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INDUSTRIAL DEVELOPMENT AND

CONSULTING BUREAU

DP/KUW/71/507

KUWAIT.

Technical report: study of a proposed soap factory

Prepared for the Government of Kuwait
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of Ahmed M. Aboushadi, expert
in soap making

United Nations Industrial Development Organization
Vienna, 1977

id. 77-798

Explanatory notes

References to dollars ($) are to United States dollars, unless otherwise stated.

The monetary unit in Kuwait is the dinar (KD), containing 1,000 fils. In this report, the expert used conversion rates in the range of KD 1.000 = $3.45-$3.50.

The following forms have been used in tables:

Three dots (...) indicates that data are not available or are not separately reported

A dash (-) indicates that the amount is nil or negligible

A blank indicates that the item is not applicable

Totals may not add precisely because of rounding.

Besides the common abbreviations, symbols and terms, the following have been used in this report:

hg	hectogram
kg/a	kilogram per year
t/a	tonne per year
TFA	total fatty acid content

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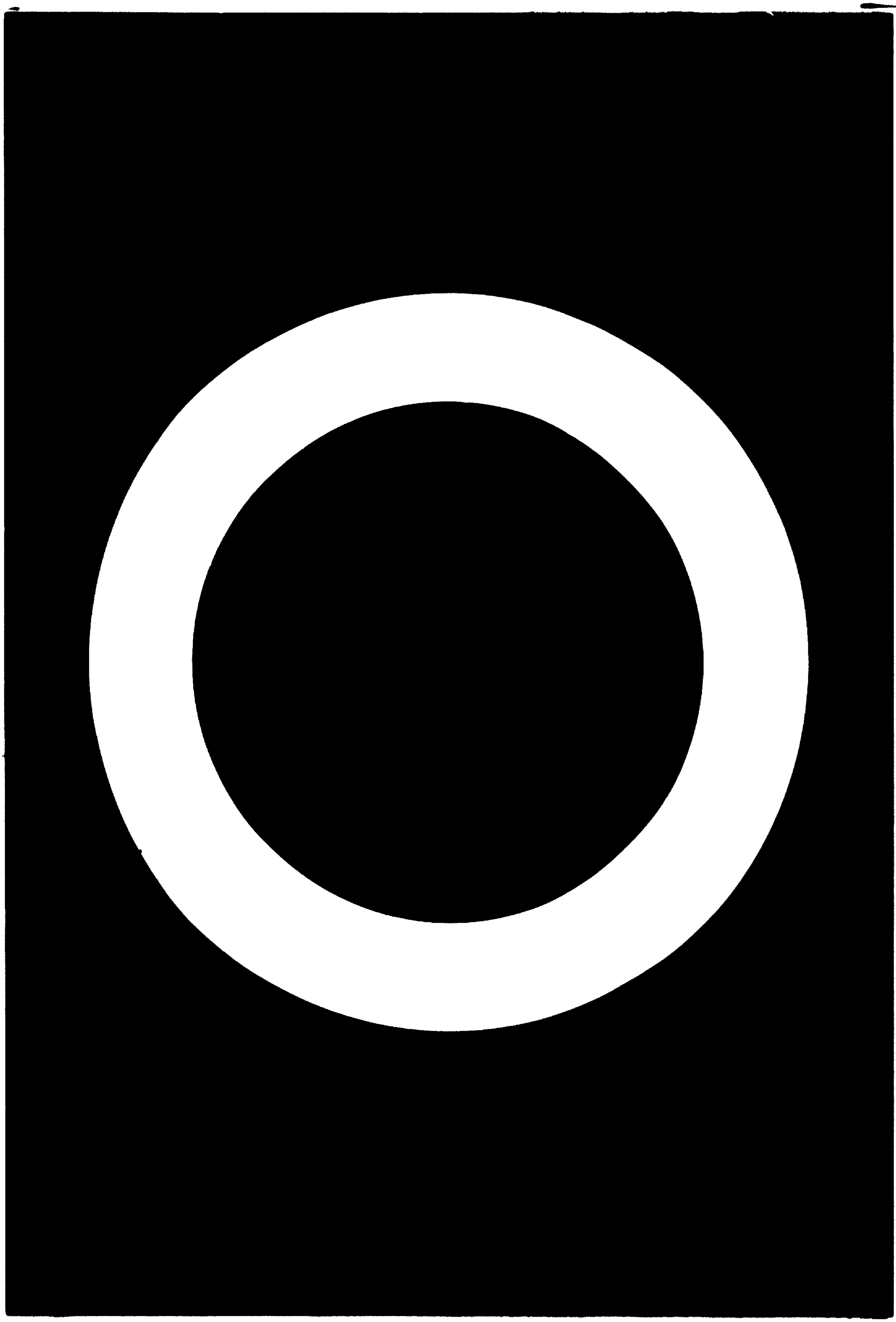
ABSTRACT

As part of the United Nations Development Programme (UNDP) Project KUW/71/507, "Industrial Development and Consulting Bureau", an expert in soapmaking was sent to Kuwait in late 1976 by the United Nations Industrial Development Organization (UNIDO), the executing agency for the project, to investigate the feasibility of soap production in Kuwait. The expert determined that the establishment of a factory producing 8 400 t/a of laundry soap bars, and 3 600 t/a of toilet soap bars, with 926 t/a 98% glycerine as a by-product, would meet projected demand and yield annual profits of close to KD 1.8 million over the cost of importing soap. A detailed description of the operation of the plant is given, as well as estimated requirements for land, buildings, equipment, raw materials and labour. The fixed and working capital required for the first 30 months is estimated to be KD 2.7 million.



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INTRODUCTION

Soap is not made in Kuwait and must be imported at considerable expense, even though the raw materials and other requirements for its production are readily available. A study of the feasibility of soap production in Kuwait was therefore one of the many tasks included in the United Nations Development Programme (UNDP) project DP/KUW/71/507, titled "Industrial Development and Consulting Bureau", which was started in 1973 to provide assistance to the Ministry of Commerce and Industry in elaborating its industrial development strategy.

An expert on soapmaking was sent to Kuwait by the United Nations Industrial Development Organization (UNIDO), the executing agency for the project, for the last three months of 1976. This is his report on the feasibility of establishing a soap factory in Kuwait. His verdict is that it is indeed feasible and he recommends the establishment of a factory large enough to provide complete independence from imports.

After a survey of the local soap market (chapter I), the situation with regard to imports and exports of raw materials and finished products, and the projected demand, the expert provides a complete description of the machinery, equipment, land, buildings and labour needed for the proposed soap factory (chapter II). Detailed data on the estimated requirements, costs and profits of the enterprise are collected in self-explanatory tables in the annex.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. Soap sold in the local market is not subject to any specifications or standards. As a result, there is a wide range of price and quality, with price being no guide to quality.

2. Much of the animal and vegetable fat suitable for soapmaking can be obtained locally. A promising vegetable-oil processing industry already exists in Kuwait.

3. The supply of alkalis necessary for soapmaking is no problem; there is an excess of locally produced sodium hydroxide, and sodium carbonate can easily be imported in the amounts needed.

4. Per capita imports of soap and other washing materials has doubled in the last decade; the per capita cost of these imports has tripled over the same period.

5. The estimated demand for washing materials for several years beginning with 1977 is 3 600 t/a for toilet soap and 8 444 t/a for laundry soap.

6. A soap factory with an output sufficient to meet the projected demand would require a land area of 10 000 m^2 and a work-force of approximately 70 persons (two-shift operation). The total fixed and working capital requirements for the first 30 months would be close to KD 2.7 million.

7. The annual profit over the cost of imported soap is calculated to be approximately KD 1.8 million; over the price of soap on the local market, KD 2.4 million.

Recommendations

1. Soap marketing should be made subject to international specifications and standards before a local soap industry is set up.

2. A new soap factory, sized to meet projected demand, should be set up in close connection with, and in the vicinity of, the new vegetable oil processing plant.

3. Although the estimated profits of the proposed plant range from 160% to 230% over the local market price, it is suggested that a profit of only 50% be taken to meet foreign competition.

4. The profit should be used as follows (percentage of total profit): amortization, 50%; raw materials, 30%; expansion, 20%.

I. STUDY OF THE MARKET

A. Types of soap available to consumers

Many different types of soap and other washing materials can be found in Kuwait shopping centres. Table 1 gives the types and prices at four of these centres.

Table 1. Soap prices in local shopping centres (fil/hg)

Type and package size	Shopping centre			
	Elshamy	Elkadsseya	Kifan	Fahd Essalem
Toilet				
Ordinary bar[a]	76-110	73-88	76-88	76-100
Flakes, 420 g	78	78	...	...
Baby				
74 g	...	...	161	...
135 g	...	...	141	...
Glycerine, 118 g	55	...	...	...
Carbolic, 155 g	42	...	...	...
Laundry bar				
Various sizes, 117-984 g	30-51	29-51	29-39	41

a/ Ordinary bars come in many sizes. The three most frequent sizes are approximately 200, 145 and 85 g, in order of increasing cost per hectogram.

Table 2 shows the chemical analysis of different soap types collected from the local market, and analysed by the General Research Laboratory of the Ministry of Public Works.

Table 2. Composition of soap samples (%)

Component	Laundry bar brands				Toilet bar, best selling brand
	A	B	C	D	
Moisture	10.4	40.0	7.77	10	5.99
Total fatty acid (TFA)	80.4	0.61	82.95	82.89	87.07
Acidity	0.70	0.34	0.56	2.82	7.9
Insolubles	0.29	7.57	0.57	1.73	0.21

The following conclusions may be drawn:

(a) There is a wide variation in the price for the same type of soap in different markets;

(b) There does not appear to be a standard specification for laundry soap; the soaps differ greatly in composition especially in fatty acid and moisture content. One brand tested contained over 7.5% insoluble matter. Price is no guide to quality;

(c) Among toilet bars, special types can be found in the market (baby, carbolic, disinfectant, deodorant). Some of these are priced much higher, others much lower, than the ordinary types;

(d) The medium sizes (85-100 g) of toilet bars are the most popular;

(e) A popular type of the laundry bar is the translucent type, which is made in Italy by a continuous, automatic process;

(f) The majority of the laundry bars have a high fatty acid content and a low moisture content because of long storage time;

(g) The weight and composition of the soaps are not checked locally.

B. Raw materials: imports and exports

Fats and oils

According to the annual bulletins of foreign trade statistics for the last three years, animal fats and vegetable oils are not manufactured locally to any great extent. The imports and exports for those years are shown in table 3.

Table 3. Imports and exports of animal fats and vegetable oils, 1973-1975

Year	Animal fats				Vegetable oils			
	Imports		Exports		Imports		Exports	
	Amount (t)	Value (thousand KD)	Amount (t)	Value (thousand KD)	Amount (t)	Value (thousand KD)	Amount (t)	Value (thousand KD)
1973	14.7	1.1	388.6	17.9	3 492	987	146.0	30.3
1974	121.2	19.4	426.7	30.7	4 315	1 709	99.3	36.5
1975	6.5	1.2	300.4	16.3	2 372	819	25.0	10.0

The large excess of exports over imports of animal fats means that the possibility of extracting such materials locally exists. An important source would be local and regional slaughterhouses. Most of the vegetable oils, on the other hand, are consumed locally.

On the basis of a visit to the modern factories of the National Flower Mill Co. for the extraction of vegetable oils and the manufacture of vegetable butter, the expert concludes that a promising oil industry using advanced technology has already begun in Kuwait. The products, however, have not yet entered the market. These are some of the observations made on the visit:

(a) The total capacity of extracted oil is 15 000 t/a;

(b) The estimated refining loss (acid oils) is 900 t; these materials could be treated for use in a soap industry;

(c) The new factory is already supplied by two steam boilers of more than 10 t each; that is more than adequate for a soap industry or supplementary oil industries;

(d) Fatty raw materials can be transferred to the factory directly from steamers at the nearby harbour;

(e) The factory is already equipped with sufficient power and water, quality-control and chemical research facilities;

(f) The factory is located near the soda and chlorine factories, facilitating the delivery of the sodium hydroxide and salt needed for soap making.

Alkalis

The data in table 4, obtained from annual bulletins of foreign trade statistics, show the imports and exports of sodium hydroxide and sodium carbonate, which are important chemicals for soap industry, in the last three years.

Table 4. Imports and exports of sodium hydroxide and sodium carbonate, 1973-1975

Year	Sodium hydroxide				Sodium carbonate			
	Imports		Exports		Imports		Exports	
	Amount (t)	Value (thousand KD)	Amount (t)	Value (thousand KD)	Amount (t)	Value (thousand KD)	Amount (t)	Value (thousand KD)
1973	112.5	4.9	2 398	106	226.2	13.5	35.8	3.1
1974	1.7	0.3	4 055	245	409.1	31.1	2.0	1.2
1975	195.1	26.8	28 303	3 034	193.0	19.1	69.0	6.7

From table 4, it is clear that the local production of sodium hydroxide is increasing. On a visit to the soda and chlorine factory, the expert learned that the local production of sodium hydroxide far exceeds local consumption; an excess of more than 6 000 t/a of active alkalinity are available for the proposed local soap industry, which will need not more than 4 000 t/a.

As far as sodium carbonate is concerned, the annual needs are quite low, and there will be no problem in importing the quantities needed, which will depend on the amount of fatty acids used.

C. Finished products: imports and exports

The annual imports and exports of soap and other washing materials in the years 1964 and 1973-1975 are shown in table 5.

Table 5. Imports and exports of soap and other washing materials, 1964-1975

Year	Soap				Other washing materials			
	Imports		Export		Imports		Exports	
	Amount (t)	Value (thousand KD)	Amount (t)	Value (thousand KD)	Amount (t)	Value (thousand KD)	Amount (t)	Value (thousand KD)
1964	743	161	37.0	5.1	1 717	333	53.3	6.4
1973	2 150	580	30.9	9.3	6 780	1 260	53.1	16.3
1974	1 704	666	47.6	17.5	6 495	1 541	31.8	7.8
1975	2 557	1 070	73.9	30.7	6 506	1 817	40.7	11.9

If exports are subtracted from imports, the figures in table 6 are obtained, which clearly show how much the consumption of these materials has increased in the last decade.

Table 6. Consumption of soap and other washing materials, 1964-1975

Year	Soap		Other washing materials	
	Amount (t)	Value (thousand KD)	Amount (t)	Value (thousand KD)
1964	706	156	1 663	326
1973	2 119	571	6 727	244
1974	1 656	649	6 463	1 533
1975	2 483	1 040	6 465	1 805

Table 7 shows the increase in the price paid for the imports of soap and other washing materials over the same period.

Table 7. Price paid for imported soap and other washing materials, 1964-1975
(KD/t)

Year	Soap	Other washing materials
1964	216.832	93.763
1973	269.866	185.862
1974	391.045	237.301
1975	418.686	279.275

Table 8 compares the total imports with the population in 1964 and 1975.

Table 8. Comparison of imports of washing materials with the population, 1964 and 1975

Year	Population (thousand)	Imports			
		Amount		Value	
		Total (t)	Per capita (kg)	Total (thousand KD)	Per capita (KD)
1964	448	2 459	5.49	494	1.102
1975	995	9 063	9.11	2 887	2.902

D. Projected demand

Usually, before setting up a soap factory, it is necessary to estimate first the annual capacity, which depends on the local consumption, and the export limits. Unfortunately, official statistics break down washing materials into only two categories; soap and other washing materials, and it proved impractical to obtain the figures for the consumption of toilet soap from those statistics. To obtain an estimate, information from local soap importers, the different marketing centres and international use figures for toilet soap were used. The estimate was 3 kg/a per capita, or since the population of Kuwait is approximately 1 million, 3 000 t/a total.

The estimate of the required annual production (in tonnes) of both toilet and household soaps was calculated as follows:

Toilet soap

Estimated annual local consumption	3 000
Additional estimate of annual development increase (20%)	600
Total	3 600

Household soap

Average annual import, 1973–1975	6 594
1964 import	1 717
Difference	4 878
Average annual rate of increase, 1964–1975	443
Estimated annual requirement, beginning of 1977	7 037
Additional estimate of annual development increase (20%)	1 407
Total	8 444

The proposed soap factory should therefore have a total capacity of 3 600 + 8 444 = 12 044 t/a to meet the demand projected for the beginning of 1977.

II. SOAP MANUFACTURING REQUIREMENTS

A. Machinery and equipment

Soap-making machinery and equipment should:

(a) Be capable of running in a fully automatic system, with a minimum number of skilled workers to tend it;

(b) Insure high quality and adequate quantity with negligible loss and at low cost;

(c) Be easy to operate and maintain with readily available spare parts.

The following plants and units make up the soap factory:

1. Oil and fat bleaching unit
2. Continuous saponification plant
3. Continuous neutralization unit
4. Continuous soap processing plant
5. Glycerine recovery unit
6. Steam boiler

Since these units must operate together to make a single, continuous production line, it is important, when selecting them, to make sure they are compatible.

The operation of the individual units will now be described.

1. Oil and fat bleaching unit

Machinery and equipment

The unit to be described has a capacity of 12 t per batch, which takes 6 h running time, giving a daily (24-h) capacity of 48 t. It consists of the following items of equipment (the numbers in parentheses are keyed to figure I):

Bleaching vessel, vertical, cylindrical shape; capacity 17 000 l (1)

Two filtration pumps (2)

Two filter presses, each 25 m^2 (3)

Receiver for the first filtration oil, capacity 2 000 l (4)

Filtered oil receiver, capacity 15 000 l (5)

Mixing vessel for preparing the suspension of bleaching earth in oil, capacity 800 l (6)

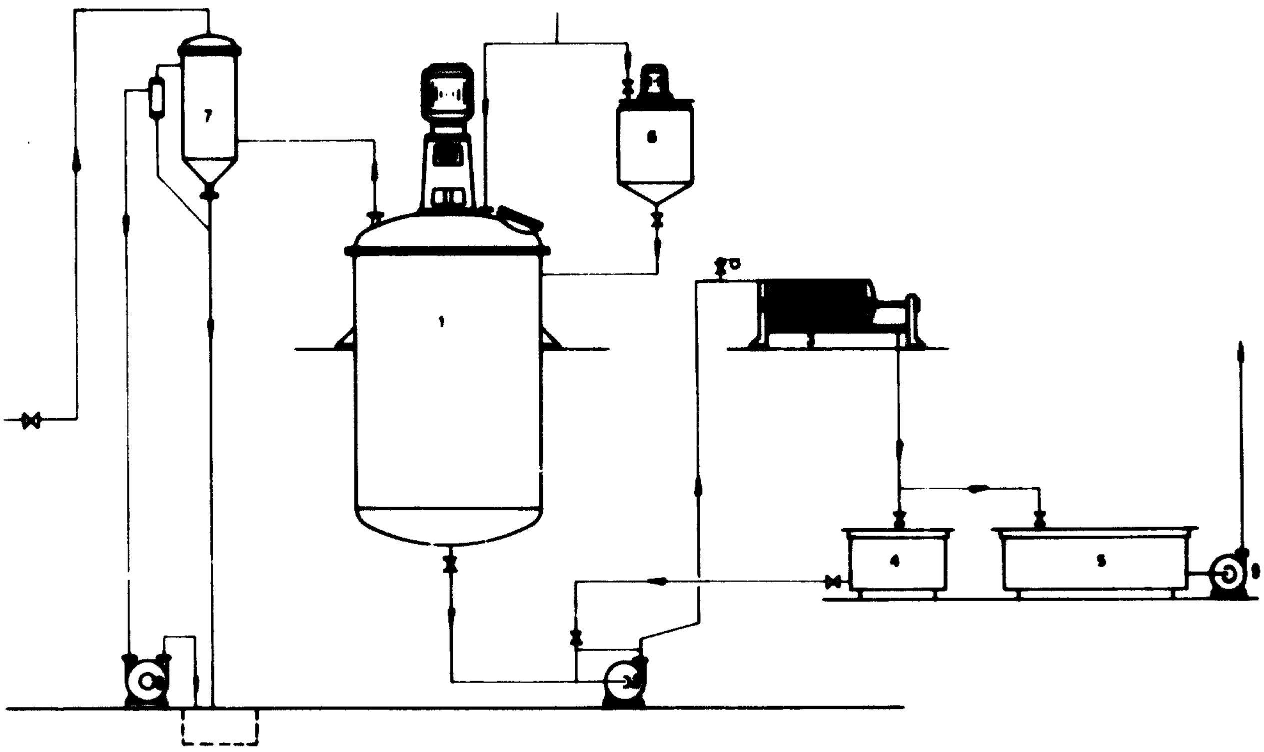
Barometric condenser for the bleaching vessel (7)

Vacuum pump, liquid-ring type (8)

Power-driven centrifugal pump for transfer of the bleached oil (9)

Set of valves, instruments and piping for interconnecting the items

Figure I. Flow diagram of an oil and fat bleaching unit



1 Bleaching vessel
2 Filtration pump
3 Filter-press
4 First filtration oil receiver
5 Filtered oil receiver
6 Mixer for bleaching earth
7 Barometric condenser
8 Vacuum pump
9 Transfer pump

Operation

The bleaching plant is arranged to dehydrate and bleach oils and fats in batches. A measured amount of oil is fed to the bleaching vessel (1) which is equipped with a mechanical stirrer so as to obtain a uniform dispersion of the bleaching earth throughout the oil, an indirect heater and cooling coils. (The bleaching-earth suspension fed to the bleaching vessel is prepared in the mixer (6) after vacuum dehydration of the oil.) After a suitable length of time, the mixture in the bleaching vessel is fed by pumps (2) to the filter presses (3). The first filtrate, which is quite thick, is discharged into a receiving tank (4) and then filtered again. The second filtrate is collected into another tank (5) and transferred to the next stage (9). The vacuum system consists of a water-ring pump (8) and a direct-contact barometric condenser (7).

2. Continuous saponification plant

Machinery and equipment

The main part of the plant consists of the following machinery (see figure II):

Three constant-temperature and constant-level feed tanks for caustic soda solution, fats, and water, each provided with steam coils, an automatic thermoregulator with electrical contacts, a level-regulating device, an alarm device etc., all made from American Iron and Steel Institute (AISI) type 304 stainless steel (SS 304) (1, 3, 4)

Constant-temperature and constant-level feed tank for sodium chloride solution, equipped with heating, regulators and control devices, all made of SS 316 (2)

Four sets of strainers for caustic soda solution, half-spent washing lye, fats and water, made of SS 316 drilled plates (6, 8, 9, 10)

Set of two strainers for sodium chloride solution, made of SS 316 (7)

Multiple-heat proportioning pump with variable-speed drive, adjustable while running, all contact parts made of SS 316 (21)

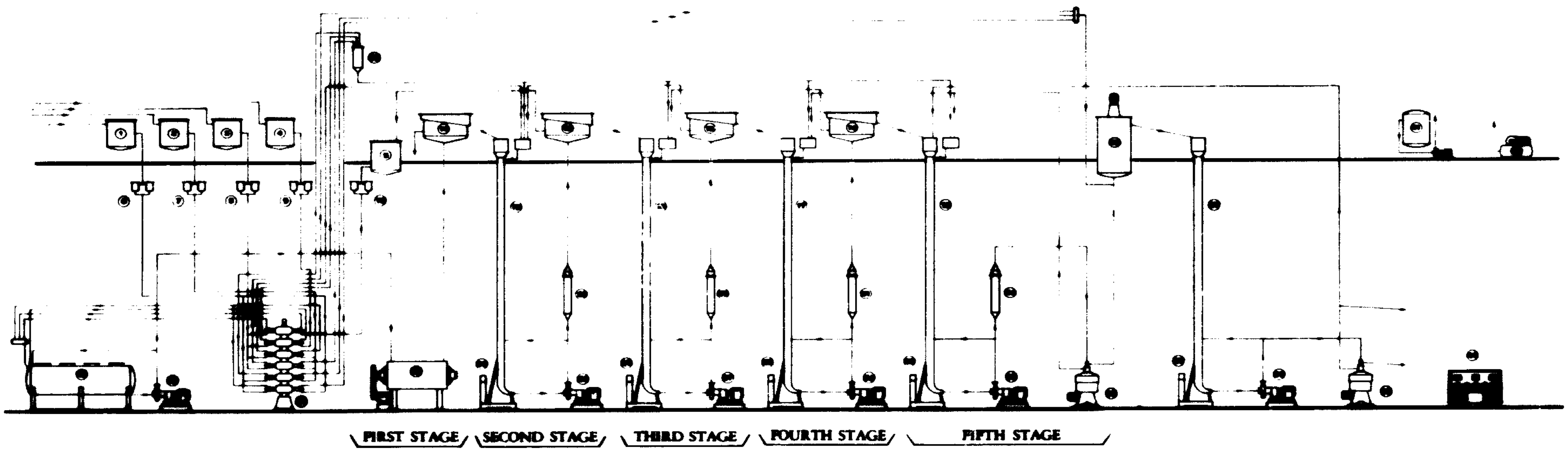
Four-stage saponification autoclave made of stainless steel with cooling and heating coils; pressure gauge with electrical contacts for adjustment of the working pressure; discharge, cleaning and inspection fittings; pressure regulators and recorders, easily removed for maintenance (19)

Special centrifugal recycling pump for the saponification autoclave made of SS 316, with a patented-profile impeller and a hydraulically cooled stuffing box (20)

Cooling mixer, made of stainless steel, with a water-cooling coil and an automatic thermoregulating system (22)

Four special centrifugal recycling pumps made of SS 316, with patented-profile impellers, hydraulically cooled packing glands, complete with baseplates, flexible couplings and enclosed fan-cooled electrical motors (24, 27, 30, 33)

Figure 11. Flow diagram of a continuous saponification plant



1 Water feed tank
2 Brine feed tank
3 Caustic feed tank
4 Fats feed tank
5 Washing lye feed tank
6 Water strainers
7 Brine strainers
8 Caustic strainers
9 Fats Strainers
10 Washing lye strainers
11 First-stage separator (static)
12 Second-stage separator (static)
13 Third-stage separator (static)
14 Fourth-stage separator (static)
15 Second-stage constant-level tank
16 Third-stage constant-level tank
17 Fourth-stage constant-level tank
18 Fifth-stage constant-level tank
19 Saponification autoclave
20 Autoclave recycling pump
21 Proportioning pump
22 Cooling mixer
23 Second-stage level controller
24 Second-stage recycling pump
25 Second-stage heat exchanger
26 Third-stage level controller
27 Third-stage recycling pump
28 Third-stage heat exchanger
29 Fourth-stage level controller
30 Fourth-stage recycling pump
31 Fourth-stage heat exchanger
32 Fifth stage level controller
33 Fifth-stage recycling pump
34 Fifth-stage heat exchanger
35 Fifth-stage separator (centrifugal)
36 Fitting mixer
37 Fitting-stage constant-level tank
38 Fitting-stage level controller
39 Fitting-stage recycling pump
40 Fitting-stage separator (centrifugal)
41 Hot-water generator
42 Air compressor
43 Washing lye homogenizer
44 Main control board

Four constant-level SS 304 tanks for washing lye circulating in the various stages of the plants, including covers and fittings (15-18)

Four air-operated level-controlling units for the tanks above, with SS 304, continuous-weighing units, pneumatic level regulators, automatic valves, triple-needle electric pressure gauges, terminal boxes and fittings (23, 26, 29, 32)

Four special static separators made of SS 304, with welded conical bottoms, flat covers, fitted heating coils, double jackets, sightglasses over low soap outlets, special variable-height discharges for lye and floater regulation systems (11-14)

Two centrifugal separators for final washing of lye from neat soap leaving the plant, all parts in contact with soap or lye made of SS 304 (35-40)

Four heat exchangers made of SS 304, with thermometers and electrical contacts, and automatic thermoregulators (25, 28, 31, 34)

Holding and feeding tank for half-spent washing lye, SS 304 (5)

Hot-water generator of welded steel, with automatic temperature controlling system (41)

Main control board, containing remote starters for all motors, aural and visual alarm devices, voltmeters, ammeters and warning lights (44)

Air compressor, for a pressure of 12 atm, complete with automatic pressure controllers, safety valve, automatic starter, storage tank, connected through V belts and pulleys to a totally enclosed fan-cooled electric motor mounted on rails (42)

Precision reduction valve, self-bleeding type, sensitive to 0.05 atm, for regulating the compressed air for pneumatic controls

Not mentioned above, but having similar specifications, are the mixer, constant-level tank, level controller and recycling pump for the fitting stage (36-39) and the washing-lye homogenizer (43)

Operation
(see figure II)

Raw materials handling and proportioning

The four basic raw materials, water, sodium chloride solution, caustic soda and fats are continuously fed from their main storage tanks to feed tanks (1), (2), (3) and (4). Each tank is provided with high-precision pneumatic temperature and level controllers and serves as a constant gravity feed tank for the multiple head proportioning pump (21), which is of the recriprocating, positive-displacement type. The pump is provided with a variable-speed drive, which permits frequent changes of the strokes of all the plungers simultaneously. The stroke (and thus the throughput) of each pump head, is individually adjustable, whether the unit is in operation or stationary.

Saponification

The saponification autoclave (19) is a specially designed four-stage reactor operating at 120°-130°C and 2 atm. In the autoclave, the reacting mass is recycled through the four stages by a pump (20). The material leaving the autoclave is 99.5% soap and 0.4% free caustic (as NaOH).

First washing

The cooling mixer (22), together with the first static separator (11) constitute the first washing stage of the plant. The cooling mixer serves two functions: it completes the saponification and prepares the two-phase separations of the soap-lye mixture. The free caustic present in the mixture coming from the autoclave is used up in this further saponification, leaving an almost neutral spent lye for glycerine recovery. The cooling reduces the solubility of the soap in the lye so that a good soap-lye separation can be achieved in the static separator.

Counter-current washing

The continuous saponification plant uses counter-current washing of the soap in five stages. Each washing stage consists of several elements, each having a definite function: a constant-level tank (15, 17, 18), to provide a constant head on the pump; a level-control unit (23, 26, 29, 32), to compensate for any variations in the flow of soap and washing lye; a recycling and washing pump (24, 27, 30, 33), to obtain maximum mixing and washing; a heat exchanger (25, 28, 31, 34), to maintain the optimum soap-lye separation temperature; a static (first four stages) or a centrifugal (fifth stage) separator (11, 12, 13, 14, 35), to separate the soap from the washing lye.

Soap circuit. The crude curd-soap leaving the first-stage separator (11), after separation of the spent neutral glycerine lye (which leaves the circuit at this point and is sent to the glycerine recovery plant), goes into a constant-level tank (15) for the second washing, the first having been accomplished in the cooling mixers (22). The washing lye separated from the third washing stage is also fed into a constant-level tank. This soap-lye mixture is recycled and washed by a pump (24) and passed through a heat exchanger (25) en route to the second-stage separator (12). The soap separates and proceeds in turn to the third, fourth and fifth washing stages.

In the fifth stage, washing takes place in a pump (33), with fresh lye coming directly from the portioning pump (21) through the washing-lye homogenizer (43) and the fifth-stage constant-level tank (18). After passing through the last heat exchanger (34), the mixture goes to the fifth-stage (centrifugal) separator (35) to obtain complete separation of the soap from the washing lye. The solid impurities remain in the bowl of the centrifuge, and the separated lye is sent back to the fourth washing stage. The soap, which has 62% TFA, goes directly to the finishing line, if a laundry soap is being made, or to the continuous fitting section, if a neat soap for toilet production is being made.

Lye circuit. The fresh washing lye going to the fifth-stage constant-level tank (18) contains water, caustic, and brine. This lye is prepared by three pump heads of the proportioning pump (21), which feeds the ingredients into the homogenizer (43) for mixing. The soap encountered by the fresh lye has been washed four times in the previous stages and is practically free from glycerine- and lye-soluble impurities. Thus, washing is complete, as the fresh lye can easily dissolve and remove even the smallest traces of soluble impurities originally contained in the crude soap leaving the autoclave.

The washing lye follows the soap circuit, but in the opposite direction. The mixture formed by the fifth-stage pump (33) is separated in the centrifugal separator (35). The lye goes back to the fourth-stage constant-level tank (17), washes the soap and is separated in the fourth-stage separator (14). Then the lye washes the soap in the third-stage pump (27) and is separated again in the third-stage separator (13). Another washing takes in the second-stage pump (24). This time, the proportioning pump adds a small quantity of caustic soda to the mixture in the second-stage constant-level tank (15) to complete the saponificatic of the last traces of fat present in the crude soap coming from the first-stage separator (11). Lye from the second-stage separator (12), which has washed the soap four times, goes into the washing-lye holding tank (5). This tank feeds, by gravity, one of the heads of the proportioning pump (21), which in turn feeds an in-line mixer with a quantity of washing lye exactly corresponding to the quantity of fresh lye being fed to the fifth-stage constant-level tank (18). In the mixer, this washing lye encounters the balance of the caustic soda for saponification and the balance of the brine for salting out the soap, both measured out by the proportioning pump. The final mixture forms the saponification lye.

The air compressor (42) provides constant-pressure compressed air for the various pneumatic controls. The main control board (44) contains all measuring instruments, switches, and safety controls; aural and visual alarms indicate any irregularities that may occur.

Fitting and nigre recycling

The soap leaving the fifth-stage separator (35) is fed to the fitting mixer (36). Fitting lye formed by suitably proportioned quantities of water, brine, and caustic is homogenized by an in-line mixer and is also fed to the fitting mixer. The fitted soap overflows from the mixer (36) into a constant-level tank (37), which with the fitting level controller (38) and recycling pump (39) forms an assembly similar to the washing stages already described. The homogenized fitted soap is fed to another centrifugal separator (40) for separating the neat soap from the nigre. The neat soap is sent for further processing, and the nigre goes to the fifth-stage constant-level tank (18). It is also possible to degrade a certain quantity of the nigre in order to improve the quality of the neat soap.

A fitting stage connected to a saponification section guarantees that there will be no losses, since the fitting lye contained in the nigre is recovered completely and is used to wash the soap in the previous stages. Therefore, any glycerine present in the soap leaving the fifth stage is recovered and sent back for recovery in the spent lye leaving the first-stage separator (11).

Advantages of the continuous saponification plant

The advantages of the plant described are these:

(a) A high degree of saponification is achieved, insuring no deterioration of the soap during storage;

(b) Impurities, such as those contained in used raw materials are efficiently removed;

(c) The proportioning system guarantees consistent quality;

(d) Only one operator is needed to control the plant;

(e) Glycerine is obtained at yields close to theoretical, since the saponification system runs in closed circuit; while

(f) The system of washing permits a 20-25% recovery of highly concentrated spent lye, 30% if coconut oil or palm-kernel oil is used;

(g) Operating costs are low; the savings pay for the cost of the plant in a very short time;

(h) There is no maintenance except for periodic lubrication of moving parts and replacement of worn stuffings and packings;

(i) Any soap stock can be used.

Table 9 summarizes the utility and labour requirements of the plant.

Table 9. Utility and labour requirements of a continuous saponification plant

(Per tonne of finished neat soap with 58-64% TFA)

Item	Requirement
Steam at 6 atm	150 kg
Cooling water at 18°C	1 500 l
Electrical energy	16 kWh
Labour	1 person

3. Continuous neutralization unit

A continuous neutralization unit is essential in the production of internationally acceptable grades of toilet soap. It is usually integrated with the continuous saponification plant.

Machinery and equipment

The unit described has a capacity of 3 t/h and consists of the following machinery and equipment (see figure III):

Feed tank for fatty acids or coconut oil, vertical, cylindrical shape, with heating coils and supports, made of SS 304 (1)

Two line strainers, drilled plate filtering baskets, made of SS 304 (2)

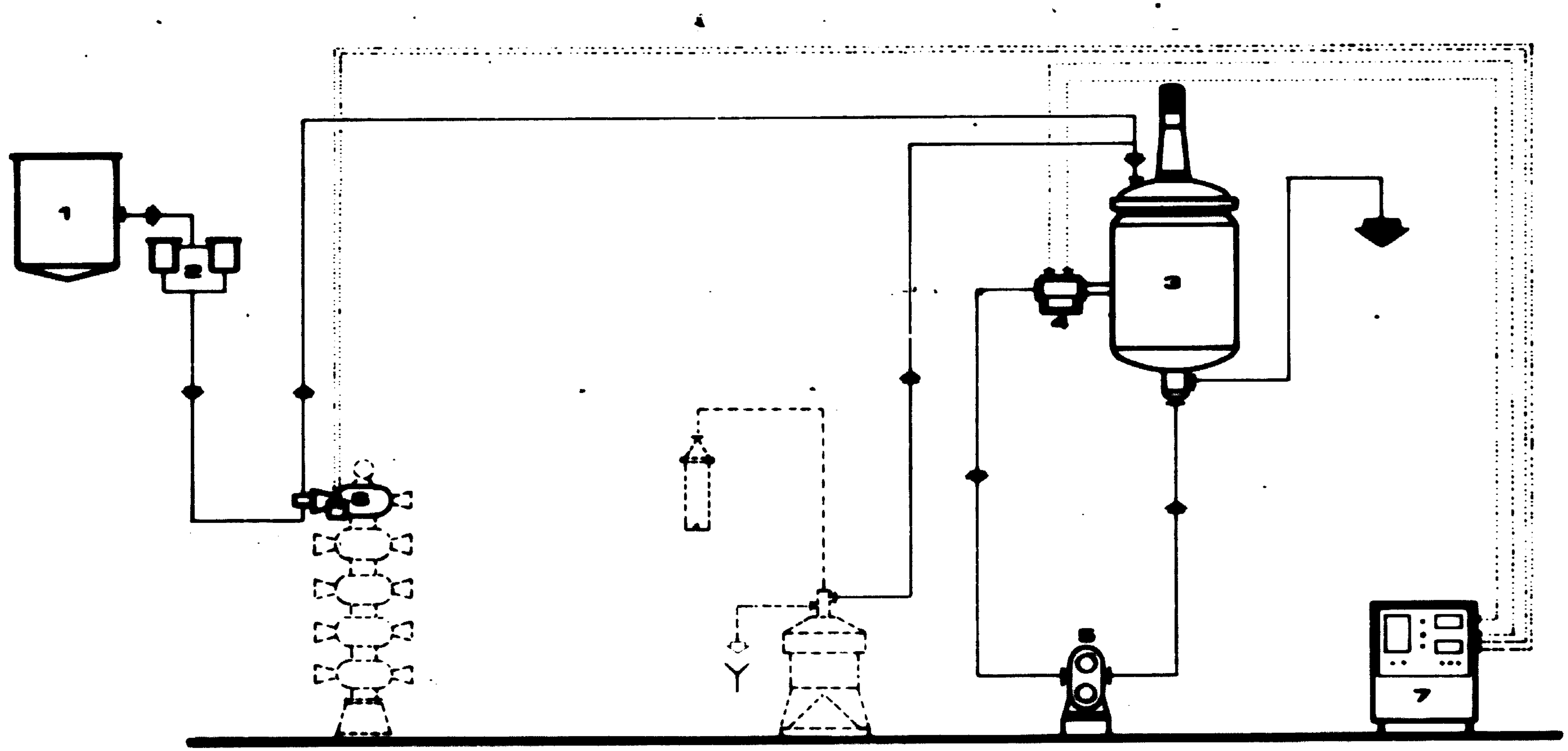
Closed-type continuous-flow mixer, with vertical screw rolling inside one barrel, directly coupled to the driving motor-reducer by a flexible coupling, made of SS 304, complete with hot-water heating jacket and overflow discharge tank made of SS 304 (3)

Flow chamber for control and adjustment of the free alkalinity in the soap (4)

Gear pump for recycling soap in the continuous mixer, all soap-contacting parts made of SS 316, with steam heating jacket, driven by a gear motor connected to the pump by pulleys and V belts (5)

Metering pump for dispensing the fatty acids (or coconut oil) needed for the neutralization of free akalinity, made of SS 316, with pneumatic device for the automatic adjustment of the stroke (installed on the proportioning pump of the continuous saponification plant) (6)

Figure III. Flow diagram of a continuous neutralization unit



1. Fatty acid feed tank
2. Strainers
3. Mixer
4. Flow chamber
5. Soap recycing pump
6. Metering pump
7. Control board

Control board for the automatic, electronic adjustment of the free alkali content of the soap, with shunt connection for the automatic regulation of the stroke of metering pump (6) (fitted to the main control board of the saponification plant) (7)

Three remote starter-breakers for the driving motors (fitted to the main control board of the saponification plant)

A mixing crutcher, not shown in the figure, is used for homogenizing and making additions to the liquid soap prior to drying. It consists of ordinary steel or stainless steel containers fitted with heating jackets. The mixing unit consists of a vertical screw made of ordinary steel or stainless steel running in a barrel of the same material. The screw is driven by an electric motor through V belts, a gear box and a flexible coupling.

Utility requirements

The utility requirements per tonne of soap at 62-63% TFA are as follows:

Steam at 6 atm	10 kg
Electrical energy	5 kWh

4. Continuous soap processing plant

The continuous soap processing plant consists of a cooling and drying unit followed by a laundry soap finishing line or a toilet soap finishing line.

Cooling and drying unit

The continuous cooling and drying plant has a capacity of 3 t/h of laundry soap bars weighing 250 g or more, or of 1.5 t/h of dried soap pellets or chips at 78-80% TFA for toilet soap manufacture.

Machinery and equipment

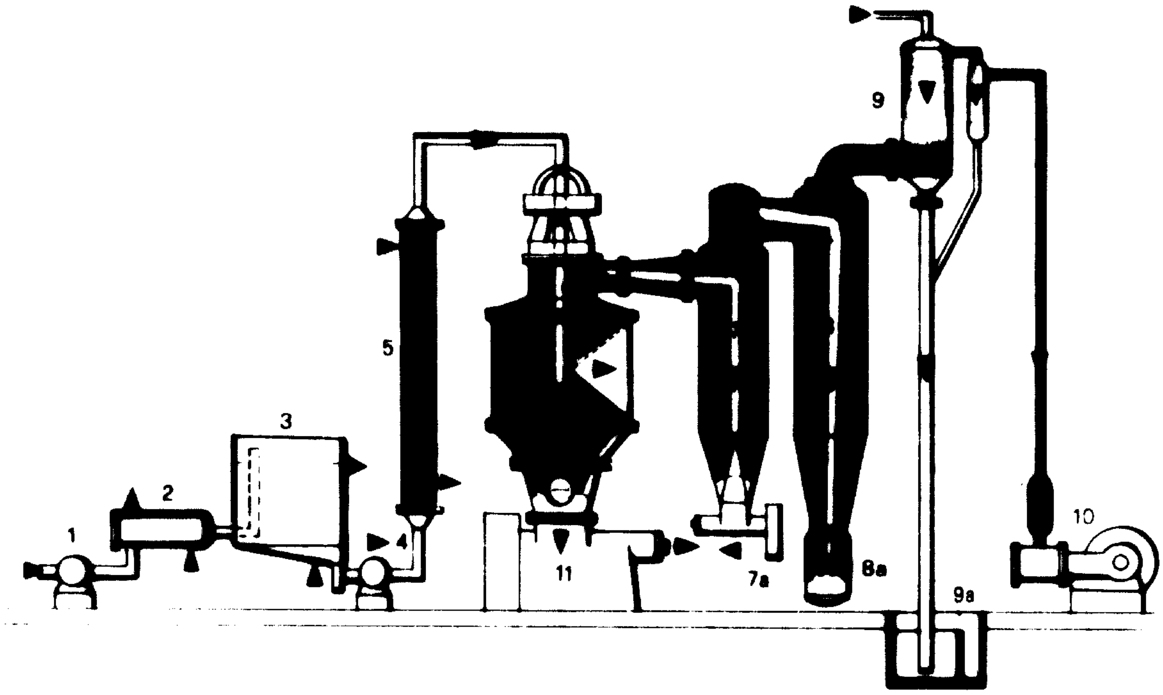
The cooling and drying unit consists of the following machinery and equipment (see figure IV):

Variable-speed filtration pump, complete with electric motor, speed reducer, flexible coupling, pulleys and V belts mounted on a common cast-iron baseplate (1)

Large capacity soap filter with all heating and gauge fittings (2)

Feed tank with steam heating jacket and various fittings (3)

Figure IV. Flow and pictorial diagrams of a cooling and drying unit



1. Filtration pump
2. Filter
3. Feed tank
4. Feed pump
5. Heat exchanger
6. Vacuum spray chamber
7. First fines separator

7a. Fines collector or extrusion plodder (latter shown)

8. Second fines separator

8a. Fines collector

9. Barometric condenser

9a. Barometric hot-well

10. Vacuum pump

11. Plodder

Variable speed feed pump with electrical motor, speed reducer, flexible coupling, pulleys and V belts (4)

Heat exchanger, of SS 316, for pre-heating liquid soap (5)

Vacuum spray chamber, with external mountings, driving motor, adjustable scrapers and knives made of special plastic material and inspection glasses (6)

First fines separator (7), centrifugal type, upper part connected to the spray chamber, lower portion of conical shape terminating in a fines extrusion on plodder (7a)

Second fines separator (8), centrifugal type, with fines collector (8a)

Barometric condenser (9), direct-contact type, complete with condensate trap (hot-well) (9a)

Vacuum pump, piston type, single stage, with electric motor, accessories and droplet separator; made of steel, with sightglass fittings (10)

Duplex vacuum plodder, fitted with bar extrusion nozzle with thermostatic control, to extrude two parallel soap bars; complete with fittings, electric motor, self-regulating devices and instruments controlling soap, water, steam and vacuum lines (11)

Operation

Liquid soap is filtered at the beginning by a filter (2) fed by a variable-speed drive pump (1). The filtered liquid soap is collected in a feed tank (3).

Another variable-speed drive pump (4) transfers the soap from the feed tank into a shell-and-tube heat exchanger (5). The soap passes inside the tubes and is heated counter-currently by steam, which passes outside of the tubes. The degree of pre-heating depends essentially on the steam pressure.

The pre-heated soap is injected into the vacuum spray chamber (6) through a revolving nozzle, which sprays a thin film of soap onto the internal walls of the chamber. The dry, cooled soap is removed by rotating scrapers and falls to the bottom of the chamber into a plodder (11).

The amount of water evaporated and the temperature of the soap depends on the amount of heat imparted to the soap in the heat exchanger and the degree of vacuum in the system. For example, to produce low-TFA laundry soap, pre-heating is not used. High-TFA toilet-soap base requires considerable pre-heating. The degree of vacuum affects both the amount of drying achieved and the final temperature of the product.

Fines are produced only when toilet-soap bases or dry industrial soaps are processed through the dryer. In these cases, the fines are recovered at the bottom of two centrifugal separators (7,8) connected in series. A collector or small extrusion plodder (7a) oolleots the fines ooming from the first separator (7). The fines reoovered in the second separator (8), amounting to only about one tenth of that reoovered in the first, is oolleoted in a barrel (8a). The small plodder (7a) oan be set to return the fines to the bottom conioal seotion of the spray ohamber (6) or to another oolleotor for disposal.

The vapours from the vacuum spray ohamber are almost free of soap fines. They are condensed in a barometric condenser (9) by water at a suitable temperature. A hot-well (9a) reoeives the condensed vapours.

Vacuum is maintained by either a piston pump (10) or a steam-jet system.

The soap scraped off the vacuum chamber walls is extruded by a plodder (11). Depending on the type of soap and the degree of refining required, the plodder is of the simplex, duplex or triplex type, i.e., it aotually consists of one, two or three plodders. The last plodder oan be fitted with a nose to produoe pellets (for toilet soap) or a heated extrusion cone to produoe a oontinuous soap bar (for laundry soap). The plodders have oompression worms with speoial profile, refining plates and screens, and cooling jackets.

The product from the plodder goes to either a laundry soap or a toilet soap finishing line.

Laundry soap finishing line

Machinery and equipment

The laundry soap finishing line is depioted in figure V as part of the complete plant, including the cooling and drying unit described above. It consist of the following additional equipment:

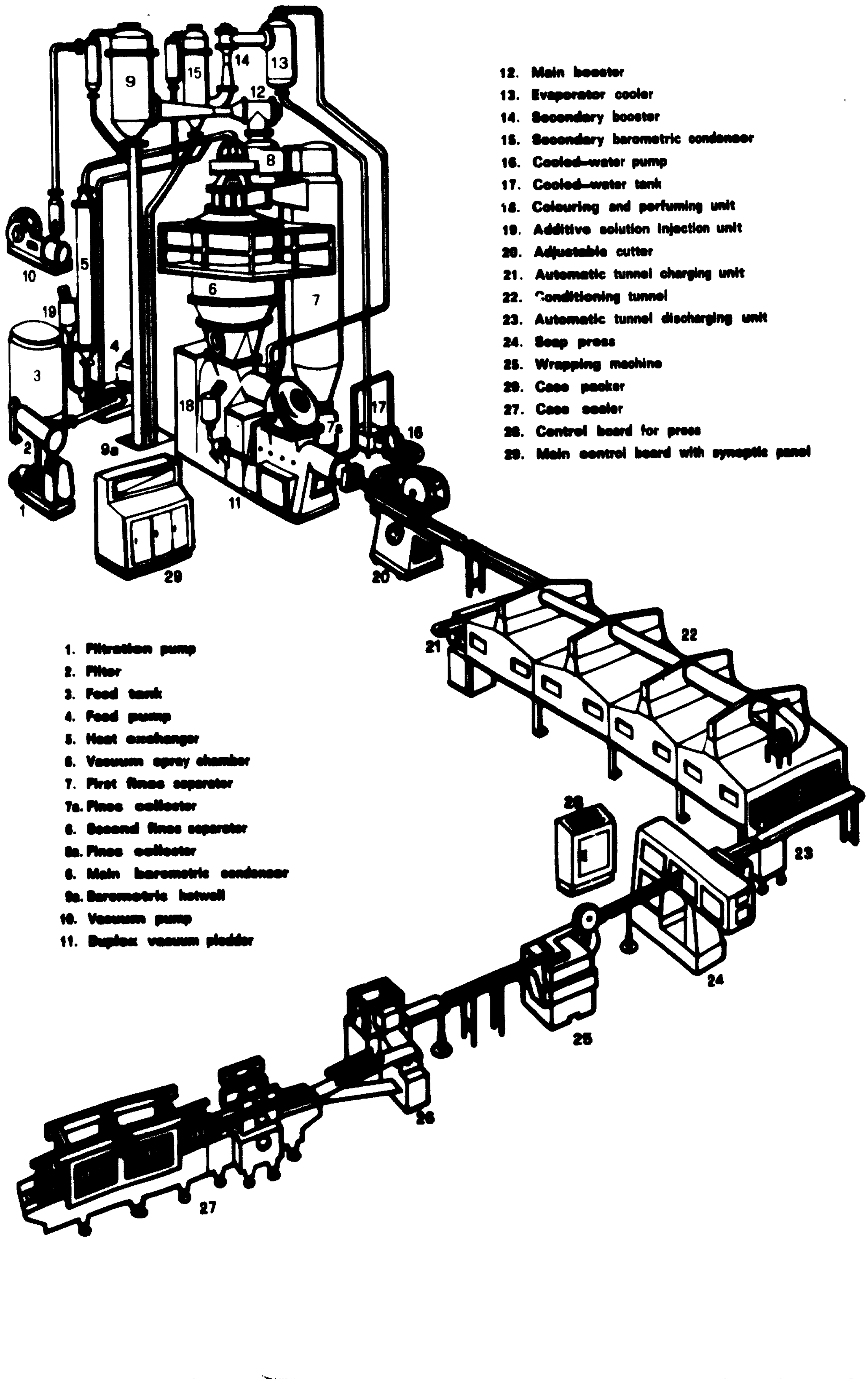
Large capacity booster for increasing the vacuum in the oooling and drying unit for reducing the temperature of the oooling water in the plodder jackets (12). Other parts of the water-oooling system are an evaporative cooler (13), a secondary booster (14), a seoondary barometrio condenser (15), with hot-well, a oentrifugal pump for circulating the oooled water (16) and a oooled-water tank (17)

Solution-injection line, including a proportioning pump, a oonstant-level reservoir and filter and a flowmeter, all made in stainless steel (19)

Soap perfuming unit, with a preoision metering pump, all neoessary fittings, including a feed tank of 50-l oapaoity made of stainless steel and a totally enclosed 0.5-hp motor (18). Fitted with power-driven stainless-steel stirrers and a totally enolosed 1-hp motor, the same unit is also used for colouring the soap

Adjustable cutter, with widened outting blades to out two parallel soap bars simultaneously (20)

Figure V. Continuous laundry soap processing plant



Conditioning tunnel (22) with charging (21) and discharging (23)

Automatic soap press for stamping soap tablets at the rate of 50-250 per minute. The machine, self-contained, consists of an electric motor, a gear-box, the mechanism for driving the moulds, safety guards for all the moving parts, and feeding and discharging conveyor belts (24)

Wrapping and packaging machines (25, 26, 27)

Control boards (28,29)

Operation

Figure V shows the laundry soap finishing line connected to the cooling and drying unit. Together, they comprise a continuously operating, fully automatic plant.

In case the water available for steam condensation is not cold enough to maintain the required level of vacuum, a steam booster jet (12) can be used in addition to the vacuum pump or steam-jet system. When the water, besides being warm, is not available in sufficient quantities, a closed-circuit water cooling and recovery system can be used.

For the production of low-TFA (high moisture-content) and filled soap, very cold water is needed in the jackets for proper plodding. A vacuum water-cooling system provides it. The water discharged from the plodder jackets goes to an evaporator (13) kept under high vacuum by a booster (14), where it cools as it boils at low pressure. The cooled water is then returned by a pump (16) to the plodder jacket inlet through a filter. The steam separated from the water in the process is condensed in a second barometric condenser (15). The amount of water lost by evaporation is automatically replaced in a tank (17).

In the colouring and perfuming unit (18), the metering pump injects a predetermined amount of perfume or perfume-colour solution into the vacuum chamber of the first plodder, which is under the spray chamber. The plodder ensures uniform distribution of the additives in the moving soap mass.

The continuous bar coming from the final plodder is cut into individual bars by the adjustable cutter (20). Before the billets can be stamped into finished soap bars, they must be conditioned to the optimum temperature and consistency. They are charged into the conditioning tunnel (22) by a charging unit (21), which spaces them properly on the endless belt that carries the billets through the tunnel. Fans circulate air throughout the tunnel, and different sections of the tunnel can be maintained at different temperatures depending on product requirements. The discharge unit (23) collects the billets and feeds them to the press (24), where the bar receives its final shape and has designs stamped on its faces.

Finally, the bars are wrapped by machine (25) and loaded into cartons (26), which are sealed (27) and made ready for shipping.

Utility and labour requirements

Table 10 gives the utility requirements for the production of laundry soap in the plant described above. The labour required is one person up to the tunnel discharge, three for the entire plant.

Table 10. Utility and labour requirements of a continuous laundry soap processing plant
(Per 1 000 kg of finished bars)

Type of soap	TFA (%)	Steam (kg)	Power (kW)	Water at 18°C (m^3)
Filled	35-62	175	30	12
Pure	62-64	150	30	12
Semi-dry	68-72	50	35	10
Translucent	68-72	50	40	10

Toilet soap finishing line

The line described here produces high quality toilet soap in bars continuously and fully automatically at the rate of 1 000 kg/h.

Machinery and equipment

The line includes the following machinery and equipment (see figures VI and VII):

A pneumatic duct conveyor for dried soap chips coming from the cooling and drying unit (figure VI), consisting of a high-capacity centrifugal blower, a venturi at the feeding point, a duct (circular cross-section) made of SS 304 plate and reinforced with angle irons, and a cyclone separator, also of SS 304. The duct has two wide bends, one of which is fitted with an inspection window. The bends are connected to the straight portions with quick-fastening devices

Figure VI. Pneumatic duct conveyor

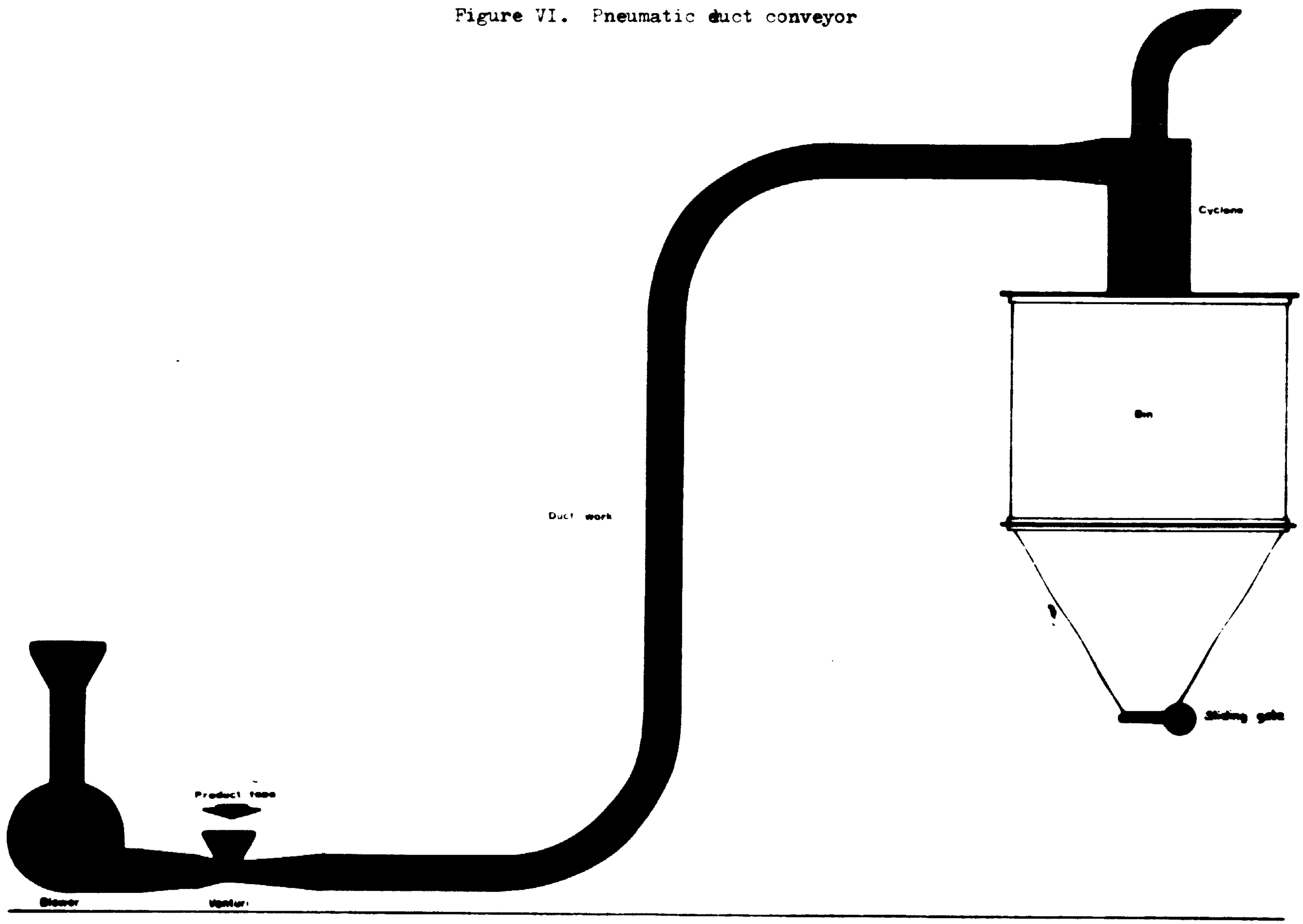
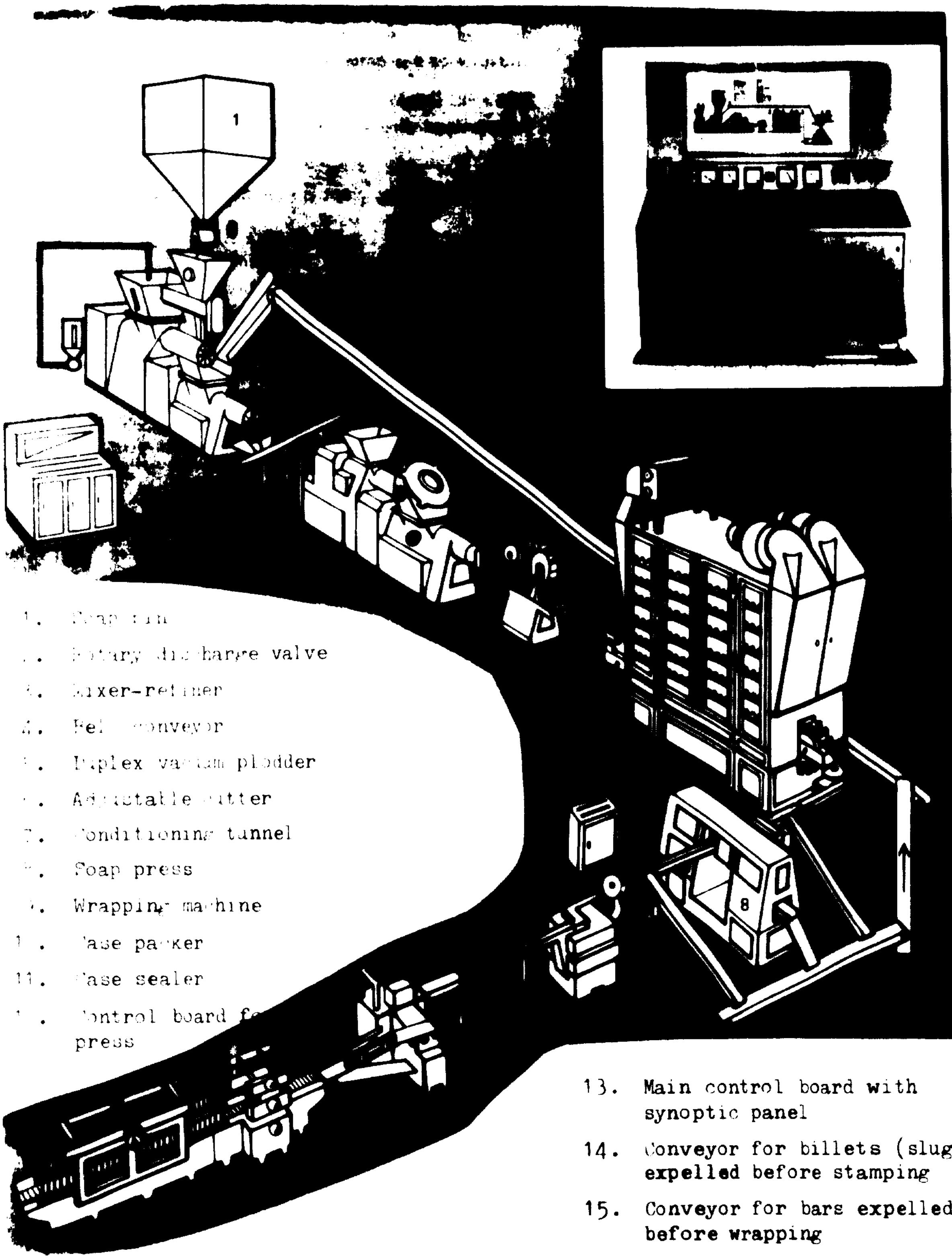


Figure VII. Continuous **toilet soap processing line**



1. Soap bin
2. Rotary discharge valve
3. Mixer-refiner
4. Belt conveyor
5. Duplex vacuum plodder
6. Adjustable cutter
7. Conditioning tunnel
8. Soap press
9. Wrapping machine
10. Case packer
11. Case sealer
12. Control board for press
13. Main control board with synoptic panel
14. Conveyor for billets (slugs) expelled before stamping
15. Conveyor for bars expelled before wrapping
16. Discharge chute for trimming and flashing waste
17. General waste conveyor
18. Waste recycling mechanical conveyor

Soap bin and rotary discharge valve (1 and 2 in figure VII)

Mixer-refiner (3) consisting of a solids worm feeder with hopper, a liquids metering assembly and two plodders in tandem connected by a feed hopper. All parts in contact with the product are made of SS 304, except the worms, which are made of a special silicon-aluminium alloy. The duplex mixer-refiner is usually supplied complete with the following motors:

Solids worm feeder	1.5 hp, variable speed
Liquids metering assembly	0.5 hp, fixed speed
Liquid agitator	0.75 hp, fixed speed motor
Preliminary plodder	20 hp, fixed speed motor, pneumatic or electromagnetic clutch

Belt conveyor (4), complete with structural-steel supports with built-in height adjustment, 0.75-hp gear motor, side guards, easily removable stainless-steel U pan on its underside to eliminate product losses, stainless-steel receiving hopper at the low end and castors for movability

Duplex vacuum plodder (5). The two plodders, mounted in tandem, are connected by a vacuum chamber. The preliminary plodder has a 300-mm diameter worm designed to give maximum refining through fine screens and is fed through a stainless-steel hopper

In the final plodder, remote-control starting and stopping of the motor is achieved through a pneumatic or electro-magnetic clutch which is an integral part of the motor. It also has a 300-mm worm diameter and is specially designed for final refining, compression and air-free extrusion of the product. All parts in contact with the product are made of SS 304, except the worms, which are made of a special silicon-aluminium alloy. The following motors are employed:

Preliminary plodder	20 hp, fixed speed
Final plodder	5-20 hp, variable speed
Vacuum pump	1 hp, fixed speed

Adjustable cutter (6), capable of cutting soap, soap-synthetic, and synthetic products of different length without changing the cutting chain in single or double lines

Vertical conditioning tunnel (7)

Soap press (8), suitable for stamping the billet on two sides and capable of stamping 200-230 soap tablets a minute

Wrapping and packaging machines (9, 10, 11)

Control boards (12, 13)

Operation

The toilet-soap base is composed of dry pellets produced by the cooling and drying unit. These can be fed directly to the line or stored in special bins (like 1 in figure VII) before processing. Bins of different capacities and designs are usually supplied with the plant, as well as mechanical and pneumatic automatic conveyors and automatic feeding and discharging equipment (such as the discharge valve (2) in figure VI).

The first operation is the addition of a number of solid and liquid ingredients and mixing them with the soap base. That is the function of the mixer-refiner (3), which meters, mixes, and refines continuously all liquid ingredients or solid-liquid mixtures.

The simple plodder used consists of a feed-screw conveyor and a hopper section mounted above a refining plodder. The two units are connected by means of a hopper. A volumetic dosing unit completes the system. This doser consists of a jacketed holding tank with a stirrer and a precision metering pump.

All the ingredients are dispensed on top of the pellets by one or more volumetric dosing units, and the pellets are fed at a predetermined rate by an adjustable-speed screw conveyor into the refining plodder.

The mixer-refiner may be replaced by a batch doser-mixer (BDM) system, which operates as follows (numbers in parenthses refer to figure VIII):

The automatic programmer (13) normally starts the operation by opening the rotary discharge valve (2) located at the bottom of the soap bin (1). (These would be the same bin and valve as in figure VII). The pellets fall by gravity into the scale (3). As soon as the scale's pointer indicates the predetermined batch weight, a photoelectric cell stops the soap discharge from the bin by closing the rotary valve.

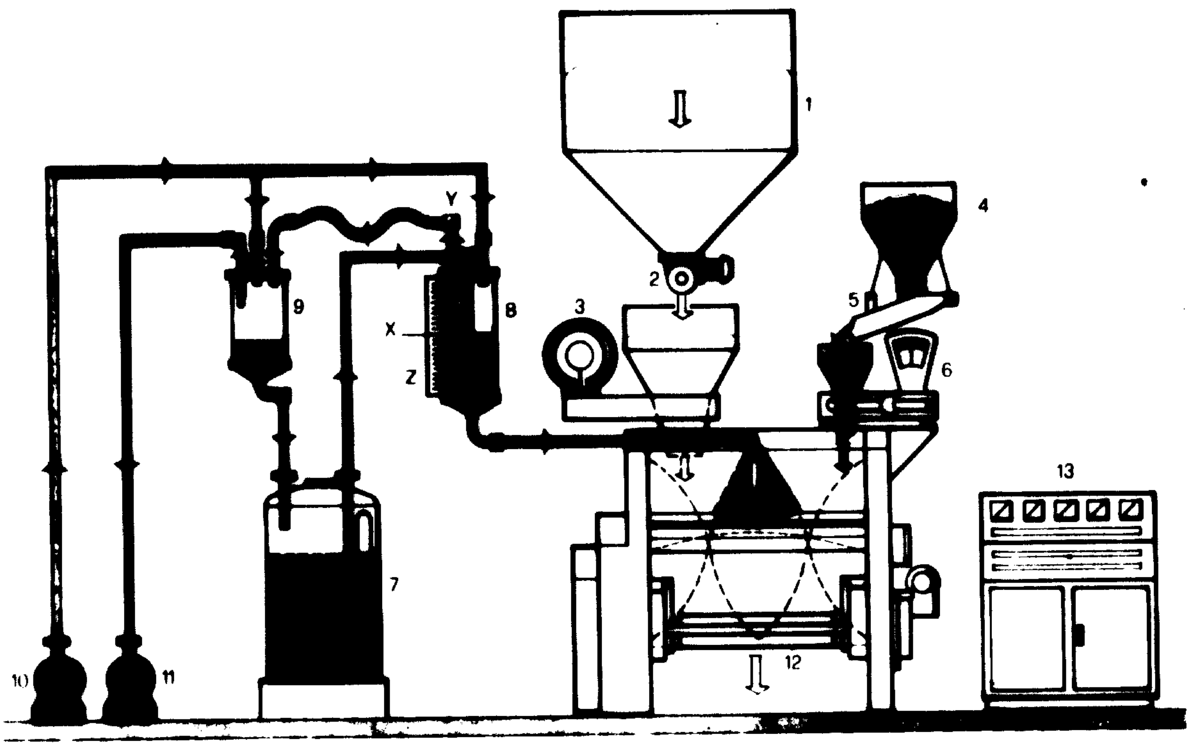
The solid ingredients, other than the soap base itself, should be in powder form. From a bin (4), they are transferred by a vibratory feeder (5) to the hopper of a precision scale (6).

A vacuum circuit siphons the liquid ingredients from their holding tanks (7) and transfers them to calibrated liquid feeder tanks (8). The level (X), and thus the amount, of each liquid ingredient in its feeder tank is varied by adjusting an overflow pipe (Y) and is measured by a gauge (Z). The liquid doses are transferred into an amalgamator (12) by compressed air through spray nozzles. The excess liquids are collected in overflow tanks (9) and recycled to the holding tanks (7).

The various solid and liquid ingredients are thoroughly mixed in the batch amalgamator (12). After the pre-set time allocated for mixing, the contents are discharged from the bottom of the totally enclosed amalgamator through a sliding gate.

To continue with the description of the toilet soap processing line (figure VII):

Figure VIII. BDM system



1. Soap bin
2. Rotary discharge valve
3. Soap-weighing scale
4. Solid ingredients bin
5. Vibratory feeder
6. Precision scale for solids
7. Liquid holding tank
8. Liquid feeder tank
9. Liquid overflow tank
10. Compressed-air pump
11. Vacuum pump
12. Batch amalgamator
13. Programmer

X. Liquid level
Y. Overflow pipe
Z. Level gauge

After mixing, either by the mixer-refiner (3) or the BDM system, the product is transferred by a belt conveyor to a duplex vacuum plodder (5). In the first plodder, the soap undergoes further refining through a fine screen and is cut into pellets by rotary cutters. The pellets fall into the vacuum chamber between the plodders, which acts as the feed hopper of the second plodder, where the soap is compressed and extruded free from air. The temperature is adjusted and controlled by an automatic control system. The speed of the plodder is adjustable.

The continuous soap bar leaving the final refining plodder is cut into individual billets (slugs) by means of the automatic, adjustable cutter (6). This type of cutter is particularly recommended for medium- and high-speed lines and when changes in the billet length are frequently made. The cutter is usually supplied with several chains, each covering a certain cutting range.

Conditioning of the billets received from the cutter to an optimum temperature before stamping is important for many reasons: conditioning increases the production rate by minimizing the time needed to clean the soap-press dies, allows for easy handling of sticky products and eliminates "sweating" of the bars, thus facilitating wrapping.

Conditioning takes place in a vertical tunnel (7). Air-conditioned models are recommended for use in hot climates.

The individual bars are finished in a soap press (8), which uses a rotation of the die-box. There are four steps: feeding of the billet to the die-box, stamping, discharge of the stamped bar, and discharge of the waste soap "flashing". These flashings and rejected bars can be recycled by an accessory conveyor system (14, 15, 16, 17, 18).

Finally, the bars are wrapped (9) and packed in cases (10) and the cases sealed (11) and made ready for shipping.

Utility and labour requirements

The average utility and labour requirements for the production of toilet soap using the line described above are given in tables 11 and 12.

Table 11. Utility and labour requirements for production of toilet-soap base (78-80% TFA) (Per tonne of pellets)

Item	Requirement
Steam	150-170 kg
Water at 18°C	8-10 m^3
Electrical energy	15-16 kWh
Labour	1 person[a/]

a/ One person can supervise more than one drier.

Table 12. Utility and labour requirements for the production of toilet soap (Per tonne of bars)

Item	Requirement
Water at 18°C	2 m^3
Electrical energy	55 kWh
Labour	2 persons[a/]

a/ One person supervises the soap press, the other the packaging section.

Advantages

The advantages of these fully automatic soap processing lines are:

(a) It is possible to produce a wide range of products merely by changing operating conditions;

(b) Utility requirements are lower;

(c) Labour requirements are low;

(d) Highly skilled personnel are not needed;

(e) Space requirements are minimal;

(f) The processing time from liquid soap to finished product is very short;

(g) No soap is wasted;

(h) The finished product is highly homogeneous;

(i) It is easy to use different fatty raw materials of various kinds and qualities. Stable soaps can be produced from olive oil, cottonseed oil or any other unsaturated fat;

(j) There is a uniform distribution of moisture in the finished product, where beta-phase crystallization assures superior lathering and eliminates the bar warping problem;

(k) Refining is carried out in closed plodders, avoiding contamination and eliminating air from the soap;

(l) It is possible to process products requiring a higher degree of drying, e.g., industrial soap with 6% and lower final moisture and soap-synthetic mixtures with 40% initial moisture content.

4. Glycerine recovery plant

Glycerine is recovered from spent lye in the plant diagrammed in figure IX. It consists of two main sections.

Treatment section

The spent lye treatment section can treat 30 t of spent lye every 24 h. It consists of the following equipment:

Air blower (1) for supplying the low-pressure air for the agitation of the lye in the treatment tanks (2, 5); made of cast iron and carbon steel, connected by means of flexible coupling to electric motor, complete with cast-iron base

Two tanks for treatment of the lye (2, 5); cylindrical form with flat bottom, made of mild steel, equipped with closed copper coil for steam heating and copper sparger for agitating air

Three centrifugal pumps for filtration and transfer; made of SS 316, connected by means of flexible coupling to electric motor, complete with cast-iron base

Two filter presses (4, 7) with plates and frames made of pitch pine, sides of cast iron and base of carbon steel, provided with manual closing device and equipped with filtering cloths

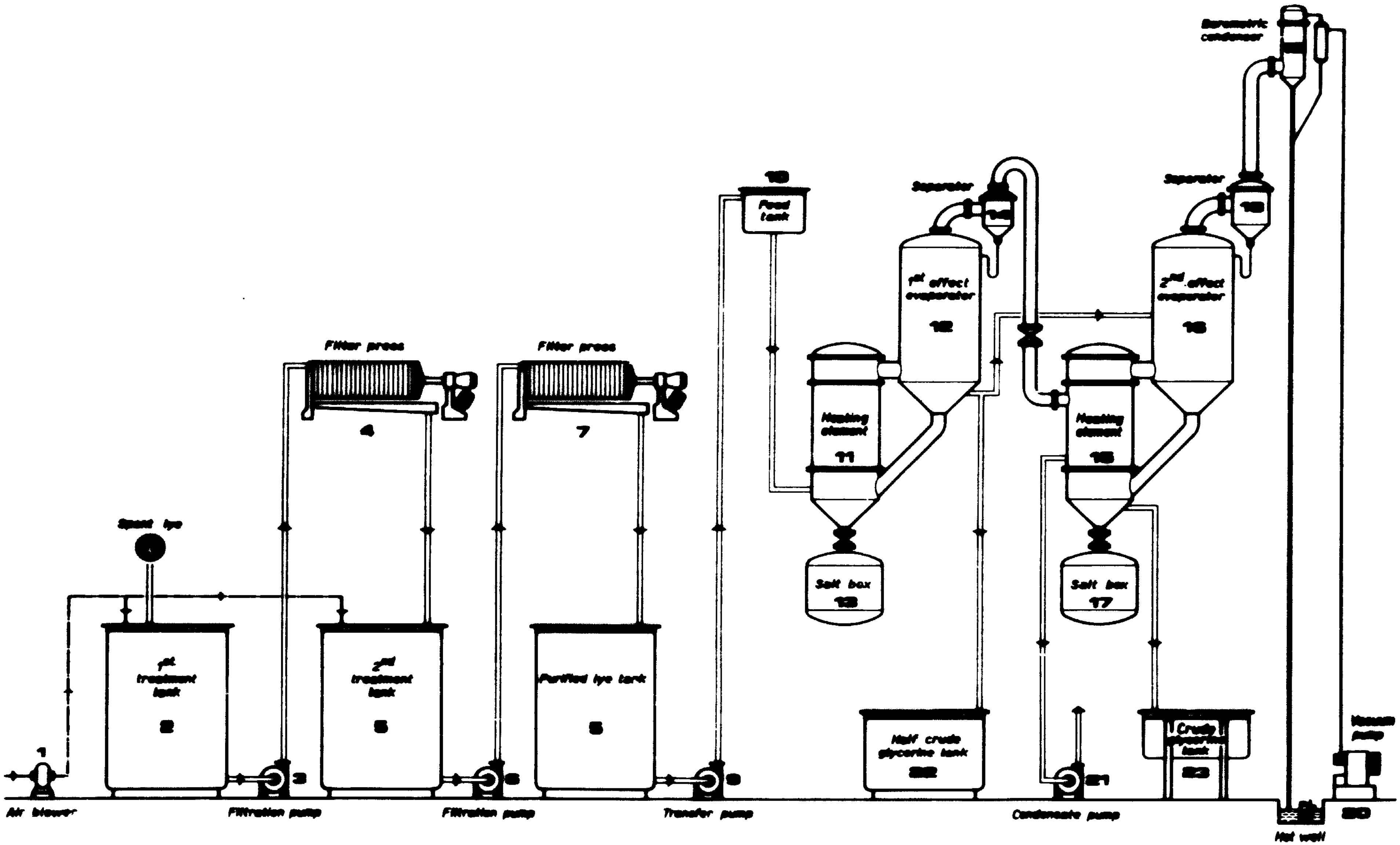
Tank for the purified lye (8); of cylindrical form with flat bottom, made of mild steel

Evaporation section

The evaporation section operates in two stages to evaporate 1 500 kg of water every hour. It consists of the following equipment:

Feed tank (10) for supplying the lye to the first stage evaporator; made of mild steel

Figure IX. Flow diagram of a glycerine recovery plant



Two heating units for evaporation, one for each stage (11, 15); short-tube type, tested for a steam pressure of 2 kg/cm^2, equipped with a quickly removable upper cover, lower inspection manhole, supporting brackets; made of mild steel with special boiling tube

Two evaporating chambers, one for each stage (12, 16); of cylindrical form with manhole, internal diaphragm, sight-glasses, supporting brackets; made of mild steel

Two salt boxes, one for each stage (13, 17); provided with discharge door for salt, flat cover with hinge and locking screw; complete with filtration screen for the salt slurry, sight-glasses, supporting brackets; made of mild steel

Two centrifugal entrainment separators, one for each stage (14, 18); with flanged cover; made of mild steel

Jet barometric condenser (19); equipped with barometric down-pipe and droplet separator; made of mild steel

Single-stage vacuum pump (20) for dry air; equipped with electric motor, V belts, pulleys and fittings

Centrifugal pump (21) for the removal of the condensate from the second-stage evaporator; made of cast iron and carbon steel, connected by means of flexible coupling to electric motor, complete with base of cast iron

Tank for half-crude glycerine (22); made of mild steel

Tank for crude glycerine (23); made of mild steel

Operation

The process shown in figure IX is suitable for the recovery of the glycerine contained in the spent lye obtained from the saponification of neutral fats by the conventional pan-process system or modern continuous soap-making lines.

The two-stage evaporator utilizes heating units of the vertical-tube type separated from the vapour space by expansion chambers. By this arrangement maximum heat exchange is obtained; in addition, access can easily be gained to the heating tubes for cleaning purposes by the simple removal of a clean-out door in the top cover-plate.

The evaporating chambers and the centrifugal separators are designed so as to reduce glycerine losses to a minimum.

The salt boxes are oversized, and the recovered salt can be readily removed through the wide door provided for the purpose.

The vapour piping from the first to the second stage is fitted with an isolating valve. When closed, the second stage can be operated as a single-stage unit for working down the half-crude (40-44%) to crude (80-84%) glycerine.

Utility requirements

When the plant is operated as a two-stage unit, the service requirements per tonne of water evaporated with feed liquor at 70°C, are as follows:

Steam at 2 atm	600 kg
Cooling water at 15°C	15 m^3
Electric power	4 kW

When the second stage is operated as a single stage for finishing, the evaporating capacity is about 50% lower than the average capacity of the two-stage plant when concentrating the lye to half-crude glycerine.

5. Steam boiler

The steam boiler is of the three-pass fire-tube type, mounted on a heavy supporting frame, with a fuel-oil burner, blower, water-feed pump, stack, safety valves, trim panel and controls. The complete boiler is usually factory assembled and is ready to operate after it is connected.

A water softening unit should be installed in the water supply to the boiler.

The hourly output of the boiler should be 5.5 t of saturated steam at 12 kg/cm^2.

B. Land and buildings

Factory location

The ideal location for the proposed soap factory has these characteristics:

Good drainage

Easy transportation of raw materials and finished products

Easy access for personnel

Adequate and steady supplies of electrical energy and water

Clean environment

Proximity to allied industries

In a visit to the new local oil extracting factory, the expert recognized that this factory is itself in a convenient area for the installation of a soap factory. Enough power is available, and the area has laboratories, plenty of room for the buildings, technical staff, supplies of residuals of acid oil refining, drainage facilities, and easy transportation of fatty materials by the harbour's direct pumping system. Moreover, the area is near the sources of supply for alkaline and brine solutions.

Buildings

Manufacturing

Fatty materials storage and transfer

The raw fatty materials annually needed for the production of 3 200 t of toilet soap are:

Extra fancy tallow	2 400 t
Coconut oil	800 t

For the production of laundry soap:

Fancy tallow, laundry grade	9 440 t
Other oils of the soft or medium grades	2 360 t

The containers needed are:

	Number of tanks	Capacity (t)
Extra fancy tallow	3	500
Fancy tallow (laundry grade)	5	500
Other oils	5	250

The figures above are for two-shift operation. After a year, when the factory goes on a three-shift basis, four more fancy tallow tanks will be needed.

The required area is 600 m^2, with a height of 7 m. At the rate of 40 KD/m^2, the building will cost KD 24 000.

Bleaching

The bleaching unit requires a floor space of 12 m x 15 m = 180 m^2 and a ceiling height of 10.5 m. Cost: KD 7 200.

Saponification

The saponification plant requires a floor space of 30 m x 15 m = 450 m^2 with working floors at heights of 6 and 10.5 m. Cost: KD 18 000.

Soap processing line

The plant should be 15 m wide by 40 m long. The first 12 m should have a ceiling height of 9 m, the remaining 28 m, a height of 5 m. Total area, 600 m^2; cost, KD 24 000.

Glycerine recovery

Floor space, 8 m x 20 m = 160 m^2; height, 10 m; cost, KD 6 400.

Steam boilers

Area required for two boilers: 2 x 6 m x 15 m = 180 m^2.

Height should be 6 m. Cost: KD 7 200.

Total

The total area for manufacturing is 2 170 m^2; cost, KD 86 800.

Pre-treatment and storage

Neat soap storage

Storage consists of waiting pans, which receive the daily production liquid soap base for the toilet or laundry soap finishing units. They are usually located between the saponification and the cooling and drying units. Six pans of 30 t each should be sufficient for daily production of 72 t liquid soap base. The pans are 3 m in diameter and 4 m high and need an area of 200 m^2. At the rate of 35 KD/m^2, the building cost will be KD 7 000.

Sodium hydroxide and sodium chloride preparation and storage

The daily needs of liquid alkali for the saponification plant at the rate of treating and saponifying of 50 t/d is about 20 t of 50% NaOH solution. Three storage tanks of 50 t each are required to guarantee smooth, continuous running for a week and adequate cooling.

Two tanks of 50 t each are needed for the preparation of sufficient 20% brine solution to insure at least a week's trouble-free production.

The recommended area for both the preparation and storage of both solutions is 250 m^2. Cost at 35 KD/m^2: KD 8 750.

Supplementary raw fatty materials storage

For supplementary storage an area of 400 m^2 surrounded by a fence 2 m high is required. At the rate of 10 KD/m^2, the cost will be KD 4 000.

Total

The total area for pre-treatment and storage is 850 m^2 at a cost of KD 19 750.

Finished products storage

Sufficient storage should be provided for two month's production, operating in two shifts.

Toilet soap

Space for 100 000 cases, each of 72 bars of 100 g. The needed area (3 m high) is 750 m^2. The cost at the rate of 35 KD/m^2 is KD 26 250.

Laundry soap

Space for 84 000 cases, each of 50 cakes of 400 g. The needed area (6 m high) is 1 000 m^2; cost, KD 35 000.

Total

The total area for finished products storage is 1 750 m^2; cost, KD 61 250.

General storage

General storage includes:

Aromatic perfume compounds and other toilet soap additives

Wrapping materials, cartons, glue, colouring materials

Mechanical and electrical spare parts and tools

Bleaching earth and other chemical powders

Recommended area is 1 000 m^2. At the rate of 30 KD/m^2, the cost will be KD 30 000.

Quality control and research laboratories

The chemical control laboratory (for raw materials), the production quality control and technical research laboratories, and the pilot plant will require about 300 m^2. At 40 KD/m^2, the cost will be KD 12 000.

Water supply tower

The water supply tower should be large enough to hold twice the daily water requirement of 2 500 m^3. A tower of this size will require 130 m^2 of area at a cost of 70 KD/m^2 or KD 9 100.

Mechanical and maintenance workshop

An area of 300 m^2 is required for workshops. At 40 KD/m^2, the cost will be KD 12 000.

Factory administration

Area, 300 m^2; cost, KD 12 000.

General administration

Area required for the main offices is 400 m^2. At the rate of 60 KD/m^2, the cost will be KD 24 000.

Miscellaneous

There will be 400 m of fence, 2 m high, around the property. At the rate of 10 KD/m, the cost will be KD 4 000.

Land

Roads, plantings and expansion are allotted 2 800 m^2 of land to bring the total land area of the factory to an even 10 000 m^2. The cost of this land is not included in the cost summary below.

C. Labour

Since the plants are fully automated, labour requirements are low; in many cases only one operator per shift per plant is needed (see section A). However, it is recommended that this operator be assisted by a mechanic during the first year of operation.

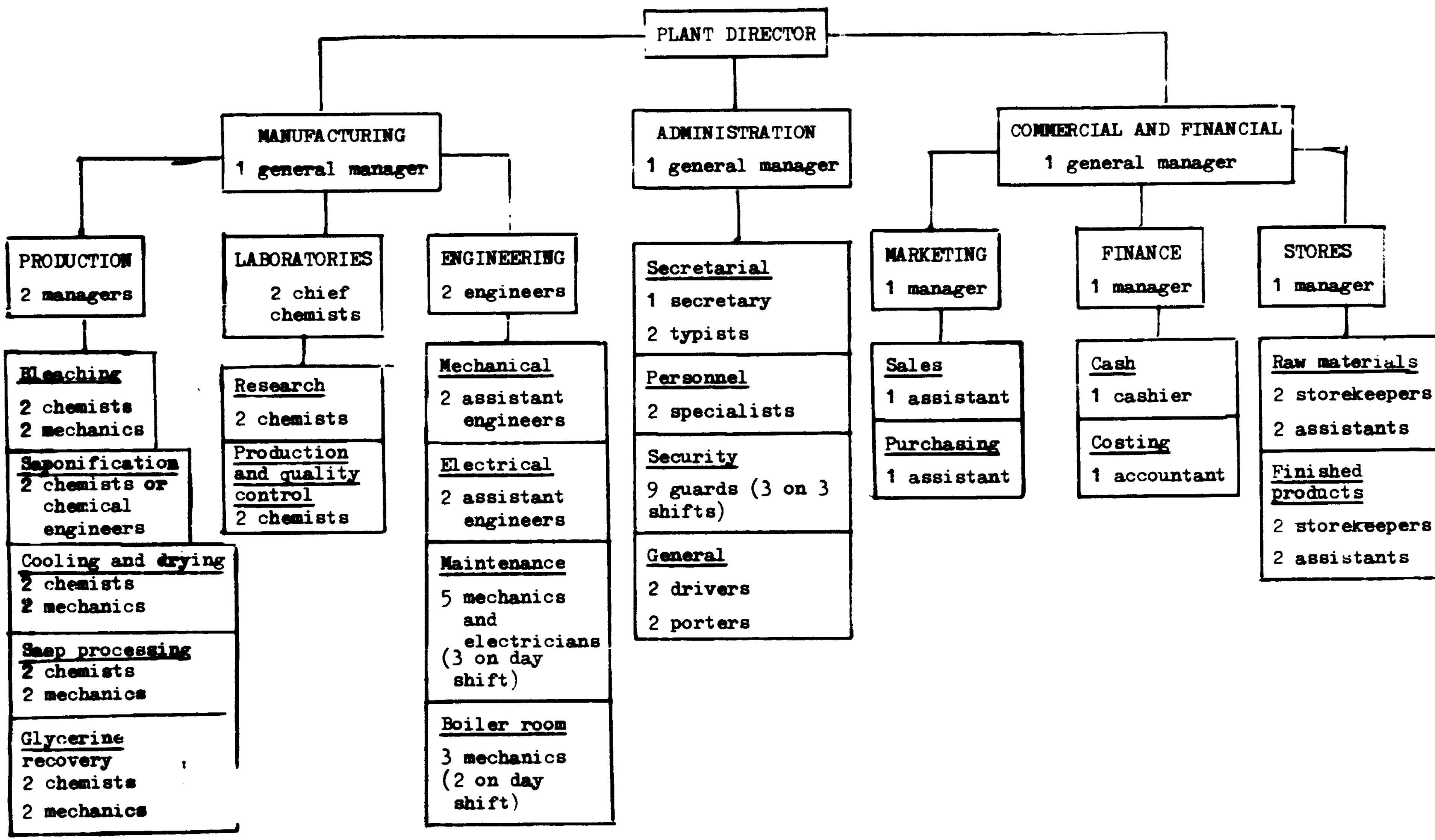
The operator must be a graduate chemist with at least three months' experience in continuous soap production. He should have assisted with the erection of the units from the very beginning. The possibility should be investigated of employing technicians from the local institute for applied technology, after they have been trained in the use of automatic soap machinery.

Figure X is an organization chart showing the number and type of employees needed in the first year of operation. It is assumed that the plant will run on two 8-h shifts and manufacture 3 600 t of toilet soap and 8 400 t of laundry soap and recover 900 t of glycerine.

Personnel qualifications

The qualifications expected of the personnel listed in figure X are as follows:

Figure X. Organization chart and labour requirements for the first year of operation (two shifts)



Manufacturing

General manager - a chemical engineer with 15 years experience, preferably in oils and fats

Production managers - chemical engineers with over 6 years experience, preferably in soapmaking

Production chemists - graduate chemists or chemical engineers with over 6 years experience, preferably relevant to the units to which they are assigned

Laboratory chief chemists - graduate chemists with over 6 years experience, preferably in fats and oils

Laboratory chemists - graduate chemists with over 6 years experience in oil and soap analysis

Engineers - graduate engineers, mechanical or electrical, with over 6 years experience, preferably in automatic soap manufacturing plants

Assistant engineers - technical secondary level of education with over 6 years experience or with less education but over 10 years experience; two electrical, with experience in motors and panels, and two mechanical, with experience in processing machinery

Maintenance - experienced mechanics and electricians

Boiler room - stationary mechanics with over 10 years experience

Administration

General manager - college graduate with over 15 years administrative experience

Secretarial - business school, or secondary school with 5 years experience

Personnel - vocational specialists with over 5 years experience

Security - factory guards with over 10 years experience

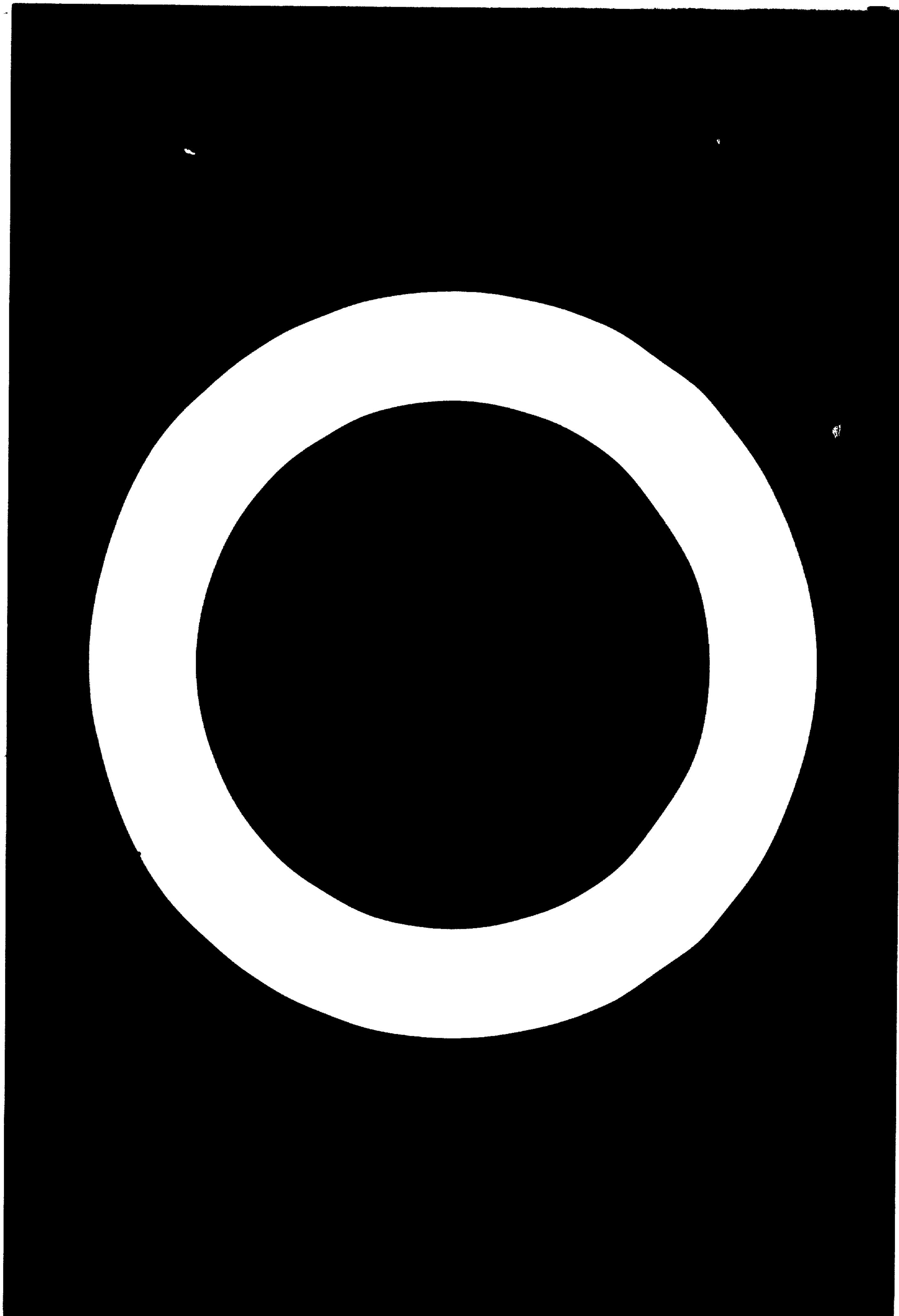
Commercial and financial

General manager - college graduate with 15 years experience in financial and marketing matters, preferably in soap marketing

Marketing - manager, college graduate with 10 years marketing experience; assistants, 10 years experience

Finance - manager, college graduate with 10 years experience; cashier and accountant, graduates with 6 years experience or non-graduates with 10 years experience

Stores - manager, graduate with 10 years experience, preferably in soap storage; storekeepers and assistants, over 10 years relevant experience



Annex

ESTIMATED REQUIREMENTS, COSTS AND PROFITS

This annex contains tables 13-23, which present data on the estimated reqirements, costs and profits of a soap factory with the following annual output:

Product	Quality	Amount (t)
Laundry soap (420 000 cases, 50 bars of 400 g per case)	TFA 62%-63%	8 400
Toilet soap (500 000 cases, 72 bars of 100 g per case)	TFA 78%-80%	3 600
Glycerine (4 000 barrels, 231.5 kg per barrel)	98% crude	926

Table 13. Plants and eqipment costs

(United States dollars)

Plant or equipment	Basic price	Delivery cost	Total
Oil and fat bleaching unit	168 400	21 000	189 400
Continuous saponification plant	395 450	33 000	428 450
Continuous neutralization unit	64 360	5 500	69 860
Crutcher	25 750	2 150	27 900
Cooling and drying unit	393 770	32 000	425 770
Glycerine recovery unit	144 360	14 670	159 030
Steam boiler	52 290	6 500	58 790
Pneumatic duct conveyor	9 120	800	9 920
Toilet soap finishing line	242 530	20 200	262 730
		Total	1 631 850
			(KD 465 406)

Notes: 1. If fully automatic wrapping, packing and sealing are desired, add following equipment:

	Price	Delivery	Total
High-speed toilet-soap wrapper	78 890	6 550	85 440
Case packer	21 320	1 770	23 090
Automatic case sealer	11 105	925	12 020
			120 550

2. For supplementary steam boiler, add $58 790.

Table 14. Comparison of proposed plant with single and double plants

Item	Proposed plant	Double plant	Single plant
Toilet soap produotion capacity (t/a)	3 600	5 400	2 700
Laundry soap production capaoity (t/a)	8 400	10 800	5 400
Total capacity (t/a)	12 000	16 200	8 100
Total neat soap base capacity (t/a)	15 600	21 600	10 800
Total investment for plants ($US)	1 805 341	1 805 341	1 257 510
Total investments for plants (KD)	523 549	523 549	364 678
Annual depreciation at 10% (KD)	52 355	52 355	36 468
Annual depreciation per ton of neat soap base (KD)	3.356	2.424	3.367
Crude (98%) glycerine recovered (t/a)	1 114	1 542	771
Inoome from glycerine sales (£)	167 100	225 000	115 650
(KD)	83 550	112 500	57 825

Notes: 1. Production capacities are based on 300 days operation per year.

2. Investment and depreciation items for the single plant do not inolude wrapping, packing or sealing units or a stand-by steam boiler.

Table 15. Estimated amounts of different raw fattv materials needed annuallv

Material	Amount (t)				Average price		Total cost (2 shifts)	
	2 shifts		3 shifts					
	Toilet	Laundry	Toilet	Laundry	($US/t)	(KD/t)	(Thousand dollars)	(Thousand dinars)
Coconut oil	800	-	1 250	-	469	136	375	108.7
Extra fancy tallow	2 400	-	3 750	-	440	128	1 056	306.2
Fancy tallow (laundry grade)	-	4 116	-	5 292	400	116	1 646	477.4
Palm-oil	-	588	-	756	445	129	262	75.9
Soft oil (cotton seed, ground-nut etc.) / Soft acid oils (soap stock, refinery residues)	-	1 176	-	1 512	355	103	417	121.1
TOTAL Each soap type	3 200	5 880	5 000	7 560				
TOTAL Both types	9 080		12 560				3 756	1 089.3

Notes: 1. Palm-oil may be used instead of fancy tallow, and acid oils instead of soft oils, if the price for equal quality is more favourable.

2. Prices are averages of late 1975 and late 1976 international prices.

3. The proposed amounts of raw fatty materials for toilet soap are based on the formulas for a top quality product.

Table 16. Estimated amounts of the principal chemical raw materials needed annually

Two-shift operation

Material	Toilet soap Amount (t)	Toilet soap Cost (KD)	Laundry soap Amount (t)	Laundry soap Cost (KD)	Glycerine recovery (KD)
Sodium hydroxide	500	30 000	900	54 000	
Sodium chloride	230	5 750	350	8 750	
Activated bleaching earth	128 a/	...	118 a/	...	
Other					2 000
Total cost		35 750		62 750	2 000

a/ Assuming fatty raw materials of high quality.

Table 17. Estimated amount of water, electricity and steam needed annually

Two-shift operation

Unit	Product	Amount of product (t)	Water		Steam a/		Electricity	
			Rate (m^3/t)	Total (m^3)	Rate (kg/t)	Total (kg)	Rate (kWh/t)	Total (kWh)
Bleaching	Bleached fats	9 080	2	18 160	80	726 400	3.5	31 780
Saponification	Neat soap, 61% TFA	13 100	1.5	19 650	150	1 965 000	16	209 600
Neutralization	Neat soap, 61% TFA	4 600	-	-	10	46 000	5	23 000
Cooling and drying	Laundry bars, 62-63% TFA	8 400	12	100 800	150	1 260 000	30	252 000
Toilet soap	Pellets, 78-80% TFA	3 600	8	28 800	150	54 000	15	54 000
	Bars, 78-80% TFA	3 600	2	7 200	-	-	55	198 000
Glycerine recovery	Evaporated water	2 724	12 b/	32 688	600	1 634 400	4	10 896

a/ At 6 kg/cm^2 except for glycerine recovery, which is at 2 kg/cm^2.

b/ At 15°C.

Table 18. **Estimated annual cost of utilities**

Two-shift operation

Product		Water			Steam			Electricity		
Type	Amount (t)	Amount (m^3)	Total cost (KD)	Cost per unit product (kD/t)	Amount (t)	Total cost (KD)	Cost per unit product (KD/t)	Amount (kWh)	Total cost (KD)	Cost per unit product (kD/t)
Laundry soap	8 400	124 570	24 914	2.966	3 206	8 550	1.018	408 621	817	0.097
Toilet soap	3 600	50 040	10 008	2.780	1 231	3 280	0.911	359 759	720	0.200
Glycerine	926	32 688	6 538	7.060	1 634	2 170	2.343	10 890	22	0.024
Total		207 298	41 460		6 071	14 000		779 270	1 559	

Notes: 1. The following utility rates are assumed:

Water	200 fil/m^3
Electricity	2 fil/kWh
Fuel (liquid)	8 KD/t

2. It is assumed that 0.333 t of fuel is required to produce 1 t steam at 6 kg/cm^2 pressure.

Table 19. Estimated annual labour costs

Two-shift operation
(KD)

Number of persons	Occupation	Individual monthly salary a/	Total annual cost
1	General manager (manufacturing)	880	10 560
1	General manager (commercial and financial)	660	7 920
1	General manager (administrative)	660	7 920
2	Production manager	660	15 840
2	Chief chemist	550	13 200
2	Engineer	550	13 200
1	Marketing manager	550	6 600
1	Finance manager	550	6 600
1	Stores manager	550	6 600
2	Chemists (glycerine recovery)	330	7 920
2	Chemist (saponification)	440	10 560
2	Chemist (cooling and drying)	440	10 560
2	Chemist (soap processing)	440	10 560
2	Chemist (bleaching)	330	7 920
2	Chemist (quality control)	330	7 920
2	Chemist (research)	330	7 920
2	Mechanical engineer	330	7 920
2	Electrical engineer	330	7 920
1	Sales assistant	275	3 300
1	Purchasing assistant	275	3 300
1	Cashier	220	2 640
1	Accountant	165	1 980
2	Storekeeper (raw materials)	165	3 960
2	Storekeeper (finished products)	165	3 960
2	Assistant storekeeper (raw materials)	110	2 640
2	Assistant storekeeper (finished products)	110	2 640
3	Boiler room mechanic	220	7 920
5	Maintenance worker	165	9 900
1	Secretary	165	1 980
2	Typist	132	3 168
2	Driver	132	3 168
11	Porter, guard	77	10 164
66	Total		228 360

a/ Including 10% social charges.

Table 20. Estimated fixed and working capital requirements

Breakdown by product
(KD)

Item	Laundry soap	Toilet soap	Glycerine	Total
Fixed capital				
Buildings	114 150	114 150	32 700	261 000
Furniture	2 000	2 000	1 000	5 000
Equipment	218 629	251 316	55 300	525 245
Installation	35 065	35 965	8 970	80 000
Air conditioning	700	700	600	2 000
Laboratories	2 000	3 000	5 000	10 000
Motor vehicles	2 500	2 500	2 000	7 000
Technical training	1 240	1 440	320	3 000
Insurance[a]	1 664	1 828	439	3 931
Maintenance[b]	3 328	3 655	879	7 862
Advertising	16 742	16 761	327	33 830
Total	398 018	433 315	107 535	938 868
Working capital				
Land rental	10	10	10	30
Raw materials	677 192	510 308	2 000	1 189 500
Utilities	34 281	14 008	8 730	57 019
Packaging materials	13 000	27 500	5 000	45 500
Perfume and other additives	2 000	132 848		134 848
Labour	135 914	69 228	23 218	228 360
Shipping	4 000	8 000	8 000	20 000
Customs duties	24 730	18 670		43 400
Miscellaneous	4 000	6 000	6 000	16 000
Total	895 127	786 572	52 958	1 734 657

a/ On buildings and equipment, at 0.5%.

b/ Of buildings and equipment, at 1%.

Table 21. **Estimated production cost**
(Dinars per tonne of finished product)

Item	Laundry soap	Toilet soap	Glycerine
Depreciation			
Furniture (20%)	0.048	0.111	0.216
Equipment (10%)	2.603	6.981	5.972
Installation (20%)	0.829	1.998	1.937
Air conditioning (20%)	0.017	0.039	0.130
Laboratories (10%)	0.024	0.080	0.540
Motor vehicles (33 1/3%)	0.100	0.232	0.720
Technical training (20%)	0.029	0.080	0.069
Fixed and variable costs			
Land rental	0.001	0.003	0.011
Raw materials	80.618	141.752	2.160
Utilities	4.081	3.891	9.428
Packaging materials	1.548	7.639	5.400
Perfume and other additives	0.238	36.902	
Labour	16.180	19.230	25.073
Insurance	0.198	0.508	0.474
Maintenance	0.396	1.015	0.949
Advertising	1.993	4.656	0.353
Shipping	0.476	2.222	8.639
Customs duties	2.901	5.186	
Miscellaneous	0.476	1.667	6.479
Total	112.756	234.192	68.550

Table 22. Estimated profits

Item	Laundry soap	Toilet soap
	(KD/t)	
Cost of imported soap, 1974-1975 average	258.288	405.068
Local selling price, late 1976	290.656	764.840[a]
Estimated production cost, late 1976	112.756	234.192
Return from glycerine sales[b]	0.985	1.249
Net production cost	111.771	232.943
Profit		
Over import cost	146.517 (130%)	172.125 (73%)
Over local price	178.885 (159%)	531.897 (227%)
	(KD)	
Total annual profit		
Over import cost	1 230 743	619 650
Over local prioe	1 502 634	1 914 829

a/ Normal grades; some higher grades sell for as much as 970 KD/t.

b/ Assuming the glycerine is sold for 82.344 KD/t and weighting the return to each soap type by its fat oontent.

Table 23. Suggested capital investment schedule

Six-month period	Fixed capital: Item	Fixed capital: Amount (KD)	Working capital: Item	Working capital: Amount (KD)	Total (KD)
First	Buildings (½)	130 500			
	Equipment (90%)	210 098	None		
	Installation (½)	40 000			
	Motor vehicles (½)	3 500			
	Total	384 098			384 098
Second	Buildings (½)	130 500			
	Equipment (60%)	315 147			
	Installation (½)	40 000	None		
	Motor vehicles (½)	3 500			
	Technical training	3 000			
	Total	492 147			492 147
Third	Furniture	5 000	Land rental	30	
	Insurance	3 931	Raw materials (⅓)	396 500	
		8 931	Utilities (¼)	14 255	
			Packaging (¼)	11 375	
			Additives (¼)	33 712	
			Labour (½)	114 180	
			Shipping (¼)	5 000	
			Customs (¼)	10 850	
			Miscellaneous (½)	8 000	
				593 902	602 833
Fourth	None		Raw materials (⅓)	396 500	
			Utilities (¾)	42 764	
			Packaging (½)	22 750	
			Additives (½)	67 424	
			Labour (½)	114 180	
			Shipping (½)	10 000	
			Customs (¾)	32 550	
			Miscellaneous (½)	8 000	
			Total	694 168	694 168

Fifth	Air conditioning	2 000	Raw materials (1/3)	396 500	
	Laboratories	10 000	Packaging (1/4)	11 375	
	Maintenance	7 862	Additives (1/4)	33 712	
	Advertising	33 830	Shipping (1/4)	5 000	
	Total	53 692	Total	446 587	500 279
	Total	938 868		1 734 657	

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