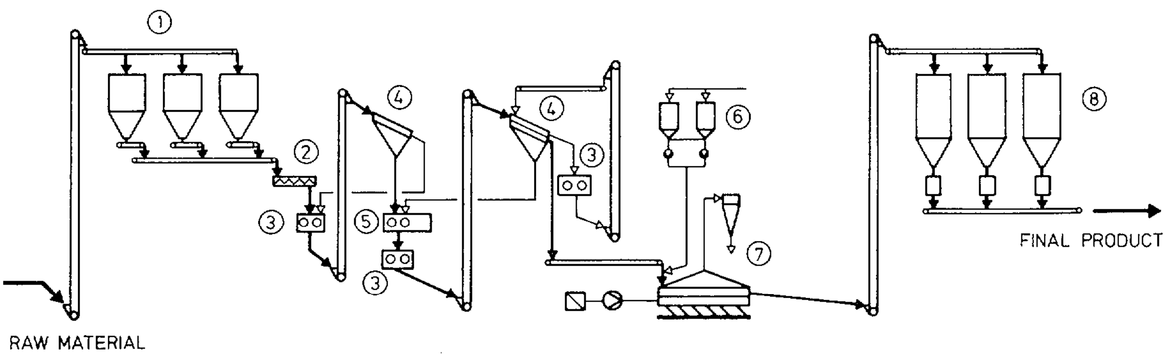


Introduction

Everybody knows about the necessity to increase the world's food-production. That, of course, also increases the need for mechanical and chemical aids. The application of fertilizers, even in minor quantities, and in combination with high-grade seed material could result in a drastic increase of the food-production.

The production of fertilizers, however, is a complex technical procedure and requires high capital-investments. The fertilizer blending plant is an alternative to mix and compact nitrogen, phosphate and potash fertilizer on the basis of raw materials that are either imported or even locally available. Production can be made in smaller units that are easier to operate without renouncing the advantages of mass production.

Flow sheet:



1 Intake
2 Mixing
3 Crushing
4 Separation
5 Compactation
6 Dosing
7 Cooling
8 Bagging

Description of the Production Process

The fertilizer blending plant described here is a unit of 30,000 t annual capacity. It is subdivided into 3 main sections:

1. storage section
2. blending section
3. bagging and loading station

1. Storage section

The raw materials – for example Urea, DAP or MAP – which have been transported to the plant by means of trucks, are dumped into a concrete feeding bunker. The materials are conveyed into compartments of a stockpile system. The processing plant is fed by a portal scraper-reclaimer and subsequent conveying system.

2. Blending section

The various raw-material flows are extracted with the help of weigh-belt feeders to be conveyed to a mixing screw conveyor. The product which by then has been mixed at the desired ratio, is conveyed to a toothed disk mill where it is crushed. After passing a cyclone and a bucket elevator, the material reaches the compactation machine via a vibration feeder. There it is pre-compacted by means of dosing screws. The subsequent actual compacting is done at high pressure. The pressed and compacted fertilizer is conveyed to the separation unit. The grain of correct size is taken out of the production, where the fines are returned to the compactation machine and the oversized grain is milled down to correct size.

In the course of the compactation process the product has been heated and consequently must be cooled down to approx. 50 °C which is done in a cooler.

3. Bagging and loading station

The bagging line is fed from cooler by means of belt conveyors and bucket elevators leading to the bagging machines. A collecting conveyor under the bagging machines transfers the filled and closed bags to the final product storage or alternatively to a truck loading station.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Storage section	1
1.1	Conveying system	1
2.	Blending section	1
2.1	Daily storage silos	3
2.2	Conveying system	1
2.3	Crusher	2
2.4	Separator units	2
2.5	Compactation machine	1
2.6	Cooler	1
2.7	Dosing unit	1
2.8	Dedusting unit	1
3	Bagging and loading station	1
3.1	Conveying system	1
3.2	Bagging machines	3
3.3	Storage System	1
3.4	Loading station	1
	FOB-price for machinery and equipment	US$ 3,250,000.00

Required Buildings and Areas

Administration	250 sq.m
Raw material storage	1,200 sq.m
Blending section	420 sq.m
Final product storage	480 sq.m

Required Manpower

Management	3
Production manager	1
Foremen	3
Workers	16
Helpers	16
Quality control	1
Maintenance	3
	43

Required Power and Utilities

Electric power, installed	800 kW

Required Raw Materials

Capacity of the plant at one-shift operation:	30,000 t/year
Possible recipe Urea	13,800 t/year
Diamon-phosphate	7,600 t/year
SIO2 filler	8,600 t/year

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How to Start Manufacturing Industries

Lubricating Grease

Introduction

Lubricating grease was practically known already in ancient times to the Pharaohs and Romans who used tallow and melted fat for lubricating the axles of their vehicles. Only since the middle of the last century mineral oil and soap have been used as basic components of lubricants for industrial purposes. Initially the production was based only on simple saponification of mineral oil with lime soap in open vats. Subsequent treatments like homogenization and deaeration as well as admixing special additives have developed gradually (deaeration devices since appr. 1940 only) with increasing standards as set by industrial development. Both the hot and the cold production methods are applied in modern plants by using autoclaves in which temperatures in the range of 200 to 250 °C can be reached for producing various sorts of grease under pressure.

The most important types of lubricating greases manufactured at the present time are metal-saponified and non-saponified products:

- Approximately 90% of the greases commonly used today, are made on metal soap-mineral oil basis, out of which the most important ones are lithium, calcium, sodium and aluminium greases.

To keep production cost of saponified grease as low as possible, fatty acids are added, thus influencing the properties of the grease. The following types of acids are used: fish oil acids, tallow acids, cotton seed fatty acid, wool fat stearin, horse fat, resin stick oil, 12-hydroxide stearic acid etc.

- Non-saponified greases are produced on the basis of bentonites, polycarbamide, carbon-black etc. with synthetic oils and with mineral oils of the paraffinic type as lubricating agents.

Apart from these main components as lubricating and thickening agents different additives are used for special purposes:

- to improve the chemical properties for preventing oxidation: so-called oxidation inhibitiors such as metal naphthenates, alkalisulphonaphthenates, nitrites, benzoates etc. are used as corrosion protection additives;
- to improve the texture and adhering properties: additives such as polyisobutyls, latex etc. improve the adherence of lubricating grease, whereas the texture can be adjusted by adding fatty acids, alkali, glycerin, glycol, acetone;
- to improve the lubricating properties: sulphuric compounds, molybdenum sulphides, phosphor compounds or other lead soaps are used as additives for emergency running properties;
- to effect colouring: various trade marks have a distinguishing colour that can be obtained by adding oil soluble colouring agents; aliphatic amines (cyclohexylamin, dibutylamin etc.) are used as colour stabilizers.

Example formulae for conventional lubricating greases:

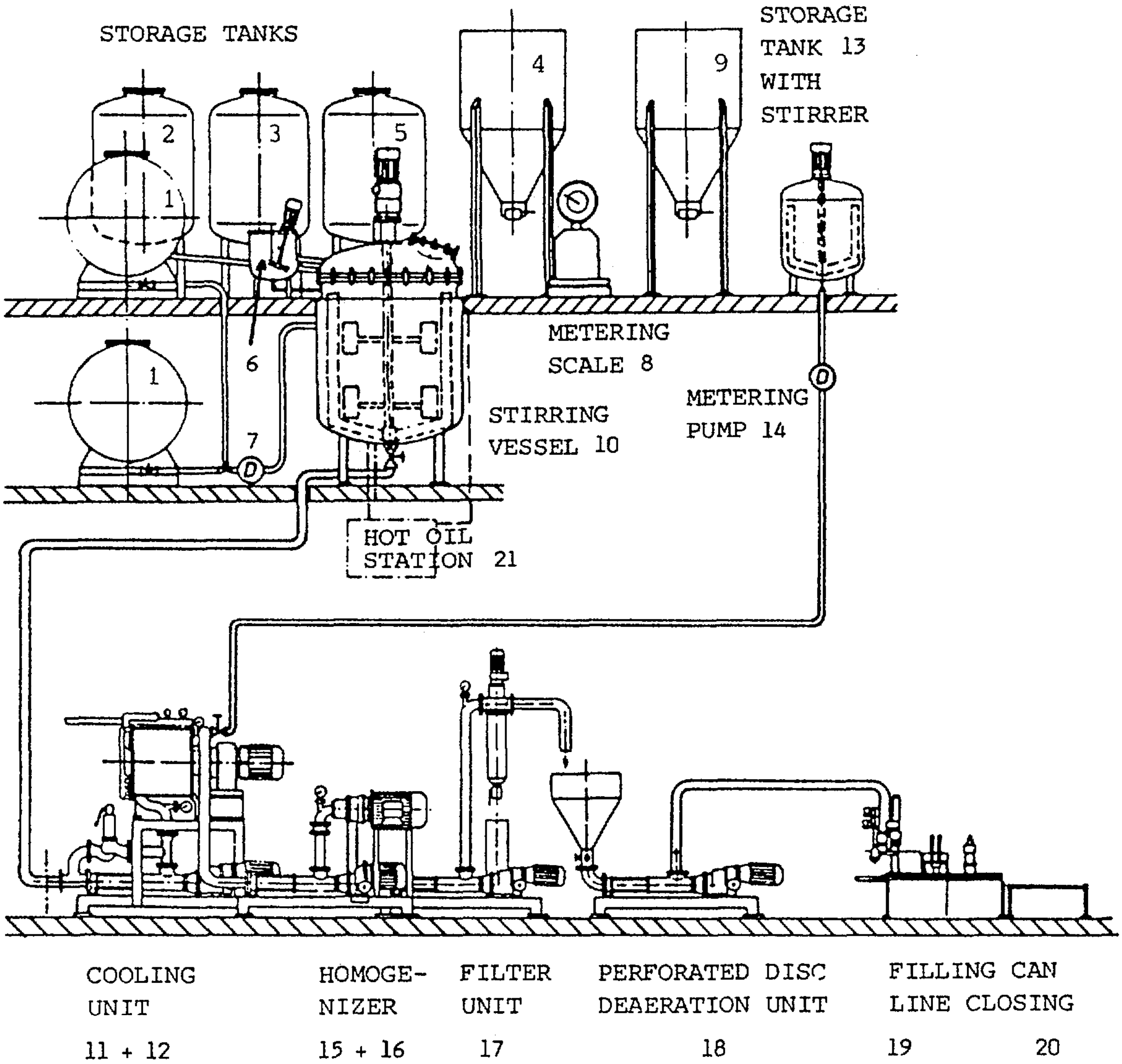
Calcium Complex Grease	
mineral lubricating oil N 49 naphthenb.	83.5%
tallow hydrate	6.0%
100% acetic acid	8.0%
filtered castor oil	2.0%
filtered fish oil fatty acid	2.0%
vinylalphanatphthylamin	0.5%
Lithium Fat	
mineral lubricating oil N 36 naphthenb.	82.0%
$LiOH.lH_2O$	1.5%
12-hydroxylstearic acid	10.0%
Lithium-Calcium Lubricating Grease	
mineral lubricating oil N 49 naphthenb.	82.0%
cotton seed fatty acid	15.5%
lithiumhydroxydmonohydrate	1.75%
calcium hydrate (71%)	0.75%

Process Description

The liquid components are drawn from the storage tanks and metered by a pump batchwise to the plant, together with the dry components, preweighed by dosage scales.

A proportion of the mineral lubricant is used to dissolve the 12-hydroxylstearic acid (if e.g. lithium at formula is applied) in the autoclave

Process Flow Diagram

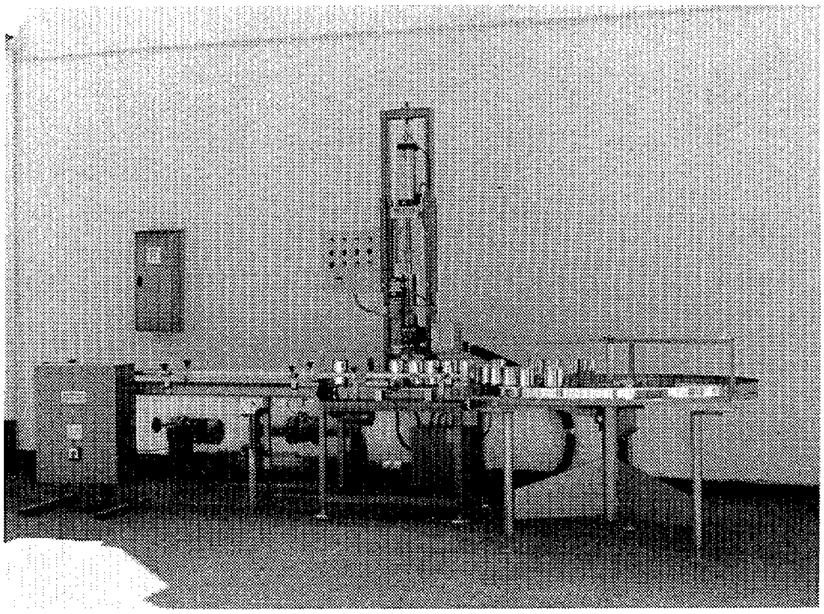


1 Mineral lubricating oil storage tanks
2 Special storage tanks for different oil types depending on the applied formula
3 Storage tanks for liquid additives
4 Vessel for fatty acids
5 Storage tank for solvent as used for special grease (i.e. acetone)
6 Mixing and suspending vessel with built-in mixing turbine
7 Metering pump for apportioning the mineral lubricating oil into the autoclave vessel
8 Metering scales for weighing the dry ingredients, such as stearic acids, calcium hydrates, bentonite etc.
9 Vessel for dry substances
10 Autoclave vessel (design pressure 8 bar) double-walled, for thermal oil circulation heating with 1,600 kg working volume and about 2,500 l total volume
11 Special displacement pump
12 Continuously working scraper cooler with multi-chamber scraper system, laid out for cooling the grease from about 220 °C to 90 °C under continual stirring action
13 Storage tank fitted with stirrer
14 Metering device
15 Displacement pump
16 In-line toothed colloid mill as lubricating grease homogenizer with metal toothed homogenizing elements
17 Automatic working plate-type filter, with automatic and continuous cleaning device
18 Perforated disc deaeration unit
19 Complete filling line for filling containers of various sizes
20 Can-closing device
21 Hot oil station (auxiliay aggregate) for heating the heat conducting oil up to 300 °C (usually with the aid of an oil burner).

vessel. Simultaneously lithium hydroxide is mixed with water to a paste in a small mixing vessel before being added to the dissolved acid in the autoclave. The mixture is heated to about 180° C whilst being constantly and intensively stirred.

At the end of the saponification phase, about 2 hours later, the hot fat is taken from the autoclave and pumped into the scraper-cooler, where it is cooled to 90 °C.

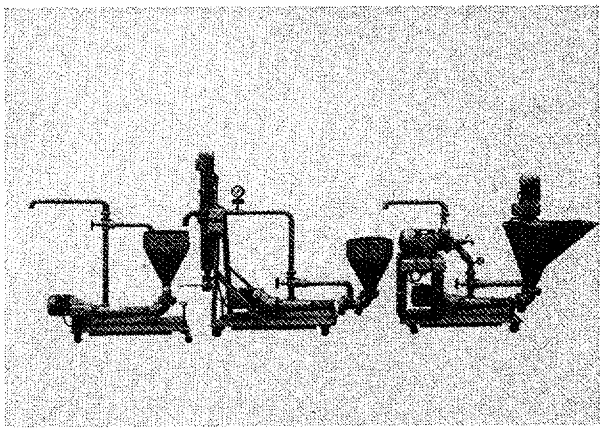
Thereafter the remainder of the mineral lubricant and the additives are metered continuously into the product until the latter has adopted the right consistency. Other components can also be



Can Filling

added at this point. The metering pump is operated via a dosaging meter.

The product is then pumped straight into the homogenizer, a toothed colloid mill. After having been homogenized and cooled by admixing more mineral lubricant, it is conveyed to the filter unit and subsequently, via a perforated sheet deaeration unit, to the filling equipment. After intermediate storage it is filled into market size cans of 1 to 2.5 kg. Manual cartoning is the final stage of this production process.



Homogenizer Deaeration Unit Filter Unit

Example of the Plant

Daily capacity: 3,000 kg/8 hours

Required Machinery and Equipment
is itemized below the Process Flow Diagram.
The FOB price (in 1986) for the machinery and equipment amounts to approx. US$ 900,000.

Daily Requirements of Production Materials
Approximately in proportions of 3,000 kg according to the applied formula, e.g. for lithium fat-based production:

Mineral lubricating oil N 36 naphthenb.	approx. 2,650 kg
$LiOH \cdot 1H_2O$	approx. 45 kg
12-Hydroxylstearic acid	300 kg

Utility Requirements (per 8 hours)

Electric power	approx. 300 kWh
Cooling water	approx. 40 m^3
Fuel oil (see equipment item 21)	80 kg

Required Manpower

Machinist	1
Trained operators	2
Unskilled labourers	5
Laboratory assistant	1
Fork-lift driver	1

Plant Site Requirements

Floorspace for production (height 6 m)	400 m^2
Floorspace for raw materials and finished products	400 m^2
Offices and laboratory (height 3 m)	60 m^2
Approx. size of total plot	3,000 m^2

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How to Start Manufacturing Industries

Lipstick Production

Introduction

The production of lipsticks was until a few years ago one of the more complicated techniques in the cosmetic industry. Manufacturing methods have been improved considerably. The development of the casting system and the introduction of the corundum stone mill for the preparation of colour pigments have contributed to simplifying and economizing the production process. Moreover the traditional method of premixing pigments with a kneadermixer and then grinding them on a triple roller mill did not sufficiently guarantee the dispersion of the colour in the past.

Process Description

The manufacturing process consists of two main steps, i.e. preparation of the bulk material and moulding the sticks.

1. Preparation of the Bulk Material

The normal kind of lipstick formulation requires three phases: oil, wax and pigment, to be dispersed or premixed and then to be blended together.

Outline Formula

Oil phase
(mixture of castor oil, vegetable oil, triglyceride, isopropyl, lanolate solid) 60–70%

Wax phase
(beeswax, ozokerite, candelilla wax, carnauba wax and similar materials) 22–28%

Colour pigment phase
(colour pigments, pearl glimmer etc.) 5–15%

Main Equipment

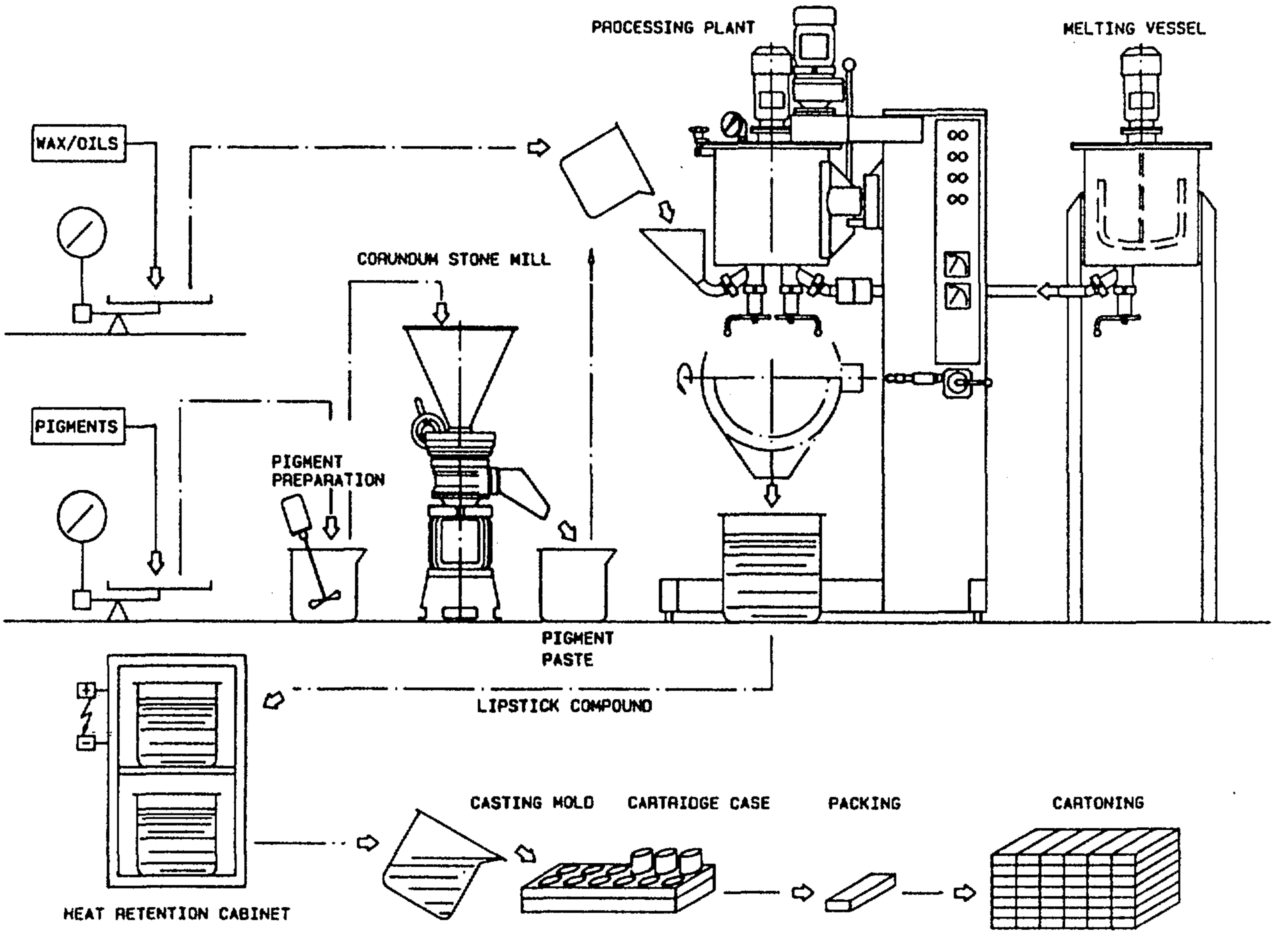
- A device for dispersing the colour pigment in a part of the oil phase.
- A corundum stone mill for pulverizing the colour pigments. The advantages of this mill over the conventional triple roller mill are the low investment (only about 40 to 50%) and the low service cost, the better degree of grinding the colour pigments (8–9 microns) with only one course. The reproducibility of a certain degree is possible through precise adjustment of the gap between the grinding stones.
- A double jacketed melting vessel for melting the wax phase with a simple propeller-type agitator for mixing the molten components.
- The processing plant with the mixing vessel, also double-jacketed and connected to a cooling water system, and to be used as a vacuum vessel. It is equipped with an anchor-type agitator with wiper, a dissolver with exchangeable discs and a built-in thermometer for exact temperature control. All mixing elements are fixed to the kettle lid, which can be lifted by a hydraulic device for easy cleaning.
- Storage containers for the bulk material to be stored in small batches of approx. 8 kg for achieving faster solidification.

Preparation of Colour Pigments

The colour pigments are mixed at 1,400 rpm, with part of the oil phase in a proportion of one part pigment to three or four parts oil. After 15 minutes of mixing, the pigments are ready for the grinding operation.

If colour correction is necessary, as in the case of raw materials that are not resistant to shearing (such as pearl and mica), such correction is done after the grinding course. A small amount of colour dispersion is mixed with an equivalent amount of molten base. To correct the colour, additionally needed pigments are mixed with oil to a paste. The ground corrective amount is then mixed into the pigment dispersion. Normally, from one to three corrections may be necessary to achieve the exact shade called for. The pigment phase can be prepared and corrected a day or two before the planned production of the lipstick. Thus no additional time will be needed during the regular production operation.

Process Flow Diagram



Preparation of the Wax Phase

The required waxes are weighed into the vessel and melted at a temperature of 80 °–85 °C. Adding a part of the oil phase to the wax phase accelerates the melting process.

Preparation of the Oil Phase

This phase is fed into the mixing vessel and heated to 80 °–85 °C. When the proper temperature is reached, the vessel is deaerated. Then, the wax phase can be drawn through the suction pipe with built-in 60 micron filter.

Final Mixing

After the oil and wax phases have been mixed for 20 to 30 minutes under vacuum, the colour-corrected pigment phase is added to the batch. Mixing the colour pigments into the batch normally can be completed in 30 to 60 minutes.

Approximately 10 minutes before the end of the mixing period, pearl and mica (if the formulation calls for them) are added. At this point a sample should be drawn for a final colour test. Since the pigment phase has already been corrected, normally no additional correction should be necessary.

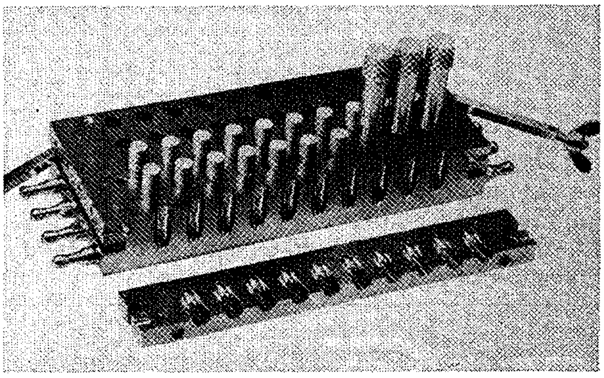
After approval of the colour, the perfume oil is added and the batch is cooled to slightly above the dripping point (60 °–62 °C). At this temperature the content of the mixing vessel is filled into the storage container. Solidification of the batch should start within a few minutes so that pigment settling will be avoided.

2. Moulding the Lipsticks

The final production, i.e. the casting and moulding, is the more sophisticated part of the lipstick manufacture.

The storage containers with molten lipstick mass have to be kept ready for casting at the suitable temperature by means of the heat retention cabinet. The temperature can be regulated with a thermostat to ±1 °C, indicated by the built-in thermometer. Exact observation of the temperature is most important and mandatory for moulding an excellent final product.

One casting form has 50 lipstick moulds and is fitted with removable strips and a stripping comb. This type of casting mould enables the cartridges to be put on the sticks easily by hand whilst they are still in the mould. It can be heated up and cooled down by water to reach the required operation temperatures.



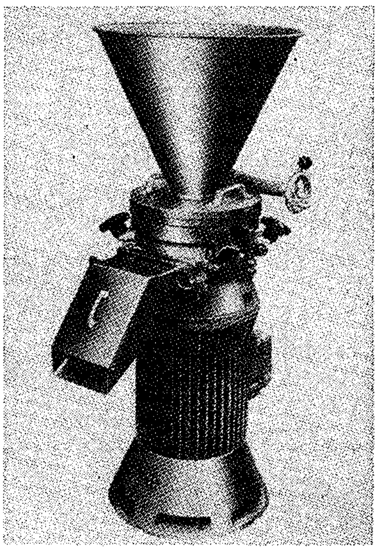
Casting mould

Casting Procedure

The moulds are heated to between 56° and 58 °C. The dew point being 62°, as is normally the case, it is advisable to cast at a temperature of 65 °C to avoid the product becoming hard and funnel-shaped. The residence time between casting and cooling should be about 1 minute. Cooling can be carried out in about 4 minutes at a water temperature of 20 °C

In general one operation course – casting, moulding and capping – can be performed in approximately 12 minutes.

The packing and cartoning of the finished lipsticks is carried out manually.



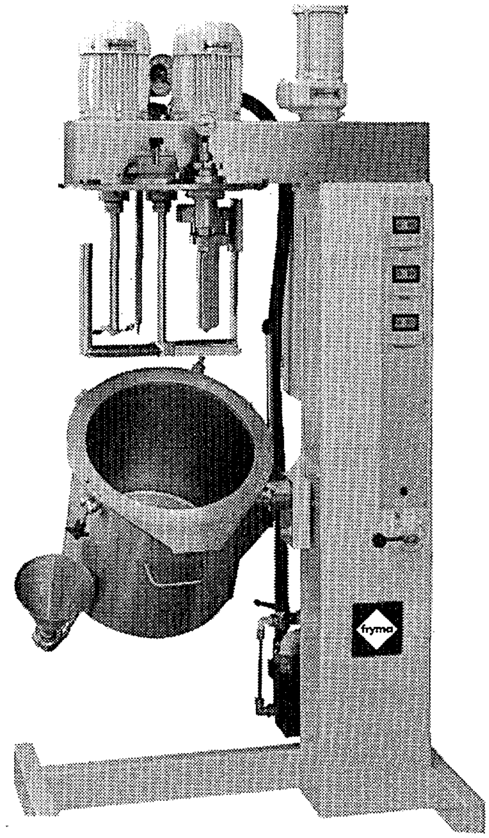
Corundum stone mill

Example of the plant

Daily capacity: approx. 6,000 pieces

Required Machinery and Equipment

1 Melting vessel (water heated) with anchor mixer, working volume 10 l
1 Corundum stone mill



Processing plant

1 Processing plant with temperature regulator, working volume 8 l
1 Storage vessel for pigment suspension with mixer, 10 l
1 Set of laboratory scales 0–200 g
1 Set of table scales 0–10 kg
1 Grindometer (fineness measuring device)
1 Heat retention cabinet for intermediate storage and electrical heating of two storage containers
10 Storage containers, 8 l
3 Casting moulds
1 Hot water generator for heating and cooling the moulds

The FOB price (in 1986) for the machinery and equipment amounts to approx. 100,000 US-$.

Daily Requirements of Production Materials
(depending on the applied formula):

Oil phase: 14–17 kg
Wax phase: 5–7 kg
Colour pigments: 1.5–4.5 kg
6,000 cartridges

Plant Site Requirements

Plant site area approx. 600 m²
Floorspace required for production at 3 m height approx. 50 m²
Floorspace required for office and laboratory at 3 m height approx. 40 m²
Storage room for raw material and finished products approx. 50 m²

Utility Requirements

Electrical power approx. 90 kWh/d
Cooling water at 15–20 °C, 3 bar: 6.5 m^3/d

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File: H 29
ISIC CODE 3529

How to Start Manufacturing Industries

Disinfectant Making Plant

Introduction

With the development of new diagnostic and therapeutic aids, physicians inevitably have to treat increasing numbers of patients either in the surgery or in their own homes. The risk of cross infection in the surgery has therefore significantly increased.

Preventing infection and interrupting bacterial transfer requires a practical and efficient application of aseptic and antiseptic techniques especially in treatment and control of infectious and contagious diseases.

The main areas of risk are treatment rooms, waiting rooms, laboratories, furniture etc. Medical personnel and most of the assistant staff as well as the patients themselves are directly exposed to infection.

A number of direct measures serve to reduce or even to exclude such risks, i.e.

- cleaning, disinfecting and sterilization of instruments, materials and equipment coming in direct contact with patients;
- frequent washing and disinfecting hands of the medical, nursing and assistant staff;
- frequent disinfection of rooms and complete wards at regular intervals.

It is obvious that besides special sterilization and steady cleaning disinfection is the most important necessity in the field of medical treatment and to a certain extent also in other areas.

A range of disinfectants has therefore been developed to cope with medical, clinical or surgical requirements. Many of them are on alcoholic basis with additional inhibitors for the specific use.

As for skin disinfectants by way of example they must be microbicide, quick drying, ungreasing, in general suitable to patients and personnel (regarding smell, fluid etc.)

Process Description

Water Treatment

The manufacture of disinfectants depends to a great extent on the appropriately prepared water component. Therefore a full demineralization treatment has to be carried out:

- Prefiltration
- Active carbon filtration
- Sterile filtration and
- Demineralization via ion exchanger (anion/cation columns).

Proper storage before entering the solution preparation is provided by a suitable storage tank.

Preparation of Disinfectant Solutions

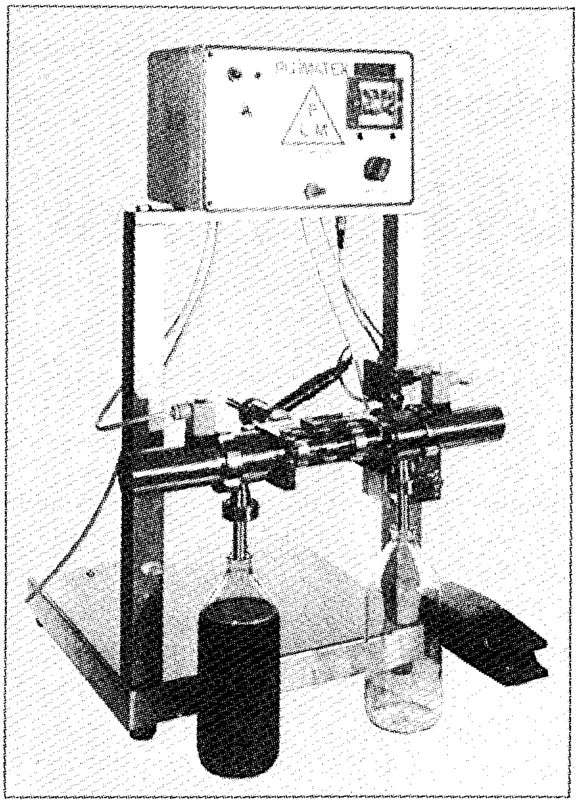
With a view to the different purposes there is a wide range of formulae containing a variety of components a number of which is difficult to fuse or to dissolve and which need special treatment or melting before the final admixture. For this purpose a steam heated pre-preparation tank is necessary from which, after having been mixed and melted, theses components are fed into the main preparation tank for final mixing. Other components like alcohol, easy-soluble chemicals and demineralized water are filled directly into the main preparation tank for mixing.

A typical composition is shown as an example formula for a skin disinfectant:

Ethanol	approx. 80.0% by wt.
Total chemicals	approx. 0.1% by wt.
Demin. water	approx. 20.0% by wt.

Hand washing lotions in general consist of approximately 65% demineralized water, 15% chemicals and 20% solid additives.

Disinfectants, final product



Semi-automatic filling machine

All solid parts and chemicals are weighed in accordance with the formula as applied for a distinguished item of the disinfectant production program.

Production of Plastic Bottles

For final delivery ex-factory the disinfectant solutions are filled into plastic bottles. They are manufactured in a blow moulding machine consisting of an extruder and a single station blow moulder with a closing force of 40 kN.

For intermediate storage of the bottles before filling contamination-proof conditions are to be provided.

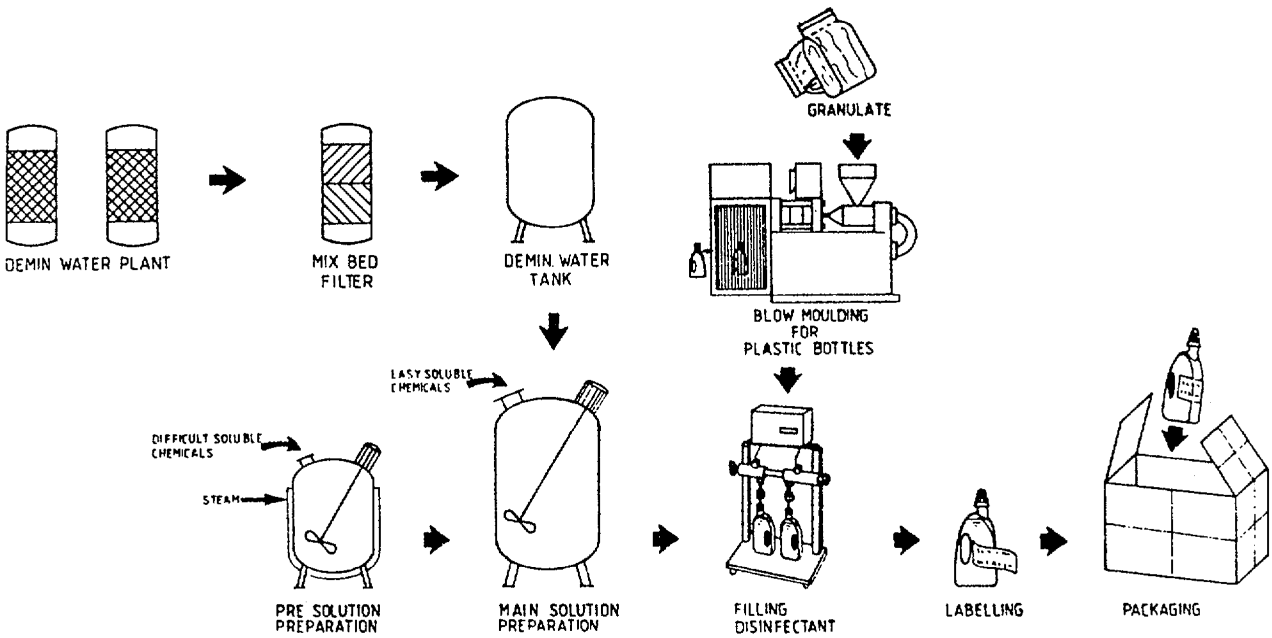
Filling, Closing and Packaging

The bottles to be filled are placed on a conveyor transporting them to the semi-automatic filling machine. The product is fed to the filling machine under a pressure of 1–2 bar. A measuring turbine in the filling line is connected with an electronic counter to be pre-set for distinguished bottle volumes. An exhaust system should be installed above the filling machine to withdraw the fumes by suction. After closing and labelling the bottles will be packed in cardboard boxes ready for delivery.

Example of the plant

Capacity: 4,000 litres per day

Production flow sheet



Required Machinery and Equipment

1 Demineralization unit with 2 filter sets, 2 pumps and 1 storage tank
1 Pre-preparation tank
1 Preparation tank
1 Storage tank
2 Pumps
2 Agitators
1 Blow moulding machine
1 Filling machine
2 Conveyors
1 Labelling machine
1 Compressed air plant
1 Steam generator
Laboratory equipment

The FOB price (in 1986) for the machinery and equipment amounts to approx US$ 900,000.

Required Production Material per Day

based on the example formula for skin disinfectant (1) and the general composition for handwashing lotion (2):

	(1)	*(2)*
Ethanol	3,200 l	–
Total chemicals	10 kg	600 kg
Solid soap additives	–	800 kg
Demin. water	800 l	2,600 l
Granulate PE for bottles (depending on produced size)	300–400 kg	300–400 kg

Required Utilities per Day

Electric power approx.	600 kWh
Water	20 m^3

Required Manpower per Day

Preparation of solution	1
Filling of bottles	3
Production of bottles	3
Packaging	2
Workshop	1
Laboratory	1
Total	11

Required Plant Site Area

Production area approx.	600 m^2
Storage area approx.	600 m^2
Outdoor space approx.	800 m^2
Total approx.	2,000 m^2

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File: H 30
ISIC CODE 3523

How To Start Manufacturing Industries

Toothpaste Production

Introduction

The industrial manufacture of liquid dental care articles, made on a basis of chalk and soap can be traced back to approx. 1870. At the turn of the century, the first toothpastes in tubes appeared on the market. The expansion of civilisation, higher standards of living and also the increase in the consumption of sweets and intensive advertising, brought about a rapid development and increase in the use of toothpaste. Modern toothpaste formulations have gradually replaced other dental care articles, such as toothpowder, mouth rinses, tooth soap etc.

Research and development, carried out by the larger companies, produce such modern formulations, which can no longer be compared with the toothpastes made at the beginning of the century. Both the composition and the production methods of the toothpaste have been rationalized and modernized to bring them up to current requirements and technical standards.

Essential Components

Abrasives are the most important ingredients, which influence the cleaning effect of the toothpaste. They shall be free of grit to protect the dental enamel. The hardness of the abrasive material shall not be more than 4 Mohs. Conventional abrasive components are:

- calcium carbonate
- calcium sulphate
- aluminium silicates (caolines)
- dicalciumphosphatedehydrate

(When using dicalciumphosphatedehydrates and calcium carbonate, the formation of apatite must be avoided which is possible by adding trimagnesiumphosphate). The primary fineness of the abrasive components should be below 15 microns.

Water and moisturizing components such as sorbitol, glyceriol, propylenglycol. Distilled water is used in general. However, pure, filtered well-water is also acceptable. The application of moisturizers improves the resistance to thermal effects and also keeps the toothpaste smooth and prevents if from drying out. They also give the toothpaste a glossy, attractive appearance.

Thickening, bonding and stabilizing agents give the toothpaste a certain viscosity and prevent sedimentation. They also add to the glossy appearance. At present the following substances are mainly applied:

- coagulated silicium dioxide
- carboxymethylcellulose (CMC)
- methylcellulose
- special betonites
- alginates and cargheens

Carboxymethylcellulose or methylcellulose, which are soluble when cold, are usually given preference (unless toothpaste containing enzymes shall be produced).

Foaming agents such as:

- fat alcohol sulphates
- Turkey-Red Oil

are currently applied to improve the cleaning effect. Soap is nowadays used less and less as a foaming agent. It has not only an unpleasant after-taste, but also induces the danger of calcium soap forming.

Flavours are achieved by the application of peppermint oil, winter-green oil, methol and different sorts of fruit aroma. Saccharine, sodium cyclamate and other additives are used as sweeteners.

Active ingredients and preservatives are currently applied depending on the wanted effect:

alcohol, bromclorophene, chloroform, magnesiumperoxide, sodiumlaurylesarcasinate, calcium chlorate, fluor compound, sodium carbonate, sodium chloride, camomile extract, vitamin K.

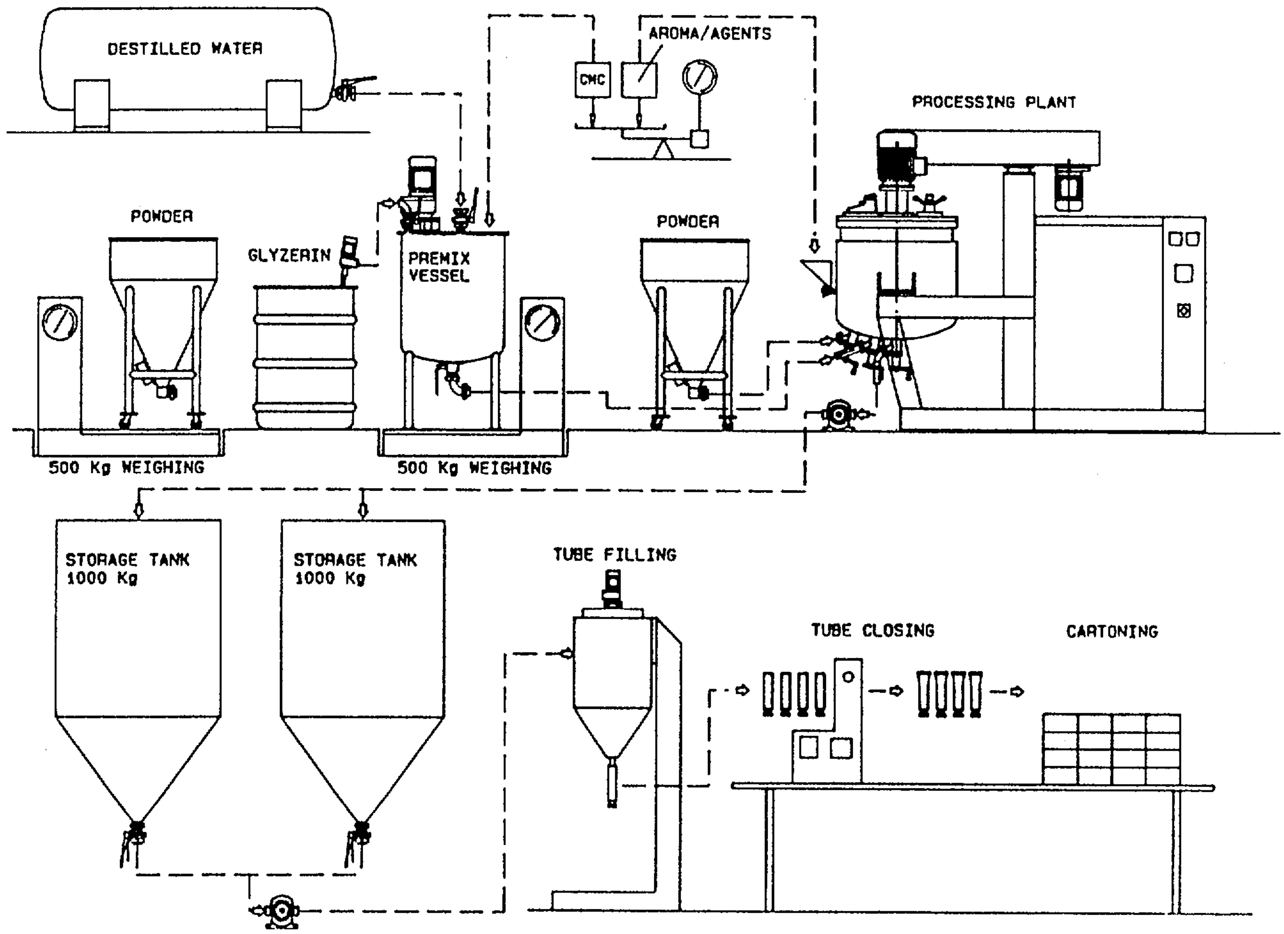
As preservatives the following additives are mainly used:

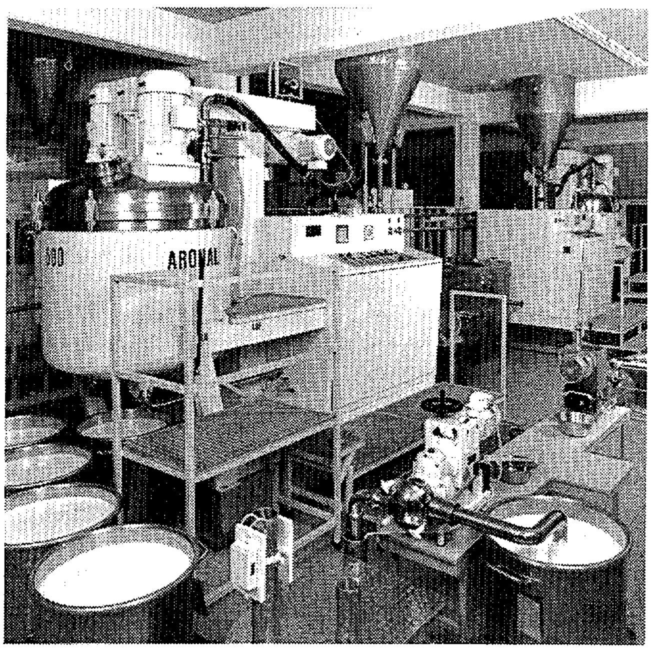
methyl and propylesters of the p-hydroxy benzoic acid, sodium bonzoate etc.

The outline toothpaste formule is composed of:

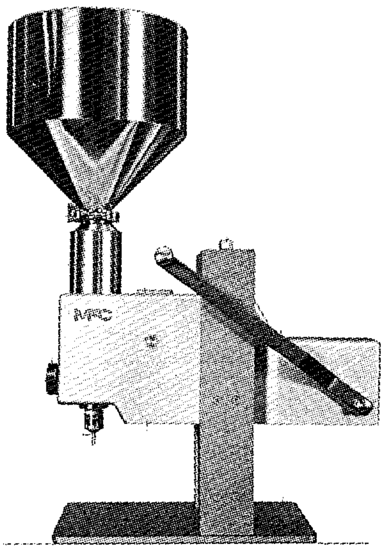
calcium carbonate	40–50 %
CMC (thickener)	2 %
water	20–30 %
glycerin	20 %
perfume oil	2– 2.5%
moisturizing agent	1– 3 %
preserving agent approx.	0.5%

Process Flow Diagram

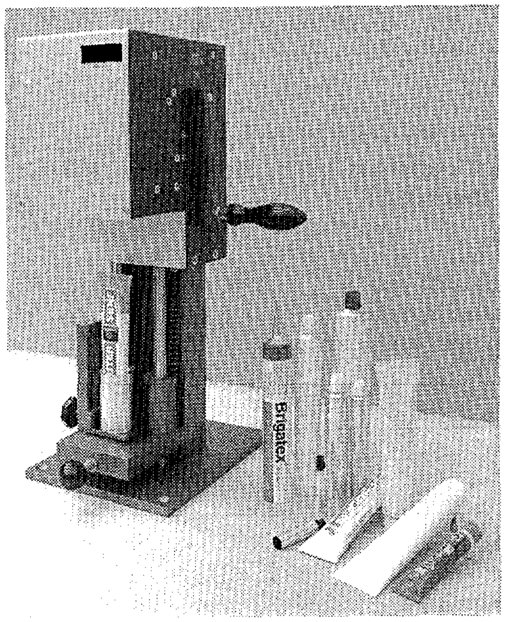




Processing plant



Tube filling



Tube closing

Process Description

For the production of toothpaste from various raw materials as described above a processing plant has been developed, which incorporates a combination of various functions. The equipment is specially designed for the production of toothpaste and is now being used by most of the well-known toothpaste manufacturers. Of course, other products can by made on the processing plant as well, such as cosmetic cream, lotions etc.

The processing plant comprises a highly effective vacuum mixer with mixing and dispersing system, which can be used for each individual toothpaste formulation.

The average time for a batch, made according to the outline formula given above, is roughly one hour up to the final product ready to be filled into tubes.

The raw materials are drawn into the processing vessel by means of the vacuum. The suction studs are located in such a way as to ensure that the dry, powdery components are immediately moisturized on entering the vessel. The finished toothpaste is pumped out of the central outlet stud of the vessel by means of a feed pump and conveyed into intermediary storage tanks. As an additional safety precaution, a basket screen can be fitted between the pump and the pipeline.

Storing and Filling the Finished Toothpaste

The toothpaste is pumped into two storage tanks below the processing plant, from where it is later pumped into the feed hopper of the filling machine, which is manually operated and can fill aprox. 800 tubes of 70–120 cm^3/h semi-automatically. The capping machine also operates semi-automatically. It closes tubes of 10–38 mm in diameter, and 60–200 mm in length. The packaging and cartoning of the tubes is done by hand.

Example of the Manufacturing Plant

The features are shown for two different plant sizes, i.e. 1 for 500 kg and 2 for 1000 kg per day (8 h operation).

Required Machinery and Equipment

	Plant Size 1	Plant Size 2
Mobile powder vessel (volume)	250 l	400 l
1 Premix vessel fitted with propeller mixer (volume)	200 l	300 l
1 Processing plant (volume of vessel)	100 l	200 l
2 Floor scales	0–500 kg	0–1000 kg
1 Table scale	0– 20 kg	0– 20 kg
2 Storage tanks with conical bottoms	1000 l	2000 l
2 Discharge pumps		
1 Pump for discharge glycerin tank		
1 Semi-automatic tube-filling machine		
1 Semi-automatic tube-closing machine		

Approximate total FOB prices (in 1986) amount to US$ 400,000 for plant size 1 and US$ 600,000 for plant size 2.

Requirement of Production Materials per Day
(outline only, the precise quantities depend on the finally chosen formula).

	Plant Size 1	2
Calcium carbonate	200–250 kg	400–500 kg
CMC (thickener)	10 kg	20 kg
Water	100–150 kg	200–300 kg
Glycerin	100 kg	200 kg
Perfume oil	10– 12 kg	20– 25 kg
Moisturizing agent	5– 15 kg	10– 30 kg
Preserving agent approx.	2.5 kg	5 kg

Utility Requirements

	Plant Size 1	2
Electric power	100 kWh	150 kWh
Water	0.5 m^3/d	1 m^3/d
Cooling water 15–20° C 3 bar	5 m^3/d	8 m^3/d

Required Manpower

	Plant Size 1	2
Technician	1	1
Trained operator	1	1
Unskilled workers	2	3
Laboratory assistant	1	1

Plant Site Requirements

	Plant Size 1	2
Required overhead space 5 m	150 m^2	250 m^2
Storage room for raw materials and finished products	200 m^2	300 m^2
Required office and laboratory overhead space 3.5 m	50 m^2	50 m^2
Required plant site area	1500 m^2	2500 m^2

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How To Start Manufacturing Industries

Intravenous Solutions Making Plant

Introduction

During the last 30 years the possibilities of infusion therapy have been increasingly recognised and the therapy has thus been developed to its present standard.

There are four main ranges of application of highly specialised intravenous infusion solutions:

a) Treatment of disturbed water and electrolyte metabolism, especially in severe cases.
b) Therapy of acid-base imbalances.
c) Volume substitution and volume replacement in surgery of in accident victims suffering blood loss.
d) Parenteral nutrition for severely ill and postoperative patients.

Infusion therapy supports the restoration and maintenance of physiological conditions of patients, referred to as "homeostasis".

Homeostasis is an essential presupposition for human life. It can be described as "the physiological equilibrium" of the human organism.

Shock, stress, trauma, haemorrhages, infections and nutritional or metabolic diseases may disturb the physiological balance of the homeostasis and result in a disturbance of the body's functions. Changes in water/electrolyte balance, acid/base balance, and protein/carbohydrate/fat metabolism are linked to organic and circulatory misfunctions and thus are of vital importance for the survival of the patient.

The human organism is able to compensate an impaired intake and utilisation of electrolytes, proteins, carbohydrates and fats to a certain extent and for a certain period. This compensation, however, causes further stress on the patient as well as frequent metabolic crises which in the worst cases lead to the death of the patient.

Infusion therapy as a basic toll of modern medical care enables the physician to restore and stabilise homeostasis states quickly and completely

Process Description

Water needed for the production of infusion solutions must be of extremely high quality, which can be achieved only by special purification treatment.

The following quality requirements have to be met:

• Silicea	non detectable
• Sodium	non detectable
• Potassium	below 0.05 ppm
• Pyrogene free	
• Sterile filtration	

Water Treatment

The following steps are generally in practice for treatment:

- Prefiltration
- Active carbon filtration
- Sterile filtration
- Demineralization via ion exchanger (anion/cation columns)
- Demineralized water storage tank
- Prefiltration of demineralized water
- Sterile filtration of demineralized water

Distillation

The distillation unit is fed with fully demineralized water; the distillate is generated by multistep evaporators and subsequent condensation. After condensation the water is stored at a temperature of approx. 90° C. From this sorage it is pumped to the various production points by centrifugal pumps.

Preparation of Solutions

Typical infusion solutions formulae are:

• Normal saline in water	0.9%
• Dextrose in water	5.0%
• Dextrose in normal saline	5.0%

The chemicals are controlled by the quality control section prior to the manufacturing process. They are weighed according to the applied formula and stored in the respective containers. The preparation tank, equipped with an agitator, is filled with distilled water before the chemicals are added and the mixing procedure is started.

From the preparation tank the solution is pumped through depth and membrane filters to the filling section.

Filling and Sealing of Bottles

Depending on the type of bottles generally three types of filling and sealing methods are used:

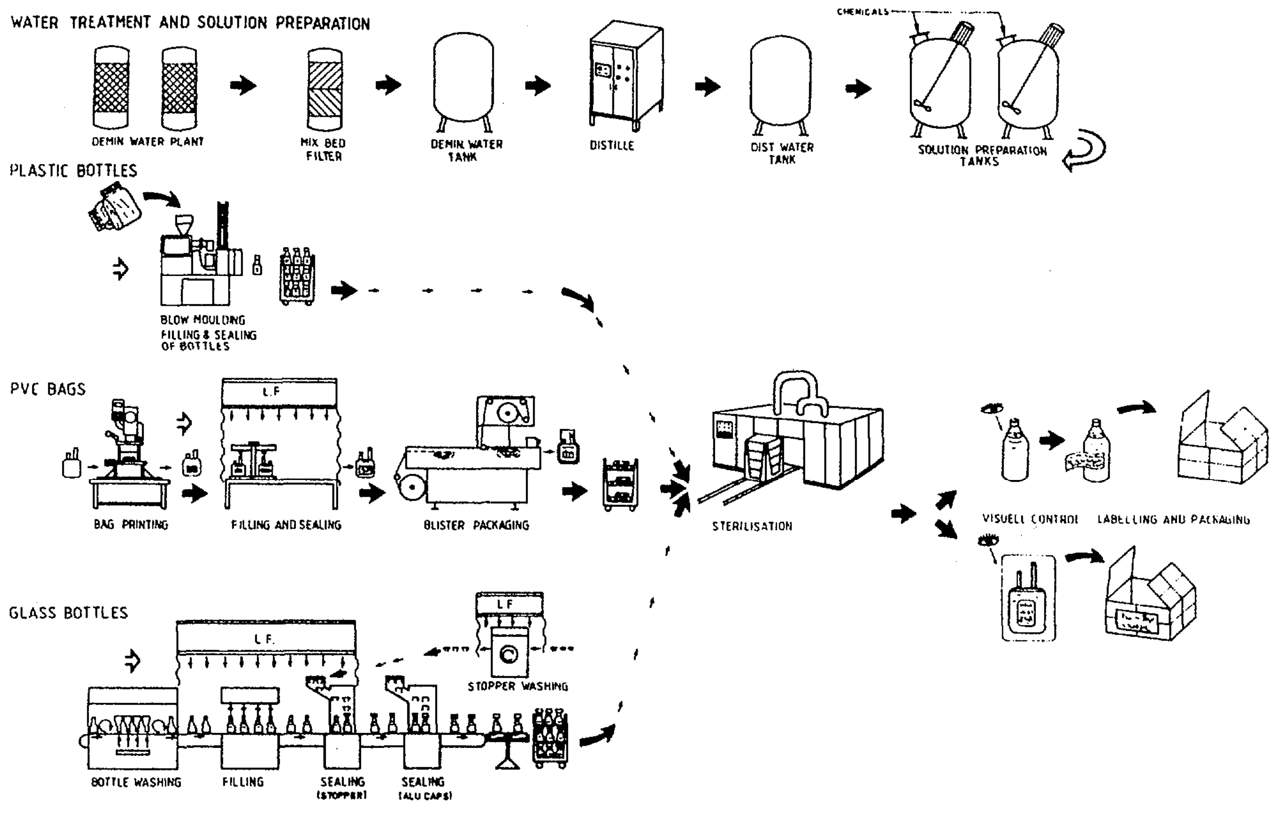
1. Blowing, filling and sealing of plastic bottles.
   The plastic bottles are blown in the bottle-pack machine which is fed with plastic granules.
   This machine represents a system where the bottles are blow-moulded, filled and sealed in one course. Thus the highest hygienic standards possible and an almost completely aseptic filling are guaranteed. The bottle heads can be produced in different designs with or without rubber disc for tight insertion of the infusion set.
   The seald bottles are discharged from the machine and stacked on autoclave trolleys for transport to the sterilization section.
2. Filling and sealing of plastic bags.
   Prefabricated plastic bags of 100 ml–1000 ml content are imprinted by an embossing machine before being transported to the filling machine where they are also sealed. After getting a plastic coat in the blister machine, the bags are stacked on pallets and rolled to the autoclave for sterilization.
3. Filling and sealing of glass bottles.
   The glass bottles (to be supplied by hollow glass suppliers) are washed with demineralized water before filling as are the stopper seals.
   After the fully automatic filling process the bottles are sealed with the washed stoppers and in a second step with alucaps before being transported to the sterilization process.

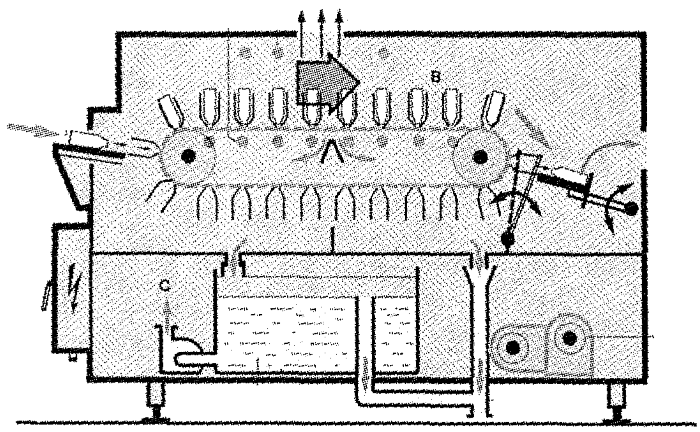
The subsequent process flow is identical for the three of the described filling lines. The single steps are as follows:

Sterilization (by Autoclave)

The bottles stacked on the special wagons are rolled into the autoclave chamber and sterilized in accordance with an electronically controlled cycle comprising three stages:

Production Flow Sheet





Bottle washing machine tunnel washer type (schematic)

1. Heating period
2. Actual sterilization period
3. Cooling period.

Visual Inspection

After sterilization the bottles are transported to visual inspection for checking their exterior integrity (walls) as well as the quality of sealings and solution. Defective bottles can thus easily by recognised and eliminated.

Labelling

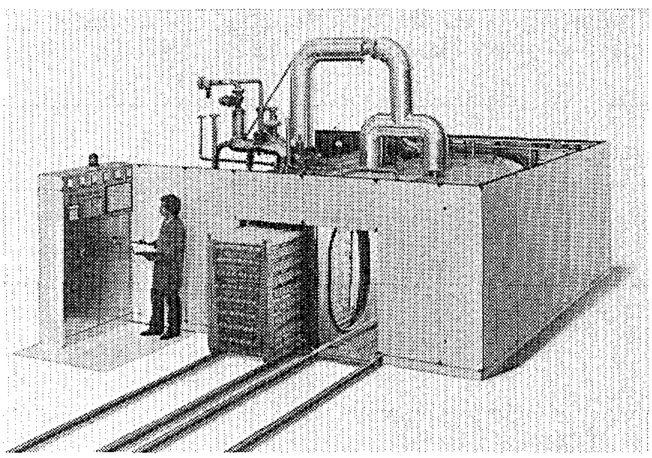
The inspected bottles pass a labelling machine providing them with self-adhesive product labels indicating the specification of the content and other information as may be necessary. The respective batch number is printed on each label by a printing device installed in the labelling machine.

Packaging

The labelled bottles are packed into cardboard boxes usually containing 10 bottles. An instruction leaflet is added to each cardboard box before closing and sealing it with self-adhesive tape. For safe identification of its contents the boxes are marked with the respective product label before being stacked on pallets and released for use.

Example of the Plant

Three alternative bottling systems (I, II and III are considered:



Autoclave

Required Machinery and Equipment

1 Demineralization unit
1 Distillation unit
1 Solution preparation unit
I. 1 Filling and sealing machine for 500 glass bottles per hour
II. 1 Moulding, filling and sealing machine for 850 plastic bottles per hour
III. 1 Embossing machine
1 Filling machine
1 Blister machine for the filling of 500 plastic bags per hour
1 Autoclave
1 Visual control device
1 Labelling machine
1 Packaging machine

1 Steam generator
1 Compressed air plant
1 Cooling and chilled water plant
Laboratory equipment for chemical, sterility and pyrogene testing.

FOB prices (in 1986) for the machinery and equipment amount to

- approx. US$ 1.5 mill. for system I based on 400 glass bottles (500 ml) per shift
- approx. US$ 1.7 mill. for system II based on 7200 plastic bottles (500 ml) per shift
- approx. US$ 1.2 mill. for system III based on 4000 plastic bags per shift

Required Production Material per Day
(based on a sample solution 5% dextrose)

Requirement	*System* *I*	*II*	*III*
Chemical (dextrose)	100 kg	170 kg	100 kg
PE for plastic bottles	–	340 kg	–
PVC bags with stoppers	–	–	4000 pcs
Glass bottles with stoppers	4000 pcs	–	–
Packaging boxes	400 pcs	680 pcs	400 pcs

Required Utilities per Day

	System *I*	*II*	*III*
Electric power	1400 kWh	1700 kWh	1400 kWh
Water	40 m^3	30 m^3	30 m^3

Required Man Power per Day

	System *I*	*II*	*III*
Preparation of solution	2	3	2
Filling of bottles	5	5	5
Sterilization	2	2	2
Visual control	10	2	8
Packaging	10	10	10
Laboratory	5	5	5
Total	34	27	32

Required Plant Site Area (m^2)

	System *I*	*II*	*III*
Production approx.	1400	1400	1300
Storage approx.	1000	800	800
Outdoor space approx.	1500	1500	1500
Total approx.	3900	3700	3600

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File: H 32
ISIC CODE 3523

How To Start Manufacturing Industries

Soap Production

Introduction

In Germany the production of equipment for industrial soap factories looks back at a tradition of nearly one hundred years. In that period rich experience has been collected by steady development of the machinery. Trials for new modes of processing in addition to improved manufacturing methods guarantee the high-standard equipment today.

For the production of soaps several kinds of fats are required, mainly beef tallow and coconut oil, but also palm kernel oil as well as castor oil, olive oil, peanut oil and porc tallow in smaller quantities. The liquid fats are boiled with the aid of steam and saponified with caustic soda lye. Glycerine is recovered by washing with brine. For the production of laundry or toilet soap the neat soap has to be dried and cooled. The finishing of laundry soap is achieved by extrusion, imprinting and cutting of the solidified soap slug, whereas the procedure for the finishing of toilet soap is more expensive, requiring the steps of mixing, homogenizing, refining, extrusion, cutting, pressing and wrapping.

Description of the Process

Processing of soap includes three main operations: saponification of neutral fats or fatty acids, drying and finishing.

Neutral fat saponification: In general soap is produced with 70 to 85% beef tallow and 15 to 30% coconut oil. Instead of tallow, bleached palm oil can also be used, but for highgrade toilet soap the palm oil content of soap should be limited to a maximum of 75%. Instead of coconut oil, palm kernel oil can be used.

Caustic soda lye which is required for the saponification of fats, can be produced by dissolving crystalline caustic soda in water. After saponification of fats and reaction of fatty acids with caustic soda, glycerine is split and can be extracted with brine. The brine is produced by dissolving crystalline sodium chloride in water.

Saponification: The saponification process develops in three steps – saponification, glycerine extraction, soap fitting. During the treatment fats and electrolyte are mixed for reaction and for the formation of new phases to be subsequently separated.

Saponification occurs by reaction of NaOH with fat separating glycerine. After glycerine washing the soap is treated for fitting by adjusting the electrolyte content to form the two phases: neat soap and niger. Neat soap is the fitted soap, niger contains most of the impurities and is recycled to the saponification step.

Neutralization of fatty acid: Fats can be split into fatty acids before saponification, e.g. by high-pressure hydrolysis. This process usually becomes economic when production rates are high (50 tons/day or more). It is particularly applied when fatty acids are the base both for soap and other products.

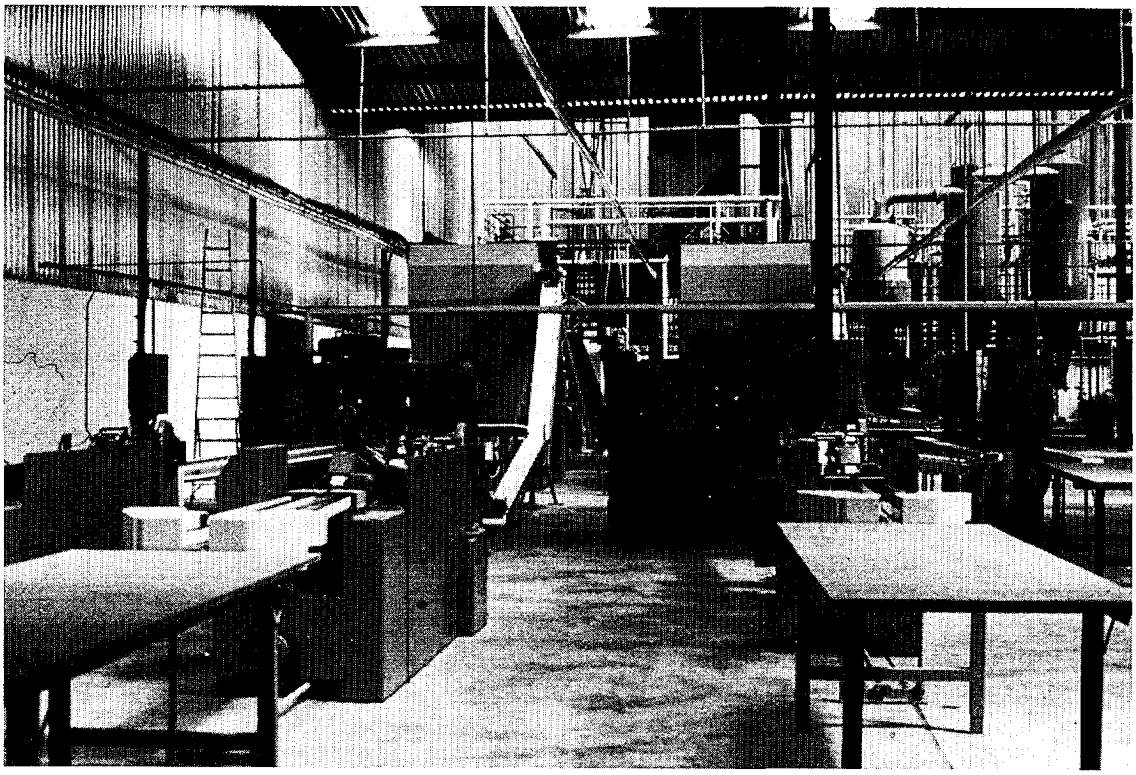
For neutralization the same process as for saponification of fats is used, except the glycerine washing step.

Vacuum drying: Vacuum driers and finishing lines are built for standard production rates from 300 to 6,000 kg/h. The neat soap is filtered and pumped into a feeding tank and then fed to the drier by a proportioning pump with speed variator. It is heated in a heat-exchanger and cooled and solidified in the vacuum chamber. A soap noodle press discharges it from the vacuum chamber. The vapour produced at drying is condensed in a barometric condenser after passing dust-separators. Evacuation of non-condensable gas is done by means of steam ejectors or mechanical pumps.

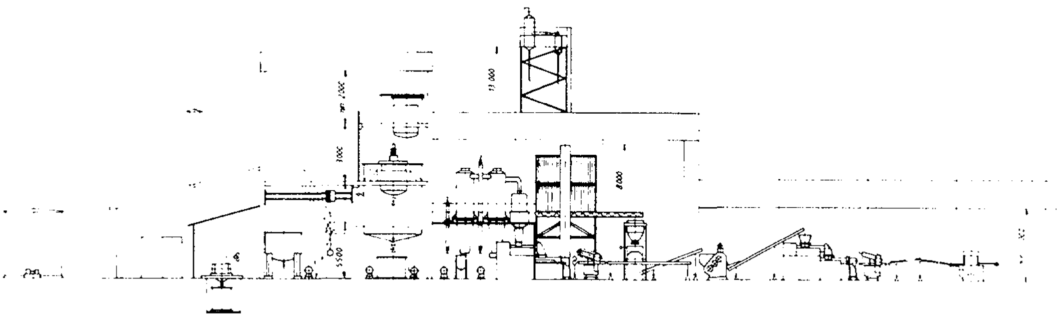
The picture shows the vacuum drying part and the following supply of the finishing line of a soap plant.

Toilet soap finishing includes the following steps:

- mixing of soap noodles with colour, perfume and other additives
- homogenizing of the soap mixture by roll-mill or refining by refining plodder
- refining/extruding with a vacuum plodder
- cutting of the extruded continuous bar by means of a cutter
- stamping of the bar by a soap press



Scheme of a toilet soap factory



The scheme shows a soap factory with the following units:
1. outdoor storing facilities
2. drum blowout device
3. kettle saponification
4. vacuum drying and cooling system
5. finishing line

Example of the Plant

Required Machinery and Equipment
for a one-shift production of toilet soap with a capacity of 1 ton per hour

Item	*Description*		*Piece*
1.0	Kettle saponification plant		
1.1	Storage tanks of	28 cu.m	4
1.2	Dissolving vessel	5 cu.m	1
1.3	Dissolving vessel	4 cu.m	1
1.4	Dilution tanks	9 cu.m	2
1.5	Boiling vats	30 cu.m	4
1.6	Tank for soap	2.1 cu.m	1
2.0	Continuous vacuum drying and cooling plant		

Item	*Description*	*Piece*
2.1	Soap feeding tank 170 l	1
2.2	Soap heat exchanger	1
2.3	Vacuum spray	1
2.4	Dust separator unit	1
2.5	Barometric condenser	1
2.6	Plodder	1
3.0	Toilet soap finishing line	
3.1	Mixer	1
3.2	Roll mill	1
3.3.	Duplex vacuum plodder	1
3.4	Cutter	1
3.5	Soap press	1
3.6	Packing machine	1

FOB-price for machinery and equipment approx. US$ 950,000.00

Required Buildings and Areas

Administration	350 sq.m
Production	1,050 sq.m
Storage for soap bars	250 sq.m

Required Manpower for a One-shift Production of Toilet Soap with a Capacity of 1 ton/h

Manager	1
Assistant	1
Administration	3
Operator for saponification	1
Mechanical technician	1
Foreman	1
Workers	6
Driver	1
	15

Required Power and Utilities
(per ton of toilet soap)

Electric power	approx. 186 kW
Water for saponification	860 l
Cooling water	26.6 cu.m
Steam	1,500 kg

Required Raw Materials
(per ton of neat soap)

Fat	660 kg
NaOH (36%)	240 – 330 kg
NaCl (21%)	110 – 190 kg

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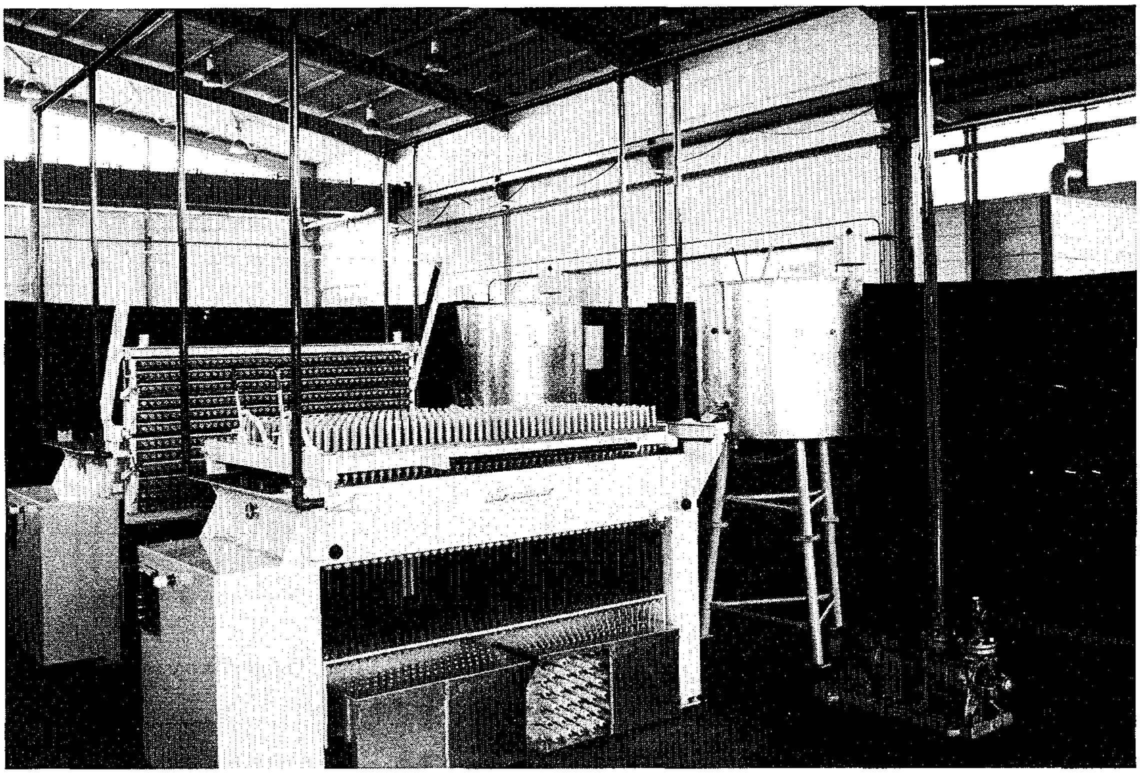
File: H 33
ISIC CODE 3529

How To Start Manufacturing Industries

Candle Manufacturing



Introduction

From ancient times candles have been important as sources of light, and although they were replaced first by kerosene lamps and later by incandescent electric lamps, their use has actually expanded because of their ornamental value. In spite of the technical progress in lighting, the term "candle power" is used as a unit for measuring the brilliance of any given light.

Candles were manufactured by moulding a blend of fats and wax around a flax or cotton wick and so are their modern varieties. Machines have replaced manual labour, new wax formulations have been introduced for decorative effects. The first waxes used were mutton tallow and beeswax.

Spermaceti obtained from whales were introduced to candle manufacture at the time of the American Revolution. Since the middle of the nineteenth century paraffin wax was added to the list of waxes recommended for candle manufacture.

Description of the Production Process

The classical household candle is the basis of any candle factory. It ensures steady sales and low production costs. Sizes of household candles differ slightly in various parts of the world. A candle size which is very frequently found and which we have taken as an example for this documentation, is a 40-gram candle with a diameter of 19 mm (¾″) and a length of 200 mm (8″). The output of the described plant will be approx. 28,000 household candles per 8-hour day.

The main raw material required for the manufacture of household candles is paraffin wax, a by-product of the oil refining industry.

The paraffin wax to be used for the manufacture of household candles on the machinery and equipment described hereafter should have a maximum oil content of 0.5% and a melting point of 56 to 62 °C.

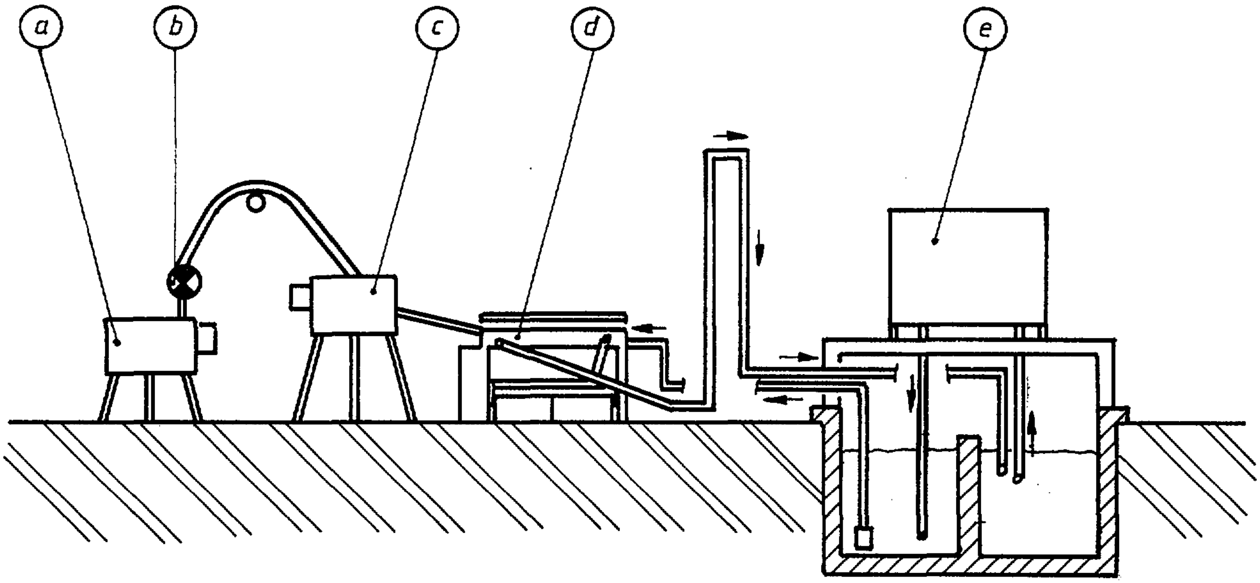
The paraffin wax which is normally supplied in solid slabs of 5 kg each, is melted in electrically heated melting pans (a), pumped by means of a special wax pump (b) into the higher positioned wax feeding tanks (c), from where it flows into the moulds of the moulding machines (d) where the candle wick has already been placed in the right position.

As soon as the moulds are filled, cooling water from the water cooling unit (e) flows through the moulding machines to solidify the paraffin wax in the moulds.

After a solidification time of approx. 20 minutes the finished candles can be ejected and packed.

Packaging machinery has not been included since in countries with comparatively low labour costs the packing is better done by hand. In many countries the household candles are simply packed in blue paper, in cellophane bags or cardboard boxes.

Flow sheet



Example of the Plant

Required Machinery and Equipment

Item Description		*Pieces*
1.	Electrically heated wax melting pans	2
2.	Wax pump	1
3.	Electrically heated wax feeding tanks	2
4.	Candle moulding machines	2
5	Water cooling unit	1
	FOB-price for machinery and equipment approx.	US$ 130,000.00

Required Manpower

Commercial manager	1
Secretary	1
Skilled workers for machine operation	2
Unskilled workers	3
	7

Required Area

Production area	100 sq.m
Storage	27 sq.m
Facilities	54 sq.m

Required Power and Utilities

Electrical power AC 380 V, 50 c/s, 3-phase	27 kW

Required Raw Materials
for an 8-hour production of 28,000 candles

Paraffin wax	approx. 1,120 kg
Candle wick (braided cotton yarn)	approx. 6,440 m

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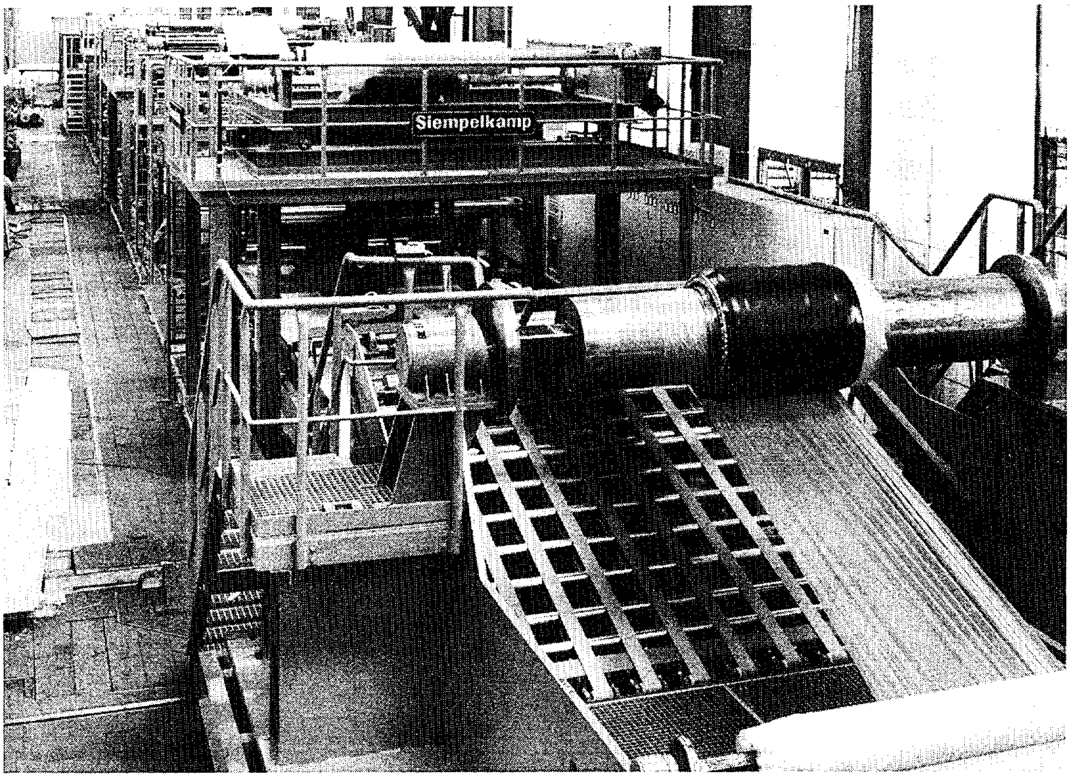
J

How To Start Manufacturing Industries

Steelcord Conveyor Belts



Introduction

Nowadays conveyor belts are used both in surface- and in underground-mining for the transport of mineral coal, brown coal, phosphate and ore. It is international use to produce these belts in widths of 800 to 3,200 mm and thicknesses of up to 400 mm.

The implementation of a production plant of steelcord conveyor belts is based on the assumption that a production plant for rubber products, such as fabric conveyor belts, tyres or other large products is in existence and its machinery can be used for the production of the required rubber cover plates and core rubber sheets, such as calenders or roller head plants.

Steelcord conveyor belts do not only mean that the strength of the belt is considerably increased; there are quite a few more advantages to this type of belt which is a convincing alternative to fabric conveyor belts:

- steelcord belts have a long life and, to a large extent, are nearly maintenance-free,
- there is hardly any stretching of the belt, thus allowing to plan a plant with large distances between the supports,
- straight movement, no detrimental influence by climatic conditions,
- no local stretching due to loading with large and heavy pieces,
- easy repair by hot or cold vulcanization.

Quality requirements, testing, belt connections, measures and denominations are specified in German Industrial Standards DIN No. 22131. The standard sizes for steelcord conveyors are belt widths of 1,830 – 2,000 – 2,135 – 2,540 – 3,050 and 3,200 mm.

Description of the Production Process

The plant described here for the production of steelcord conveyors is laid out for a capacity of 60,000 m total length at a belt width of 2 m, and it is based on an annual production time of 240 working days at 3-shift operation.

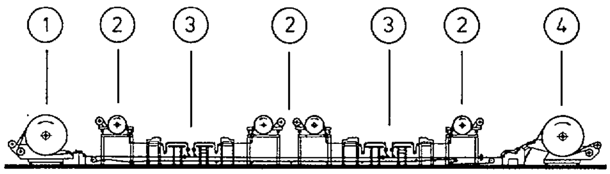
The production process is divided in the following steps:

- calendering of extrusion of rubber cover plates and the core rubber sheets
- doubling of cover rubber resp. core rubber sheets to required thickness
- doubling of cover rubber with core rubber sheets
- longitudinal splice of the cover rubber doubled with the core rubber sheets to required belt width
- winding of the finished raw belt and conveying of the raw belt to the steelcord production plant
- placing of steelcord spools into the creel
- tensioning of steelcords to 315 kp/rope
- placing and pressing of rubber cover plates and core rubber sheets
- after production of the raw belt of a certain length, placing this length into the vulcanizing press for vulcanizing
- winding the vulcanized belt up to a roll of 200 to 400 m according to its thickness
- transport of the finished steelcord belt to storage or dispatch.

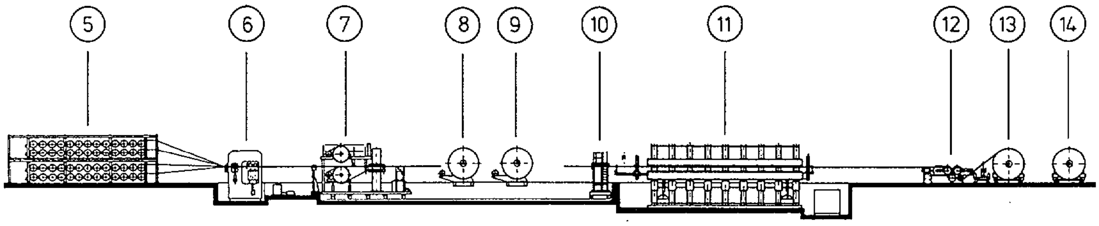
Flow-sheets

Flow-sheet No. 1 shows the preparation of production of the raw belt. Flow-sheet No. 2 the finishing of the steelcord belt.

No. 1



No. 2



Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
A.	Conveyor belt building machinery	
1	Intermediate let-off	1
2	Let-off for rubber or rubber-frictioned fabrics	3
3	Depositing device for longitudinal splice and edge splicing with cutting device	2
4	Wind-up for uncured belt	1
B.	Steelcord conveyor belt line	
1	Creel with loading device	1
2	Cable tensioner	1
3	Compactor lorry	1
4	Let-off for fabric belts	1
5	Let-off for fabric belts	1
6	Inspection platform	1
7	Belt curing press	1
8	Pull-roll stand	1
9	Wind-up device	1
10	Wind-up for cured belts	1
	FOB-price for machinery and equipment approx.	US$ 7,000,000.00

Required Buildings and Areas

Administration	180 sq.m
Production	2,160 sq.m
Storage raw materials	500 sq.m
Open-air storage	750 sq.m
Facilities	300 sq.m

Required Manpower

Production manager	1
Engineer for the production of belt conveyors	1
Workers	6
Quality control	2
Helpers	6
	16

Required Power and Utilities

Electric power	approx. 600,000 kW/yr
Heating energy	approx. 600,000 Gcal/yr
Cooling water	approx. 900,000 cu.m/yr

Required Raw Materials

Steel cable	approx. 1,000 t/yr
Rubber	approx. 2,500 t/yr

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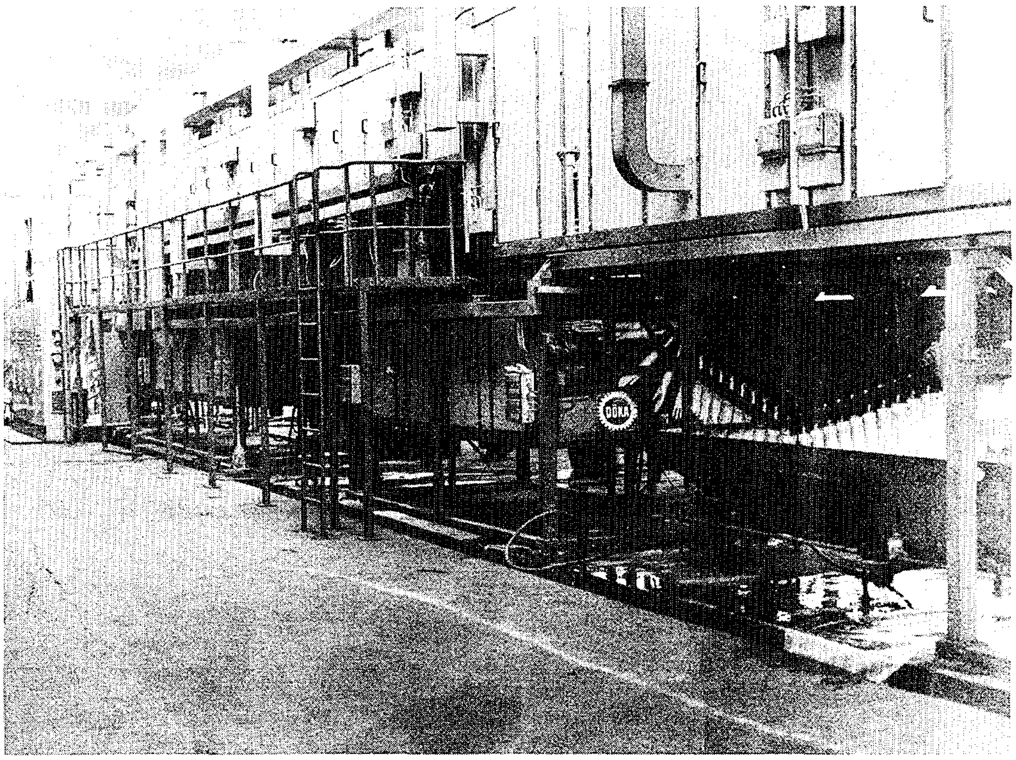
File: J 4
ISIC CODE 3559

How To Start Manufacturing Industries

Surgical Gloves



Introduction

The necessity of surgical gloves in operation theatres need not be explained, and the demand will never be satisfied since one of their advantages is that they will be disposed of after use, apart from their being cheap, safe and handy for those who have to wear them for their delicate tasks. Nowadays, however, surgical disposable gloves have also been found to be most useful for many other fields of work owing to the fact that the tendency to allergic reactions has increased to the same degree as the quantity and aggressiveness of chemicals that are used both in industry and household. Protective gloves are the answer to those problems arising from contact with cleansing agents which might prove dangerous to the skin, and there are many more examples showing the usefulness of these gloves.

Description of the Production Process

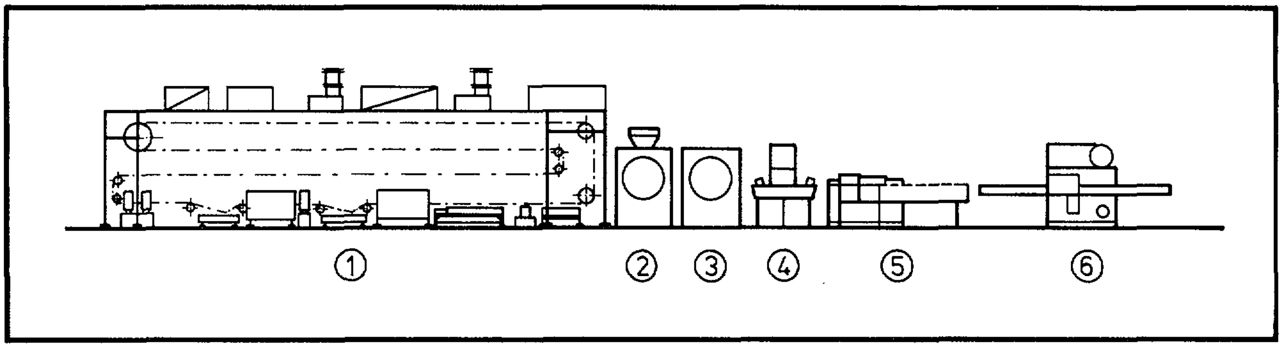
The first step of production is to prepare a mixture of latex (60% dry matter) and additives. This mixture is stored in a storage vat at a temperature of 30 °C. There it matures. These storage vats ought to have as minimum capacity the quantity that is required for one shift.

After the rest-time the mixture is conveyed to the actual production plant, the so-called dipping and vulcanization plant. This plant is a chain-plant. Mounted at both sides of a guide chain are unglazed porcelain forms in the shape and size of the gloves to be produced. The size of the forms depends on the statistic distribution of the hand-sizes.

Production on this chain is carried out in the following steps:

- application of an anti-stripping agent to the

Flow sheet



1 Production equipment
2 Powdering machine
3 Drying machine
4 Polishing tumbler
5 Washing tumbler
6 Tumblers

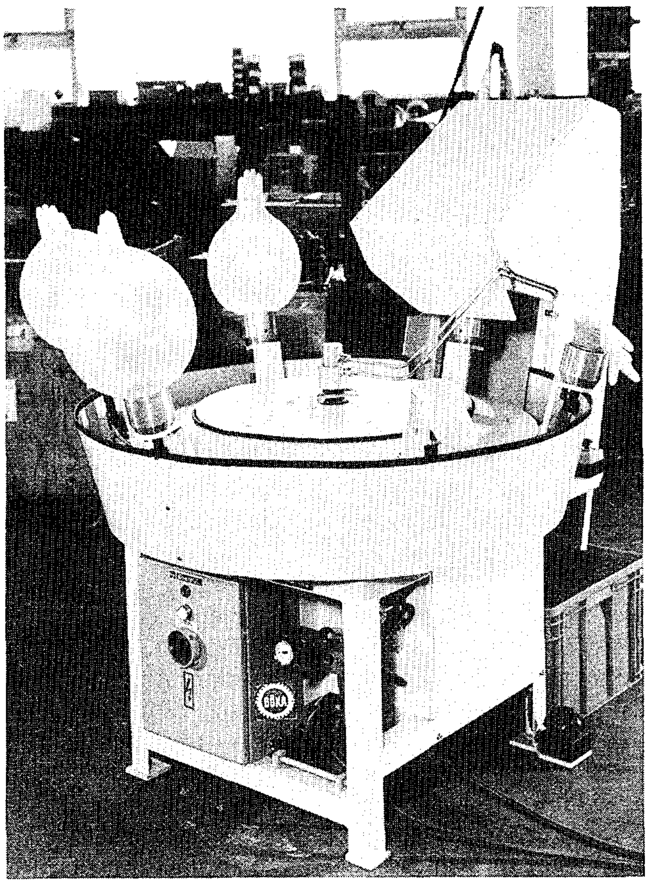
forms by way of dipping the forms into a coagulant bath

- drying of the anti-stripping agent
- application of the latex mixture to the forms by way of dipping them into a latex bath
- drying of the latex mixture
- beading of the semi-finished gloves on the dipping form
- washing and drying of the semi-finished gloves
- stepwise vulcanization
- swelling of the gloves
- automatic stripping of the gloves from the dipping form

In the wet-powder plant a water-absorbent powder is applied. In addition to that, the gloves have to be dried in a dryer.

Testing machine

Before they can be packed, they must be inspected for leaks. The quality requirements are determined according to the British Standard for surgical rubber gloves BS No. 4005.



Example of the Plant

Required Machinery and Equipment

Item	Description	Pieces
1	Storage units	2
2	Preparation and mixing unit	1
3	Surgical rubber gloves production line	1
	Coagulant dipping section	
	Coagulant drying section	
	Latex dipping section	
	Drying section	
	Beading section	
	Washing and drying section	
	Vulcanizing section I-III	
	Swelling section	
	Stripping section	
4	Powdering machine	1
5	Drying units	3
6	Testing machines	3
7	Inner wrapping machine	1
8	Outer wrapping machine	1
	FOB-price for machinery and equipment approx.	US$ 2,600,000.00

Required Buildings and Areas

Latex preparation	150 sq.m
Production	800 sq.m
Storage raw material	150 sq.m
Laboratory	150 sq.m
Packaging and testing	220 sq.m

Required Manpower

Administration	3
Production manager	1/shift
Foremen	3/shift
Workers	8/shift
Helpers	8/shift
Quality control	2/shift
Maintenance	2/shift
	27/shift

Required Power and Utilities

Electric power installed	130 kW
Heating energy	
start up	820,000 kcal/hr
production	430,000 kcal/hr
Steam	185 kg/hr = 120,500 kcal/hr
Water	5,000 l/hr
Compressed air	5 cu.m/hr

Standard Recipe for the Production of Surgical Rubber Gloves

	% of weight
natural latex, centrifuged full ammonia 60%	44.84
calcium nitre tetrahydrate	4.48
oxethyl-polycondensate	1.80
powder	1.80
formaldehyde	0.90
electrolytic zincoxide	4.48
oxide of zinc of merkaptanbezoldiazol	4.48
zincdicutiditionate carbamate	4.48
tetrasulfide of depentamethylene-di-copper	4.48
non-staining, anti-ageing additive	4.48
physical anti-ageing additive (wax mixture)	4.48
latex casein	4.48
bone glue	1.80
aromatic polyglykol-ether	0.90
sodium-alkyl-naphtalen-sulfonate	2.24
diottilftalat	0.90
oleic acid	0.90
lauric acid	1.80
sodium-o-phenyl-phenolat	1.80
anti-foaming additive SMA	4.48

Design Data

Capacity of the plant	7.71 million pairs per year at 6,000 working hours
Size of gloves	5–9 1/2
Average weight of gloves	25 g
Production capacity	192.75 t/yr

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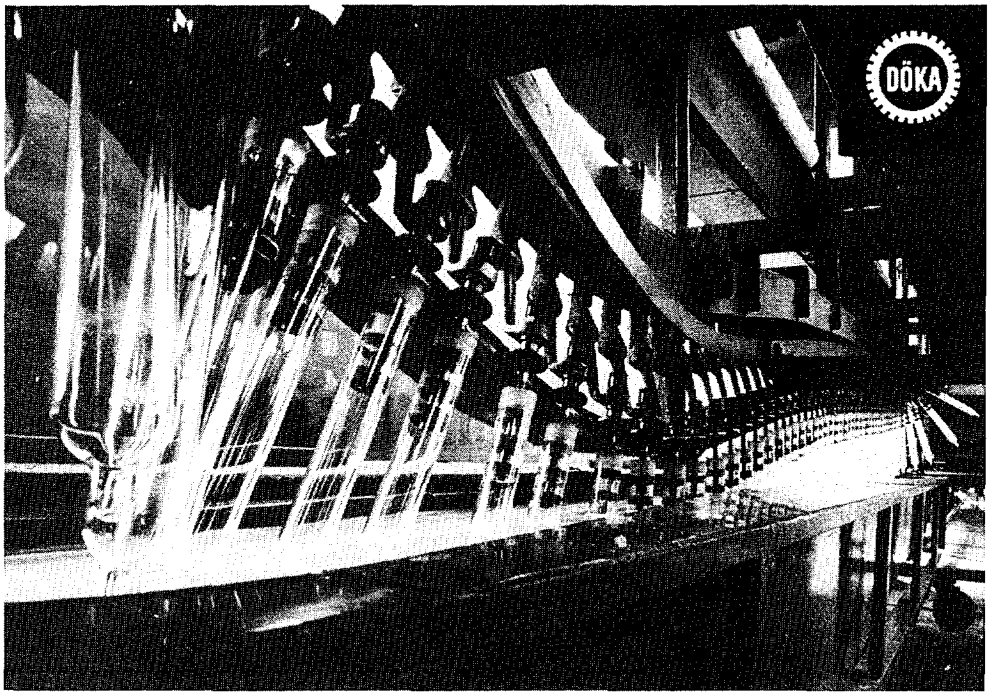
File: J 5
ISIC CODE 3559

How To Start Manufacturing Industries

Condoms



Introduction

Condoms have been in use and on the market for a long time. The materials used for them, were ingenious, but their usefullness and easy application left a lot to be desired. In the early thirties of this century a new process was developed, the so-called latex process, which made condoms cheaper and safer.

Description of the Production Process

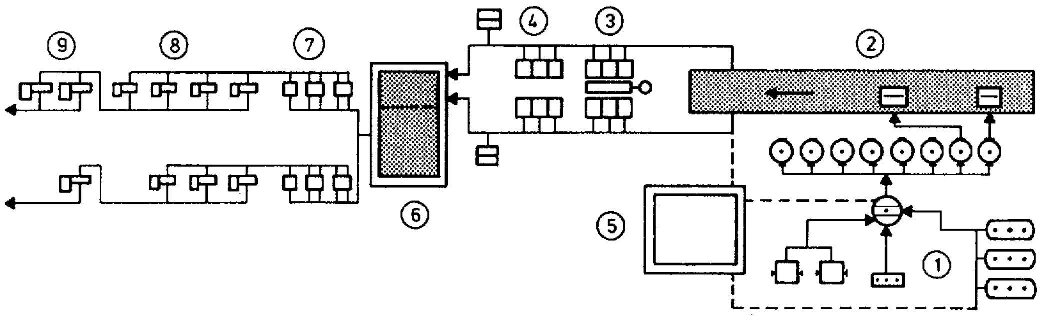
Condoms are manufactured by dipping a form into a latex mixture, which procedure is followed by drying and vulcanization.

The achieved thickness of the material depends on the viscosity of the latex-mixture, the dry matter and also on the speed with which the dipping form is withdawn from the latex-mixture. The ordinary thickness varies between 0.05 and 0.08 mm. Standard for quality requirements is the British Standard Specifications No. 3074 for Rubber Condoms.

The first step is to prepare a mixture of latex 60% dry matter and additives. This mixture ought to rest for 16 hours in so-called resting-containers at approx. 30 °C. After that time the raw material is pumped to so-called dipping containers. These are laid out in such a manner that even temperature and viscosity of the raw material solution are guaranteed.

A glass form is dipped into the latex mixture and withdrawn. Experience has taught that it is best to withdraw the glass-form at exactly the same speed as that of the latex-mixture flowing down the form thus preventing the formation of a drop at the end. The film is dried in hot air. Usually this procedure – dipping and withdrawal – is repeated. After the second dipping the rim is beaded. This raw product is then vulcanized. A squelling bath prepares the vulcanized

Layout



1 Preparation and mixing station
2 Condom production section
3 Washing section
4 Drying section
5 Laboratory station
6 Product transit storage
7 Testing section
8 Sealing section
9 Packaging section

condoms for the stripping off the glass form. This stripping is achieved by means of brushes.

The condoms thus manufactured are now taken to the following stages: wet powder treatment, washing, drying and polishing. Quality control is the last stage before the product is packed according to market requirements. Usually this control is carried out by electronic devices.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Preparation and mixing unit	1
2	Condom production line	1
	Dipping section I	
	Drying section I	
	Cooling section I	
	Dipping section II	
	Drying section II	
	Beading unit	
	Stripping section	
	Soaking, washing and draining section	
	Drying formers	
3	Condom testing units	6
4	Condom packaging machines	5
	FOB-price for machinery and equipment approx.	US$ 2,600,000.00

Required Buildings and Areas

Administration	250 sq.m
Production	1,200 sq.m
Packaging section	220 sq.m
Latex preparation section	150 sq.m
Laboratory	150 sq.m
Storage	600 sq.m

Required Manpower

Management	3
Production manager	1/shift
Foremen	3/shift
Workers	10/shift
Helpers	10/shift
Quality control	2/shift
Maintenance	2/shift
	31/shift

Required Power and Utilities

Electric power	approx. 6 kW
Heating energy	
starting	900,000 kcal/hr
production	540,000 kcal/hr
Water	5,000 l/hr
Compressed air	2 Nm3/hr

Standard Recipe

	% of weight
Centrifugal latex, 60%	92.00%
Potassium hydroxide solution, 10%	2.80%
Potassiumcaprylat solution, 20%	1.10%
Sulphur dispersion, 50%	2.50%
Zinc diethyldithiocarbamat dispersion, 50%	1.10%
Protective agent against ageing	1.10%
Zinc oxide dispersion, 50%	0.55%

Design Data

Capacity of the plant	50 million pieces/at 6,500 working hours
Quantity of latex required (centrifugal latex)	110,500 t/yr
Working time	3 shifts
condom production	2 shifts
condom packaging	1 shift
latex preparation	1 shift
laboratory	

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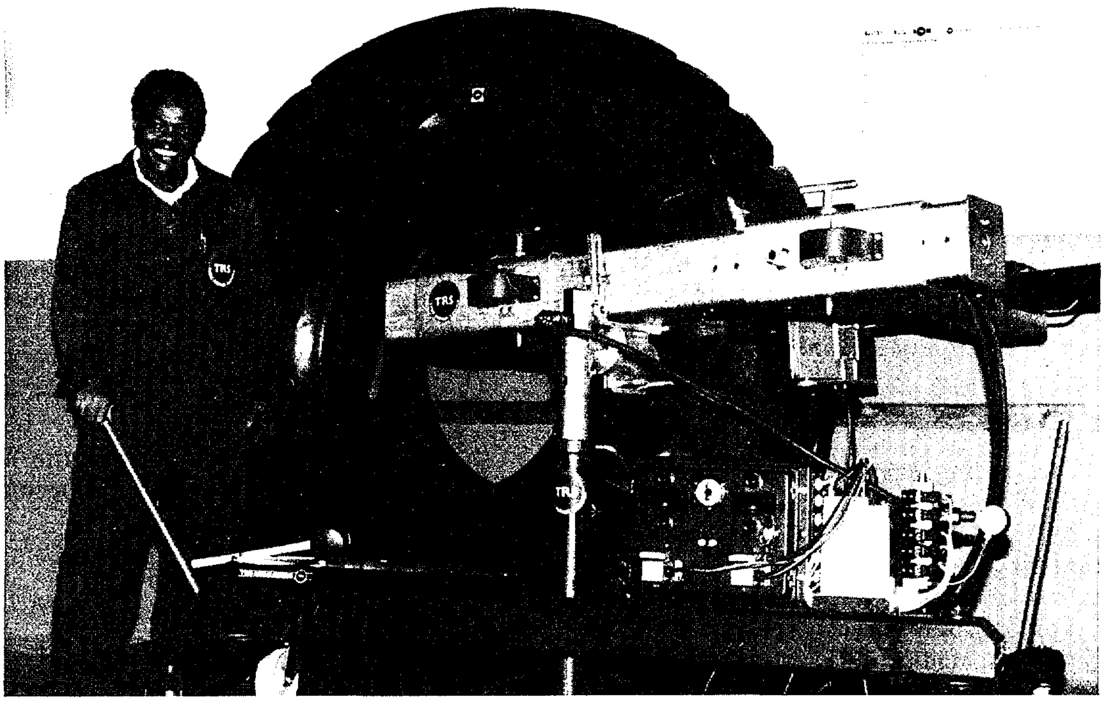
File: J 6
ISIC CODE 3551

How To Start Manufacturing Industries

Tyre Retreading Plant



Introduction

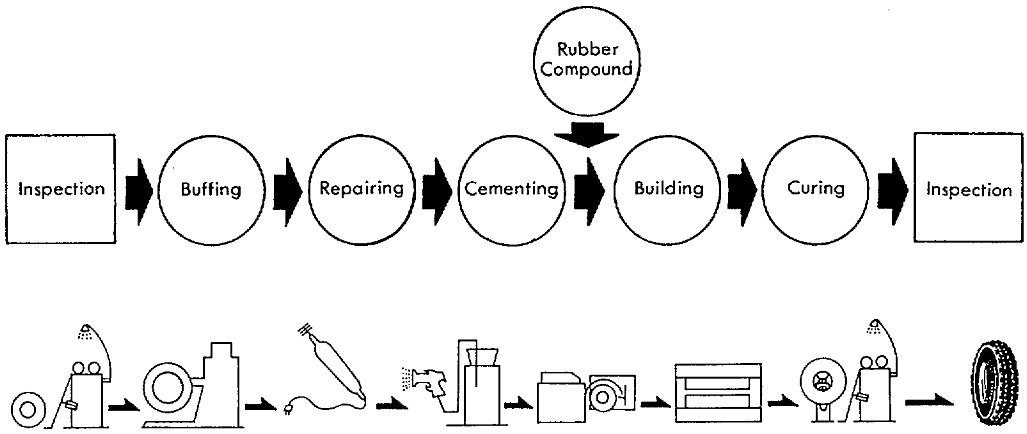
Nowadays highly industrialized countries just as developing countries more and more consider the process of tyre retreading under favourable aspects

- saves raw materials
- saves foreign currency
- recycles products that otherwise would go to waste
- helps the economy of the country
- and finally creates jobs.

Retreading of tyres is a recycling job. While it takes 26.5 litres of crude oil to manufacture one new passenger tyre, a retread requires only 9.5 litres. The savings in truck-tyre retreading are even greater. In 1986 for example, Americans saved about a quarter of a billion gallons of crude oil by buying retreads. With today's oil prices being what they are, this is an important point.

The described retreading plant is a standard plant with a capacity of 22–24 truck tyres in one 8-hour-shift.

Flow sheet:



Description of the Retread Production Process

The process of retreading tyres can be divided into 5 consecutive steps:

1. initial inspection of the used tyre
2. buffing and touching-up the used tyre
3. application of new rubber
4. vulcanization of the new tread onto the tyre
5. final inspection of the finished retread.

1. Initial inspection

Before retreading, every used tyre casing must pass inspection. The casing is carefully examined by an inspector on a specific automatic inspection machine. It must be kept in mind that inspection is always a matter of trained judgment. The most sophisticated equipment cannot replace the inspector's decision. Therefore the human element always plays an important part in the process of retreading.

2. Buffing and touching up the used tyre

The buffing process establishes the foundation upon which the new tread is built. At buffing, parts of the remaining original tread rubber is removed from the used tyre. The object of this operation is to prepare a clean velvet surface with the correct texture for maximum adhesion of the new tread rubber and establish the contour/radius of the tread area.

3. Application of new rubber

After the application of a rubber solution by means of a spray-gun, uncured cushion gum with the final profile is applied to the casing. After this application, the tyre is mounted on a rim.

4. Vulcanization of the new tread

Vulcanization is made in autoclaves which are usually designed to process up to 22 tyres. The uncured cushion gum which acts as a bridge between tyre casing and precured tread, is vulcanized at a temperature of 97 to max. 100 °C. This process takes approx. 4½ to 5 hours. After the curing time all tyres in the autoclave are finished simultaneously.

5. Final inspection

At the last step of production the finished tyres are carefully tested by the inspector on an automatic inspection machine.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Tyre inspection machine	1
2	Buffing machine	1
3	Tyre builder	1
4	Hoists	4
5	Monorail	1
6	Conveyors	2
7	Tyre repair spreaders	2
8	Tyre buzz-out repair stations	2
9	Airless spraying tuners	2
10	Buzz-out repair filling stations	2
11	Enveloping machine	1
12	Rim fitting machines	2
13	Curing chamber	1
14	Autoclaves	2
	FOB-price for machinery and equipment approx.	US$ 780,000.00

Required Buildings and Areas

Administration	70 sq.m
Production	600 sq.m
Storage	200 sq.m

Required Manpower

Management	2
Mechanician	1
Skilled workers	2
Unskilled workers	5
	10

Required Power and Utilities

Electric power	620 kW
Compressed air	1,000 l/min at 14 bar

Required Raw Materials

- Used tyres casings
- Cushion gum and solvent
- Unvulcanized tread rubber

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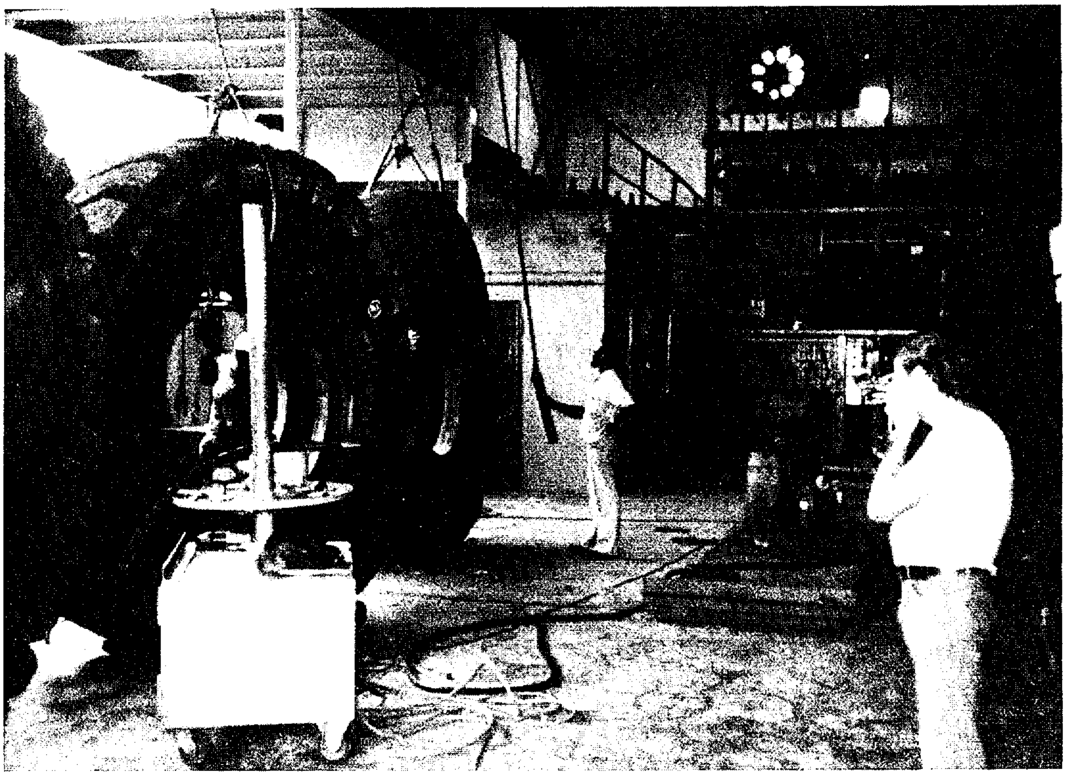
File: J 7
ISIC CODE 3551

How To Start Manufacturing Industries

Tyre Repair Workshop



Introduction

Transport by trucks is the corner pillar of supply with goods of all possible kind in many developing countries. But for instance bad road conditions which may have been caused by extreme climatic influences, will lead to a considerable material strain. In particular a comparatively high percentage of injuries. The import of tyres requires payment in foreign currency which is hard to come by, and in such case bottle-necks in the supply are inevitable. This again leads to long, costly standstill periods of high-quality equipment, namely the vehicles.

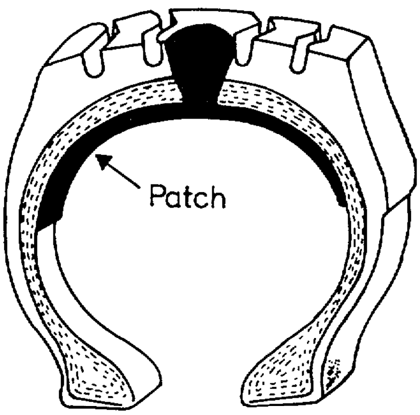
This unwelcome situation can be helped by the implementation of a tyre-repair workshop. All the work to be done there, is easily picked up by those who have interest and skill, but nevertheless it must be performed with utter care, since the safety of a vehicle largely depends on the quality of its tyres.

The plant that is described in the following, is laid out for the repair of shoulder and sidewall injuries of radial as well as bias ply tyres for cars, trucks, tractors, and earthmovers. Suitable sites for tyre repair workshops are important cities, junctions, mining plants, agricultural centres or construction sites.

Description of the Production Process

For the determination of the maximum possible injury size, special repair charts have been elaborated.

Tyre damage quite often is not limited to rubber damage, but it is likely that the fabrics are cut, too. Being the essential part of the tyre, ply cords and radial plies must be perfectly replaced by a complete repair. For this purpose special tyre patches can be used, having exactly those fabrics in their inner parts.

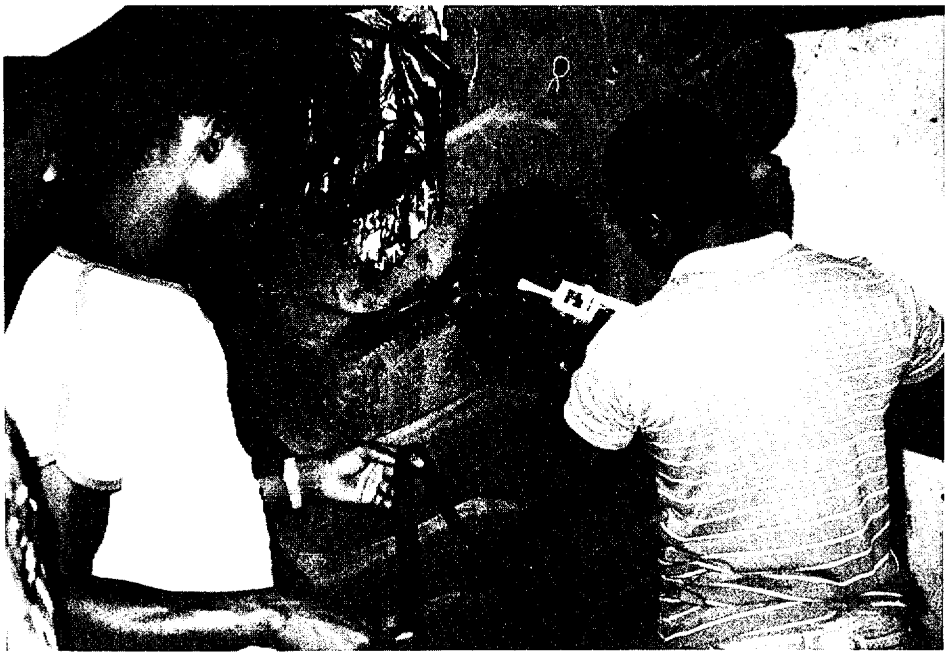


The vulcanization of the patches will practically reinforce the damaged part by an artifical casing.

The system as well as the materials of repair are similar for all kinds of tyres.

Repair work on damaged tyres is done in the following consecutive steps:

- skiving and buffing of the damaged parts
- coating of the prepared surface with heating solution
- filling up of the tyre damage with all gum by means of a hand extruder
- vulcanization of the prepared tyre parts
- buffing of the inner lining
- coating of the buffed area with cement and a counter patch of the injured area
- uniform adjustment of the patch to the casing
- buffing down of spots on the repaired casing
- regrooving of the original tyre profile
- inside and outside painting of the tyre with tyre paint
- final inspection



Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Vulcanizer 5 t	1
2	Thermostatic vulcanizers	3
3	Hand extruder	1
4	Pneumatic hammer	1
5	Electric hand drill	1
6	Compressor	1
7	Buffing motor	1
8	Tyre changer truck, tractor	1
9	Hand tools	3 sets
	FOB-price for machinery and equipment approx.	US$ 28,000.00

Required Buildings and Areas

Workshop area	100 sq.m
Storage	30 sq.m
Office	20 sq.m

Required Manpower

Technical manager	1
Foreman	1
Skilled workers	3
Unskilled workers	10
	15

Required Power

Electric power approx. 8.4 kW

Required Raw Materials

1.	Chemical solutions:	Vulcanizing fluids, heating solutions, patch cement, rubber compounds
2.	Tube patches of all sizes	
3.	Gums:	Tread, fill and cushion gum, extruder gum

Output of the Workshop

In 200 hours per month the following numbers of tyres could be repaired:

Item	*Description*	*Pieces*
1.	Earth-mover tyres	24
2.	Tractor tyres	30
3.	Truck tyres	100
4.	Car tyres	140
5.	Tubes	any

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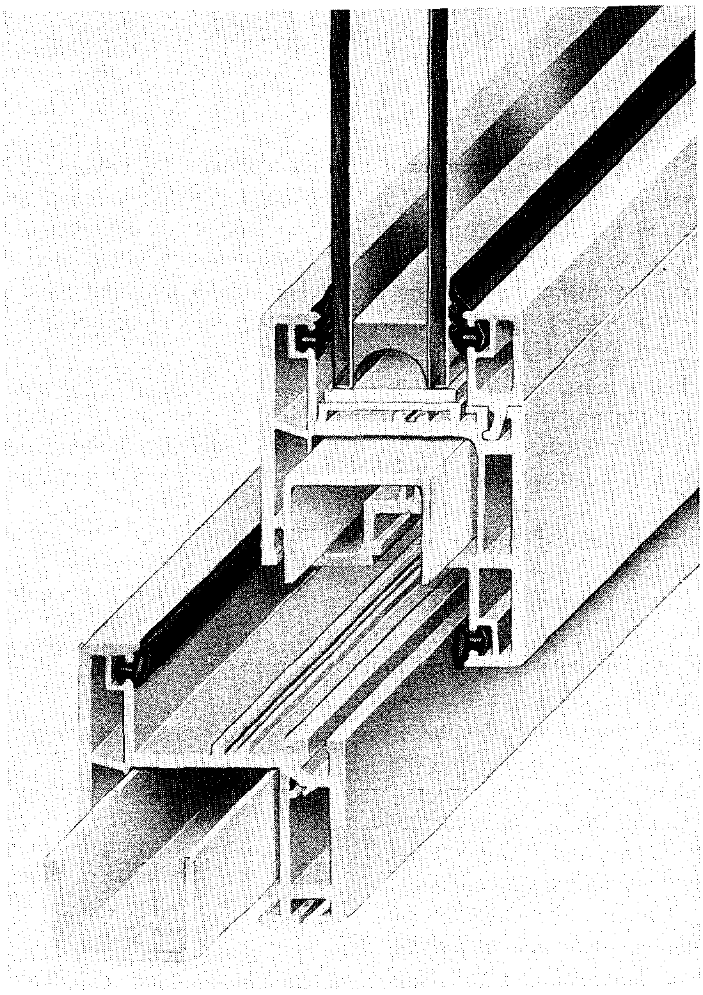
How To Start Manufacturing Industries

PVC Windows



Introduction

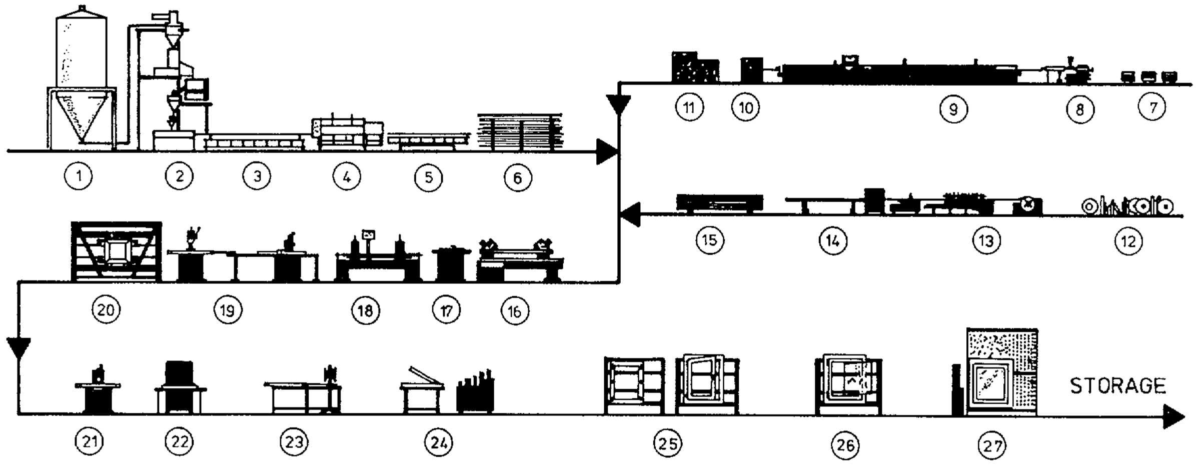
The experiences gained in European countries and the United States have shown that the PVC-window meets a great many requirements of our time.

The raw material PVC has proved to be an ideal material for windows. In the course of recent years, various standards have been developed for PVC-windows and now constitute a regular quality system. PVC-windows have all the positive qualities of wood/aluminium and steel windows, but with regard to their negative features, PVC-windows are quite an improvement.

Long life, stability, safe protection against weather and wind, insulation against heat or cold and noise, plus numerous possibilities for variety, are the main advantages of this type of window. These qualities also contribute to the saving of energy in every home and every climatical zone regardless whether heating or air-conditioning is required or not.

PVC-window production also stands for minimum investment, small required building area, low raw material prices, short production time and good market chances.

Flow sheet



Description of the Production Process

The PVC raw material is extracted from the silo and fed to a mixing plant where the additives required for a product suitable for window units are dosed in and thoroughly mixed. The treated bulk PVC is fed to the twin-screw extruder, which transports, melts, homogenizes and extrudes the desired profile, all in one operation. The downstream calibrating table stabilizes the profile and cools it rapidly, thus preserving the form.

A specialized caterpillar haul-off unit transports the finished continuous profile length to the tilting table where the sections are cut to length and stacked before assembly.

The extruded window section is cut to length on a double mitre saw and fed to the automatic screwing machine by the transport carousel. Here the PVC section and the steel reinforcement section are screwed together.

Once the section has passed the water slot cutter, the olive borehole and the window gear recess are cut on the drilling and milling machine.

The next production stage is the insertion of the rubber gasket profiles which are essential functional parts of the window and an absolute must for good glazing quality.

The frames and sashes are brought together by means of two conveyor belts and assembled. The fittings are also mounted at this stage. They ensure uniform load distribution to all points of attachment, an arrangement which gurantees permanent stability.

The window pane, glazing bead and rubber sealing gasket are inserted in the downstream glazing press. After functional testing the finished window is delivered to store.

Continuous production and efficient assembly are basic prerequisites for an economic performance ratio and low personnel, raw material and energy costs.

The window has to pass through careful quality checks at all stages of production. Particular attention must be paid to the quality of the PVC raw material, the extruded section and the finished window and, in the case of the latter, special attention must also be paid to the fittings, sealing and reinforcement.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Raw material silo	1
2	Mixing and extrusion plant	1
3	Calibrating table	1
4	Caterpillar haul-off unit	1
5	Tilting table	1
6	Profile storage	1
7	Raw material storage	1
8	Extruder	1
9	Salt bath and cooling unit	1
10	Winder	1
11	Gasket storage	1
12	Raw material storage	1
13	Roll-forming unit	1
14	Tilting table	1
15	Reinforcement storage	1
16	Double mitre saw	1
17	V-cutting saw	1
18	Water slot machine	1
19	Reinforcement station and cutting saw	1
20	4-head welding machine	1
21	Single-head welding machine	1
22	Corner cleaning machine	1
23	Working table	1
24	Fitting installation and cutting unit	1
25	Assembly and function testing table	1
26	Glazing unit	1
27	Testing equipment	1
28	Window and door storage	1
	FOB-price for machinery and equipment approx.	US$ 1,650,000.00

Required Buildings

Production building (including offices and social rooms)	20 × 65 m = 1,300 sq.m.
Height of factory	6 m

Required Manpower

Management and administration	6
Production engineers	2
Supervision personnel	6
Extrusion section	6
Raw material preparation	2
Window and door manufacturing	70
Laboratory	2
Service station	5
	99

Required Power and Utilities

Electrical power	100 kW installed
Water	4 cu.m/hr at 4–6 bar
Compressed air	6 NM3/hr at 6 bar

Technical Data

Raw material	
PVC granulate	
Sheet-glass, fittings	295,000 kg/year
Capacity of the plant:	
2-swing windows	
1.2 m × 1.4 m	21,985 units/year
doors	
0.9 m × 2.0 m	4,397 units/year

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How To Start Manufacturing Industries

Injection Moulding, Die Casting Process

Introduction

Synthetic materials are solid organic substances which have been produced artificially in a chemical process and are not found in nature. In their properties they differ to a large extent from metallic materials. They are considerably lighter, have a much lower elasticity module and are excellent insulating material. Considering their low weight, their strength is rather remarkable, diminishing, however, with rising temperatures, so that their use at temperatures exceeding 120 °C is a rare exception.

Principally synthetic materials are divided into duroplastics and thermoplastics.

The following description of the production of pencil sharpeners is an example for the processing of thermoplastics by injection moulding.

Thermoplastics

Thermoplastic synthetic materials have solidified in a reversible process; that means they can, contrary to duroplastics, be made re-mouldable by heating.

Injection Moulding

By injection moulding thermoplastic synthetic materials are moulded which will not harden, but solidify by cooling in their mould.

The injection material is filled into the heated cylinder, liquefied in it and injected into the mould by the injection plunger through a nozzle. This is done at a pressure of 600 up to 1,000 kp/sq.cm, for parts with thin walls may be up to 1,500 kp/sq.cm. The quick cooling of the walls of the mould makes it possible to eject the finished parts after a few seconds. Liquefying and solidifying are reversible processes, consequently reject and waste material can be used again.

Description of the Manufacturing Process

The raw materials polystyrene granulate, colour pigments and reject material are filled into a moving mixer. These raw materials of different nature must be thoroughly mixed, as to obtain an even quality of the injection material for the moulding process.

The injection moulding machine works rather fast at high pressure. It injects the plastic material into moulds that are shaped according to product design. After cooling and hardening the pencil sharpener casings are collected and taken to assembly. There the blades are inserted by hand and screwed to the cases. For economic reasons blades and screws are bought, not manufactured in the plant itself.

Synthetic reject material is processed by a scrap mill into granulate which can be added to the moulding process at a portion of up to 20% of the virgin material.

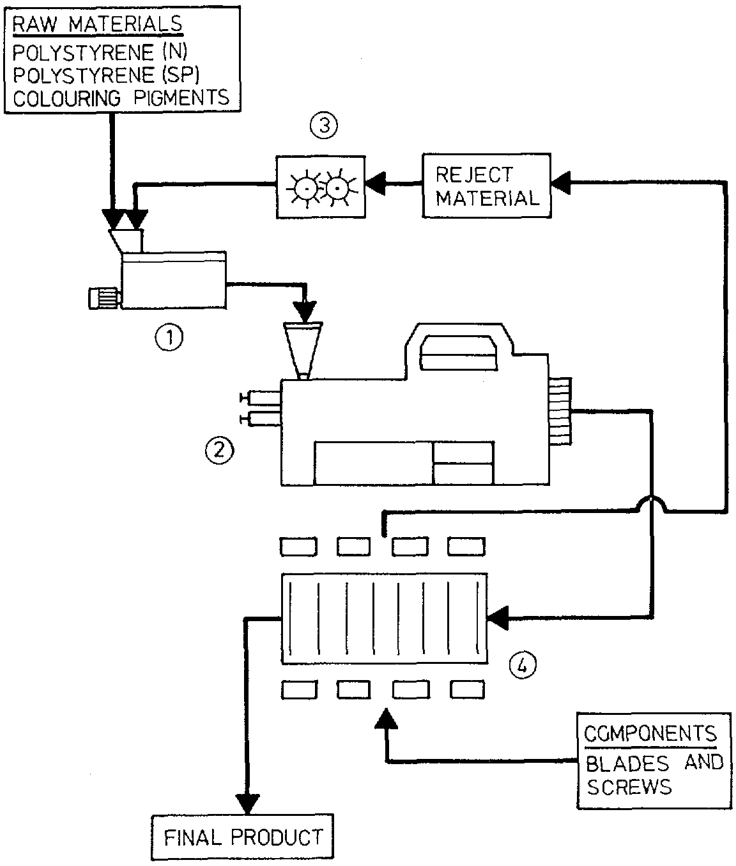
The finished products are packed in certain numbers just as the market requires.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Injection moulding machines	2
2	Injection moulds	3
3	Scrap mill	1
4	Water Chiller	1
5	Assembly line	1
	FOB-price for machinery and equipment approx.	US$ 875,000.00

Flow sheet:



1 Moving mixer
2 Injection moulding machine
3 Scrap mill
4 Assembly line

Required Buildings and Areas

Administration	60 sq.m
Production	360 sq.m
Storage	60 sq.m

Required Manpower

Management	2
Engineer	1
Foremen	2
Workers	15
Maintenance	1
	21

Required Power

Electricity	280 kW

Outline of the Plant

Capacity	10 million sharpeners in various forms for ordinary pencils (7 mm dia. or hexagon dia. resp).
Raw materials	polystyrene normal polystyrene shockproof colouring pigments sharpening blades fastening screws
Standard recipe	polystyrene normal and polystyrene shockproof at a ratio of 2 : 1 and 1 to 2% colouring pigments; reject material can be re-used to an amount of up to 20% of the virgin material

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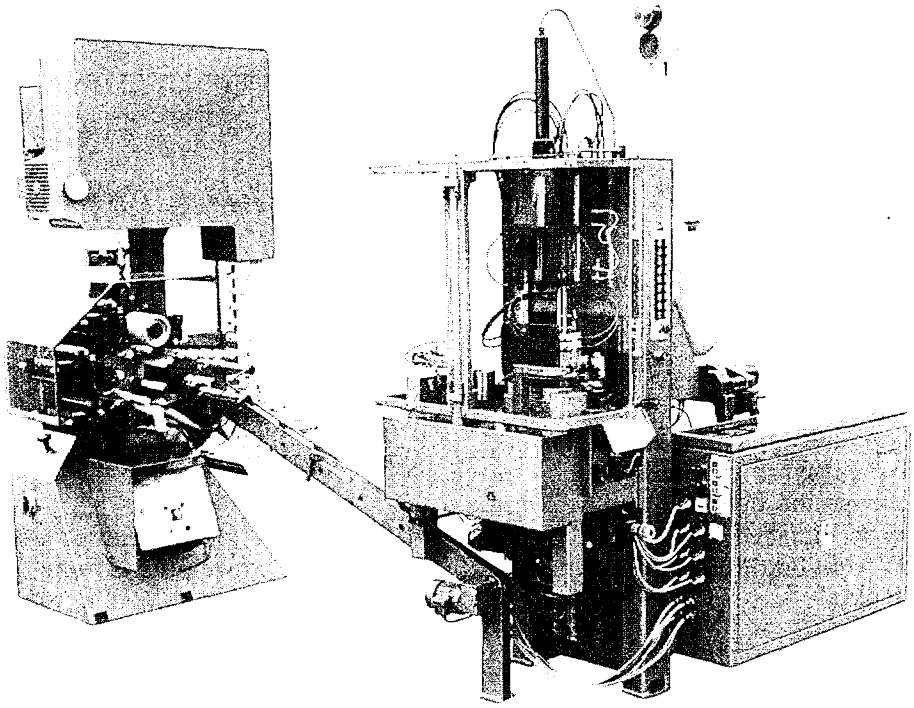
How To Start Manufacturing Industries

Plastic Containers



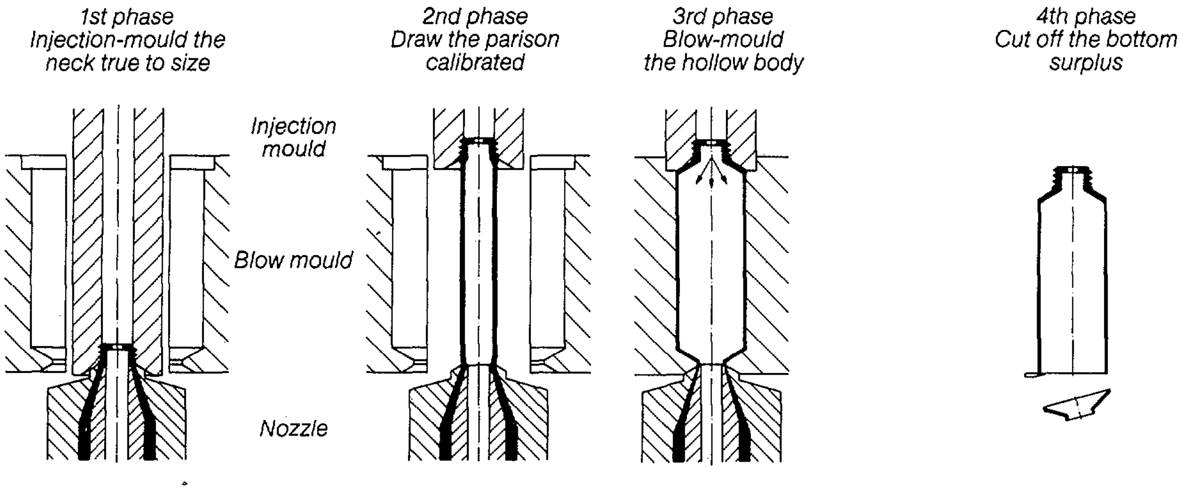
Introduction

Previously, material of liquid consistency used to be packed in ceramic and glass containers or tinned boxes. The use of laminated paper boxes has been known as well. Since plastic material has been developed, the packaging industry has to an increasing extent used plastic containers to contain liquid media.

The production of hollow thermoplastic bodies is a matter for blow-moulding machines. Bottles with precision threads are produced on conventional injection blow-moulding machines. For hollow bodies with head-sections accurate in dimension and thin-walled bodies of uniform wall-thickness – such as plastic tubes, bottles, ampoules, folding bellows and casings – press-blowing injection blow-moulders are required which combine no waste injection moulding of the head section with drawing of the parison (this means partly formed bottles) subsequent blow-moulding of the body-section in smooth transition (patent Ossberger).

Description of the Press-Blowing Process

At the start of each cycle, an injection die recessed with the shape of the future head section fits tightly onto a ring-nozzle. The injection mould produced in this manner, is at the first operation filled with the required amount of plastic stock which after cooling will form the finished head section. The decisive section of the hollow body – i. e. the thread or internal and external neck diameter, cannula, intended breaking point, membrane, annular ring – is thus accurate in its dimensions. As the injection die now moves upward in the second operation, a quantity of plastic stock correlated to the speed at which the tube is drawn, is fed from the ring nozzle. Gripped in the injection mould on the one hand and in the centred ring nozzle on the other hand, a tubular parison of precise wall thickness is thus formed. When the parison has been drawn, two halves of a blow mould enclose it, forming a tight seal against the injection die and the nozzle. Final blowing of the parison to the shape of the end product takes place in this blow mould third operation.



After the cooling period which can be regulated to requirements, the injection and blow moulds open, and a gripping device removes the finished piece from the nozzle to convey it to the cutting unit.

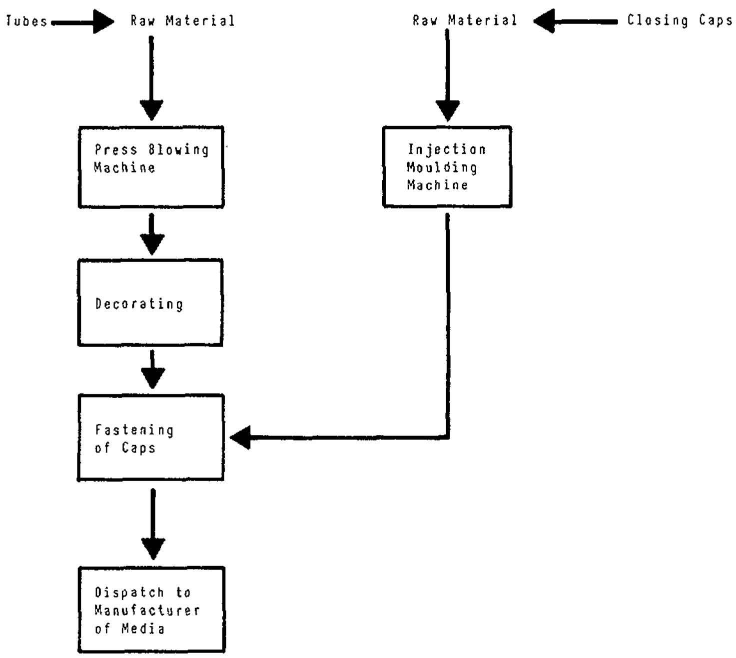
If the hollow bodies – such as tubes, casings and hoses – are required to be open-ended, a rotating knife removes the bottom surplus giving the parts their exact finished length. The bottom surplus is cut off from bottles and removed from contour by punching.

According to market requirements a subsequent decorating unit is connected to the press-blowing machine to finish the product.

Production of closing caps is made on conventional injectionmoulding machines.

The filling of the plastic bottles/tubes and closing by heatwelding is done by the respective manufacturer of the media.

Blockdiagram:



Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Press-blower injection blow moulders including tool sets	1
2	Impeller breaker	1
3	Decorating unit	1
4	Compressor	1
5	Cooling system	1
6	Injection moulding machine	1
	FOB-price for equipment and machinery approx.	US$ 1,350,000.00

Required Manpower

Chief operator	1
Workers	8

Required Buildings and Areas

Administration	60 sq.m
Production and storage	300 sq.m

Required Power and Utilities

Electric power	80 kW
Compressed air	2,000 l/h, 6–10 bar

Design Data

Capacity	approx. 5 million hollow bodies per year		
Method of operation	three-shift operation		
Production programme:	Plastic tubes		
		diameter:	min. 12 mm max. 60 mm
		body length:	min. 50 mm max. 20 mm
		volume:	2 to 600 ml
	Bottle sizes		
		diameter:	min. 10 mm max. 90 mm
		body length:	min. 50 mm max. 50 mm
		volume:	2 to 1500 ml
	Containers		
		diameter:	min. 10 mm max. 90 mm
		body length:	min. 50 mm max. 50 mm
		volume:	2 to 1500 ml
Raw materials:	Polyethylene Polypropylene Polycarbonate Acrylonitrile butadiene, styrene Polyamides Cellulose acetate Polyvinylidene chloride		

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L

How To Start Manufacturing Industries

Sheetglass Production

Introduction

The manufacturing of sheetglass – a chemical process at very high temperatures – was already known by our ancestors although the first efficient industrial production process was invented only 70 years ago. Today sheetglass is required nearly everywhere, particularly in the building industry, manufacture of automobiles, furniture, etc.

Glass is a product of several raw materials which have to meet certain chemical and physical requirements. These raw materials are melted at very high temperatures to become liquid glass. Several processes can then be used to transform the liquid glass into sheetglass.

Clear, translucent sheetglass can be made according to the following processes:

Process	Thickness of glass	Remarks
Fourcault	1.8 - 8 mm	Plant should consist of 2-9 drawing machines achieving an output of approx. 40 to 180 tons/24 h saleable glass
Pittsburg	3.0 - 8 mm	Plants with 2 to 6 drawing machines are recommended having an output of approx. 50 - 155 tons/24 h saleable glass
Colburn	1.8 - 8 mm	1 to 4 drawing machines should be installed with a capacity of 45 to 180 t /24 h saleable glass
Float	3.0 - 20 mm	One line could achieve approx. min. 350 t to max. 1000 tons/24 h saleable glass

Basic materials for the production of glass are silica, sodium carbonate and limestone or chalk. Chemically glass consists of the compound of silicid acid (silicates) with alkaline and alkaline earth oxides.

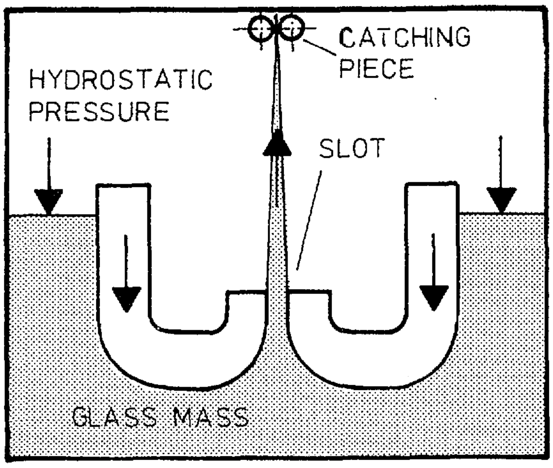
Description of the Production Process

At the batch house all raw materials are weighed and mixed according to a given recipe. This batch together with glass cullets is then conveyed into the furnace and melted at a temperature of approx. 1,500 centigrades.

Up to this process stage the production processes are similar. After that different techniques are employed when the continuous glass ribbon leaves the furnaces. These techniques depend on the required plant capacity and effect glass quality and thickness.

Of the four production processes listed above the Fourcault process is presented herewith as an example:

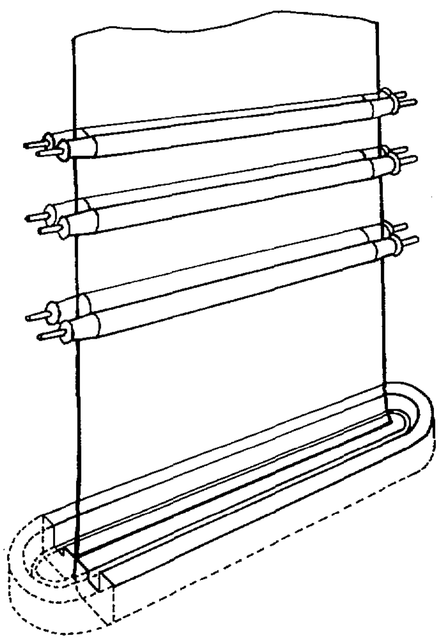
Centrepoint of this process is the drawing slot, made of fireproof material. This slot with a width of approx. 2.5 m was manufactured, dried and burnt with utmost precision. When this slot in preheated state is dipped into the glass mass,



glass will (due to the hydrostatic pressure) penetrate upward through the slot and at temperatures of 1,000 to 1,060 centigrades be caught and pulled upward by a so-called catching piece. Tube coolers in the drawing machine quickly cool the glass-ribbon particularly at its edges, thus preventing shrinking and rupturing.

By asbestos twin-rollers the solidified glass ribbon is conveyed upward into a cooling stack of a height of approx. 8 m, where it is defined and cooled. At the packing stage it is cut to size according to market requirements. Finally it is packed and taken to storage.

Faurcault-Process



Example of the Plant

Capacity of the plant

Output 40 t sheetglass/24 h

Required Machinery and Equipment

Item	*Description*	*Pieces*
1.	Raw material preparation plant	1
2.	Batch plant	1
3.	Furnace	1
4.	Drawing machines	2
5.	Glass cutting and breaking units	3
6.	Cutting hall machinery	1
7.	Packing machinery	1
8.	Handling and storage equipment	1
	FOB-price for machinery and equipment approx.	US$ 20,000,000.00

Required Manpower

Management	20
Engineers	11
Foremen	14
Skilled workers	80
Unskilled workers	25
	150

Required Area

Production area	2,800 sq.m
Storage	1,200 sq.m
Facilities	1,000 sq.m

Required Power and Utilities

1.	Electrical power AC 380 V, 50 c/s, 3-phase	150 kW
2.	Oil or gas	5,000 kcal/kg glass
3.	Water	36 cu.m/h

Required Raw-Materials

Silica sand	30.000 t/day
Soda ash	10.000 t/day
Natrium sulphate	0.850 t/day
Dolomite	8.500 t/day
Feldspat	1.900 t/day
Coke	0.150 t/day

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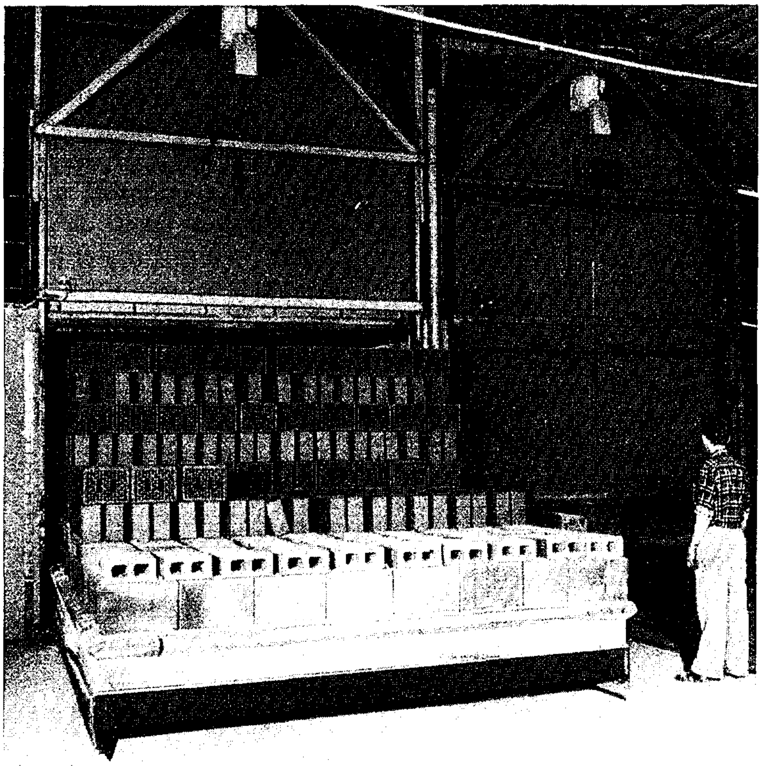
M

How To Start Manufacturing Industries

Burnt Bricks and Tiles



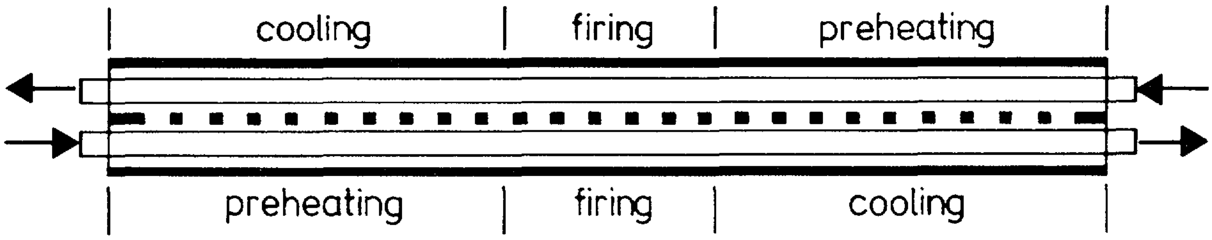
Introduction

The ceramic industry is one of the oldest industrial exploitation fields of mankind. Pottery, bricks and tiles have always been in demand. Artisan's kilns dug into the ground, were the primitive way of burning the products.

More than 130 years ago, a further step into industrialization was taken by the design of the Hofmann Kiln, the first multifuel kiln to be operated in an industrial way. It is the way that up to this day smaller brick factories are operated. Fuel consumption is rather high, and great operational skill is required since the firing time exactly determines the burning degree. Still Hofmann Kilns operate with a considerable rate of rejects.

A further step into industrialization and continuous operation was the tunnel kiln where the products to be fired are passed through the kiln on cars. Fuel consumption and the rate of rejects were thus reduced and continuous operation secured. The firing period of normal bricks amounts to approx. 60 hours.

The latest technology in kiln operation is the countertravel kiln (Patent Riedel) working as a double kiln where the products to be fired are countertravelling through the tunnel from either side. Thus the green bricks are heated up by the outcoming burnt bricks cooling down in the tun-



nel aside. The tunnels are interconnected by air-holes and the air is steaming sideways from hot to cold (convection) without any longitudinal airstream that is normally used in tunnel kilns.

The countertravel kiln reduces fuel consumption to a bare minimum of 330 kcal/kg of fired product. It is easy to operate, thus reducing the rate of rejects to 2% or in other words: 98% of the product are first-class. The kiln is multi-fuel, working on oil and gas, but also on solid matter such as coal and bio-mass (saw-dust, coffee-husks).

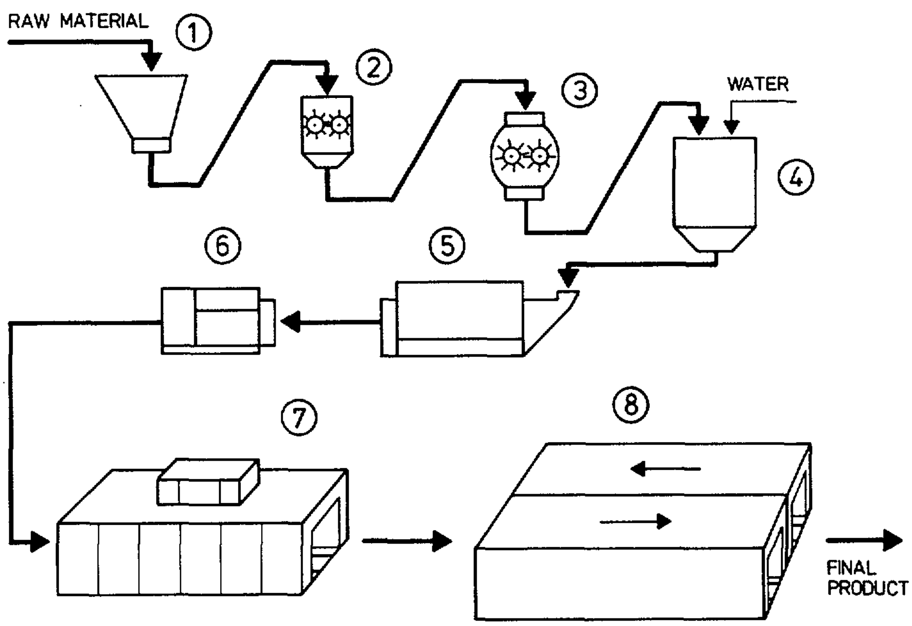
Description of the Production Process

According to the nature of the available clay, the incoming raw material must be ground down to a maximum grain size of 1.5 mm, which is done by a roller crusher and a finishing mill. Then water is added to the clay until the material has reached a humidity degree of 20–25%. After an intermediate storage the treated clay is homogenized under vacuum in a de-airing extrusion thus preventing air-inclusions in the product. The preformed mass is cut to proper size and taken to a drier via a conveying system.

The drying takes about 42 hours eventually resulting in a loss of weight of approx. 7%. The dry product is taken from the conveying system and set onto kiln cars by hand. Burning in the kiln is done at 1,000 °C, which takes approx. 60 hours. After the burning process, the final product is manually unloaded from the kiln cars and put on palets or directly on trucks.

The reject material that results from the first steps up to the outlet of the drying stage, can be completely re-conveyed to the process via the mill. Burnt material, too, can be added to the process-flow again, at a portion of 10% of the quantity of raw material. Finally, reject material may well be used for instance as an additive material for road construction.

Flow sheet:



1. Box feeder
2. Roller Crusher
3. Finishing mill
4. Preparation vessel
5. Vacuum unit
6. Cutter
7. Drying chamber
8. Counter-travel kiln

Required Machinery and Equipment

Item	Description	Pieces
1	Box feeder	1
2	Roller crusher	1
3	Finishing mill	1
4	Double-shaft mixer	1
5	Box feeder for intermediate storage	1
6	Circular feeder	1
7	De-airing extrusion machine	1
8	Cutter for bricks	1
9	Conveying and stacking system	1
10	Drier	1
11	Countertravel kiln	1
12	Loading and unloading system	1

FOB-price for machinery and equipment approx. US$ 4,350,000.00

Required Buildings and Areas

Production	3,000 sq.m
Raw material shelter	2,000 sq.m
Workshop	800 sq.m
Administration	180 sq.m
	5,980 sq.m

Required Manpower

	skilled	unskilled
Preparation and forming	2	8
Stacking and transport	2	8
Drier	3	9
Countertravel kiln	3	9
Loading and unloading	2	20
	12	54

Required Power and Utilities

Fuel consumption	6.6 x 10.9 kcal/year approx. 675 tons heavy fuel oil/year or approx. 2,100 tons coffee husks/year
Water	8,000 to 10,000 cu.m/year
Electricity	50 kW per ton of burnt goods
Compressed air	20 cu.m/hour, 8 bar

Required Raw Materials

Clay 25.000 t/year

A minimum quantity as is required for the production of 30 years, must be available. The clay pit is to be quantified and investigated by core drilling.

Outline of the plant

Capacity of the plant 20,000 t/year burnt goods

Mode of operation:

Preparation and forming	2-shift
Stacking and transport	2-shift
Drying Section	3-shift
Counter travel kiln	3-shift
Loading and unloading	2-shift

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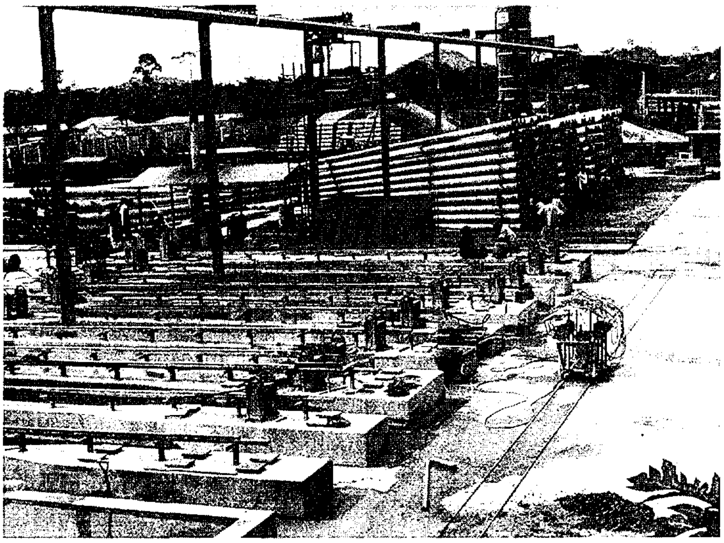
File: M 17
ISIC CODE 3699

How To Start Manufacturing Industries

Prestressed Concrete Poles



Introduction

Electricity programmes enjoy top priority in many developing countries. Apart from the actual power generating, the provision of transmission lines and poles is the cornerpillar of the succesful realization of such a programme.

The first poles used for the transmission of power and telecommunication were made of wood.

Later, as requirements for poles increased, and with the limited-life of wood in view, poles were made of steel. Yet steel, although it has a comparatively longer life time than wood, is also subject to a considerable corrosion and thus requires careful maintenance over the years.

Another and far more suitable material for poles is concrete.

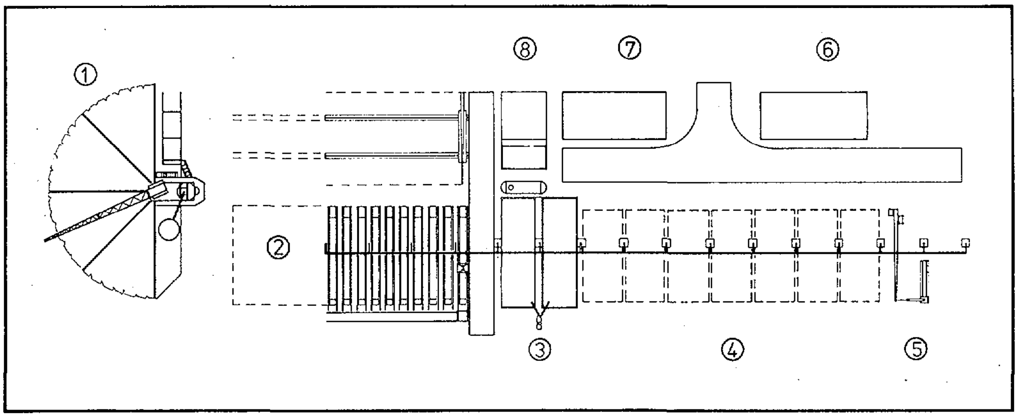
Reinforced concrete poles have been used for several decades and proved to be much more advantageous than wooden or steel poles since they last considerably longer theoretically they should last indefinitely, and, with the exception of a few lumber producing countries or countries with a well-developed steel production, concrete poles are also cheaper than poles made of wood or steel. Concrete poles, of course, cannot be destroyed by fire either.

The most advanced type of pole is the prestressed circular concrete pole.

Due to the pre-stressing, this pole has a high resistance against bending forces, and in a special process it can be manufactured as a hollow pole. Thus it has the advantage of being lighter than a massive concrete pole, and transport cost is less.

The production plant which is described in the following, will produce all current types of prestressed concrete poles with a capacity of 42 poles per day in a 2-shift production.

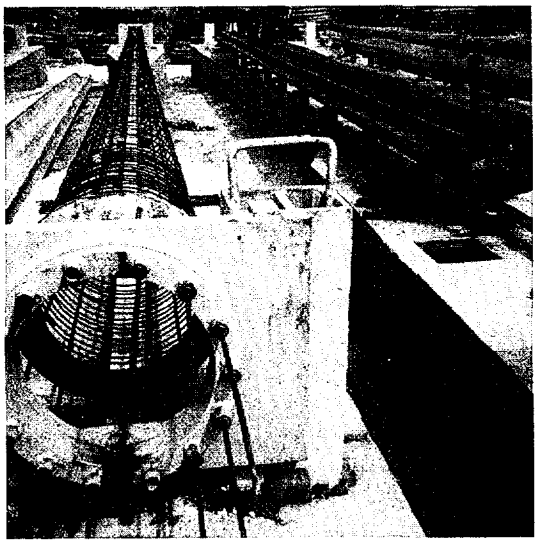
Layout:



1. Concrete mixing plant
2. Production area of poles
3. Water basin
4. Storage area of poles
5. Testing equipment
6. Storage area of jibs
7. Steamgenerator
8. Production area of jibs

Description of the Production Process

First of all the longitudinal wires for the reinforcement must be cut to the required length of the pole to be manufactured.



The longitudinal wires are placed at the bottom end of a mould. They are put through the bottom fixing plate and counterplate of the mould and then through spiral wires which have been placed into the mould beforehand, finally crossing counterplate and fixing plate and the upper end of the mould. When all the wires are placed and slightly pre-stressed, the core can be introduced and the spiral wire spread over the whole length of the pole.

Now both halves of the mould are correctly placed and screwed to each other. All these steps completed, the vibrators can be fixed to the closed mould. Concrete is poured into the mould, and vibrating is started when one third of the filling point has been reached. Filling finished, vibration will continue for at least 10 to 15 minutes.

The vibrators can be taken off and the core is stripped by means of a hydraulic cylinder. After 30 to 60 minutes the mould is also stripped and steam curing can start. For that procedure low pressure steam is introduced into the pole for about 5 to 6 hours.

Then the resistance of the concrete pole can be checked by a Schmidthammer minimum 360 kg/sq.cm. The finished pole should remain in a watering pool for at least three days. Then it is ready for transport to the area of construction.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	
1	Batching and mixing plant	
2	Basic pole manufacturing plant	
3	Vibrating equipment	
4	Pre-stressing and reinforcement equipment	
5	Moulding equipment	
6	Steam curing equipment	
	FOB-price for machinery and equipment approx.	US$ 2,250,000.00

Required Buildings and Areas

Production	1,250 sq.m
Storage	1,250 sq.m
Administration	150 sq.m
Workshops	150 sq.m
	2.800 sq.m

Required Manpower
per shift

General manager	1
Commercial manager	1
Technical manager	1
Office staff	3
Foremen	3
Operators	4
Workers	20
	33

Required Power and Utilities

Electricity	230 kW
Water	40 cu.m

Required Raw Material
basis 42 poles/day

Concrete	25 tons/day
Composition of concrete:	53% gravel
	28% sand
	19% cement
Pre-stressing steel	1 ton/day
Reinforcing steel	0.630 ton/day

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File: M 18
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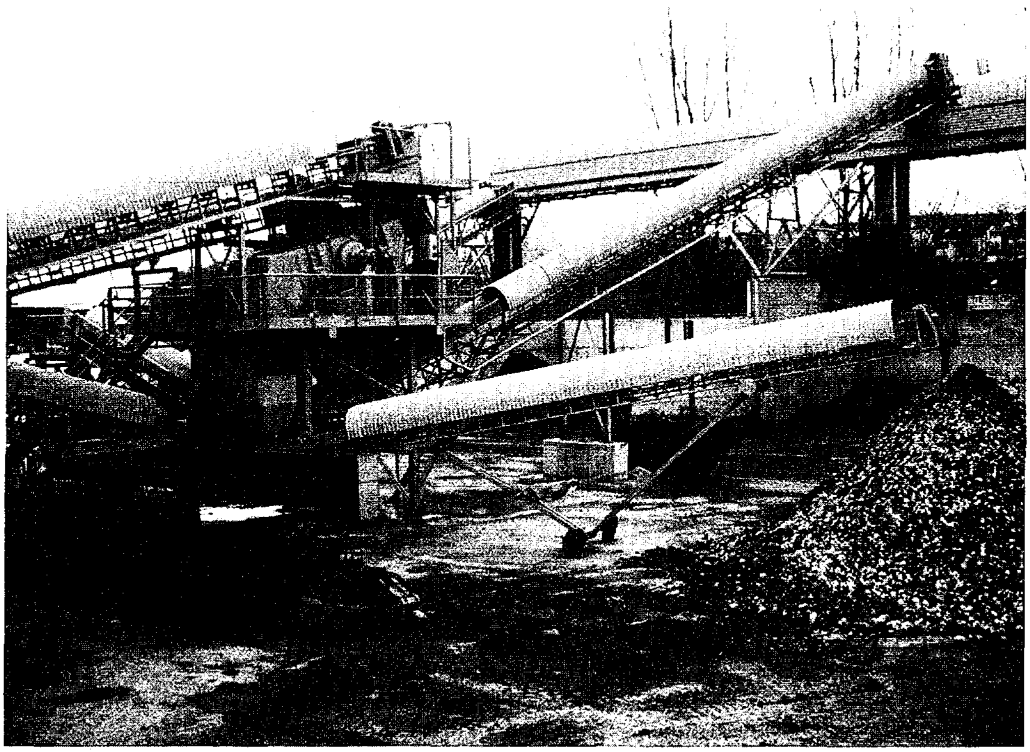
How To Start Manufacturing Industries

Recycling of Building Material



Introduction

For thousands of years, building material has been re-used: in ancient Egypt material was taken from the pyramids to build new houses and the same happened in Rome where stones from the colosseum were used for other buildings and pawing stones taken from certain roads to build new roads. In short, it is anywhere and at any time in history that we can find examples that building material has been re-used.

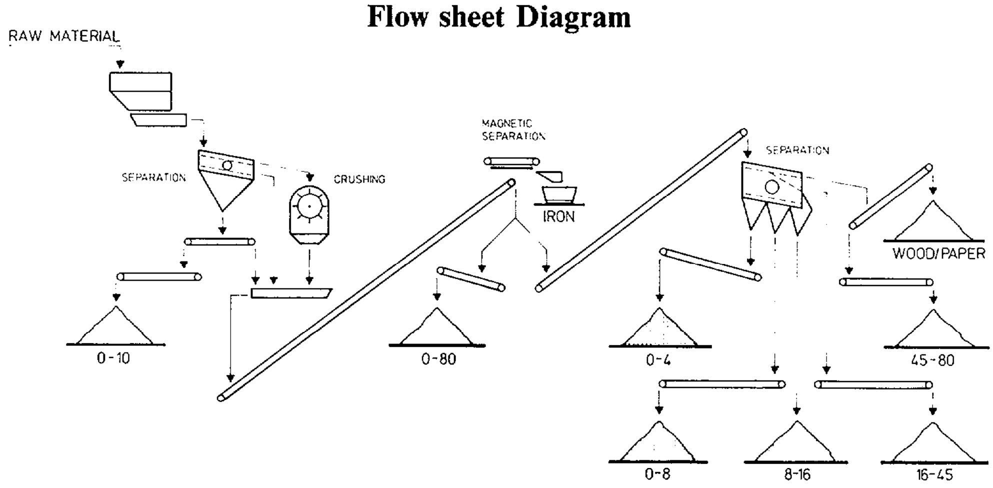
Where modern times are concerned, it was in 1986 that the Federal Republic of Germany was confronted with a two-sided problem: an annual requirement of 600 million tons of mineral raw material which meant a drain on precious ressources, and on the other hand approx. 150 million tons of waste material such as excavated material, asphalt from roads to be rebuilt, rubble and blast furnace slag, which normally would have to be deposited thus requiring space in a country with a large population and a intensely utilized terrain.

Generally speaking, the demand for raw materials has continually increased and prices have gone up to the same extent as it has become harder to find apropriate places to deposit waste materials. This situation just forces communities, districts and countries to recycle used building materials thus saving resources and currency as well as reducing the need for precious new building materials.

Recently the industry for building machines has developed crushing and screening systems particularly to recycle building rubble that is to be used either instead of new material or as a mix.

The described plant is a standard plant for the recycling of building material. It has a capacity of 80 to 130 t/hr.

Flow sheet Diagram



Description of the Production Process

Nowadays 'recycling' is much more than just re-using building material. It must be prepared according to material regulations. The product quality and, according to that, the possibilities to use the material are to a large extent dependent on the purity of the product.

Hence the first and most important rule for the recycling of building material is the selective reception and storage of raw material:

- classified reception of asphalt and milled material
- asphalt and gravel layer
- concrete
- brickwork.

The material to be recycled in the plant is conveyed to a feedhopper by means of loaders. A conveyor transports the raw material to a one-stage crusher. There it is crushed according to the requirements of its later use, for instance means 0–16 mm diameter for asphalt, 0–56 mm for concrete. The oversize grain will be either returned or used as material for road building.

A vibrating chute conveys the crushed material to a conveyor which primarily passes it under an electro-magnetic separator. This separator sorts out building steel, reinforcing steel, etc. Non-ferric metals are detected by metal detectors and separated by hand. Finally the material is classified in a sieving device according to grain sizes and put to storage.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Loaders with shovel capacity of 3 cu.m	2
2	Recycling plant feed system conveying system crusher magnetic separator metal detector sieving device	1
	FOB-price for equipment and machinery approx.	US$ 600,000.00

Required Buildings and Areas

Administration	120 sq.m
Crushing and separation incl. stockpiles	5,600 sq.m

Required Manpower

Administration	2
Technical Manager	1
Skilled workers	3
Unskilled workers	5
	11

Required Power and Utilities

Electricity	approx. 350 kW
Fuel oil	approx. 120 l/hr

Design data

Example:

Raw material	building rubble
Capacity of the plant	130 t/hr

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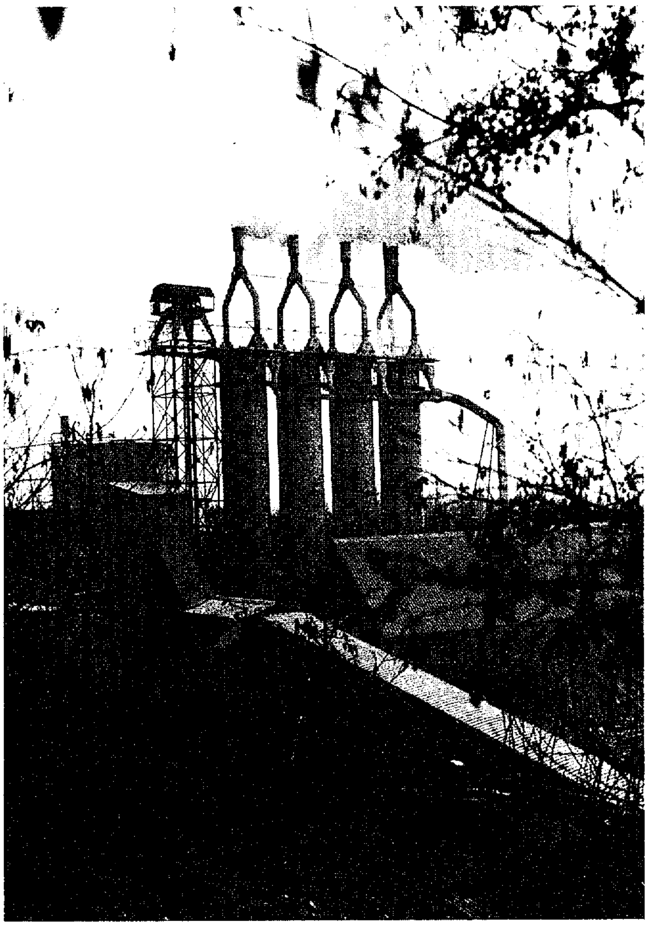
ISIC CODE 3699

How To Start Manufacturing Industries

Limestone Production

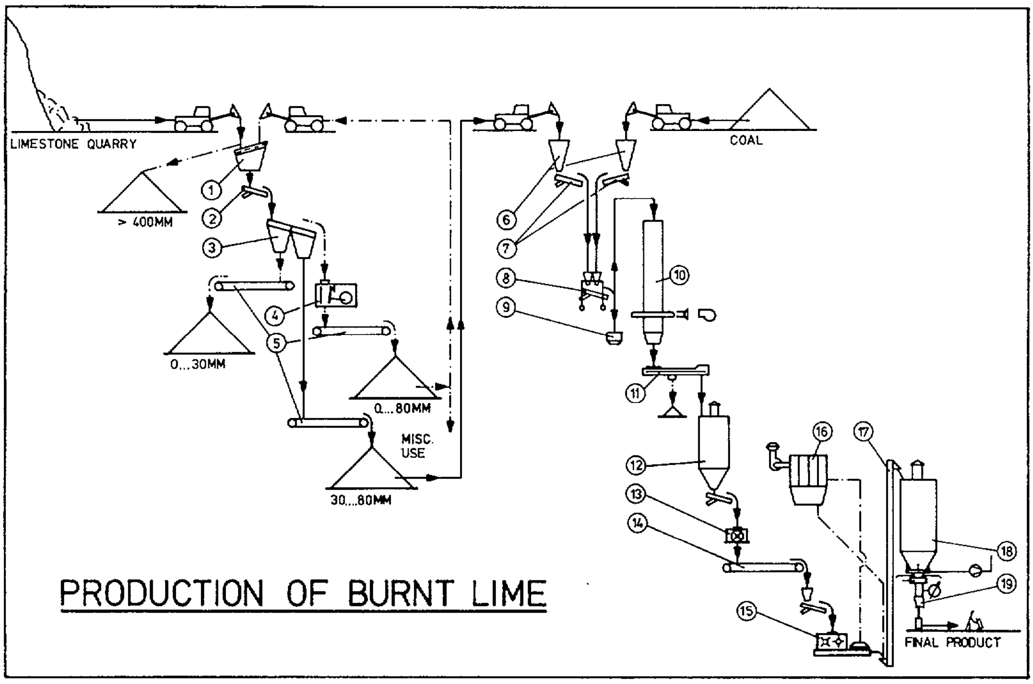


Introduction

Lime is one of the most important raw materials. Nowadays its products are used everywhere and in all possible forms – for instance lime gravel for road construction and cement block production and burnt lime for agriculture, the building and the chemical industry.

Usually it is produced on a large scale and in a highly technical way, which means enormous investment and production costs. That is why a low-cost and modified system producing both lime gravel and burnt lime has been developed and is presented here.

Flow sheet Diagram



1 Feeding bunker
2 Sieving machine
3 Bunker discharge
4 Toggle jaw crusher
5 Conveyors
6 Feedhoppers
7 Feedhopper discharge
8 Weighing device
9 Filling tube
10 Shaft kiln
11 Conveyor
12 Intermediate silo
13 Hammer mill
14 Conveyor
15 Rotor mill
16 Dedusting device
17 Bucket elevator
18 Storage silo
19 Packaging unit

Description of the Production Process

Lime Quarry

The broken limestone is fed into a bunker by means of a wheel loader or a smaller truck. A screen on top of the bunker retains the big material which must be crushed by hand.

The one-layer sieve machine is arranged behind the bunker to separate the material into 3 grain fractions:

(a) grain size 0– 30 mm
(b) grain size 30– 80 mm
(c) grain size 80–400 mm

Fraction (a) can be used for road construction and in the concrete industry, agriculture and chemical industry. Fraction (b) is used as raw material for the processing of burnt lime. Fraction (c) is crushed by a jaw crusher down to a grain size of 0 – 80 mm. A wheel loader transfers this fraction back to the intake sieve.

Conveyor belts convey the fractions 0 – 30 mm and 30 – 80 mm to their stockpiles.

Burnt Lime Production

Two feedhoppers charge the shaft kiln with limestone and solid combustibles by a tub with the quantities being weight-controlled. Limestone and combustibles are evenly distributed. The combustion air required for the burning process is supplied by a fan. The burnt lime is discharged by a conveyor system into an intermediate silo.

From the intermediate silo a drag chain conveyor transfers the burnt lime to a hammer mill for pre-crushing. The final grain size is achieved by a rotor mill. From there the burnt lime is transported to a storage silo.

The storage silo is connected with the weight-controlled and manually operated packing installation underneath. It fills the finished product into paper or PE bags of 25 or 50 kg, which can be sewed up by a manual sewing machine.

The aim is a finished product of even and high quality. This is achieved by a laboratory which checks the product of every stage for quality, and by equipment which indicates and records the operation of the entire process.

Example of the Plant

Required Machinery and Equipment

(a) Limestone Quarry Capacity 30 t/h

Item	Description	Pieces
1.1	Frontloader with 1.5 cu.m shovel	1
1.2	Compressor with 3 hammer-drills	1
1.3	Bunker	1
1.4	Sieve-machine	1
1.5	Jaw-crusher	1
1.6	Conveyor belts	3
	FOB-price for machinery and equipment approx.	US$ 230,000.00

(b) Burnt Lime Production Capacity 30 t/day

Item	Description	Pieces
2.1	Bunker, 40 t	1
2.2.	Measuring valve	1
2.3	Weighing machine	1
2.4	Shaft kiln with elevator	1
2.5	Discharge conveyors	4
2.6	Intermediate silo, 40 t	1
2.7	Hammer-mill	1
2.8	Conveyor belt	1
2.9	Rotor-mill	1
2.10	Exhaustor	1
2.11	Redler conveyor	1
2.12	End-silo, 60 t	1
2.13	Packaging unit	1
2.14	Laboratory	1
	FOB-price for machinery and equipment approx.	US$ 1,100,000.00

Required Manpower

Limestone Quarry Capacity 30 t/h

Production superintendent	1
Foreman	1
Plant operators	3
Quarry workers	4
Helpers	4
Drivers	2
Quality control	1
	16

Burnt Lime Production
Capacity 30 t/day at 3-Shift Operation

Manager	1
Production superintendent	1
Assistant production superintendent	1
Administration and store	6
Operators	15
Electricians	2
Mechanicians	2
Helpers	18
Quality control	2
Drivers	3
	51

Power Demand for the Plant: *300 kW*

Required Area

For the quarry	approx. 600 sq.m
For the burnt lime production	approx. 1,000 sq.m

Technical Data of Shaft Kiln

Daily production	approx. 20 – 40 to/d
Limestone	approx. 98% CaCO3
Diameter of kiln	2.5 m
Height of kiln	15 m
Combustibles	coal, coke, wood
Consumption of combustible, referred to coal	approx. 10 – 15% of limestone charge
Required coal quality	
calorific value:	7,700 kcal/kg
H2O:	4%
Ash:	5%
Volatile matter:	8.5%
Combustion air	6,000 cbm/hour
Quality of burnt lime	soft burnt

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How To Start Manufacturing Industries

Pickhoes Manufacturing

Introduction

There is a wide variety of tools that are indispensable for crafts and agricultural work. This manufacture of pickhoes offers the opportunity to produce a commodity which is a good seller on the market and can save foreign exchange.

The plant can manufacture pickhoes at an hourly rate of 25 pieces with a weight of approx. 3.5 kg each.

As to save investment costs, the handles have to be purchased locally because the production of these parts would not be economic.

Description of the Production Process

The square steel sheets are placed on the roller blocks of the cold circular saw (item 1) and pushed against the first adjusted longitudinal feed-stop. The contact jaws of the circular saw are clamped manually, the sawing process runs automatically. The saw has a capacity of approx. 50 segments per hour.

In the gas-heated chamber furnace the segments are warmed up to forging temperature. The hot blanks are inserted in the forging die (item 3.1) of the forging press (item 3). After releasing the forging press, the complete middle part of the pickhoe is pressed. The rough pressed blank is fitted to the trimming tool (item 4.1) of the eccentric press (item 4) where it is trimmed and perforated. In the forging segments (item 6.1) of the forging roller (item 6) the sharp end of the pick hoe is rolled automatically.

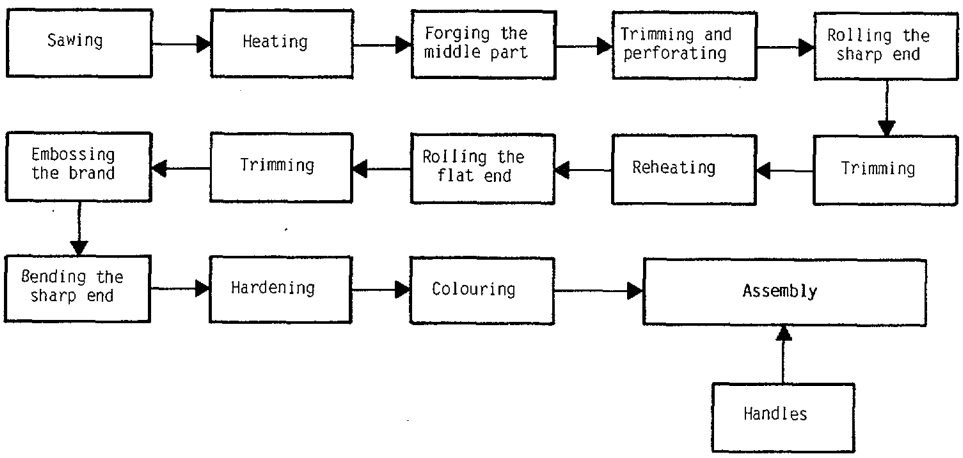
After cooling, the sharp end of the pickhoe has to be inserted into the trimming tool (item 7.1) of the eccentric press (item 7) to be cut into shape. The half of the pickhoe that is still unforged, is reheated in the spring heating furnace (item 5). As soon as the second half of the pickhoe has reached forging temperature, it is put into those rolling segments of the forging roller which roll the flat end of the pickhoe.

Then the flat end is trimmed on the press. The brand is embossed on the friction spindle press (item 8) into which the rough pickhoe is put in and taken out by hand. After the tools of the spindle press have been changed, the sharp end is bent into shape by the corresponding bending tools (item 8.2). The spring heating furnace warms up one half of the pickhoe end to hardening temperature. Hardening is done in the tempering and cooling quenching bath (item 9) with steel hardening oil circulation.

The surface is preserved by means of a splash bath (item 11) filled with colour.

The pickhoes are placed in a drying rack, and the handle is manually inserted and fastened.

Manufacturing Process Flow Diagram



Example of the Plant

Required Machinery and Equipment

Item	Description	Pieces
1.	Heavy duty circular saw	1
2.	Chamber forging furnace	1
3.	Forging eccentric press 450 t	1
3.1	Forging die for pickhoe eye	1
4.	Trimming press 135 t	1
4.1	Trimming die for pickhoe eye	1
5.	Forging spring heating furnace	1
6.	Forging roller 400 t	1
6.1	Set of rolling segments for pick hoe point	1
6.2	Set of rolling segments for pick-hoe blade	1
7.	Trimming press 300 t	1
7.1	Trimming tool for pickhoe point	1
7.2	Trimming tool for pickhoe blade	1
8.	Friction screw press 160 t	1
8.1	Embossing tool for pickhoe	1
8.2	Bending tool for pickhoe end	1
9.	Quenching bath 150 kg	1
10.	Double belt grinding machine	4
11.	Dip varnishing bath with circulation	1
12.	Set of production machines for wooden handle	1
	FOB-price for machinery and equipment approx.	US$ 1,600,000.00

Required Manpower

Commercial manager	1
Technical factory manager	1
Secretary	1
Skilled workers for machine operation	22
Unskilled workers for transportation	5
Mechanic technician for maintenance	1
Electrician for maintenance	1
	32

Required Area

Production area	approx.	960 sq.m
Storage		96 sq.m
Facilities		180 sq.m

Required Power and Utilities

1. Electrical power	
AC 380 V, 50 c/s, 3-phase	200 kW
2. Fuel gas	
natural gas or butane	
net calorific power	7,600 kcal p.cu.m
connecting load	28 cu.m p.hour
3. Compressed air	
pressure	8 bar
consumption	2,000 l p.hour

Required Raw Materials

Sqare steel bars: quality	C 45 W3
Dimensions approx.	55 × 55 mm
Cutting length approx. per pickhoe each	150 mm

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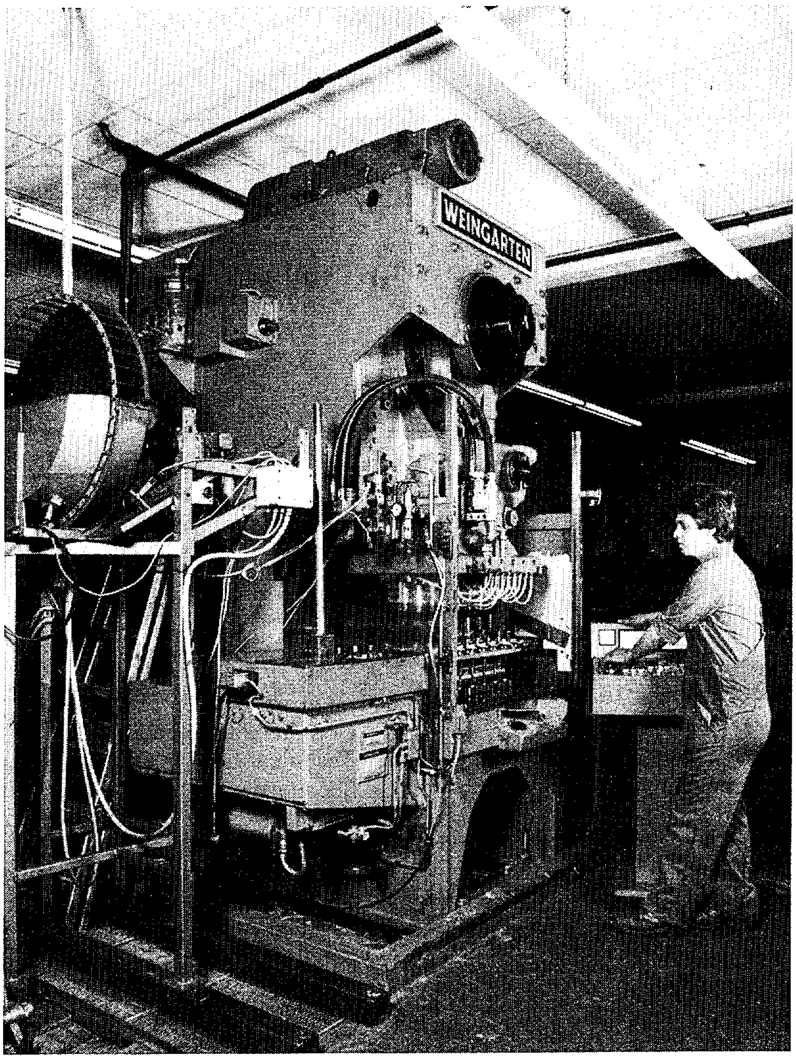
File: O 29
ISIC CODE 3811

How To Start Manufacturing Industries

Manufacturing Of Matchetes



Introduction

In tropical and suptropical countries the matchete is one of the indispensable tools. Its uses in agriculture are manifold.

Owing to the quality of their parts (high-carbon tool steel, wooden handles, double fixture with steel rivets), the matchetes have an unusually long lifetime in spite of the rough work they are used for. And there are some more advantages to the production of these matchetes: durable and sharp edges, tough as steel, but highly flexible.

The production process has been laid out in such a way that the output of 600 pieces per hour yields the highest possible rentability in relation to the invested capital.

Description of the Production Process

The sheet metal shear (item 1) cuts the steel sheets into strips. An eccentric press (item 2) punches the blade shape out of the strips and pierces the handle section.

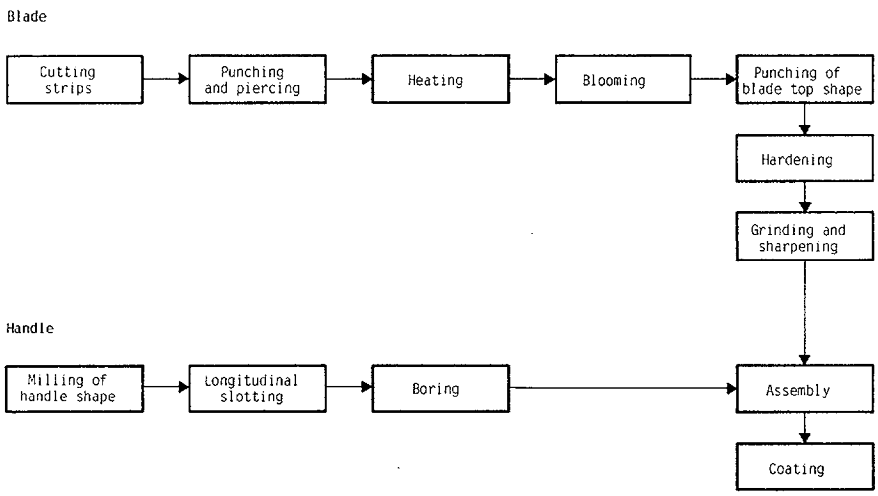
The blade is inserted in the spring heating furnace (item 3) and warmed up to forging temperature. In the forging segments of the rolling machine (item 4) and by punching eccentric press, (item 5) the shape of the top is formed.

Hardening is done by heating-up to hardening temperature (furnace, item 6) and quenching in the oil-bath (item 7). The grinding facilities (items 8, 9) grind the rough surface and sharpen the matchete blade.

For the manufacture of the matchete handles wooden parts are milled into shape by an automatic copying machine (item 11). Then a special device (item 11) slots and drills the handles at one go.

On the riveting machine (item 12) handles and blades are assembled. For protection the matchetes must be coated with colourless lacquer.

Manufacturing Process Flow Diagram



Example of the Plant

Required Machinery and Equipment

Item	Description	Pieces
1.	Crank-operated plate shear	1
2.	One-column eccentric press, 60 tons	1
3.	Spring heating furnace	2
4.	Matchete blooming device	2
5.	One-column eccentric press, 100 tons	2
5.1	Trimming tool	4
6.	Hardening spring furnace	2
7.	El. heated oil quenching bath	2
8.	Double-sided wide strip belt grinder	2
9.	Special groove grinding machine	2
10.	Double-sided wet grinding machine	2
11.	Wood working machinery	2
12.	Rotation riveting machine	2
	FOB-price of machinery and equipment approx.	US$ 800,000.00

Required Manpower

Commercial manager	1
Technical factory manager engineer	1
Secretary	1
Skilled workers for machine operation	1
Unskilled workers	20
Mechanic technician for maintenance	3
Electrician for maintenance	1
	28

Required Area

Production area	500 sq.m
Storage	70 sq.m
Facilities	150 sq.m

Required Power and Utilities

1.	Electrical power AC 380 V, 50 c/s, 3-phase	80 kW
2.	Cooling water:	approx. 3 cu.m/hr
3.	Oil:	approx. 20–30 kg/hr
4.	Compressed air:	approx. 1,200 l/min

Required Raw Materials

1.	for the blade:	
	steel sheet	C 45 or C60
	in sheets	1,000 × 2,000 mm
	material thickness:	1.5–2.5 mm
2.	for wooden handle:	
	type of wood as required	

Required Finishing Parts

(not included in the manufacture, must be purchased)

Rivets, flat-head countersunk	3 × 25 mm
Washers	3 × 3.5 mm
Thickness	0.8–1 mm
Colourless lacquer for preservation of the matchetes	

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File: O 30
ISIC CODE 3811

How To Start Manufacturing Industries

Shovels And Spades

Introduction

Man can do without sophisticated machinery, but agriculture and food production are unthinkable without the use of simple tools, tools that are easy to make and easy to use. No farming can be done without shovels and spades, and a plant that produces shovels and spades renders a most useful contribution to a country's economy.

The output of the described plant will be approx. 250 pieces per hour. Its machinery is designed in such a way that it can manufacture either spades or shovels by using different tools.

Description of the Production Process

An eccentric power shear (item 1) cuts the steel-sheets into strips. An eccentric press (item 2) punches blanks of shovel and spade blades out of the strips. In a special heating oven (item 3) the blanks are heated up to forging temperature to be inserted in the forging dies of the friction-screw press (item 4) where shovel or spade blades are formed. The eccentric press (item 5) is used for two production stages:

- at the first stage the handle tube will be formed by the rolling tools (item 12), and
- at the second stage the fixing holes for the wooden handles are punched by the tools of item 11.

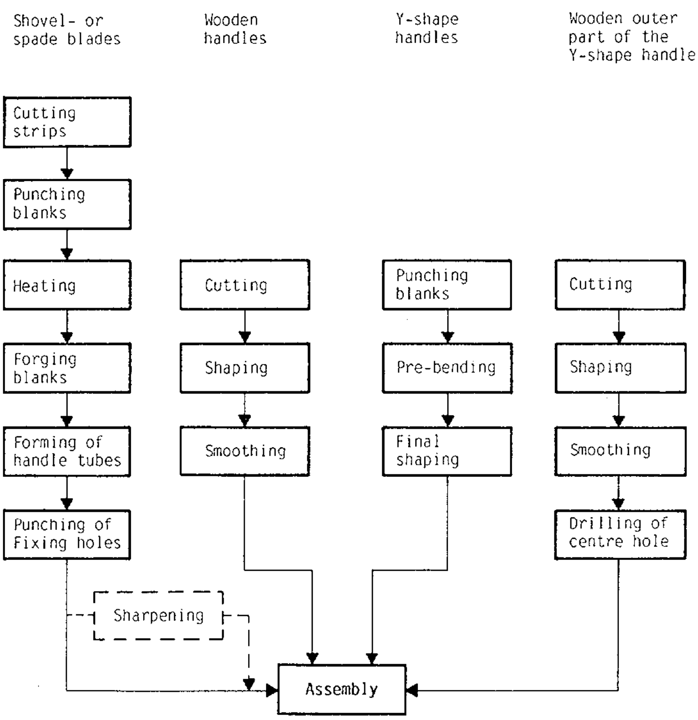
If required, the spade blades can also be sharpened.

For the manufacture of the Y-part of the handles, blanks are punched out of the strips. The tools of item 13 will pre-bend the handle-parts. The shaping tools (item 13) will give them their final shape.

For the production of the wooden handles and handle parts (outer part of Y-shape handles), ledges of timber must be cut into the required 'gross-size' by a circular saw (item 14). The copying and sanding machine (item 14) will give them their final round or oval shape and smooth them. A drilling machine (item 14) will drill the hole in the centre of the Y-handle part.

All these manufactured parts will be manually assembled.

Manufacturing Process Flow Diagram



Example of the Plant

Required Machinery and Equipment

Item	Description	Pieces
1.	Eccentric power shear, 2000 × 2	1
2.	Eccentric press, 125 tons	1
3.	Special heating equipment for blanks	1
4.	Friction-screw press, 160 tons	1
5.	Eccentric power presses, 60 tons	2
6.	Double-sided grinding machine	1
7.	Punching tool for shovels	1
8.	Punching tool for spades	1
9.	Shovel embossing tool	1
10.	Spade embossing tool	1
11.	Punching tool for handle fixing hole	1
12.	Handle tube rolling tool	1
13.	Set punching tools for steel handle parts	1
	FOB-price for machinery and equipment approx.	US$ 650,000.00

Required Manpower

Commercial manager	1
Technical factory manager engineer	1
Secretary	1
Skilled workers for machine operation	14
Unskilled workers	12
Mechanic technician for maintenace	1
Electrician for maintenance	1
	31

Required Area

Production area	480 sq.m
Storage	72 sq.m
Facilities	150 sq.m

Required Power and Utilities

1. Electrical power AC 380 V, 50 c/s, 3-phase — 75 kW
2. Light oil: consumption to heat the oven (item 3). — approx. 15 l/hour
3. Compressed air: consumption approx. — 1,500 l/min; pressure — 8 bar

Required Raw Materials

1. for the blades: steel quality — C60; in steel sheets — 2,000 × 1,000 mm
2. for the metallic handle-parts: steel quality — MU St 4; in steel sheets — 2,000 × 1,000 mm
3. for the wooden handles: timber in ledges according to local availability

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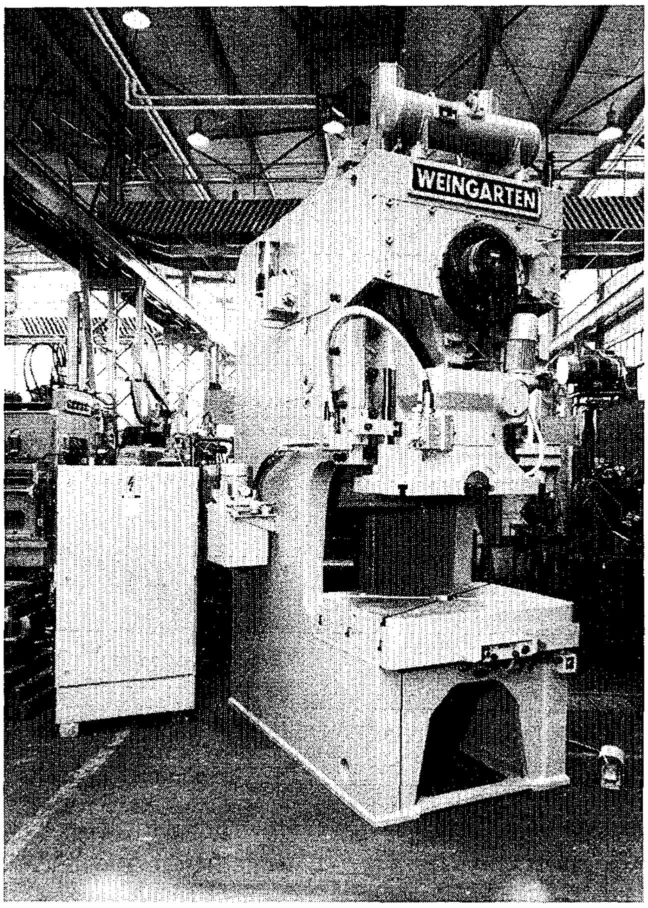
File: O 31
ISIC CODE 3811

How To Start Manufacturing Industries

Carpentry Tools



Introduction

For ages tools have been manufactured by hand. This process, however, is labour-intensive, time-consuming and expensive. A uniform quality standard can hardly be achieved. The demand for tools is steadily increasing which means that industrial production is required.

The plant presented in this paper satisfies this requirement, since a production process has been chosen by which quite a number of various tools can be produced.

The use of additional tools can enlarge the variety of the products that are produced, and adapt it to the market requirements of the individual country.

The production of saw blades is used as an eample to describe the production process. The capital to be invested, however, refers to the entity of the five listed tools.

Description of the Production Process

Cold-rolled sheets in coils, surface-ground, hardened and tempered, are put on the de-coiling device (item 1). They are punched and the teeth are set on one side. The sheets are wound up and sent again through the punching and setting machines (item 3).

At the first stage an eccenter guillotine shear (item 6) cuts the coil material to the required

Manufacturing Process Flow Diagrams

SAW BLADES	CUT PLANE IRONS	CHISELS	CLAW HAMMERS	YANKEE AXES
Steel sheets in coils	Steel sheets in coils	Rectangular or round steel rods	Square steel in rods	Flat steel
Punching and setting of the teeth	Punching	↓	↓	↓
Cutting to required length diagonally to sheets	↓	Cutting to required length	Cutting to required length	Cutting to required length
↓	↓	Heating	Heating	Heating
↓	↓	Forging	Forging	Forging
Punching out the handle side and the hole	↓	↓	Punching out the hole	Punching out the hole
↓	↓	↓	↓	Heating
↓	↓	↓	↓	Flattening
↓	↓	Deburring	Deburring	Deburring
↓	↓	Straightening	↓	↓
↓	Heating	Heating	Heating	Heating
↓	Hardening	Hardening	Hardening	Hardening
Grinding	Grinding	Grinding	Grinding	Grinding
↓	Dip-painting	↓	Dip-painting	Dip-painting
↓	↓	Mounting of wooden handle	Mounting of wooden handle	Mounting of wooden handle
Final product	Final product	Final product	Final product	Final product

length, and at the second stage the rectangular sheets with teeth at their long sides are diagonally cut and thus two saw blades are obtained.

The handle side of the saw blades is punched and provided with the necessary holes on an eccenter press (item 7). A special saw blade grinding machine (item 9) grinds the saw blades.

If required a brand-name can applied by an etching device (item 10).

Example of the Plant

Output

1.	Handsaw blades	100 pcs./h total
2.	Cut plane irons	200 pcs./h total
3.	Claw hammers	100 pcs./h total
4.	Chisels	100 pcs./h total
5.	Yankee axes	100 pcs./h total

Required Machinery and Equipment

Item	*Description*	*Pieces*
1.	Decoiling device	1
2.	Straightening and feeding device	1
3.	Tooth punching machine	1
4.	Automatic setting machine	1
5.	Coiling device	1
6.	Eccenter guillotine shear	1
7.	Eccenter press 100 tons	1
8.	Punching tool	6
9.	Grinding machine	1
10.	Etching device	1
11.	Punching tools	2
12.	Salt bath oven	1
13.	Hardening bath	1
14.	Flat grinding machine	1
15.	Hacksaw machine	1
16.	Forging oven	1
17.	Friction spindle press	1
18.	Double die for claw hammer	6
19.	Deburring tools	6
20.	Double band grinding machines	2
21.	Forging die	10
22.	Deburring tools	10
23.	Straightening tool	1
24.	Clamping devices	2
25.	Forging press 400 tons	1
26.	Forging die	9
27.	Flattening tool	1
28.	Eccenter press 125 tons	1
29.	Deburring tools	9
30.	Wet grinding machine	1

FOB-price for machinery and equipment approx. US$ 1,500,000.00

Required Manpower

Commercial manager	1
Technical factory manager engineer	1
Secretary	1
Tool makers	2
Forging experts	2
Skilled workers	20
Unskilled workers	5
Mechanic technician for maintenance	1
Electrician for maintenance	1
	34

Required Area

Production area	1,000 sq.m
Storage	120 sq.m
Facilities	280 sq.m

Required Power and Utilities

1.	Electrical power V, 50 c/s, 3-phase	250 kW
2.	Compressed air pressure: consumption approx.:	 8 bar 2,000 l/min

Required Raw Material

1.	Steel: quantity according to the production programme	Tool Steel
2.	Wooden handles: to be ready bought locally	

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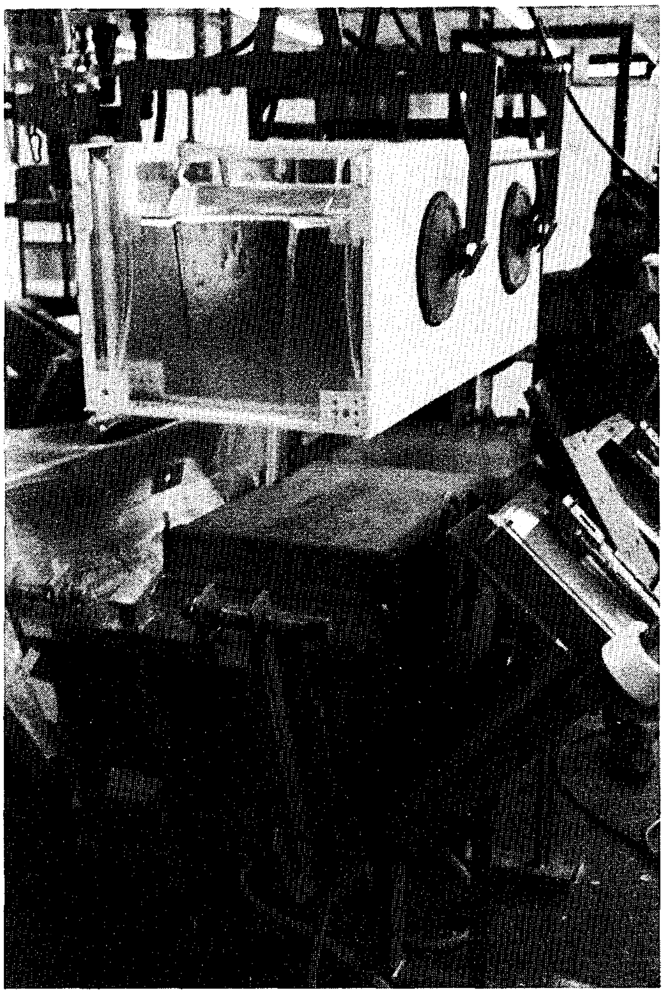
P

File: P 32
ISIC CODE 3829

How To Start Manufacturing Industries

Assembly of Refrigerators

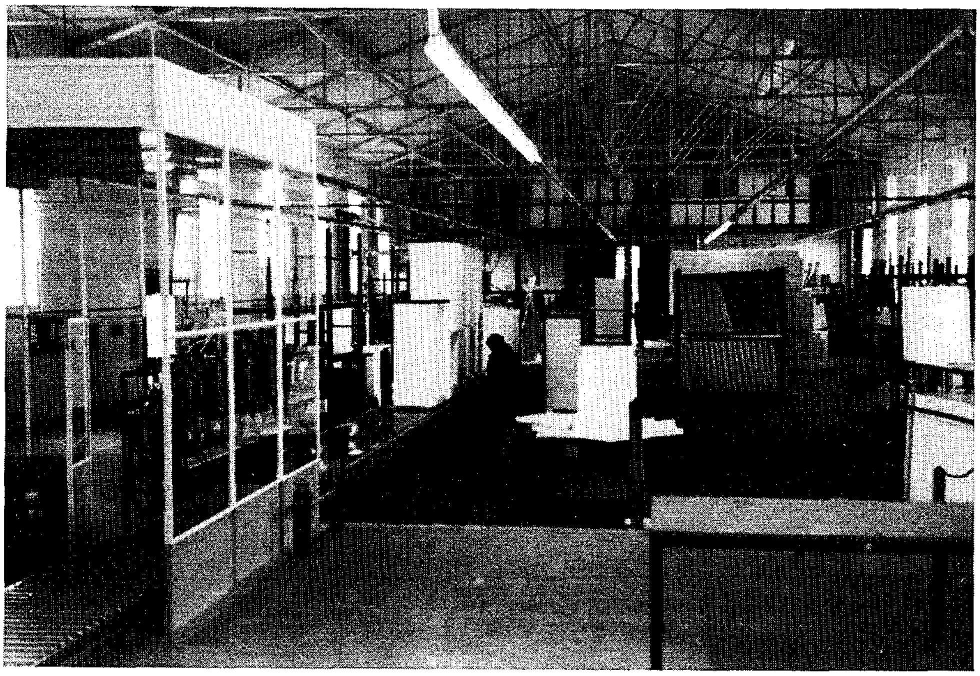


Introduction

Nowadays refrigerators are an indispensable part of any modern kitchen. It was the invention of refrigerators which enabled households to store food efficiently, or in other words: keep perishable foodstuff fresh and maintain its dietetic value. This gives consumers a chance to keep their expenses for food low and yet provide menus full of variety.

The necessity to keep something cool is not limited to food and household, either. Certain chemicals and medical stuff, for instance, quite often require a refrigerator for proper storage.

A comprehensive industrial structure is the basic condition for the production of refrigerators, which consist of numerous components. These, however, are not so easily available in many countries with a large demand for refrigerators. A recommendable alternative which is suitable to cut down imports to a considerable extent, is the production of refrigerators in assembly plants. The advantages of such a local production are:



- less import duties on imported production material instead of ready-made refrigerators
- only 1/4 to 1/5 of transport volume for production material in comparison to ready-made refrigerators
- local employment and value added
- transfer of know-how and creation of skilled labour force
- saving of foreign currency.

Description of the Assembly Process

The precut plastic sheets are transformed on a thermo-forming machine to shape inner liners, inner doors or other parts like drip trays, vegetable containers, etc. These parts are trimmed to size by cutting or sawing and all necessary holes are drilled.

The inner liners pass to the foaming section where they are inserted into foaming jigs. Other parts like side panels, traverse connections, table tops and back wall are first prepared with foam strips, adhesive tapes and other small parts, then put together with the inner liner in the foaming jig to a refrigerator housing. The foaming jig that has a supporting function, is closed, and the polyurethane foam is injected into the empty space between outer and inner shell. After some time the foam gets hard and the now rigid foamed housing is taken out of the jig and brought to the drilling.

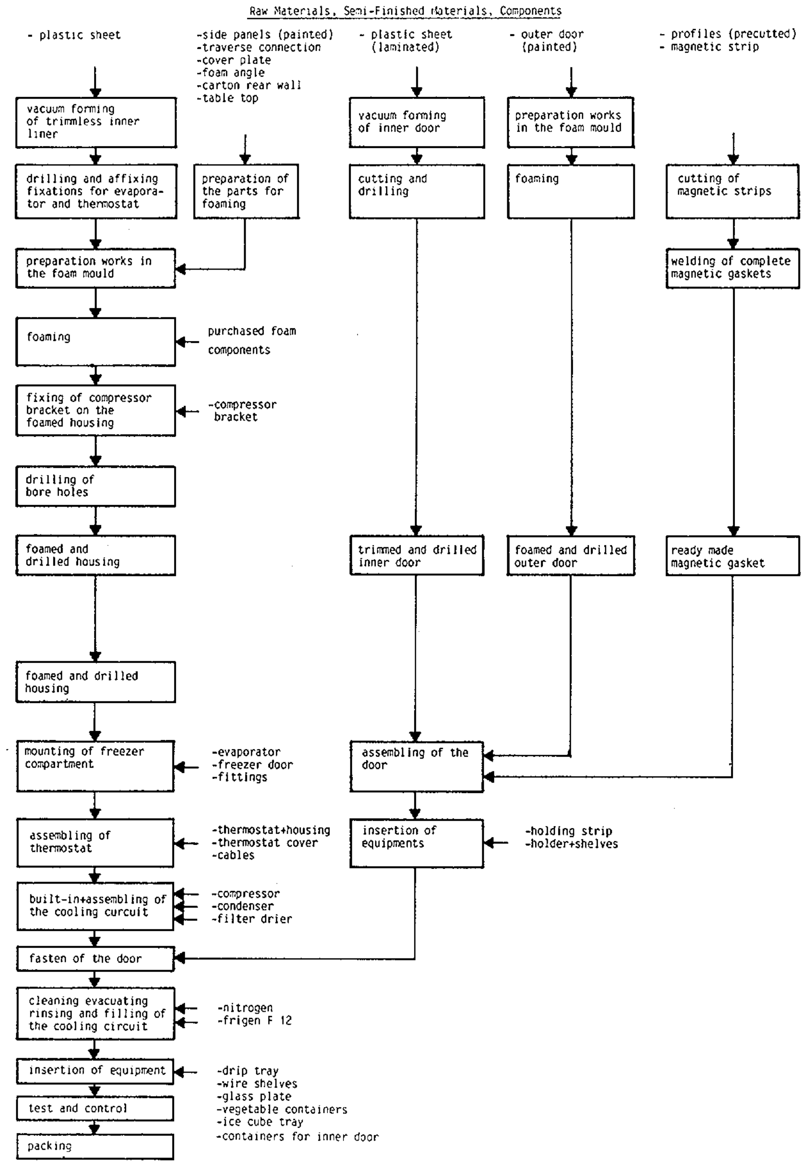
The outer doors are filled with foam in door foaming jigs. In a separate section, magnetic strips from coils are cut to length and inserted into precut soft plastic profiles. Four such parts are welded together to a complete magnetic gasket. Foamed outer door, magnetic gasket and vacuum formed inner door are screwed together and the door is completed with inside door shelves, egg tray etc.

The foamed and drilled housing comes to the final assembly line and is assembled with compressor, condenser, thermostat, filter drier and evaporator. These parts are welded or connected together to the cooling circuit. This circuit is evacuated, rinsed and filled with freon cooling agent. The freezer compartment door and the outer door are fixed and the refrigerator is equipped with vegetable container, wire grids etc.

After the electric and cooling test the refrigerator can be packed.

The assembly plant that is described here, has been designed for the production of domestic and commercial refrigerators and upright deep freezers of sizes between 5 cu.ft (150 l) and 12–13 cu.ft (360 l).

Manufacturing Process Flow Diagram



Example of the Plant

Required Machinery and Equipment

Item	Description	Pieces
1	Vacuum forming machine with water temperature regulating units and water cooler	1
2	Vacuum forming moulds	6
3	Trimming and cutting devices	misc.
4	Low pressure foaming machine, daily tanks for two-components foam, water cooler	1
5	Foaming moulds for housings and doors	4
6	Lifting device to extract the housing	1
7	Drilling devices with pneumatically operated tools	misc.
8	Machines and devices to cut and weld magnetic gaskets	misc.
9	Pre-assembly equipment for doors	1
10	Final assembly line conveyor, assembly tools welding equipment evacuating and filling devices test equipment	1
	FOB-price for machinery and equipment approx.	US$ 850,000.00

Required Area

Production building	900 sq.m
Storage for 3 months' production material	300 sq.m
Storage for 1 month's production	200 sq.m
Facilities	200 sq.m

Required Manpower

Department	*No. of non-qualified*	*No. of semi-qualified*	*No. of technical engineers*	*No. of total employees*
Storage, transport	1	1		2
Vacuum forming, trimming		2		2
Foaming	1	2		3
Pre-assembling	1	1		2
Final assembling		4		4
Tests			1	1
Repairs		1		1
Maintenance			1	1
Production manager			1	1
Total required manpower:				17

Required Power and Utilities

Installed electrical power	approx. 180 kW
Compressed air	approx. 2N Cu.m/hr, at 8 bar
Small amounts of propane gas	

Required Parts and Raw Materials

- Raw materials: foam components, plastic sheets, profiles for magnetic gaskets
- Semi-finished materials: painted side panels, doors, traverse connections, injection-moulded plastic parts, wire grids
- Components: compressors, evaporators, condensers, thermostats

Capacity of the Plant

3,000–4,000 refrigerators/year

2 different refrigerator types, single door, with 2-star freezer compartment

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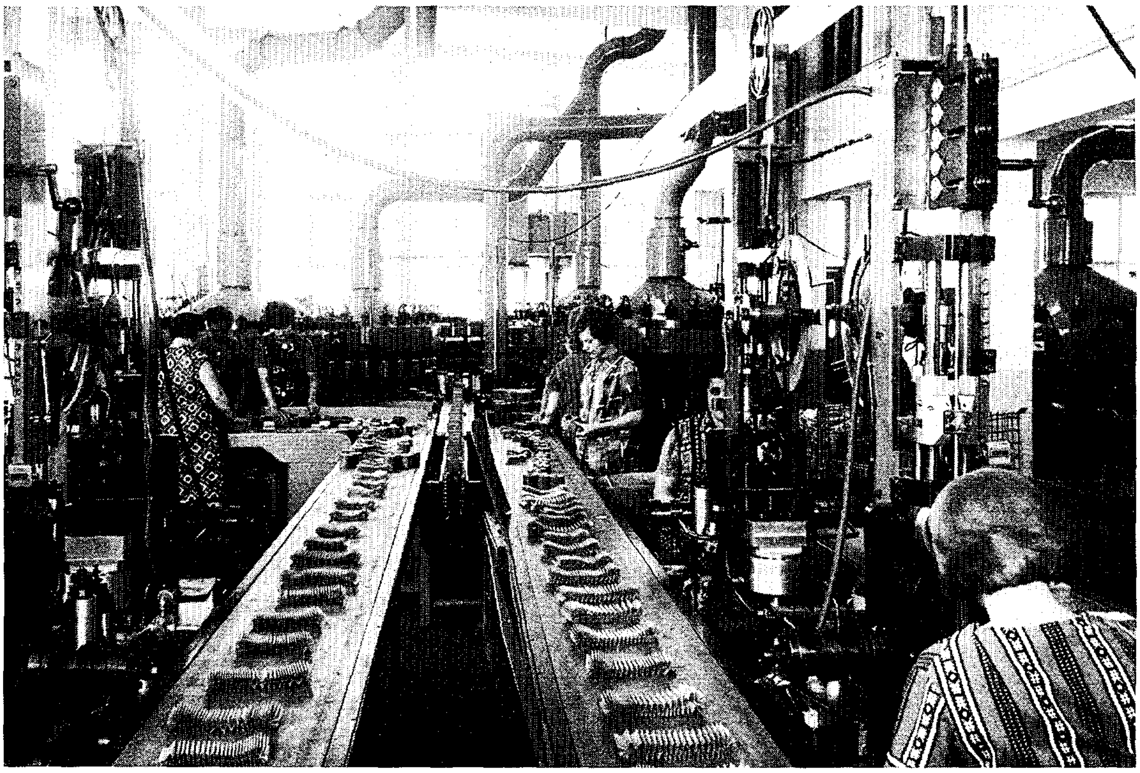
Q

File: Q 47
ISIC CODE 3843

How To Start Manufacturing Industries

Automotive Filter Plant



Introduction

With the ever-increasing use of cars, trucks and buses all over the world the production of spare and wear parts has become more and more important.

That especially applies to automotive filter products.

The production of oil, air and fuel filter elements for vehicles is a very interesting project to improve local infrastructure and make the domestic market independent of imports.

It depends on the number of local vehicles and market size whether a small, medium or large-scale production facility is to be established.

The described production plant is a medium-sized facility with a product-mix of approximately 1/3 air filter and 2/3 oil filter elements, which rate can be adapted to market requirements.

To produce first-class quality products comparable to an original equipment level, the input of high-quality materials is essential.

For the manufacturing of filters it is recommendable to start with a semi-automatic production facility as described below.

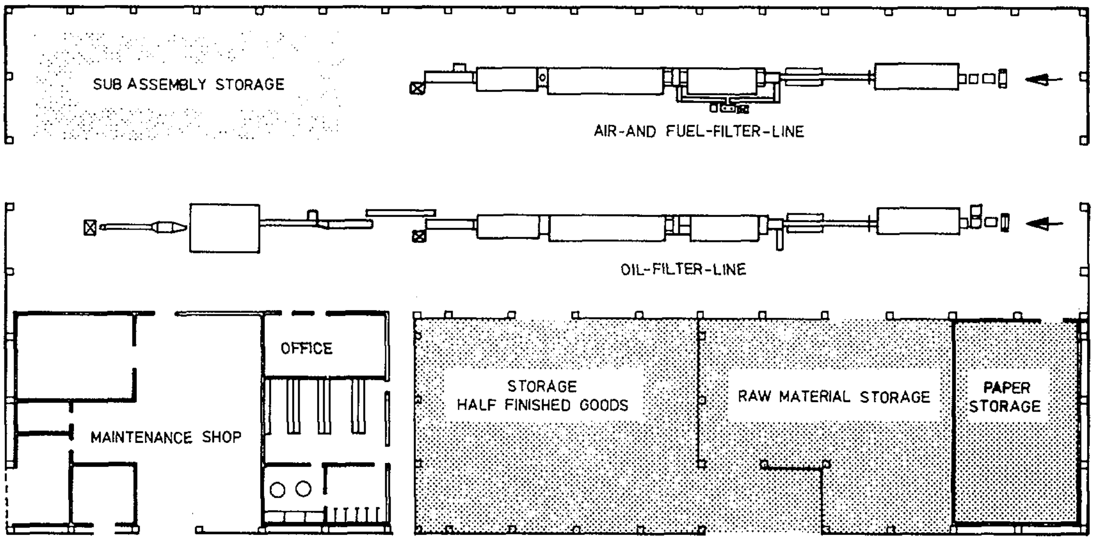
Description of the Production Process

The most important raw material for the production of filters is the filter media paper.

This filter paper is resin-treated and has to be cured to obtain exact pore sizes and water resistance.

To achieve a minimum volume and a maximum filter surface the filter paper is pleated and fastened in a filter element.

Resin-treated filter paper will be dereeled from a coil and automatically pleated by a pleating machine.



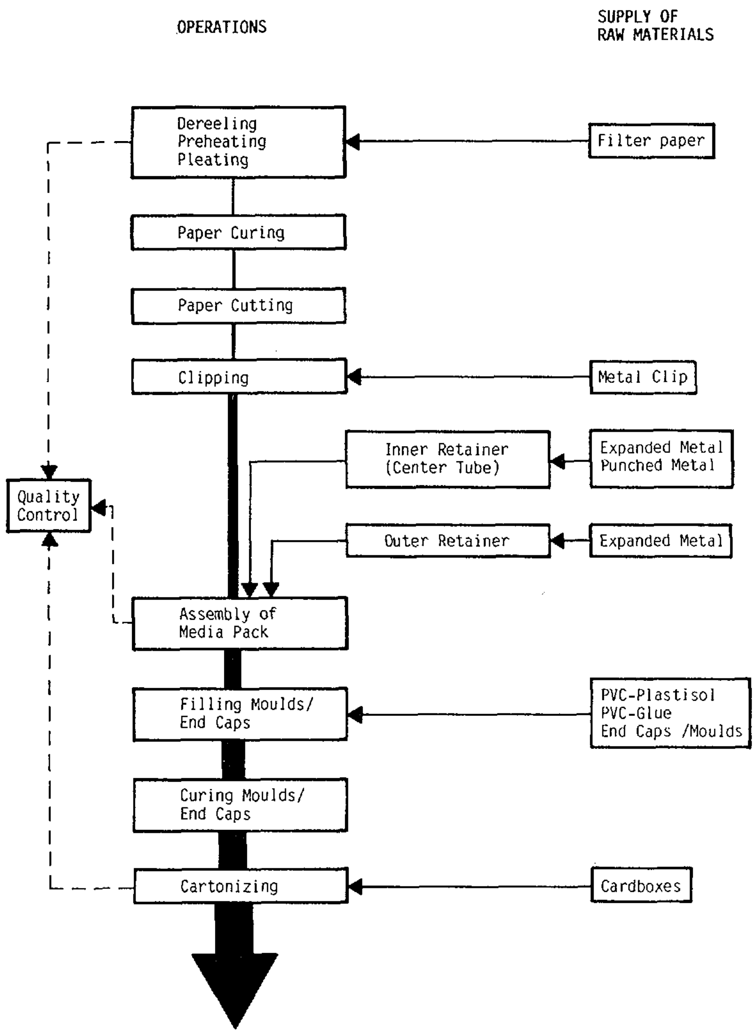
Pleated filter material runs endlessly through a paper curing oven to burn out resin.

Then the endless pleated filter paper will be cut to length after a pre-adjusted number of pleats depending on filter types.

With a special designed clipping machine both ends for the filter bulk will be tightly fitted together.

All other components like inner retainers, center tubes, outer retainers will be assembled for a

Manufacturing Process Flow Diagram



filter media pack. In case of airfilter production this pre-assembled media pack will be set into a PVC-filled mould to produce bottom and top binding.

In case of oil and fuel filter element production the media pack will be set into the filter endcap and fixed with glue.

These endcaps or moulds with the media pack are passed through further heating ovens to get short hardening times.

After the last oven they pass a special cooling zone to reduce the temperature of the filter elements to nearly room temperature. That is important for packaging the finished products into cardboxes.

This production line is highly flexible to produce nearly all kind of filter elements and the production facility can also be extended for other filter products like spin-on oil filters.

Example of the Plant

Specific Capacity

1.	Oil and fuel filter elements:	approx. 1,200 pcs/h
2.	Air filter elements:	approx. 650 pcs/h

Required Machinery and Equipment

Item	Description	Pieces
1.	Paper Reel	1
2.	Paper warming table	1
3.	Paper pleater, marathon	1
4.	Paper curing oven	1
5.	Paper cutting station	1
6.	Clipping machine	2
7.	Assembly station with conveyor	6
8.	Set in station I	1
9.	Conveyor	2
10.	Conveyor	2
11.	Dispensing station glue	1
12.	Dispensing station – PVC plastisol	1
13.	Precuring oven	1
14.	Set in station II	1
15.	Final curing oven with cooling zone	1
16.	Dismoulding station	2
17.	Tampon printer	1
18.	Packing table	1

FOB-price for machinery and equipment approx. US$ 1,100,000.00

Required Manpower

Commercial manager	1
Technical manager	1
Clerks	2
Secretaries	2
Foremen	4
Skilled workers	6
Unskilled workers	20
Mechanic technicians for maintenance	2
	38

Required Area

Production area	1,200 sq.m
Storage 900 sq.m	
Facilities	400 sq.m

Required Power

Electrical power AC 380 V, 50 c/s, 3-phase	220 kW

Required Raw Materials

1.	Filter paper	50 t/year
2.	PVC-plastisol	30 t/year
3.	PVC-glue	12 t/year
4.	Clipping material coil	3.5 t/year
5.	Expanded metal coil	615,000 m/year
6.	Punched metal coil	49 t/year
7.	Element caps oil and fuel filters top and bottom	2.8 mio.pcs./year
8.	Boxes	1.44 mio.pcs./year

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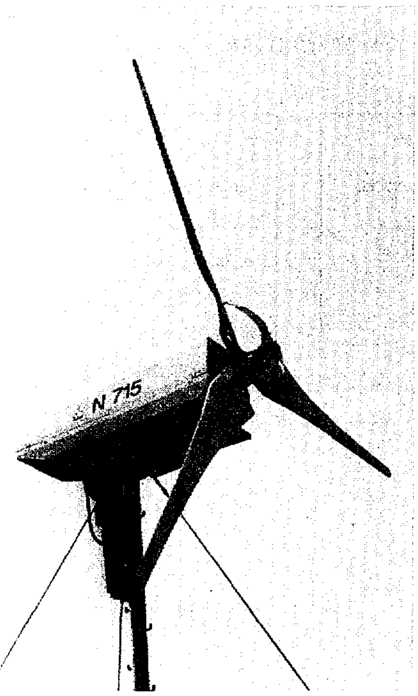
File: Q 48
ISIC CODE 3831

How To Start Manufacturing Industries

WIND-POWER GENERATOR ASSEMBLY



Introduction

'Regenerative' is the denomination for energy-sources coming from natural energy-flows. These exist without any human help and, in human minds, can be classified as 'everlasting'. Usually they are found in a considerably smaller density than fossil or nuclear energies. Hence the general point of view is that they are less suited for the utilization in overcrowded areas with a concentrated power demand than for the decentralized utilization in areas with a not so thoroughly developed technical infrastructure.

Remote consumers who are not connected to a central power supply system, quite often have to put up with much higher energy costs than centrally supplied consumers, for transport costs must be added to the costs for primary energy. In many cases the transport is subject to certain risks jeopardizing the safety and continuity of supply.

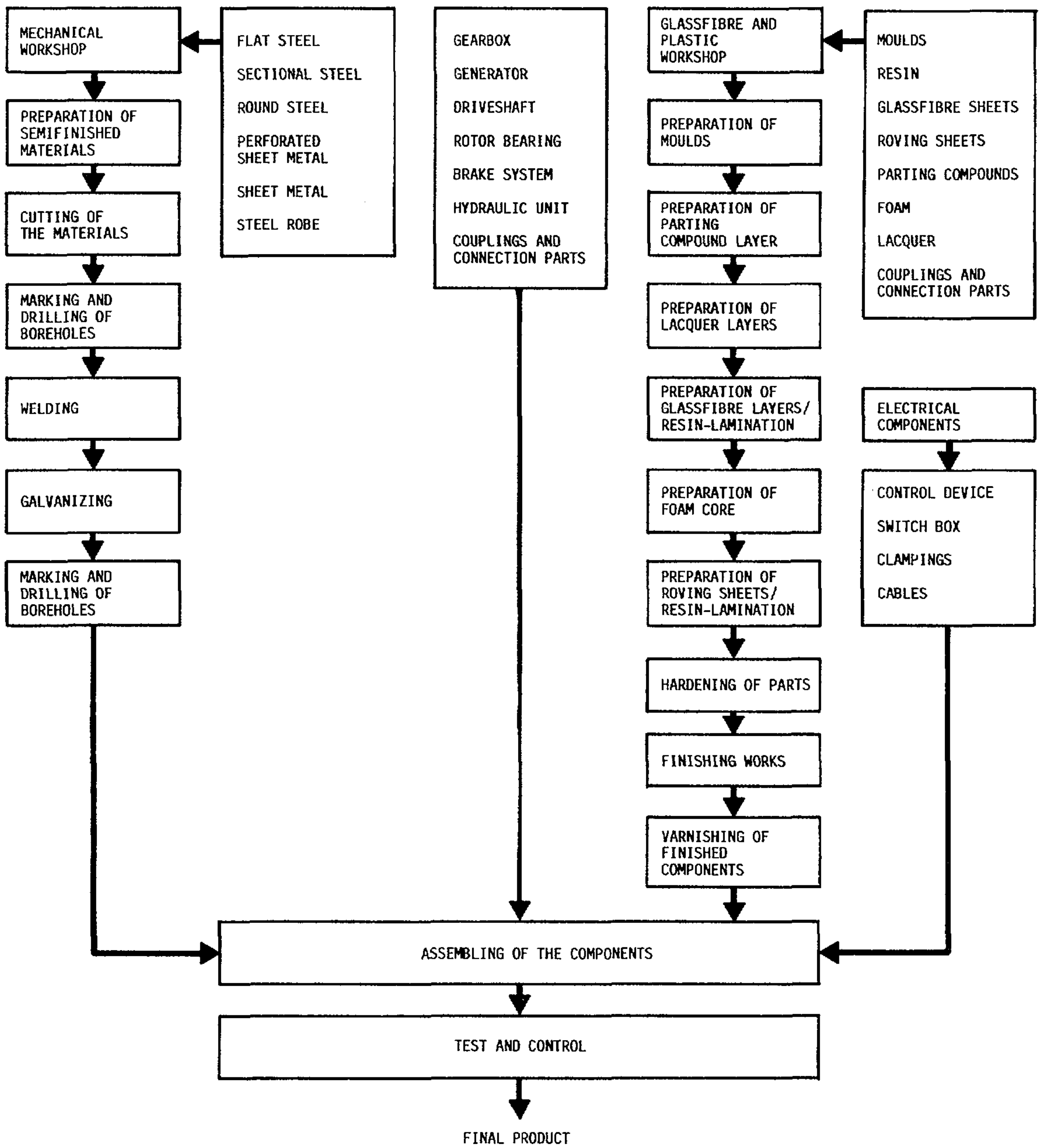
In particular this applies to many consumers in the Third World. For such problems regenerative energies offer significant advantages, for they do not require primary energy and the costs and risks of transport that go with it.

In recent years, people have more and more become aware of the fact that conventional energy sources are limited and tapping them means a steady reduction of their quantity and also means certain ecologic consequences that would better be avoided. This awareness initiated the development of a broad programme for the utilization of regenerative energy sources such as sun and wind. Alternative or additive energy sources are by no means the concern of a sophisticated minority – on the contrary, there have been detailed discussions both in the public as well as in political circles about an appropriate energy policy.

Since the Western world had to face the 'oil crisis' some years ago, the main question has been how to replace fossil oil by suitable alternatives. One of the answers was nuclear power with a great number of advantages – and the menacing, yet unsolved problem how to dispose of nuclear waste. Generally one must admit that environmental impacts are the inevitable consequence of any energy-generation.

This has resulted in a steady process to change the structure of commercial power supply and utilize energy in a more rational and economical manner. It means that decentral and additive systems utilizing regenerative sources of energy are gaining significance. Wind power is one of these sources. Wind-power generating units can be established at any place that meets certain climatic requirements, and compared to conventional generating sets, they are simple in their technical construction, cheap in price and easy in maintenance.

Blockdiagram: Assembly Process



Description of the Assembly Process

The plant presented in the following is laid out for the assembly of 50 wind power plants per year. Each assembled wind power plant with a rotor diameter of 7 metres is able to supply 15 kW power. The generator supplies either 220 V or 380 V three-phase current.

The production where the required raw materials, semi-finished materials and components are produced or assembled, is divided into three main sectors:

1. glass-fibre and plastic workshop
2. mechanical workshop
3. assembly.

1. Glass-fibre and plastic workshop

In this workshop rotors and casings are produced. Foam core, glass-fibre sheets and roving sheets are sandwich-wise put into moulds and laminated with epoxy-resin. After hardening in the tempering furnace and surface treatment of the plastic components, a polyester coating may be applied as a protection against extreme climatic conditions.

2. Mechanical workshop

This workshop is responsible for the finish of semi-finished material, thus producing masts and frames including fittings and the anchoring. Basic materials are flat-steel, sectional steel, round steel, perforated sheet materials, sheet metal, steel rope.

3. Assembly

This sector assembles the individual components and applies the finishing. The whole unit is finally subjected to a test-run where its functions and ratings are checked.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1.	Glass-fibre and plastic department	
1.1	Dosing unit	1
1.2	Exhaust unit	1
1.3	Rotor mould	1
1.4	Casing mould	1
1.5	Tempering furnace	1
1.6	Spraying unit	1
2.	Mechanical workshop	
2.1	Milling machine	1
2.2	Bench lathe	1
2.3	Cutting devices	2
2.4	Electric welding devices	2
2.5	Drilling machine	1
2.6	Exhaust unit	1
2.7	Crane installation	1
2.8	Set of tools	1
	FOB-price for equipment and machinery approx.	US$ 220,000.00

Required Manpower

Management and administration	3
Technical manager	1
Quality control	1
Engineers	2
Skilled workers	5
Workers	5
Maintenance	2
	19

Required Area

Administration	60 sq.m
Production	480 sq.m
Storage	240 sq.m

Required Electrical Energy

Electrical power installed 160 kW

Required Components and Raw Materials

Components:
- Gearbox
- Generator
- Drive shaft
- Rotor bearing
- Braking system
- Hydraulic unit
- Coupling and connecting parts
- Controlling device
- Switchbox
- Clamping
- Cable

Semi-finished material:
- Sectional steel
- Sheet metal
- Perforated steel
- Steel rope

Raw materials:

Resin	40 kg/unit
Glass-fibre (sheets)	50 sq.m/unit
Roving (sheets)	6 cm x 100 cm/unit
Foam	

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R

File: R 6
ISIC CODE 3851

How to Start Manufacturing Industries

Syringes Making Plant

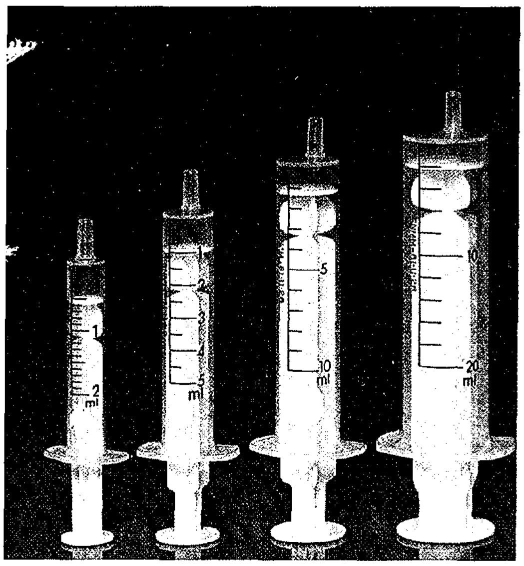
Introduction

Disposable syringes made of plastic material have been successfully used in medical and pharmaceutical practice for many years. The constantly increasing use of this type of syringe, indicates its importance, which is based mainly on the advantages it offers regarding cost and hygienic application.

The manufacture of plastic syringes has been developed to such a degree that the products now sastisfy the requirements and standards set by hospitals and physicians. At the same time they offer the best possible technique of application to the physician and the highest possible degree of safety to the patient.

To serve a number of purposes, the syringes are produced in different sizes, i.e. with contents of 1, 2.5, 5, 10 and 20 ml; larger sizes of 30, 50 and 100 ml are also required, but in much smaller quantities. It may be mentioned that 1 and 2.5 ml syringes with special graduation serve as insulin and tuberculin syringes.

There are two different types of disposable syringes on the market: the two-piece and the three-piece syringe. The two-piece syringe is made of plastic material only. The piston is produced from polyethylene, while the cylinder is made of polypropylene. The use of different materials guarantees better sliding properties.



Two piece-syringes

In three-piece syringes an additional rubber piece is attached onto the head of the piston, which is able to compensate slight variations in the dimensional tolerances of the cylinder. The rubber requires a special quality with a minimum of contaminating particles. In principle this rubber piece represents an additional cost element although the sales price of both syringe types is the same. Yet both types are still widely used. In the following process description the production of two-piece syringes is described.

Process Description

The cylinders and pistons are produced by injection moulding machines which are fed by individual granule feeding systems. The different parts to be moulded determine the relevant types and quantities of raw material to be supplied by the feeding lines.

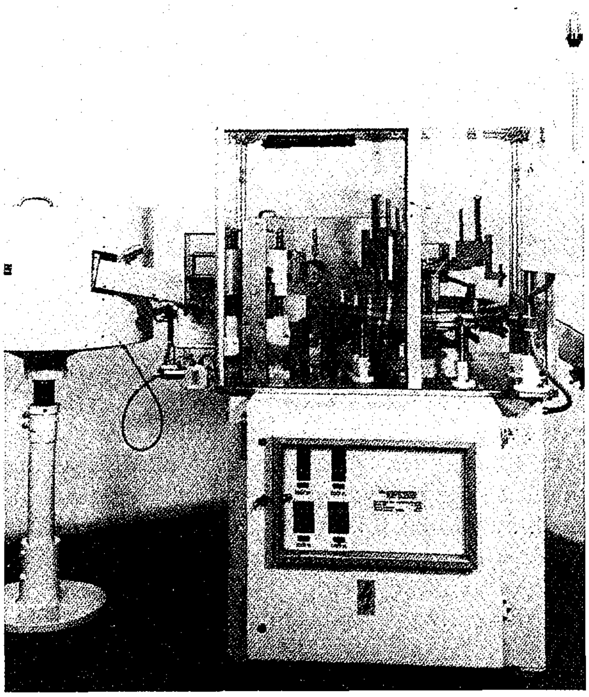
Clamping force, temperature, dosing and injection pressure of raw material, and clamping time of the machines are automatically controlled so that disturbances or faults in production should occur very rarely, and wastes are kept at the lowest possible rate.

The scraps are separated from the moulded parts which are then transported into a control channel. A conveyor belt situated below the machine removes the scraps.

For shrinking to their required dimensions, the moulded parts are packed into plastic containers or bags and are deposited in an air-conditioned interim storage room for at least one or two days.

After the shrinking is completed, the scales and the product logo are printed on the syringe cylinders by a semi-automatic embossing machine, i.e. the feeding is performed manually while printing and discharging are done automatically.

The cylinders and the pistons are conveyed to the assembling machine by means of vibrating feeders. There the piston is automatically fitted into the cylinder and is immediately tested for tightness.



Assembling machine

The completed syringes are placed by hand into the deep-drawing cavities of the blister packaging machine for sealing up the single units automatically with a plastic foil. Between 50 and 250 sealed units (acc. to delivery demands) are packed into a cardboard box by hand. The boxes are closed, labelled and subsequently palletized.

After an in-process storage over a few days, sterlization is carried out.

The outoclave sterilization with ethylene oxide allows previous packing of the final products ready to be delivered ex-works. Therefore the cardboard boxes can be placed into the autoclave on pallets, but only after having been stored under normal conditions for two to three days in order to ensure the sterilization effect. This minimum period is a presupposition for the bacteria to reach within the blister foil a certain degree of growth necessary for rendering them inocuous.

It is recommended to design the autoclave chamber for one daily production in order to minimize quality controls because bacteriological tests are done batch-wise.

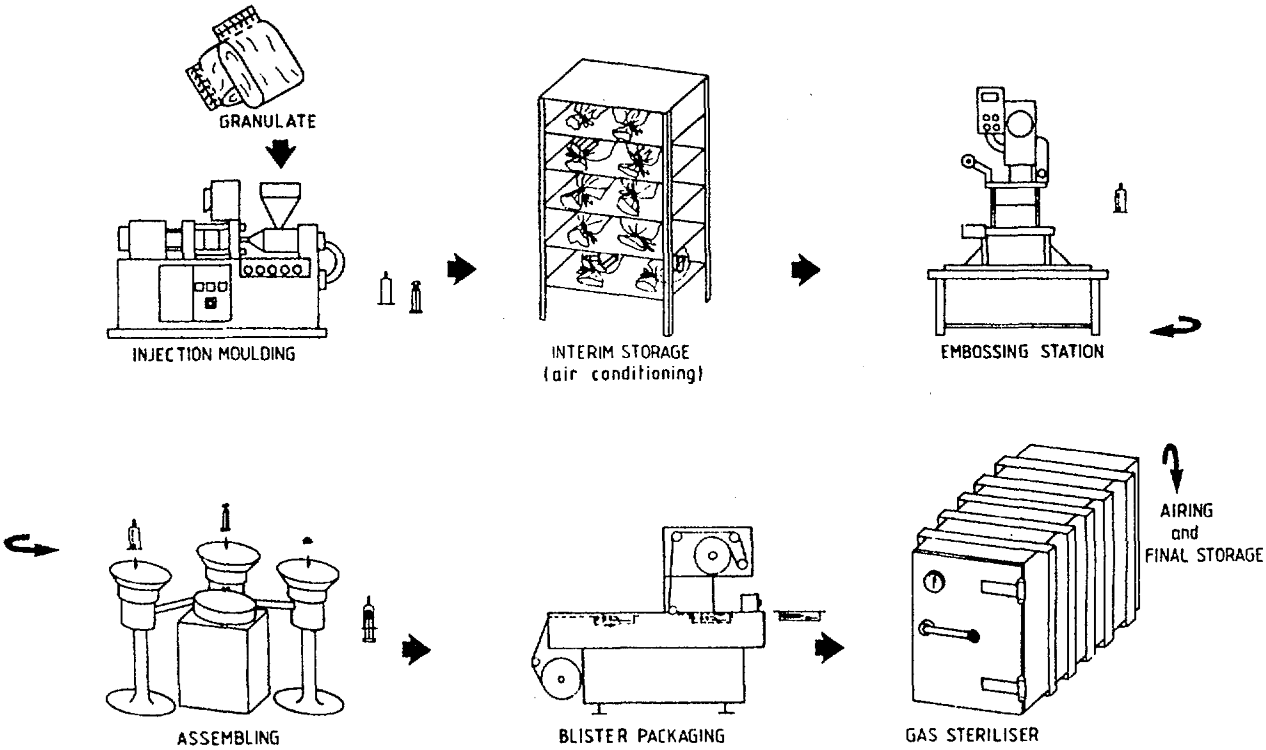
Due to the fact that ethylene oxide is inflammable, the sterilization equipment must be explosion proof and installed in a separate room. Sterilization of one batch takes about 8 hours.

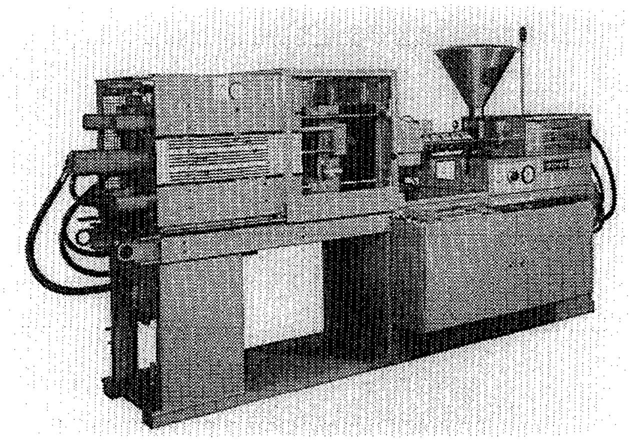
Quality Control

The sterilized syringes are stored under quarantine for airing to allow desorption of restquantities of ethylene oxide; this takes two to three days. Before being released for sale, the products have to undergo quality tests to prove

- the sterility of the syringes inside the packaging
- the absence of any pyrogens.

Process flow Diagram





Injection moulding machine

Example of the Plant

Capacity: 60,000 syringes (2.5 and 5 ml) of the two-piece types per day based on
3 shifts (24 hours) operating the inspection moulding section and
2 shifts operating the remaining sections.

Required Machinery and Equipment

2 Pastic granule feeders
2 Injection moulding machines (60 t clamping force) with
  1 mould for 2.5 ml cylinders
  1 mould for 5 ml cylinders
  1 mould for 2.5 ml pistons
  1 mould for 5 ml pistons
2 Conveyor belts with scrap separators
1 Embossing machine with 2 die sets
1 Assembling machine with 2 die sets
1 Packaging machine with 2 die sets
1 Autoclave of approx, 4–5 m^3 chamber volume
2 Air compressors for approx 100 m^3/h and 10 bar incl. pressure vessel, piping, vals etc.
1 Cooling unit for cooling the injection moulds
1 Set of laboratory equipment

Approximate total FOB price in 1986:	US$ 1,200,000

Required Production Materials and Utilities
per Day (for 60,000 syringes):

Polyethylene	approx. 130 kg
Polypropylene	approx. 150 kg
Embossing foil	approx. 700 m
Packing film	approx. 1,000 m
Medical paper	approx. 1,000 m
Cardboard boxes	approx. 600 pcs
Ethylen oxide (sterilization)	approx. 5 kg
Electric power	approx. 1,600 kWh/d

Required Manpower
per Section and Shift (8 hours)

Injection	3
Embossing machine	2
Assembling machine	2
Packaging	4
Autoclave	1
Laboratory	1
Total	13

Required Plant Site Area

Total built-up area for storage and production	approx. 1,500 m^2
Open area	approx. 1,500 m^2
	approx. 3,000 m^2

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How To Start Manufacturing Industries

Infusion and Transfusion Kits

Introduction

Transfusion sets are used for the transfer of blood, whereas infusion sets are used for administering infusion solutions.

Generally, the design of a transfusion set differs from that of an infusion set only in two minor points:

- due to the fact that the blood cells are rather big, the filter in the drip chamber of the transfusion system has a bigger pore diameter than the filter of an infusion kit;
- the drip chamber of a transfusion system has a larger volume than that of an infusion set.

Infusion therapy is becoming more and more indispensible in modern medicine. During the past few years the consumption of infusion solutions and the range of their application has extended enormously.

The application of an infusion requires–apart from the solution itself–an infusion set which allows the precise dosage to be administered according to the chosen therapy. Therefore, the adequate type of infusion set has to be selected with great care, not only with respect to the techniques for giving the infusion, but also in view of a whole series of medical and technical requirements to be met by this intricate system. The set should, for example, allow simultaneous injection of other drugs, while ensuring simple handling and a high degree of applicational safety at the same time.

The infusion and transfusion kit systems (giving sets) must meet the following requirements:

- optimum product quality
- absolute operational reliability
- convenient handling
- flexibility.

The infusion system shall be made of physiological unobjectionable materials such as ABS, PVC or PP developed specifically for medical purposes. Bacteriological tests to control the sterility and apyrogenity of the manufactured sets have to be carried out continuously during the production.

Composition of the Sets

The infusion set consists of a number of injection-moulded parts made of different plastic materials. The manufacture requires experience in handling them and in operating injection moulding machines. Moreover, the assembly of the complete sets needs well-trained personnel.

The extremely high quality standards required for infusion and transfusion sets call for a special skill in production. Training facilities in existing production plants or those to be arranged by the plant suppliers guarantee a smooth start-up and a commercial production right from the beginning.

Generally, the sets consists of 10 parts divided into four components:

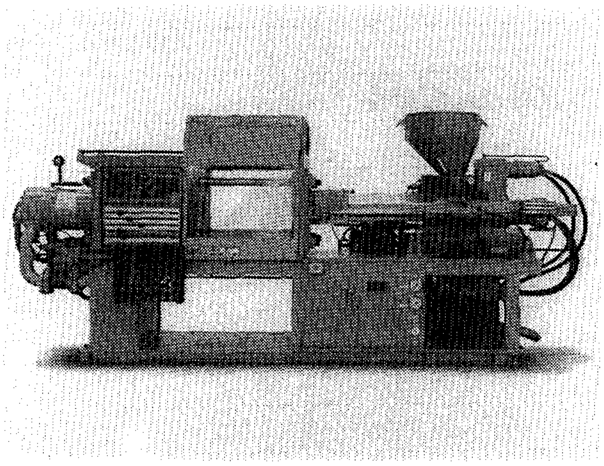
1. Drip chamber
   - large white part with plastic spike
   - transparent and flexible part of drip chamber
   - protective cap for plastic spike
   - filter
2. Tube
   - flexible tube of approx. 1.50 m length
3. Flow regulator
   - clamp housing
   - regulation roll
4. Luer connector
   - protective cap
   - injection piece made of rubber
   - connecting cone.

The filters and the injection pieces made of rubber are in general vendor parts and thus supplied by ancillary industries. To produce them in the same plant would require a completely separate investment.

Process Description

Injection Moulding and Extrusion Section

The granule is transported from the raw material storage area to the granule room. Here it is



Injection Moulding Machine

mixed and dried ready for being processed in the injection moulding machines following a co-ordinated production schedule indicating material flows and changes of moulds. The finished moulded parts are sorted and transported to the storage area. Scraps are collected for re-use.

The flexible tube made of PVC is produced in a special extruder line. The extruded tube is wound to rolls of approx. 2,000 m length.

Preliminary Assembly

The most complicated element of the infusion set which is to be assembled first, is the drip chamber. The protective cap is placed on the upper part of the chamber which is then the cementing machine. There it is fixed tightly onto the lower part of the chamber.

For the preliminary assembly three further working groups are required:

- The first group cuts the 2,000 m rolls of PVC tube into pieces of 1.5 m length using a simple cutting machine, and bundles them to lots of approx. 100 pieces.
- The second group assembles the flow regulator by fitting the regulation roll into the clamp housing.
- The third groud assembles the luer connector consisting of the connecting cone, the injection piece made of rubber, and the protective cap.

Final Assembly and Packaging

The pre-assembled components are forwarded to this section for complete assembly of the whole set.

The flow reulator is slid over the tube before the drip chamber is cemented onto the tube, and finally, the luer-connector is attached.

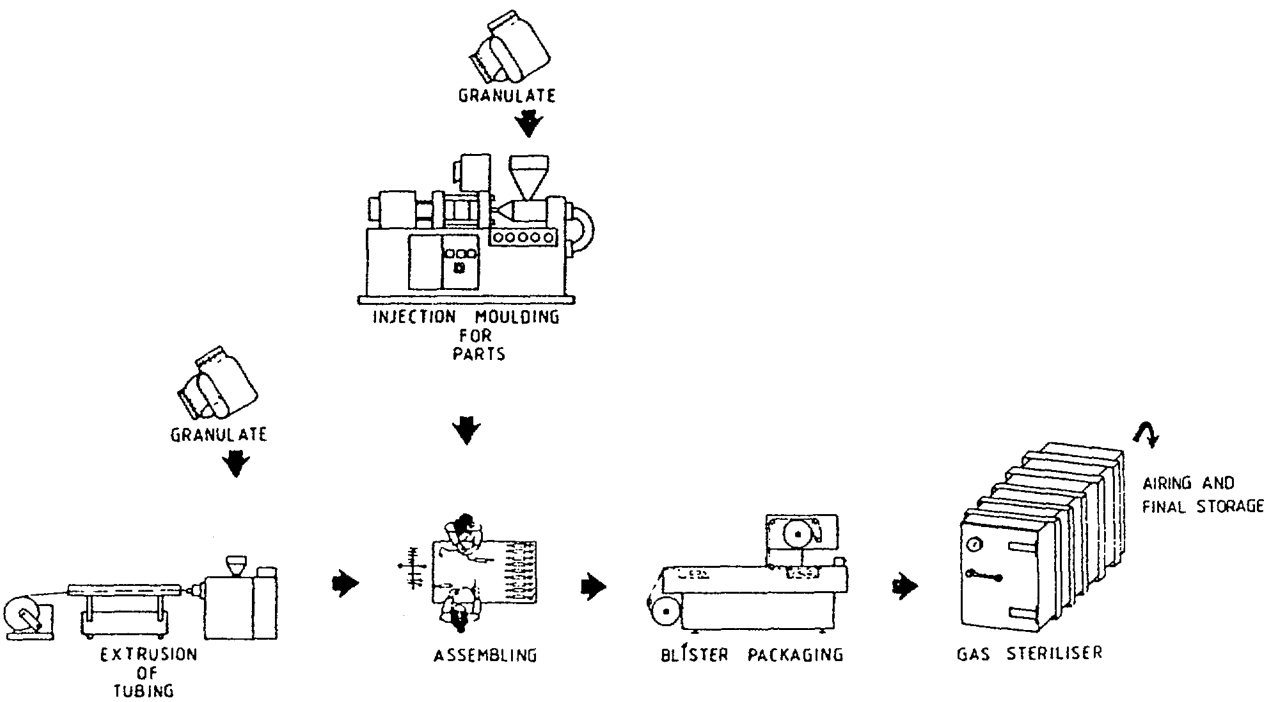
The completed infusion set is rolled to a ring and tied with an elastic tape before being stored for packaging.

Following this in-process storage, the single units are sealed by a blister packaging machine and placed into cardboard boxes, usually containing between 50 and 250 sets.

Sterilization

The autoclave sterilization with ethylene oxide allows previous packing of the final products ready to be delivered ex-works. Therefore, the

Process Flow Diagram



cardboard boxes can be placed in the autoclave on pallets but only after having been stored under normal conditions for two to three days in order to ensure the sterilization effect. This minimum period is a presupposition for the bacteria to reach within the blister foil a certain degree of growth necessary for rendering them inocuous.

It is recommended to design the autoclave chamber for one daily production in order to minimize quality controls because bacteriological tests are done batch-wise.

Due to the fact that ethylene oxide is inflammable, the sterilization equipment must be explosion-proof and installed in a separate room. The sterilization of one batch takes about 8 hours.

Quality Control

The sterilized sets are stored under quarantine for airing to allow desorption of rest-quantities of ethylene oxide; this takes two to three days. Before being released for sale, the products have to undergo quality tests to prove:

- the sterility of the sets inside the packaging and
- the absence of any pyrogens.

Example of the Plant

Capacity: 8000 sets per day, based on 3 shifts (24 hours) operating the injection moulding section and 1 shift operating the remaining sections.

Required Machinery and Equipment

2 Plastic granule feeders
2 Injection moulding machines (60 tons clamping force)
7 Moulds for different parts of drip chamber, flow regulator, and luer connector
2 Conveyor belts with scrap separators
1 Extruder line
2 Tube cutting machines
2 Assembly tables
1 Blister packaging machine
1 Autoclave with piping, pumps, valves etc. chamber volume approx. 4–5 m^3
2 Air compressors for approx. 100 m^3/h and 10 bar incl. pressure vessel, piping, valves etc.
1 Cooling unit (for cooling the moulds)
1 Set of laboratory equipment

Approximate total FOB price in 1986: US$ 800,000.

Required Production Materials and Utilities
per day (for 8000 sets):

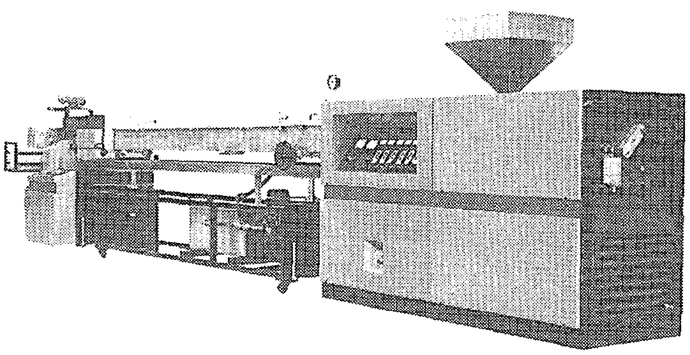
Raw materials:			
PVC (polyvenylchlorid)	approx.	50	kg
PP (polypropylene)	approx.	8	kg
ABS (acrylnitril-butadiene-styrene)	approx.	23	kg
Polystyrene	approx.	65	kg
Colour pigments	approx.	0.15	kg
Packaging material	approx.	270	kg
Ethylen oxide (sterilization)	approx.	8	kg
Separate items from ancillary industries:			
Filters (for drip chamber)		8000	pcs.
Injection pieces made of rubber		8000	pcs.
Electric power	approx.	1600	kWh/d

Required Manpower
per Section and Shift (8 hours)

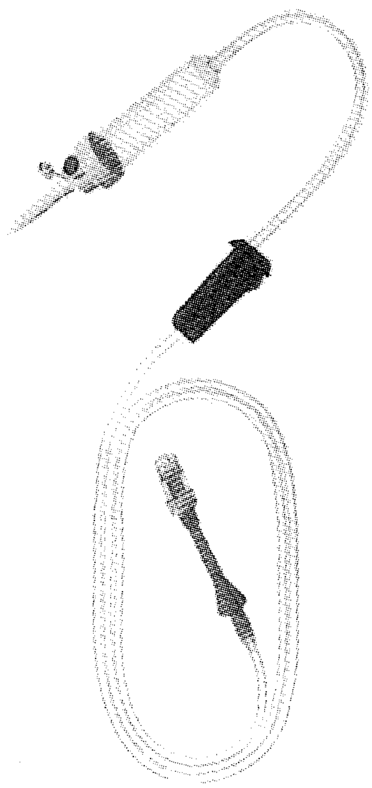
Injection moulding	3
Preliminary assembly	16
Final assembly	16
Autoclave	1
Warehouse	2
Laboratory	1
	39

Required Plant Site Area

Total built-up area for production and storage	approx.	1,200 m^2
Open area	approx.	1,000 m^2
Total		2,200 m^2



Tube Extruder



Infusion Set

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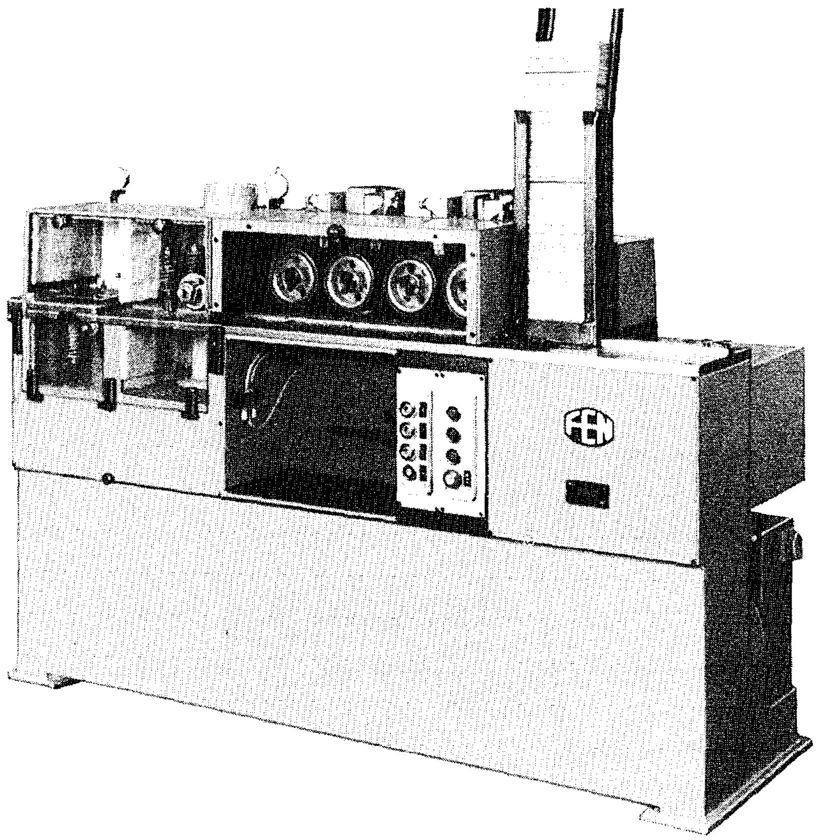
S

File: S 9
ISIC CODE 3909

How To Start Manufacturing Industries

Pencils



Introduction

Pencils play an important role in nearly everybody's daily life. The main factors that influence the demand for pencils, are the degree of literacy attained, number of schools, colleges, the period of schooling, development of business etc.

When educational and economic activities are growing steadily, the demand for pencils has a great potential for growth, too. The setting up of a pencil manufacturing unit will have the dual advantage of meeting the country's requirements of pencils indigeneously as well as providing employment opportunities to local labour.

The main components of wood-cased pencils, generally known as graphite pencils or colour pencils, are soft fine porous wood and leads in 18 degrees of hardness and various colours.

Wood slats

Beside Californian cedar the following kinds of wood are suitable for the production of pencils: aldertree, linden-tree, weymouth pine, jelutong, stone-pine and others.

Leads

Raw materials for the manufacture of graphite leads are above all graphite and pure clay. The main components of coulour leads for colour pencils are clay, talc (French chalk), calcium stearate, pigments, wax and stearin as binding agents. Both raw materials ought to be purchased pre-manufactured. They can be obtained at a low price, whereas a comparatively high investment is required for their production The described plant is semi-automatic and has a capacity of 500 gross pencils per shift.

Description of the Production Process

The production of raw, i. e. unlacquered wooden pencils, which must have very uniform dimensions because of the processing, requires the following operations:

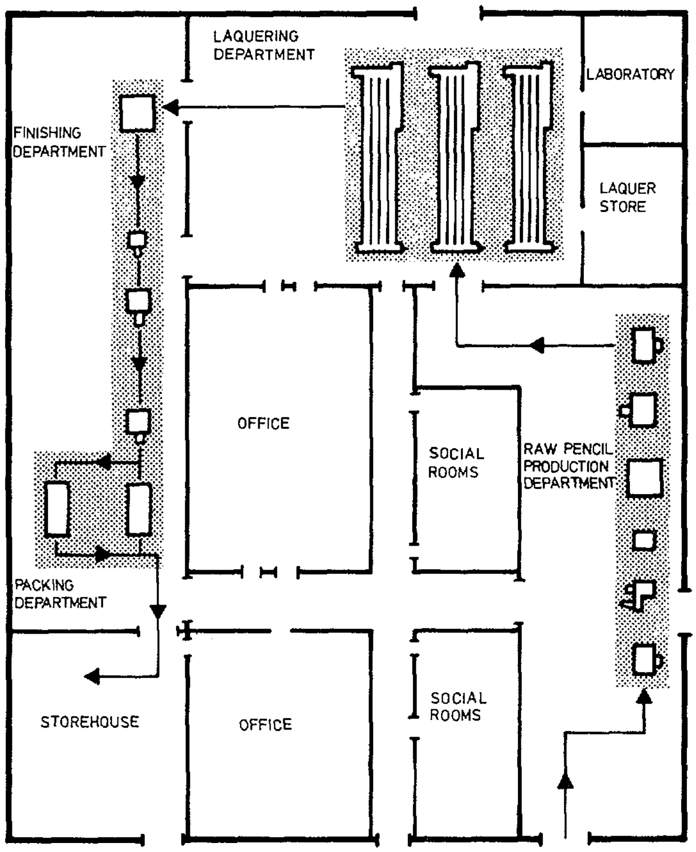
- grooving with side-cutting and planing of the wooden slats
- application of glue to the lead grooves and to one slat surface
- lead laying and making a block sandwich by joining two glued slats
- pressing of the blocks (sandwiches) and drying of the glue
- uniform end-cutting of the blocks sandwiches
- profile shaping of the pencils

Finishing of the wooden pencils:

- lacquering of pencils with several coats with intermediate drying – 2–5 lacquer coats depending on the quality of the pencils
- single or double end-cutting of the pencils (heading and sizing); in this operation the front ends of the pencils are cleaned from residual lacquer
- single stamping of the pencils one-line stamping
- pointing of the pencils

Traditionally, in the pencil industry the finished pencils are gathered in units of 1 gross (= 12 dozen = 144 pieces) or in dozens (12 pieces) and manually packed.

Plant Layout



Example of the Plant

Required Machinery and Equipment

Item	Description	Pieces
1	Standard combined grooving and shaping machine	1
2	Automatic lead laying and glueing machine	1
3	Pneumatic glue clamp closing and opening press	1
4	Block end-cutting saw	1
5	Triple lacquering machine	1
6	Single pencil end-cutting machine (heading and sizing)	1
7	Stamping press	1
8	Pointing and chamfering machine	1
	FOB-price for machinery and equipment approx.	US$ 380,000.00

Required Manpower

Administration and management	3
Engineer	1
Foremen	2
Fitter	1
Workers	18
	25

Required Area

Production area	500 sq.m
Facilities	60 sq.m
Administration	60 sq.m

Required Power and Utilities

Electric power	25 kW
Compressed air	500 l/min

Required Raw Materials

for the production of 500 gross pencils

wooden slats	
for hexagonal pencils	21.25 slat cartons
approx.	slat width 70 mm
for round pencils	24 slat cartons
approx.	slat width 70 mm
graphite leads	500 gross, lead length 180–185 mm
glue (polyvinylacetate)	10.0 kg
lacquer	40.0 kg
stamping foil	3.5 rolls, length of one roll 122 m

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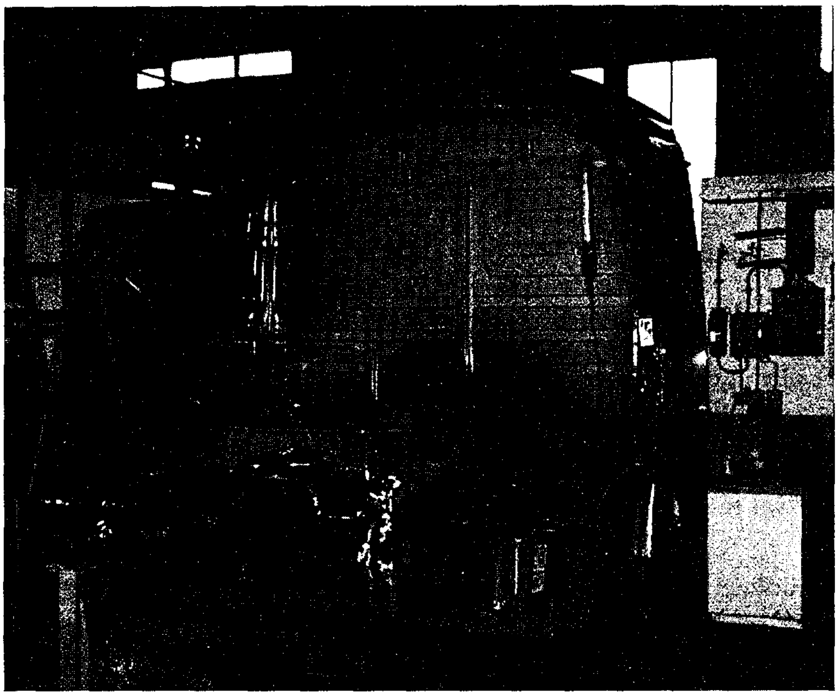
T

File: T 2
ISIC CODE 9513

How To Start Manufacturing Industries

Automobile Body Building and Repairing Plant

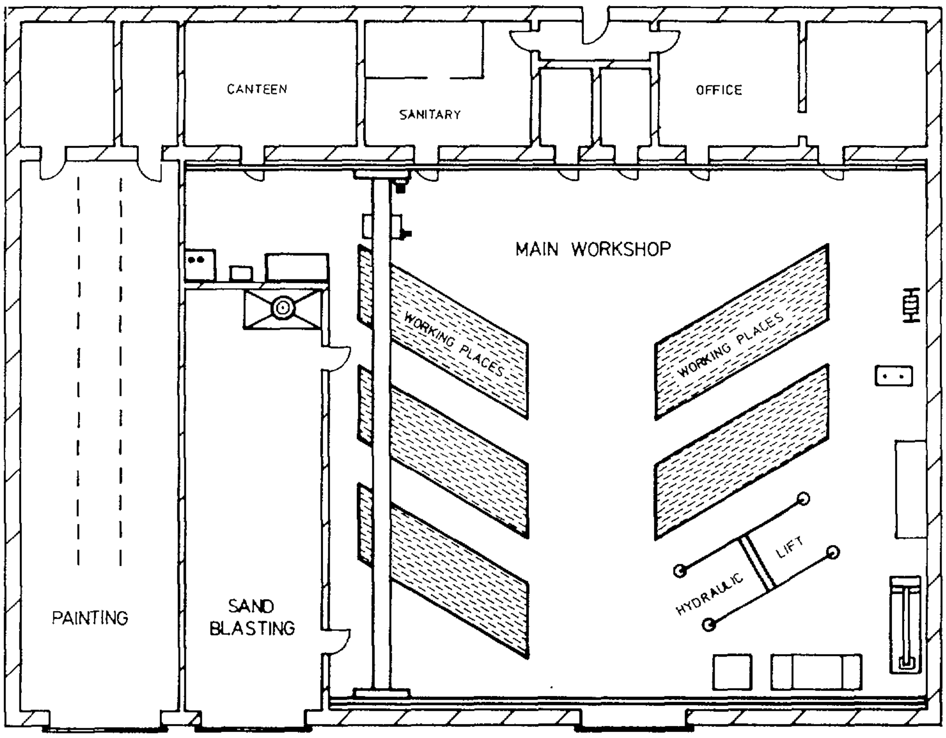


Introduction

Automobiles, especially heavy-duty, mass-transport oriented and public buses remain the important means of transport media in developing countries. In order to maintain the high performance of the automobiles, it is therefore necessary not only to repair and build their engines but also to repair their bodies and replace the old or damaged ones by building new bodies. The repair of old or damaged bodies as well as the building of new ones is not just important by itself. More than that – it helps to reduce the foreign currency requirement of a new automobile by leaving the body work to be done in the importing country with local transport and road conditions duly taken into consideration.

Car body building and repairing is done by any entrepreneur whether big or small. They range from small workshops to larger ones which employ scores of workers with a complete assortment of inspection and testing equipment and tools in the shop.

Plant Layout



Process Description

When the process in an automobile body building and repairing plant is to be described, one must take into account that the works to be done may differ just as much as the eventual damages that are to be repaired.

Hereinafter the repair of a truck will be described as an example for the manifold activities of the workshop.

Type of vehicle:	cooling truck
Damage:	by an accident the vehicle chassis has been distorted, axle and outer casing of the cooling container have been damaged, there are some smaller dents in the car body.

Procedure

1. Analysis of damage:
   Prior to the repair, the vehicle must be carefully inspected and every damage taken down. The estimate of cost is the next step discerning between costs for repair parts, new parts (original parts from the manufacturer) as well as parts that can be manufactured in the workshop itself, finally the estimated amount and cost of labour. The sum of these costs is the basis for the decision whether or not the repair is worthwhile.
2. Sequence of repair:
   The vehicle is dismantled according to its damages. The distorted axle is aligned by means of hydraulic presses. Chain and hydraulic presses straighten the distorted chassis of the vehicle. It is sandblasted, covered with a primer coat and painted. According to the extent of deformation, the damaged parts are either replaced or straightened by hand, smoothed covered with a filling substance, sandpapered and also painted.

To repair the damage of the wall of the cooling container, the damaged area is cut out. The hole is filled in a sandwich-manner by glueing glass-fibre sheets of appropriate size to the wall. When this glue on a resin basis has hardened, the area is prepared for painting by smoothing and sandpapering. Simul-

taneously, the bearings, seals, fittings, springs, etc. are replaced.
The vehicle is reassembled to get its final coat of paint which after drying is polished.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1.0	Sandblasting section:	1
1.1	Compressor	1
1.2	Filter	1
1.3	Sandblasting machine	1
1.4	Sand-storage vessel	1
1.5	Stone mill	1
2.0	Painting section:	1
2.1	Filter	1
2.2	Paint mixer	1
2.3	Vibrating grinder	7
2.4	Spray gun	3
2.5	Spraying device	1
3.0	Automobile body building section:	1
3.1	Compressor	1
3.2	Crane (sliding)	2
3.3	Lifting platform	3
3.4	Shearing machine	1
3.5	Portable drilling machine	5
3.6	Pillar drilling machine	2
3.7	Multi-purpose punching machine	1
3.8	Floor stand grinder	2
3.9	CO_2 welding set	2
3.10	Welding (steel)	2
3.11	Welding set (aluminium)	1
3.12	Spot-welding device	1
3.13	Wick-welding device	1
3.14	Electric welding set	1
3.15	Plastic welding set	1
3.16	Rollers	1
3.17	Edging machine	1
3.18	Milling machine	1
3.19	Clamping device	5 sets
3.20	Assembly tool	6 sets
3.21	Hydraulic press	1
3.22	Hoisting equipment	1
3.23	Measuring apparatus	2
3.24	Steam-jet cleaning apparatus	1
3.25	Tyre repair kit	1
3.26	Eugene test bench	1
	FOB-price for machinery and equipment approx.	US$ 2,000,000

Required Buildings and Areas

Administration and social building	100 sq.m
Main workshop	400 sq.m
Sandblasting hall	80 sq.m
Painting	100 sq.m
Store	50 sq.m

Required Manpower

Administration	3
Engineers	3
Skilled workers	8
Unskilled workers	16
	30

Required Power and Utilities

Electric power	approx. 250 kWh
Water	approx. 100 cu.m/month

Required Raw Materials

The raw material requirement depends on the kind of bodies truck or passenger car and their damages.

Glass fibre
Resin
Polyurethane foam
Sheet steel st. 37–52
Sectional steel st. 37–52
Plywood
Paint
Welding rods
CO_2 welding gas
Aluminium sheets

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U

File: U 2
ISIC CODE 1110

How To Start Manufacturing Industries

Egg Production

Introduction

Considering the specific value of the various components that make up the human food chain, the egg must certainly be credited with being one of the most important and versatile foodstuffs in itself. Hardly any other product of nature comprises as many nutrients, trace elements and vitamins.

The chicken egg contains 25 different nutrients and trace elements and 14 vitamins essential to the functions of life, and it is a major staple food all over the world.

But even so, the consumer's supply with eggs is far from being fully secured everywhere. Therefore this supply with wholesome eggs in sufficient quantities at affordable prices ranks as one of the top priorities with many authorities.

The basis for the production of full-value fresh eggs must be seen in production systems which guarantee that all the technical, climatic, production environment and feed-specific requirements are met.

In the floor regimes customary in previous egg production the maximum stocking density achievable was approximately five hens per square metre. Today's systems offer the producers to keep as many as 15 hens per square metre.

Moreover, the poultry management systems of the past did not meet hygienic and economic requirements. Feed consumption was extremely high and the average performance level of approx. 130 eggs per hen and year was only half the result that modern intensive egg farms routinely achieve.

The table egg production project described on the following pages, is designed for an annual output of 7,500,000 eggs.

Description

For the efficient production of table eggs, there are several factors of major importance apart from the obvious questions which layer strain is to be housed: the right combination of feed and lighting; the creation of optimum environmental conditions inside the layer house; cage size and stocking density. Of equally decisive importance are veterinary servicing as well as good caretaking and poultry husbandry exercised by the personnel.

Because birds' requirements of the above requirements vary from the day of hatch to the end of the production period the systems available for the cage regime are designed to incorporate these varying requirements.

House temperature, lighting intensity and duration and feed-ration composition are the foremost factors which must be adapted to the age of the birds and their respective phase of production.

Since chicks' requirements are quite different from those of mature hens, they are housed in specifically equipped rearing or growing cages where they remain until about 20 weeks of age. This is when maturity sets in and the birds begin to lay.

With the onset of egg production, the pullets are moved to the layer farm where laying cages specifically geared to egg production requirements are installed.

Prior to the arrival of a new batch of pullets, the layer house first undergoes complete disinfection and is conditioned to the right temperature and bird environment. Feed bins or silos are loaded with specific feed.

A variable lighting and feeding programme lets the birds eat feed four or five times a day.

Manure is dropped on a coated manure belt where it is dried under the influence of preheated fresh air.

The slight incline of the cage bottoms allows for a smooth rolldown of the eggs onto the collection belt. An egg cross collection belt transports them once every day to a separate egg collection and processing room located in the cool house.

Once every week the predried manure is automatically removed from the cage batteries and conveyed to an outside location for interim storage. Here, the manure is allowed to dry out completely to dry matter ratings of 90% and it can then be sold, bagged or in bulk, as the market requires, or it may be used as a farm-produced fertilizer in the farm's own operations. In any case what results is a completely odourless substance which offers ample chance of marketing a profitable byproduct.

Under normal conditions, a rate of lay of 244 eggs per hen and year can be expected on the average.

At the end of the first laying period criteria of egg production economy must dictate whether the birds are force-moulted and brought into a second period of lay or whether they are sold as spent hens, making room for a completely new batch of replacement pullets.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1.	Pullet growing cages set, day-to-lay type, complete with feeding, watering and disinfection equipment	1
2.	Set Laying cages for mature birds, complete with feeding and drinking water supply system	1
3.	Manure drying system	1
4.	Manure conveying system	1
5.	Egg collection system	1
6.	Egg grading and packing equipment	1
7.	Feed storage silo	1
8.	Feed conveyor from bins to cages	1
9.	Ventilation system	1
10.	Air cooling equipment	1
11.	Artificial heating for growing day-old chickens	1
	FOB-price for machinery and equipment approx.	US$ 400,000.00

Required Manpower

Farm manager	1
Secretary	1
Foreman	1
Farmworkers	3
Helpers	2
	8

Required Area

Production area	1,800 sq.m
Facilities	200 sq.m
Feed storage silos capacity	24 t
Outside manure storage	1,000 sq.m

Required Power and Utilities

1.	Electrical power AC 380 V, 50 c/s, 3-phases	200 kW
2.	Fuel oil	
3.	Water	0,25 l/bird/day
4.	Fresh air	10 cu.m./bird/hour
5.	Disinfectants	50 l/laying period
6.	Drugs, pharmaceuticals vaccines for New-Castle, Marek's Disease, other endemic diseases	

Required Raw Materials

1. Chick starter & pullet growing rations
2. Layer feed
3. Poultry stock
4. Drinking water

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File: U 3
ISIC CODE 1302

How To Start Manufacturing Industries

Fish Breeding and Farm Operation

Introduction

Fish contains a ligh level of proteins, minerals and vitamins and as such is an ideal contribution to the balanced diet of man.

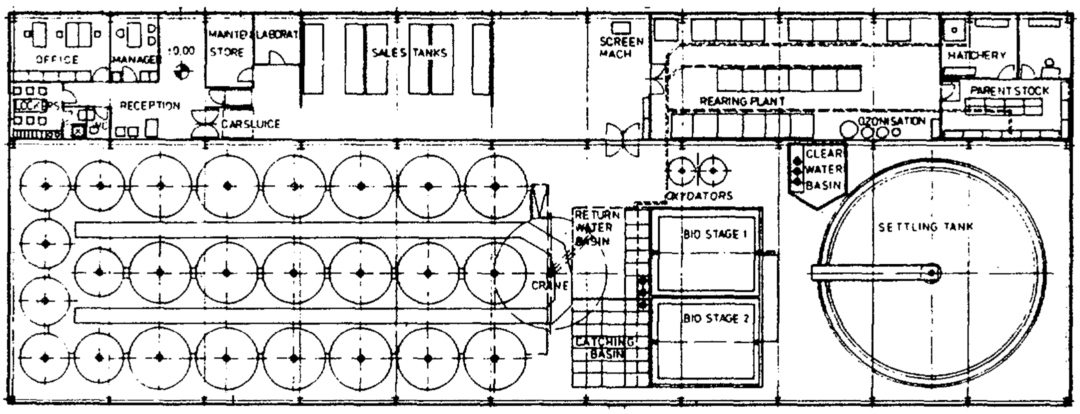
Considering the worldwide tendency to deplete the oceans resources the planned and controlled fish breeding and farm operation can constitute a significant factor in the economy of a country.

Such a fish farm can be operated in two ways – either with fry or with spawn. The main conditions are a constant water quality, temperature and oxygen content, ozonization and a permanent and careful supervision.

The closed system of this 200 t/a fish farm contains all the stages that are required for breeding – from the parent stock and hatchery to the rearing plant, fish fattening tanks and the sales tanks.

Conventional fish producing normally requires huge quantities of water and water of very good quality, too. When, however, the fish are kept in closed circuit, they are protected from diseases, predators and bad climatic conditions, and as a result of a special treatment the same water which has flown through the fish basins can be re-used. This system offers the possibility to build the farm wherever it is desirable.

Plant Layout



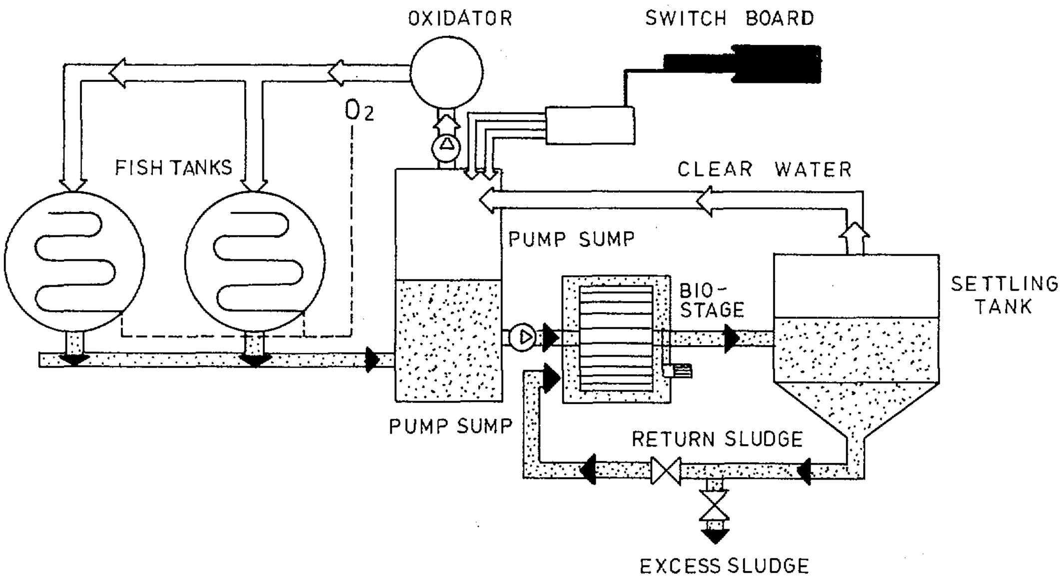
Plant Description of Water Recycling Circuit

The water that has been polluted by fish is drained from the fish fattening tank (1) by bottom screens and collected in an open gutter or duct.

By the flow of water the excreta and eventual remains of food are carried from the tank to the 'return water basin' (2). From there the water is pumped to the bio-stage (3) where it is treated biologically by contact aerators and then continues its flow to the sedimentation tank (4) where the solids settle. To maintain the biological reaction, it is necessary to lead a certain portion of the sludge from the sedimentation tank (4) back to the bio-stage (3). The surplus sludge will be removed as return sludge by the sludge recycling pump (5).

The cleaned effluent coming from the sedimentation tank (4) overflows into the 'clear water basin' (6) from where it is pumped through the oxidation equipment (7) which again increases the oxygen content to the required level, before the water is returned to the fish tanks (1). The high fish density makes it necessary that the water in the fish tanks be exchanged about once every hour.

Process Flow Diagram



Example of the Plant

Basic Design Data

1.	Total annual production (based on tilaphia)	approx. 200 t
2.	Average selling weight	310 g
3.	Fattening time	230 days
4.	Volume of the fish fattening tanks	555 cu.m
5.	Max. fish contents per tank	2.3 t
6.	Average fish density	63 kg/cu.m
7.	Optimum water temperature	26–30 °C
8.	Feed consumption per kg of fish	1.8–2 kg
9.	Total annual feed consumption	360–400 t

Required Elements and Equipment

		Pieces
1.	Parent stock	1
2.	Hatchery	1
3.	Rearing plant	1
4.	Fish fattening tanks	18+7
5.	Catching basin	1
6.	Sales tanks	6
7.	Return water basin	1
8.	Bio-stage	2
9.	Sedimentation tank	1
10.	Sludge pumps	2
11.	Water pumps	6
12.	Clear water basin	1
13.	Oxidation equipment	1
14.	Ozonization	1

FOB-price per plant: approx. US$ 1,500,000.00

Required Manpower

Commercial manager	1
Technical manager	1
Secretary	1
Foreman	1
Helper	2
	6

Required Building Area

Production area	1,482 sq.m
Office and laboratory	102 sq.m

Required Power and Utilities

Electrical power	90 kW
Fresh water comsumption per day	50–60 cu.m

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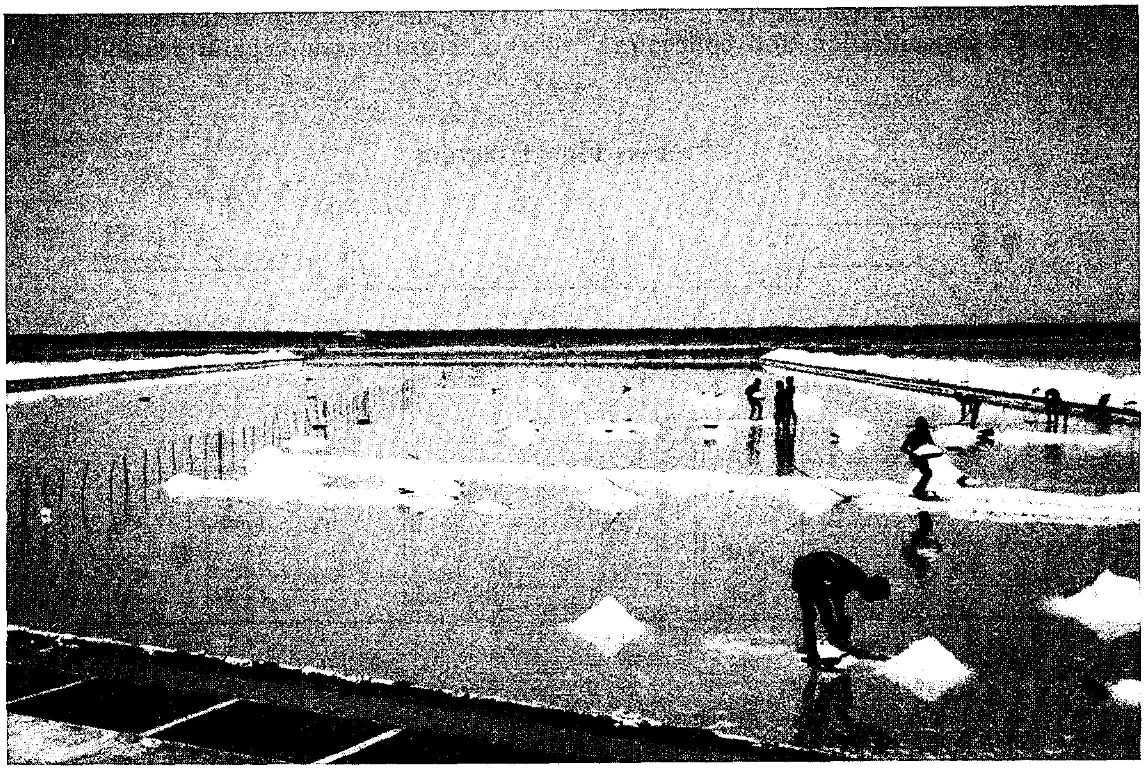
V

W

File: W 1
ISIC CODE 2903

How To Start Manufacturing Industries

Salt Production Plant

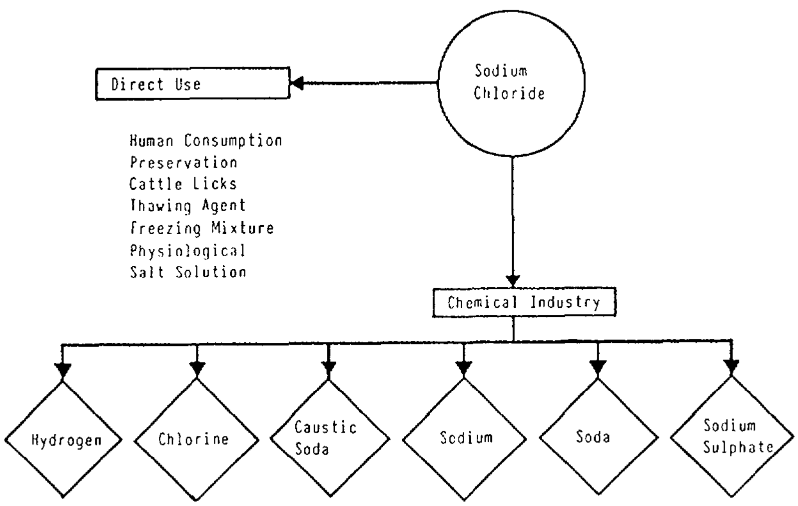


Introduction

Salt has always been indispensable for human and animal consumption, gradually developing into one of the most important raw materials of the inorganic-chemical industry. Nowadays the figures of salt consumption can be used as an indicator for the extent of a country's industrialization.

Sodium chloride is a raw material available from nearly unlimited resources – as rocksalt, as brine and in seawater. For quantity, the oceans are the most important sources.

It is a classical method to use seawater for the extraction of salt by solar evaporation, which has in stages led to the development of the highly technicalized industry we have in our time.



Plant Description of Solar Evaporation

By solar evaporation seawater is concentrated in a pond system. These ponds are designed according to the various stages of brine concentration: ponds for pre-concentration, concentration, gypsum and crystallization.

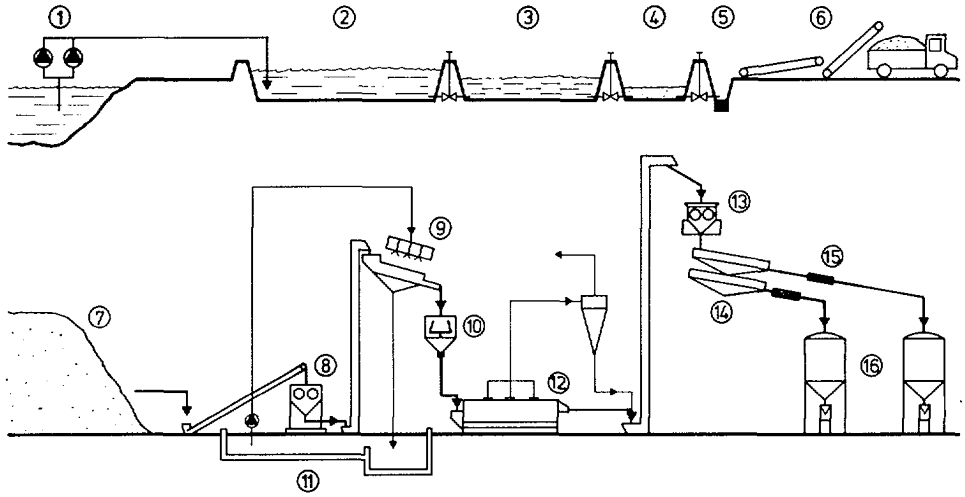
The first link in this chain is the seawater intake, a pumping station. From there the seawater flows to the pre-concentration and concentration ponds. The pre-concentration ponds also serve as reservoirs.

Leaving the concentration ponds the brine is conveyed to the gypsum ponds where the gypsum that was diluted in the seawater, will precipitate.

The thus saturated brine then enters the next stage, the so called crystallization ponds where the sodium chloride crystallizes.

After the discharge of the mother liquor and its bitterns the sodium chloride can be harvested.

Process Flow Diagram



1 Pumping station – seawater intake
2 Pre- and concentration ponds
3 Gypsum ponds
4 Crystallization ponds
5 Bittern discharge
6 Coarse salt transport system
7 Central coarse salt stackyard
8 Crushing mill
9 Washing screen
10 Centrifuge
11 Washing brine basin
12 Drying unit
13 Final product mill
14 Sieve
15 Dosing system
16 Product silos and packaging units

Locational Conditions

The ideal place for a solar salt plant is a flat coastal region with impermeable clay soil that is practically worthless for agriculture. The meteorological conditions require that there is little rainfall, or rather, that in the dry season the evaporation rate must be positive, and a hot dry wind should be blowing all the year round.

A favourable infrastructure – such as roads, railway connection or harbour facilities – would be another asset.

The harvest can be done both manually and mechanically. The mechanical salt harvest is not economical unless done at large scale.

The harvested salt is kept at intermediate storage. As coarse salt it can be marketed with an average purity of 97% NaCl. Is it, however, to be used as raw material for the chemical industry, then it must undergo a further processing.

For energetic reasons, solar salt plants have to be planned in such a way that the energy demand is kept as low as possible. Hence, whenever the topographic situation permits it, the pond systems with canals, dikes and gates have to be thus arranged that by gravity alone the seawater will flow to the next pond.

Processing of Coarse Salt by a Salt Washing Plant

The processing of coarse salt is done in consecutive stages.

- In the first stage coarse salt is reduced in size by a crushing mill.
- In the washing stage with non-saturated brine the purity of the product is improved by dissolving the bitterns and eliminating gypsum crystals and foreign matter.

- To meet the market requirements the salt grains must be ground in an additional mill.
- In the next stage the salt slurry is centrifuged and then discharged to the drying unit.
- If required, iodine and anti-caking agent can be added.
- The grain fractions of the finished product are classified by sieves. The design of the packing section will follow the market requirements.

Required Machinery and Equipment

Solar Salt Plant
(Manual Salt Harvesting, Capacity 30,000 t/yr)

Item	*Description*	*Pieces*
1.1	Seawater intake pumps	2
1.2	Mobile pumps	2
1.3	Tractors	2
1.4	Trailers	4
1.5	Tools	1 lot
1.6	Piping	1 lot
1.7	Instrumentation	1 lot
1.8	Cars	2
1.9	Salt Harvesting Equipment	1

FOB-price for machinery and equipment approx. US$ 315,000.00

Salt Washing Plant Capacity 5 t/h

Item	*Description*	*Pieces*
2.1	Feed hopper	1
2.2	Vibrating dosing units	2
2.3	Bucket elevators	2
2.4	Crushing mill	1
2.5	Wet mill	1
2.6	Centrifugal pumps	2
2.7	Washing device	1
2.8	Static thickener	1
2.9	Centrifuge	1
2.10	Drying unit	1
2.11	Dosing pumps	2
2.12	Sieve machine	1
2.13	Silos	2
2.14	Packaging machines	2
2.15	Paping	1 lot
2.16	Instrumentation	1 lot

FOB-price for machinery and equipment approx. US$ 1.45 million

Required Manpower

Solar Salt Plant
(as an example a plant with a capacity of 30,000 t/yr at 140 harvest days)

	manual
Management	1
Production superintendent	1
Assistants superintendent	2
Quality control	2
Foremen	6
Workshop (mechanical)	9
Workshop (civil)	16
Drivers	9
Harvest helpers (seasonal)	250
Helpers	50
	346

Salt Washing Plant
(as an example a plant with a production of 5 t/h at three-shift operation)

Management	1
Production superintendent	1
Assistants superintendent	2
Administration and store	18
Quality control	3
Foremen	4
Operators	8
Helpers	18
Others	8

Required Area

1. Solar Salt Plant (Capacity: 30,000 t/y)	180 ha
2. Salt Washing Plant (Capacity: 5 t/h)	
Production building	270 sq.m
Packaging	180 sq.m
Finished products storage	2,400 sq.m
Workshops	300 sq.m
Office building	200 sq.m
Lab., canteen, changing room	180 sq.m
	3,530 sq.m

Required Power and Utilities

Salt Washing Plant
(per 1 t/h Salt Produced)

Electricity	50 kW Fuel
Fuel	10 kg/hour
Water	0.5 mm/hour

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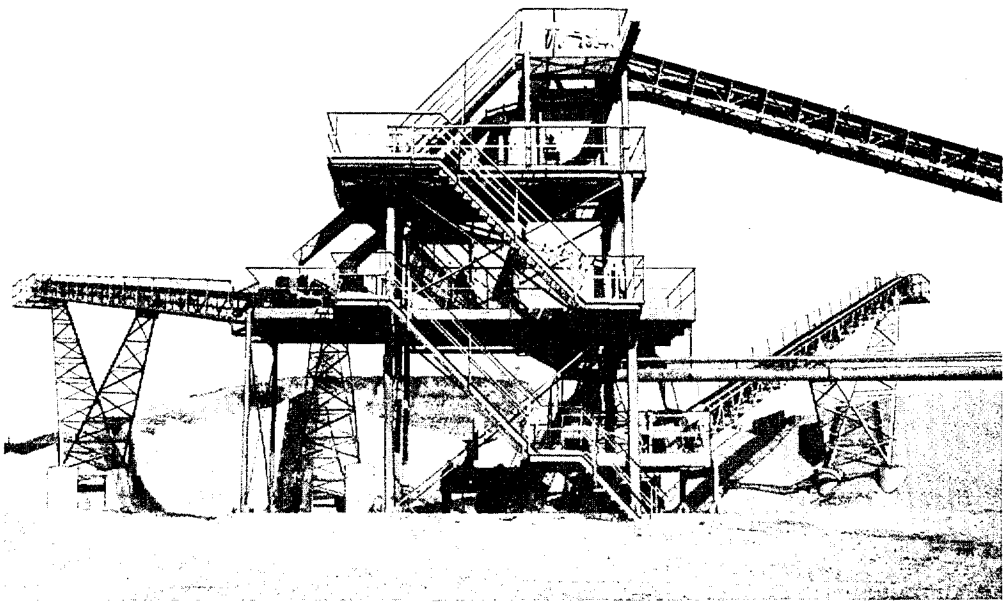
File: W 2
ISIC CODE 2901

How To Start Manufacturing Industries

Processing of Gravel and Sandworks



Introduction

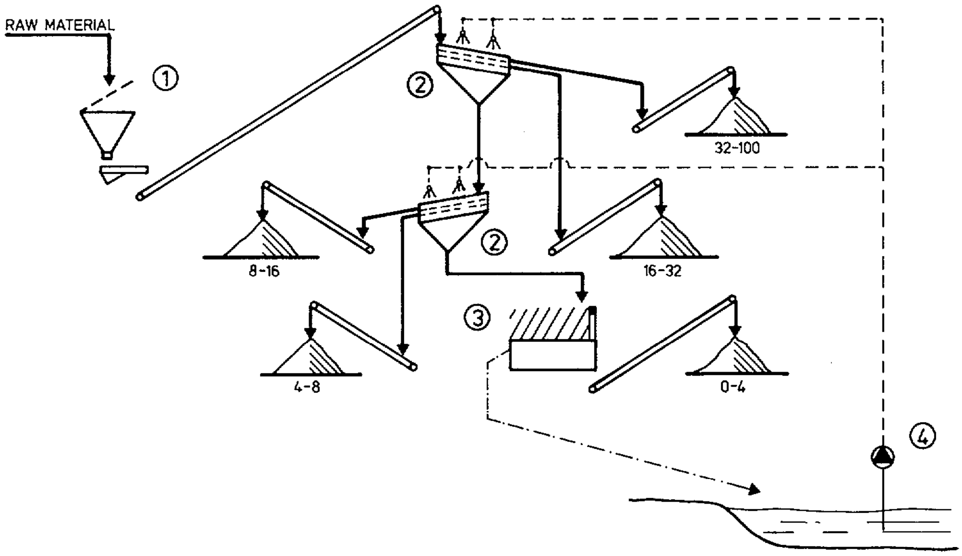
No matter what kind of building activity is planned, be it houses, factories, roads, bridges, silos or just walls – gravel and sandworks are needed everywhere.

In most cases desposits of raw gravel and sand contain impurities, and the extracted material must be processed to meet the quality requirements for building materials. Such impurities are mostly clay, loam, wood or coal. They can be removed by washing processes. It depends on the extent of pollution and the kind of pollution material, which process and which machine are to be applied.

The main steps in the processing of raw gravel are:

- the classification by means of screening, cyclone, horizontal and upward-current classifier, etc.
- sorting and washing by means of sand trap, bucket wheel, sand-drainage worm, upward-current classifier, washing tumbler
- crushing by means of jaw crusher, rotary crusher, beater mill, rod mill or swing-hammer crusher.

Process Flow Diagram:



1 Feed hopper with screen
2 Screening machines
3 Sand trap
4 Washwater pump

Description of the Production Process

The plant described here is laid out for a capacity of 80 cu.m/hour material from deposits containing impurities of medium solubility.

By means of a wheel loader the raw gravel is taken to a feed hopper with oversize screen, fed into a reciprocating-plate feeder and conveyed to the screening tower by an ascending conveyor. The screening tower consits of two double-deck screening machines which are arranged on top of each other and each equipped with a spraying unit. There the material is washed and classified into the fractions 0/4, 4/8, 8/16, 16/32 and 16/100.

The water together with the grains 0/4 flow to a sand trap where the sand is retained and drained. The water of the washing process which can be taken from any nearby lake or river, now contain the washed-out organic matter and can be put back to where it came from.

By means of chutes and conveying belts the finished products are conveyed to stockpiles for storage.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Wheel loaders	2
2	Feed hopper with screen	1
3	Reciprocating-plate feeder	1
4	Belt conveyor system	1
5	Screening machines	2
6	Spraying units	2
7	Steel construction	1
8	Sand trap	1
9	Stacking belts	5
10	Washwater pump	1
11	Piping	1
12	Generating unit	1
13	Switchboard	1
14	Wiring	1
	FOB-price for equipment and machinery approx.	US$ 345,000.00

Required Areas and Buildings

Administration	60 sq.m
Social building	60 sq.m
Production and storage area	2,100 sq.m

Required Manpower

Administration	2
Foreman	1
Skilled workers	2
Unskilled workers	2
Maintenance	1
	8

Required Power and Utilities

Electric Power	75 kW
Water	200 cu.m/h
Fuel	20 l/h

Outline of the Plant

Capacity of the plant	80 cu.m/h

Specific data of the deposit to be exploited must be available for the optimum design of the plant. Size of deposit, nature of grain, grade and kind of impurities as well as the requirements the finished product has to meet, must be known.

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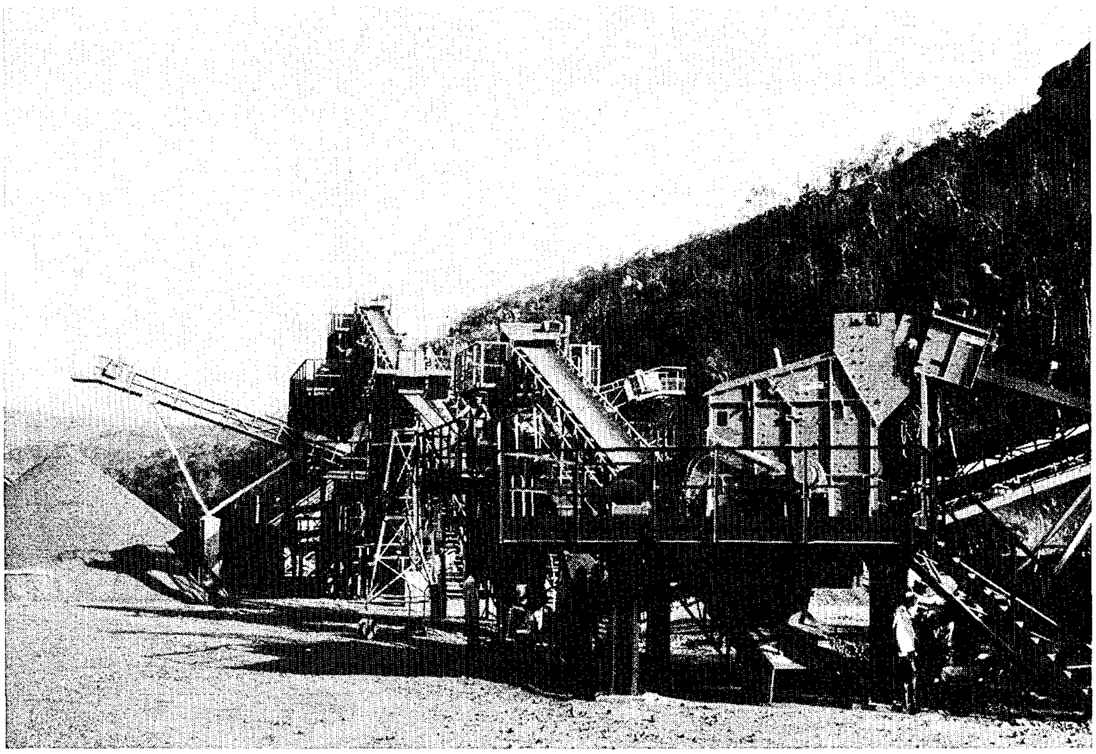
How To Start Manufacturing Industries

Quarries for Building Materials



Introduction

A decisive factor for the development of any country is the availability of building materials, such as cement, chippings, ballast, asphalt etc. Without these materials no housing project can be realized nor can the infrastructure be improved.

The first step for the production of building materials is the establishment and operation of quarries.

When looking for a suitable quarry, one should make sure that the raw material is available in good quality and sufficient quantity and that it can be extracted without major difficulties. Thickness and hardness of the overburden and the cost of its removal must be surveyed.

The extraction of the raw materials should be done in a safe and systematic manner. Soft raw materials can be extracted by means of chisels, wedges, crowbars, picks and shovels, or by compressed air hammers with or without a light blast depending on the specific conditions.

The harder variety, however, will require blasting. The type of blasting applied depends on the following points:

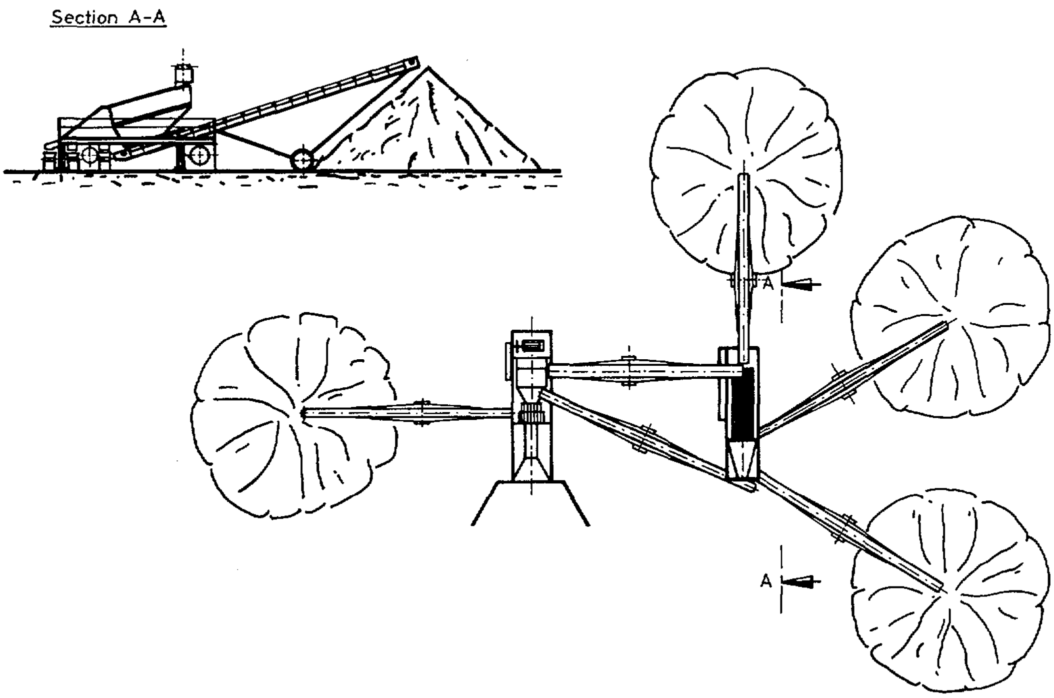
- the nature of the joints and fissures in the rock,
- size of material required,
- availability of explosives and their costs,

- availability of drilling equipment and the possibility of its operation which depends on the hardness of the material and the topography of the quarry,
- location and infrastructure.

The ideal location for a quarry is where the dip of the bedding is slightly sloping up into a hill and where the usable layers are thick and easily accessible.

A well-developed infrastructure – such as roads, communication systems, supply of water, electricity and fuels as well as the availability of the required skill levels – would be another asset for the implementation of a quarry.

Layout: Crushing and screening plant

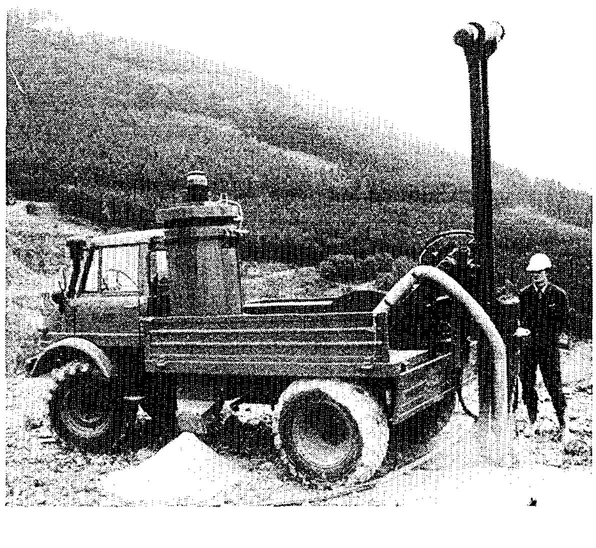


Description of the Process

The plant described here is laid out for the extraction and processing of granite with a plant capacity of 100 t/hr. The extraction of granite is achieved by blasting. This blasting itself is a very important part of the extraction requiring a trained specialist who is well versed in the handling of explosives, but also has a good judgment of geological strata.

Drilling Equipment:

The selected equipment is a mobile unit with the drilling equipment mounted on a light cross-country lorry with all-wheel drive. This system has the advantage that it can be moved together with the trailer compressor. Particularly when the material has to be blasted in several places, the mobile unit will prove highly efficient.



Mobile drilling equipment

Crushing and Separation Plant

After blasting, the raw material is loaded onto dump-trucks and transported to the feeding unit of a crushing and separation plant. From there the rocks are transported by means of a push-feeder to a Grizzly screen to remove waste material from the further process. Therefore only stones with a constant quality will reach the primary crusher. By using a belt conveyor the crushed material is transferred to a scalping screen for separation of non-cubical material. Oversize material will be conveyed to the secondary crusher – either directly or via an open stockpile – and crushed a second time.

After this second crushing process the material (grain size 0–50 mm) is conveyed to a stockpile. From this stockpile a screening unit for classification into the required fractions is fed. After separation the final products are stored on open stockpiles.

Example of the Plant

Required Equipment and Machinery

Item	*Description*	*Pieces*
1	Drilling and blasting equipment	1
2	Loaders, capacity 3 cu.m	2
3	Dump trucks, capacity 35 tons	2
4	Feeding unit with grizzly	1
5	Double toggle jaw crusher	1
6	3′ cone crusher	1
7	Four-deck screen	1
8	Conveying system	1
	FOB-price for equipment and machinery approx.	US$ 1,950,000.00

Required Buildings and Areas

Administration and facilities	120 sq.m
Crushing and separation plant including stockpiles	5,600 sq.m
Quarry	quantity of the deposits

Required Manpower

Administration and Management	3
Engineer	1
Blaster	1
Skilled workers	4
Trained workers	4
Drivers	4
	17

Required Power and Utilities

Electricity	175 kW
Fuel oil	60 l/ht

Design Data

Raw material	granite
Capacity of the plant	100 t/hr

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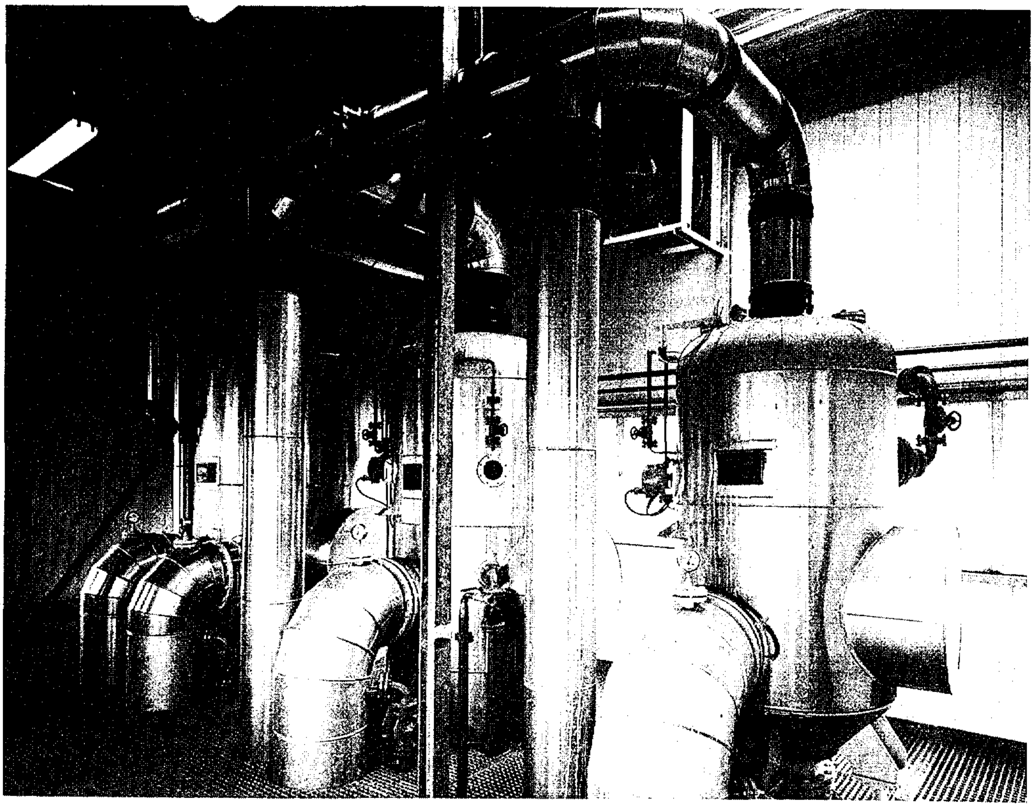
File: W 4
ISIC CODE 2903

How To Start Manufacturing Industries

Salt Refining Plant



Introduction

Sodium chloride NaCl, generally known as 'common salt' or as 'salt' for short, has had a long history as a seasoning, preserving agent and base material for a great variety of products. The compound occurs abundantly in nature, both solid in minerals or in solution. Seawater containing 3% NaCl serves as a major source for 30% of the world salt production.

Usually there are three grades of salt on the market:

- common salt
- industrial salt
- commercial salt.

Common salt: is produced in several grain sizes. As table salt it usually has an average grain size of 0.4 to 0.5 mm. The NaCl content of this grade of salt of approx. 99.5%. In order to prevent caking, several tenths of a percent of magnesium carbonate or calcium carbonate, or sometimes up to 20 ppm of potassium ferrocyanide are added.

Industrial salt requires compliance with more stringent requirements than common salt where purity is concerned. It is used in the chemical industry, e. g. as raw material for the production of caustic soda, chlorine, sodium hydrogen or sodium sulphate.

Commercial salt is a coarse-grained product having a NaCl-content of approx. 97% NaCl. The main impurities are gypsum and the so-called bittern-salts.

The described refining plant is designed for the production of 5 t/h common salt. As a raw material coarse salt will be used.

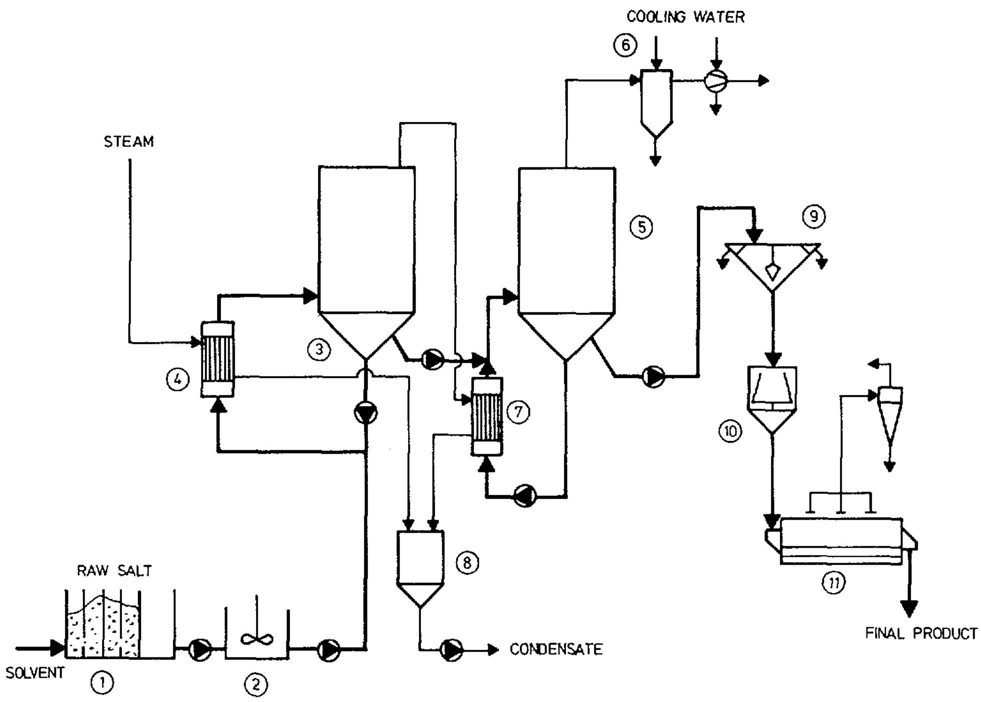
Description of the Production Process

Raw salt is dissolved in a solvent water or seawater that flows through the dissolving basin containing the raw salt. This basin is provided with a water-supply inlet at one end and with an overflow connection at the other end leading to the settling basin. As soon as the insoluble substances have settled, the brine via heat-exchangers is pumped to the concentration and crystallization section. The treatment in this section is the most important one in the whole refining process, since it will determine grain-size and purity and hence the quality of the product.

The crystals in the solution form in a low-pressure atmosphere while the water is evaporated. In other words: an oversaturated solution is prepared with the quantity of salt contained in it beyond the point of solubility, thus making the crystals fall out in lentil or spherical grains.

Mixed with motherliquor, the crystals are led to the two-stage separation section. At the first stage, the motherliquor content in the crystal slurry is reduced by gravity separation, at the second stage the mechanical separation is achieved by a centrifuge. Finally the salt is dried in a fluidized bed drier and discharged to storage silos and the packaging section.

Process Flow Diagram:



1 Dissolving and settling basin
2 Feed tank
3 Crystallizer
4 Heat exchanger
5 Crystallizer
6 Condenser
7 Heat exchange
8 Condensate collecting vessel
9 Gravity separator
10 Centrifuge
11 Fluidized bed drier

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1.	Raw material storage	1
2.	Brine preparation section	1
3	Crystallization section	1
4	Separation section	1
5	Drying section	1
6	Packaging and final product storage	1

FOB-price of machinery and equipment approx. US$ 10,000,000.00

Required Areas and Buildings

Administration	280 sq.m
Production and packaging	1,080 sq.m
Raw material storage	600 sq.m
Final product storage	1,080 sq.m

Required Manpower (3-shift operation)

Administration and management	8
Engineers	16
Operators	24
Skilled workers	32
Maintenance	16
Laboratory	4
	100

Required Power and Utilities

Electrical power	435 kW
Fuel oil	410 kg/h
Sweet water	10 cu.m/h
Sea water	30 cu.m/h

Required Raw Material

Raw salt	5 t/h

Outline of the Plant

Capacity of the plant	5 t/h refined salt
Operation of the plant	3-shift

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