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Distribution
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ID/WG.137/38
18 September 1972

United Nations Industrial Development Organization

Original: ENGLISH

Symposium on the Development of the Plastics
Fabrication Industry in Latin America

Bogotá, Colombia, 20 November - 1 December 1972

THE PRODUCTION OF PRESSURE PIPES FROM RIGID PVC 1/

by

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Rheinstahl Plastics International Ltd.
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SUMMARY

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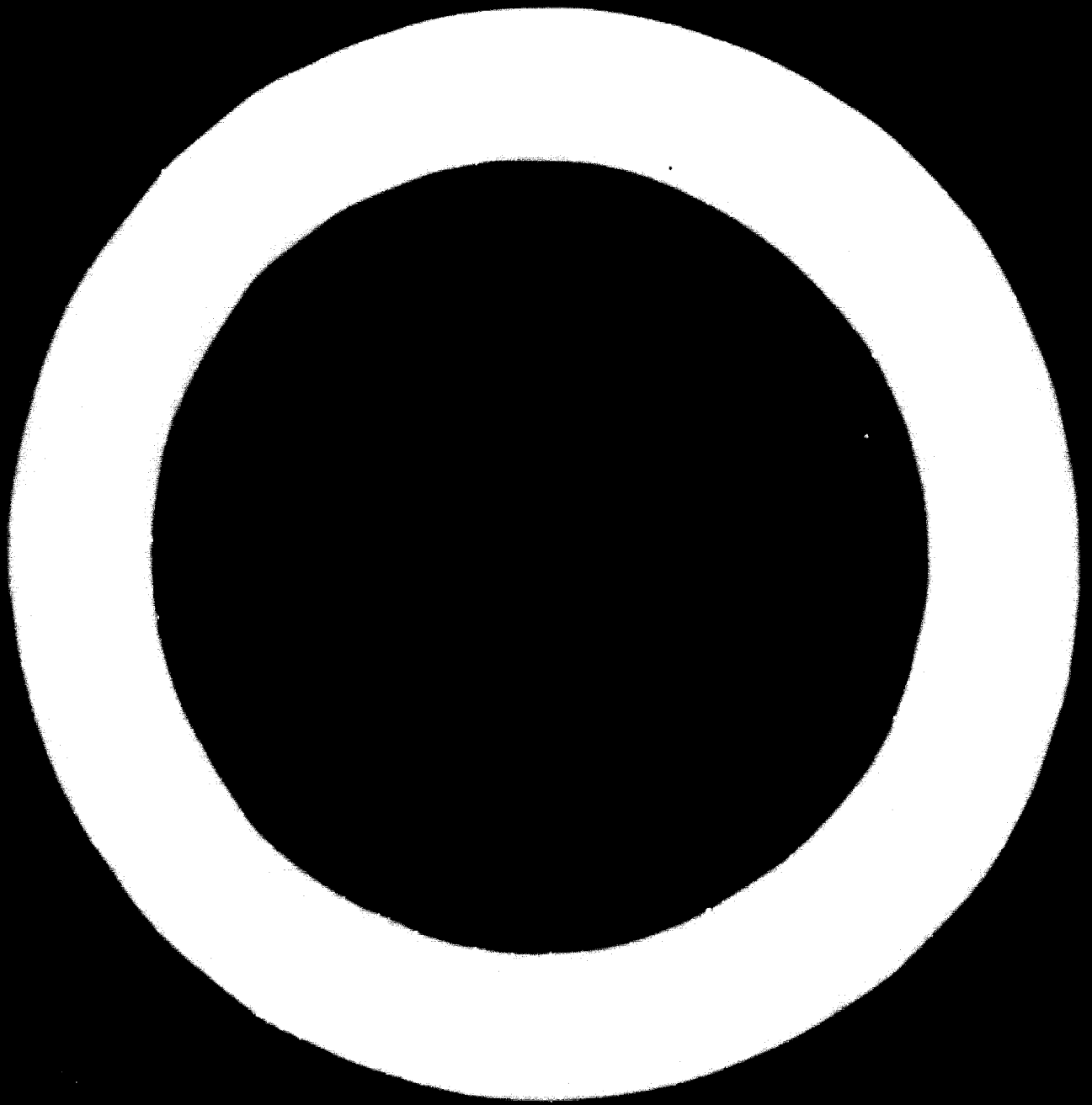
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Production plant for U-PVC pipes of nominal diameters in the range of 50 to 200 mm to operate at working pressure of up to 10 kg/cm^2 based upon twin screw extruders of 86 and 107 mm screw diameters is proposed. Plant lay-out, processing, comprehensive equipment, price schedules and commercial factors are described. Terms of technical know-how, labour and energy requirements and cost calculations are stated and delivery times given.

The proposal may well be of considerable interest to organizations intending to establish manufacture of this range of items.

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SUMMARY I

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1. PROPOSITION

We propose a production plant for the manufacture of pressure pipes from nominal diameter (ND) 50 to 200 mm with a nominal working pressure of 10 kg/cm² (KM) mainly consisting of two twin-screw extruders with 86 and 107 mm screw diameter resp.

2. LAYOUT OF THE PLANT

2.1. Production program

The following production program is recommended:

ND (mm)	dimensions of the pipes (outside diameter x wallthickness) (mm)
50	63 x 3,0
65	75 x 3,6
80	90 x 4,3
100	110 x 5,3
125	140 x 6,7
150	160 x 7,7
200	225 x 10,8

2.2. CAPACITY

2.2.1. Extruder

For the production the following extrusion line is provided:

1 Twin-Screw-Extruder
with 86 mm screw diameter
capacity: 140 - 175 kg/h (ND 50 - ND 100)
average capacity: 160 kg/h

1 Twin-Screw-Extruder
with 107 mm screw diameter
capacity: 250 - 300 kg/h (ND 100 - ND 200)
average capacity: 275 kg/h

Due to experience the output of first quality pipes is appr. 20% lower than the gross capacity. The decrease of capacity depends on changing of tools, cleaning, arising of reject material, maintenance, and other inactivity times.

Therefore the effective capacity of the 2 extruders amounts to:

Twin-Screw-Extruder 86 mm - 128 kg/h
Twin-Screw-Extruder 107 mm - 220 kg/h

The following table shows the appr. capacities:

	kg/h	tons/ month	tons/ year
Extrusion line 1	128	76,8	922
Extrusion line 2	220	132,0	1584
total:	348	208,8	2506

.....
The capacity per month as well as per year is calculated on the basis of 7.200 working hours per year, resp. 600 working hours per month.

The following table shows the capacities of the different diameters of the pipes:

ND	Extruder with screw diameter	
	86 mm	107 mm
	kg/h	kg/h
50	140	-
65	155	-
80	165	-
100	175	250
125	-	270
150	-	280
200	-	300
average:	160	275

The production programme is attached to the different extrusion lines as follows:

Extrusion line no. 1

ND	tons/month	tons/year
50	3,5	42,0
65	2,0	24,0
80	21,3	255,6
100	50,0	600,0
total:	76,8	921,6

Extrusion line no. 2

ND	tons/month	tons/year
100	7,6	91,2
125	24,1	289,2
150	57,7	692,4
200	42,6	511,2
total:	132,0	1584,0

On the basis of the a.m. range of capacity the following lengths of pipes of the different nominal diameters from 50 up to 200 mm will be produced:

	kg/meter	tons/year	meter/year
ND 50	0,854	42,0	49.200,0
ND 65	1,210	24,0	19.800,0
ND 80	1,740	255,6	147.000,0
ND 100	2,600	691,2	266.000,0
ND 125	4,160	289,2	69.500,0
ND 150	5,460	692,4	128.000,0
ND 200	10,800	511,2	47.300,0
total:		2.505,6	726.800,0

2.2.2. Mixers

Times on inactivity effected by changing of tools, cleaning, maintenance lower the capacity and have to be considered by a certain safety factor. Furthermore the peak loads which occur sometimes are protected by a safety factor.

The required safety factor amounts up to 25%.

Therefore a mixing capacity of
 $435 \text{ kg} \times 1,25 = \underline{544 \text{ kg/h}}$ is required

The following type of mixer is provided:

1 Heated Mixer - Cooled Mixer 350/1050 l
 capacity: appr. 700 kg/h
 at a cooling-water temperature of 15° C
 (appr. 500 kg/h at a cooling-water temperature of 25° C)

Therefore an additional capacity reserve exists for further increases of the total capacity of the points.

2.2.3. KN-socket-forming Equipment

(for rubber ring sealed joints)
(only for pipes from ND 50 to ND 200)

The following table shows the rate of utilization of the equipment:

ND	meters/ year	length/ pipe/ meters	required num- ber of socket /year(pieces)	cycling for socket for- ming (min)	cto. (h)	time for forming (h)
50	49.200	6	8.200	1,9	0,0317	260
65	19.300	6	3.300	1,9	0,0317	105
80	147.000	6	24.500	2,0	0,0333	816
100	266.000	6	44.333	2,2	0,0367	1625
125	69.500	6	11.600	3,0	0,05	530
150	128.000	6	21.333	4,1	0,0684	1458
200	47.300	6	7.883	7,6	0,127	1000

TOTAL:

5844 h

Therefore only one socket forming device is necessary.

In case the range of the programme will be changed, the time for socket forming also changes.

3. PROCESSING

The process engineering which is the basis of this project starts with the supply of the raw material in bags, and finishes with the pressure pipe, ready for dispatch.

It has to be considered that, at least, in the first stage of production the required fittings and rubber rings will have to be purchased externally. If you wish, you can procure such accessories from us.

Furthermore it has to be considered that the experiences concerning the production of Gebr. Anger are practiced as far as possible.

The process is briefly described as follows:

The PVC-powder which is supplied in bags has to be conveyed by a small conveying system to the mixer. Dosing of the required additives (stabilizers, lubricants and pigments) as well as feeding of these additives to the mixer are manually effected.

At the discharge of the cooled mixer a sieving machine is fitted.

The finished dry-blend is conveyed into transport-containers. In these transport-containers the dry-blend is stored for a certain lapse of time in order to remove the electro-static charging which arises from the mixing procedure and to give the dry-blend time to cool down to a fixed temperature of operation.

The transport-containers are carried by lift trucks to the extruders and conveyors are conveying the dry-blend into the extruders.

In the extruders, the dry-blend is compressed, homogenized and formed to a pipe by the forming die and calibration sleeves. The pipe is then cooled in the bath. With measuring and embossing devices which are located between water bath and cater pillar haul-off the pipes are embossed with the different data of the product.

The haul-off serves for taking the pipes out of the die, the pipes are cut in the desired length by the circular cut-off saw combined with chamfering equipment.

During the extrusion process the KM-pressure pipes with ND from 50 up to 200 mm obtain at the area which has later to be formed to a joint a wallthickening in order to equalize the diminution of the wallthickness during the process of forming the joints.

From the automatical tip of the circular saw the pipes are transported manually to the socket forming equipment. The wallthickened ends of the pipes are heated and provided with socket joints on special equipment.

The pressure-pipe joints at the pipes from ND 50 up to ND 200 are made by the so-called collapsing core process.

After jointing and testing the pipes are ready for dispatch.

4. EQUIPMENT

4.1. Dryblend-processing

The equipment for processing the dryblend consists of:

1 Feeding Device

equipped with bagged PVC handling unit, blower station, conveying pipe conduits preliminary containers with filter support, stop cock valve, conduits to mixer and control instruments to be installed in the control panel of the mixer.

1 Heated and cooled mixer combination

output capacity appr. 700 kg/h in 4-5 charges
total container volume:
heating mixer: 350 l
cooling mixer: 1050 l

complete with:
feeding device for additives
stage of installation,
driving by electro-motors and
control panel

1 sieving machine, output capacity appr. 1500 kg/h

9 Transport containers

content: each 1,5 cbm

2 Manual operated lifting devices

for handling the transport containers

Total price for the dry-blend-processing equipment

DM 202.C40,--

4.2. Extrusion equipment

4.2.1 Extrusion line no. 1

- 1 Twin-Screw-Extruder K86-0-16 D with 86 mm screw diameter complete with
 - 1 pair of screws
 - 1 vacuum system
 - 1 support for fixing the conveyor
 - 3 breaker plates
 - 3 screen plates
 - 1 horizontal dosing device
 - 1 heating unit for heating and cooling the screws
- 1 Control cabinet with thyristor device complete with 10 regulators
- 1 conveyor fixed at the feeding hopper of the extruder
- 1 Extrusion head K 2
- 1 Set of Dies ND 50
- 1 Set of Dies ND 65
- 1 Set of Dies MD 80
- 1 Extrusion head K3
- 1 Set of Dies ND 100
- (all sets of dies compl with calibrating sleeves and plugs)
- 1 Water Bath for pipes up to 120 mm \emptyset
- 1 Embossing device
- 1 Caterpillar-Haul-Off for pipes up to 315mm \emptyset (haul-off incl. additional gear units for wallthickening)
- 1 Circular Saw for cutting off, suitable for pipes up to 160 mm \emptyset (with parting tool, chamferring tool and the corresponding clamping jaws).
- 1 Discharge Table for pipes of 6 m length.

Total price of Extrusion Line no. 1

4.2.2 Extrusion line no. 2

1 Twin-Screw-Extruder K 107-0-16 D
with 107 mm screw diameter

complete with

- 1 pair of screws
- 1 vacuum system
- 1 support for fixing the conveyor
- 3 breaker plates
- 3 screen plates
- 1 horizontal dosing device
- 1 heating unit for heating and cooling the screws
- 1 Control Cabinet with thyristor device complete with 12 regulators
- 1 Conveyor, fixed at the horizontal dosing device on the extruder
- 1 Extrusion head K 4
- 1 Support Carriage
- 1 Set of Dies ND 125
- 1 Set of Dies ND 150
- 1 Extrusion head K 5
- 1 Support Carriage
- 1 Set of Dies ND 200
(all sets of dies compl. with calibrating sleeves and plugs)
- 1 Water Bath for pipes up to 225 mm \emptyset
- 1 Embossing Device
- 1 Caterpillar-Haul-Off for pipes up to 315 mm \emptyset with additional gear unit for wallthickening
- 1 Circular Saw for cutting off, suitable for pipes up to 225 mm \emptyset with parting tool, chamferring tool and the corresponding clamping jaws.
- 1 Discharge Table for pipes of 6 m length.

Total price of the extrusion line no. 2:

DM 589.620.--
.....

4.3. Socket forming equipment for pressure pipes

4.3.1 Equipment for rubbering sealed pipes consisting of:

- 1 basic equipment type I/200/A for ND 50 - 200 consisting of casing, hydraulic, sliding supports, electrical control panel desk
- 1 set of interchangeable jaws for ND 50, 65, 80, 100, 125, 150, 200
- 1 set of KM socket forming tools with compression shaft and mechanical clamping device and limit switch for the sliding support, ND 50, 65, 80, 100, 125, 150, 200
- 1 set of additional tools for double socket (MM-KS) ND 50, 65, 80, 100, 125, 150, 200 and take off device mounted on the sliding support
- 1 set of additional tools for sleeve joint U-KS ND 50, 65, 80, 100, 125, 150, 200
- 1 KM-Heating equipment with electrical regulation device and the following heating units ND 50 + 125 combined
ND 65 + 150 combined
ND 80 + 200 combined
ND 100
- 1 Electrical heated oil tank for U-KS with control panel and exhaust cover suitable for all nominal diameters

Total price of the socket forming equipment:

DM 241.030,--

4.4. Control and testing instruments

In order to make the following tests the purchase of the corresponding devices is recommended:

4.4.1 Raw material

- a) determination of the flowing speed
- b) determination of the bulk density
- c) determination of the jolting volume
- d) determination of the distribution of particle size
- e) determination of the k-value
- f) determination of volatile ingredients

Total price of the required testing devices for the raw material:

DM 24.550,--

4.4.2 Finished products

- a) measurement of the wallthickness
- b) measurement of the circumference
- c) measurement of the inside diameter of the grooves
- d) measurement of the dimensions of socket at pressure pipes with inter-face calibrated mandrel
- e) impact strength test
- f) testing of water absorption
- g) testing of changing measures during heat treatment
- h) long-term creep strength by internal pressure

Total price of the required testing instruments for testing the finished products:

DM 84.710,--

4.5. Reject material processing

As it happens with each plastic proceeding also during production of PVC-pipes a certain amount of a so called reject material has to be considered.

The reject material arises during starting the extrusion process, pipes which do not correspond to the standards of dimensions, quality, as well as off cuts.

The reject material amounts to 9 - 12 % of the production. Considering a capacity of two extrusion lines with appr. 348 kg/h reject material of approx. 40 kg/h has to be grinded.

Due to the big nominal diameters of the pipes a grinding mill is provided, which effects a higher capacity. The grinded reject material has to be sieved and again transmitted to the production process. This is effected by transport-containers.

The installation for processing the reject material consists of:

- 1 manual operated cut-off-saw
- 1 grinding mill
- 2 conveying equipments for the transportation of the grinded reject material at the sieving machine
- 1 sieving machine
- 3 Transport-Container
content 1,5 cbm

Total price for the equipment:

DM 57.210,--

5. PRICE SCHEDULE AND COMMERCIAL CONDITIONS

5.1. Price schedule

The total price of the equipment is composed as follows:

item 4.1. Dryblend processing equipment:	DM	202.040,---
item 4.2.1 Extrusion line No.1:	DM	421.468,---
item 4.2.2 Extrusion line No.2:	DM	589.620,--
item 4.3. Socket forming equipment:	DM	241.030,--
item 4.4.1 Testing equipment for raw material:	DM	24.558,--
item 4.4.2 Testing equipment for finished products:	DM	84.710,--
item 4.5. Reject material processing:	DM	57.210,--
TOTAL PRICE:	DM	1.620.636,-- *****

These prices will be increased by 10% from July 1, 1971.

These quotes can then be held valid subject to the development of costs and wages in Germany.

5.2 Commercial Conditions

Prices: The prices are to be understood f.o.b. European seaport of our choice, seaworthy packing included.

Delivery: approx. 7 months after receipt of order and settlement of all technical and commercial details.

Payment: 50 % against confirmation of order
50 % against an irrevocable letter of credit to be confirmed in our favour.

6. Technical assistance and Know-How

Gebr. Anger grants the following technical assistance for the plant:

- a) Set up and starting of the plant executed by specialists after having agreed upon in a separate contract.
- b) Detailed lay out for all machines and equipments concerning the electrical power supply, supply with compressed air and cooling water which is necessary for the channels resp. conduits.
- c) List about the type and quantity of the spare parts and parts subjected to heavy wear and tear which have to be on stock as well offers as concerning the spare parts.
- d) Formulations concerning PVC dry-blends for the manufacture of contractual objects
- e) Instruction for use as well as indications about the maintenance and lubrication for all machines and equipments.
- f) Indication concerning the assistance for the organisation of the plant.
- g) Indication about the erection of the buildings.

The production of pressure pipes with wallthickening according to system Gebr. Anger is only possible after having concluded a license agreement.

On the basis of this license agreement Gebr. Anger allows the licensee to use the patent rights in the resp. country and remits the following documentation.

- a) working standards including all details (requirements of quality, dimensions, tolerances, etc.) for all products.
- b) Training without charge of the staff in our works (only the travelling costs and the costs for maintenance of the staff have to be paid by the licensee).
- c) Indication for an optimum program organisation.
- d) Laying instructions.
- e) Permanent exchange of experience concerning all problems of the manufacture, the selling and the application of the contractual objects.
- f) Summary about the required raw- and auxiliary materials, necessary for running the plant with a statement of the sources of supply.
- g) Indication about testing and analysis methods for raw materials and finished products.
- h) Indication about precautionary measures of work and fire on the basis of the German laws.

7. REQUIREMENT OF PERSONNEL AND ENERGY

The requirements of personnel and energy is composed in the following table:

1 shift	=	7 persons
2 shifts	=	6 persons
3 shifts	=	<u>7 persons</u>
total:		20 persons

This table includes only technical staff for running the plant.

The column "electro-energy" is divided in:

total connected load
duration of switching on
effective consumption

For the calculation of the conversion costs the total consumption of 120 kWh/h has to be considered.

	requirement of staff (shifts)			compressed air m ³ /h 6 atm	cooling water m ³ /h 20°C, 4 atm	electro-energy connected load 220/380 V 50 Hz	duration of switching on	effective consumption (kW)
	1	2	3					
1. Dryblend processing 1 conveying system 1 heated/cooled mixer 500 kg/h	1	1	3	1,0	3,0	7,5 88,0	20 70	1,5 61,5
2. Extrusion lines 2 extrusion lines	2	2	2	2,0	4,5	166,-	35	58,2
3. Joint-forming 1 socket-forming equipment	1	1	1	1,0	2,0	8,-	60	6,4
4. Control + testing instruments	1	1				10,-	20	2,0
5. Processing of reject material	1					26,-	20	5,2
6. Transportation	1	1	1					
7. Maintenance			1					
8. Shift leader			1					
TOTAL:	7	6	7	4,0	9,5	305,5		134,0

8. Scope of supply

The following items are included:

- a) Cable conduits between machine resp. equipment and control panel
- b) Cable conduits between all machines of the production line.
- c) All required attachments to combine the machines and the equipment.

The following items are not included:

- a) Platforms, walkways, stairs, railings, guards as far as they are not mentioned in item 4 of this project.
- b) Conduits for water, waste water and air.
- c) Compressor station for the required compressed air.
- d) Lubricants for all drivings, hydraulic oil and oil for heat transfer.
- e) Electric cables up to the control panels of the machines and instruments.
- f) All installations for the supply of electric energy.
- g) Spare parts as far as they are not mentioned in the extension of delivery.

9. CALCULATION OF COSTS

9.1. Costs of raw material

The requirement of raw material to increase by the amount of scrap which cannot be used any more for the production of pipes.

An amount of 1 percent scrap has to be considered.

For a net output of 208,8 tons - 211 tons of raw material are therefore required.

The costs of material can be calculated by using a basis formulation as well as by means of cif. prices and costs of duty.

weight	component of formulation	DM/t cif	total price DM
203,5	S-PVC k-value 70	1.200,--	244.000,--
3,40	3-basic lead sulphate (stabilizer)	2.620,--	8.700,--
1,7	51 % lead stearate (stabil.)	3.750,--	6.360,--
0,54	calcium stearate (stabilizer with lubricant effect)	2.250,--	1.215,--
0,43	stearine acid (lubricant)	1.500,--	645,--
0,43	paraffin (lubricant)	1.200,--	515,--
0,10	pigments	5.600,--	560,--
1,00	calcium carbonate	300,--	300,--
211,00			262.295,--

The costs concerning the raw material for the manufacture of 208,8 tons of pipes per month amount to DM 262.295,--

The raw material costs for 1 kg PVC-pipes are calculated as follows:

$$\frac{262.295}{208,8} = 1,257 \text{ DM/t} = 1,26 \text{ DM/kg approx.}$$

9.2. Buildings

For the installation of the production equipment the following buildings are required:

	area	hight	reconstructed area
Mixing equipment	7,5x10 = 75 m ²	12 m	900 m ³
Extrusion hall	60x10 = 600 m ²	5 m	3.000 m ³
Processing of re- ject material etc.	33x 5 = 165 m ²	5 m	825 m ³
Raw material storage	15x10 = 150 m ²	4 m	600 m ³
Logistic rooms	50x 5 = 250 m ²	4 m	1.000 m ³
Total:	1.240 m²		6.325 m³

The costs per m³ of a reconstructed area amount to DM 70,-

The costs of the buildings are then amounting to DM 443.000,--

For the further calculation an amount of DM 500.000,-- for buildings is considered.

For the necessary plot of land of appr. 3000 m² the costs amount to DM 75.000,-- considering a price of DM 25,-/m².

9.3. Calculation of costs (summary)

Item	kind of costs	DM/month	DM/kg
(basis fob European port)			
1.	<u>Costs of raw material</u>	262.295,--	1,26
<hr/>			
2.	<u>Costs of manufacturing</u>		
2.1.	costs of wages 20 persons x 1.200 DM/month	24.000,--	
2.2.	costs of energy 134 kWh/h x 600 h/month x 0,10 DM/kWh	8.040,--	
2.3.	auxiliary materials + fuels	2.000,--	
2.4.	further operating costs	2.000,--	
2.5.	maintenance of the production plant	10.000,--	
2.6.	service of stock		
	machines DM 1.618.900,--		
	freight and packing DM 162.000,--		
	buildings DM 500.000,--		
	<u>plot of land DM 100.000,--</u>		
	total DM 2.380.900,--		
	interest 7 %p.a.DM 166.700,--	13.900,--	
	amortization for machines for 5 years p.a. DM 324.000,--	27.000,--	
	amortization for buildings for 25 years p.a. DM 20.000,--	1.660,--	
2.7.	additional costs of factory	6.000,--	
<hr/>			
	Costs of manufacturing total	94.600,--	0,475
<hr/>			
3.	<u>Costs of products total (item 1 +2)</u>	356,895,--	1,735

The figures according to item 2.3./2.4./2.5 as well as to item 2.7. are based on our experiences.

The figure according to item 2.6. (freight and packing) is estimated and is different for every country.

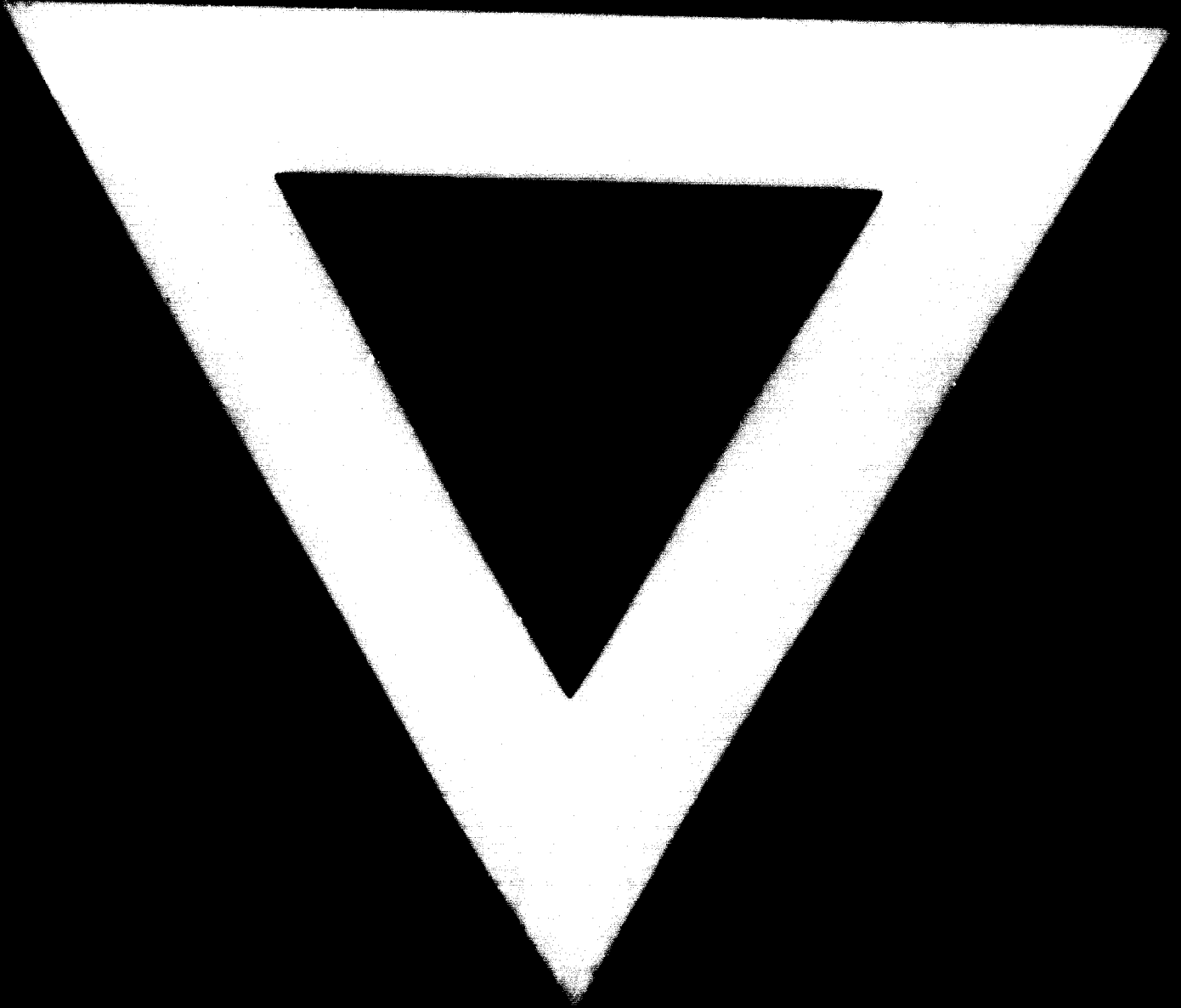
For an exact calculation the costs incurring in the country where the plant is to be installed must be considered by you.

On the basis of this calculation the average prices per m amount to:

ND 50	DM/m:	1,47
ND 65	DM/m:	2,03
ND 80	DM/m:	2,99
ND 100	DM/m:	4,47
ND 125	DM/m:	7,15
ND 150	DM/m:	9,40
ND 200	DM/m:	13,60

The a. m. prices are quoted on the basis of lengths of 6 m including the integral couplings.

If these prices are compared with prices for asbestos cement pipes, it has to be considered that asbestos cement pipes normally are quoted without couplings.



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