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23 January 1978
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ASSISTANCE FOR ZINEB AND MANEB PRODUCTION,

DP/TUR/76/061,

TURKEY.

Terminal report

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

-8 JUN 1978

Based on the work of Cesare A. Peri, chemist

United Nations Industrial Development Organization
Vienna

id.78-348

Explanatory notes

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

The monetary unit in Turkey is the Turkish lira (LT). During the period covered by the report, the value of the LT in relation to the United States dollar was $US 1 = LT 19.25.

The following abbreviations are used in this report:

TZDK	Türkiye Zirai Donatim Kurumu (General Directorate of Agricultural Supplies)

The following technical abbreviations are used in this report:

NH_4DTC	ammonium ethylenbisdithiocarbamate
DTC	dithiocarbamates
EDA	ethylenediamine
h	hour
l	litre
t	metric ton
mng	manager

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ABSTRACT

A feasibility study on the project "Assistance for zineb and maneb production" (DP/TUR/76/061) has been carried out in a two-months mission starting from 23 November 1977. The main results of the study are as follows:

1. The foreseen consumption of dithiocarbamates fungicides in Turkey amounts to about 2,125 t in 1980 and 3,200 t in 1984.

2. Turkish agriculture will need mancozeb besides zineb and maneb.

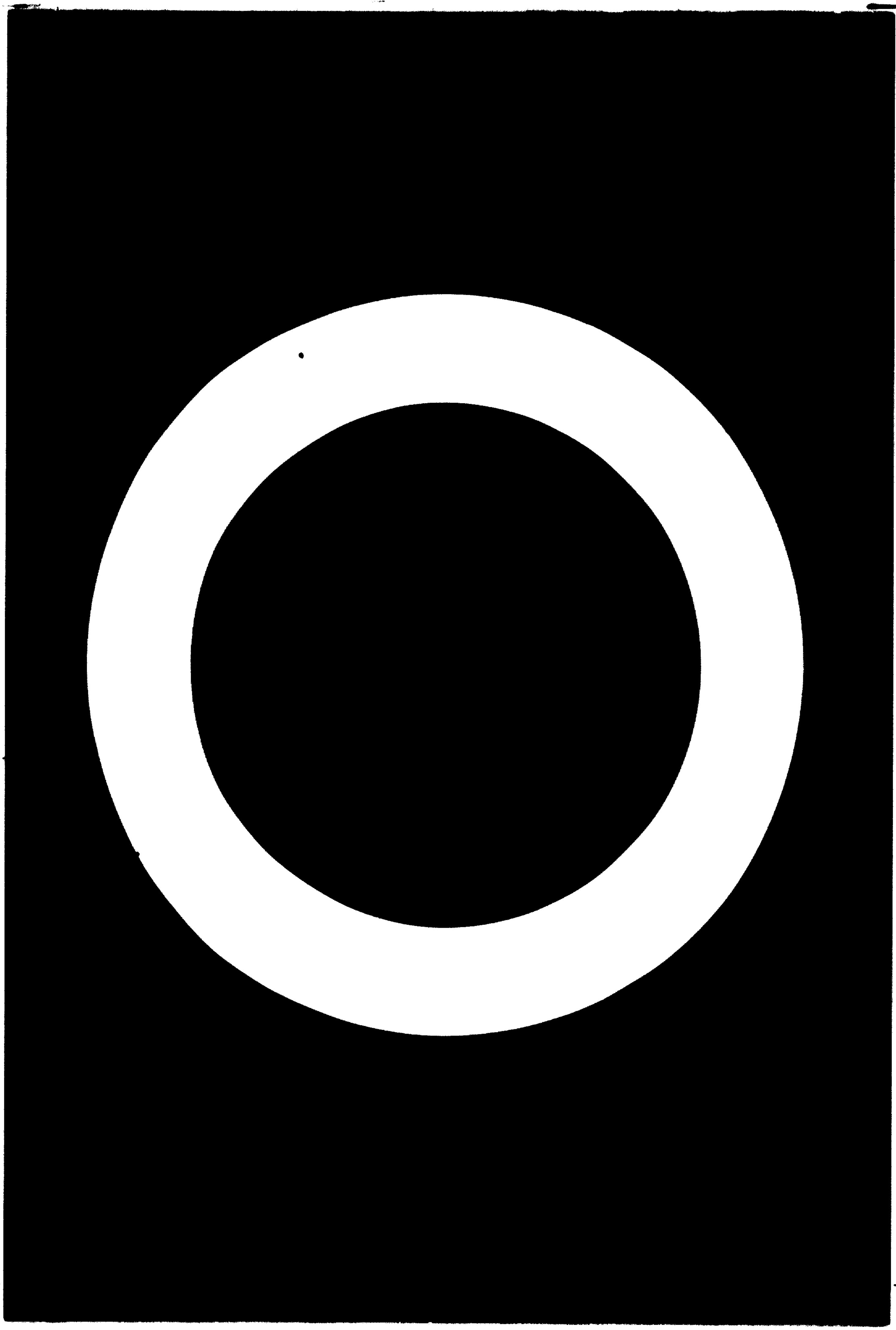
3. A feasibility study on such a type of industrial plant has been carried out, and this report gives details on raw-materials, chemistry, procedure, yields, management, equipment.

4. The total investment cost has been estimated at about LT 90 million: a part of the equipment (about 26%) has to be imported.

5. The investment profitability against the international selling prices has been calculated: only zineb production causes loss of money, while an attractive profitability rises from maneb and mancozeb production. Anyway, the overall return on investment is 10% in 1980 and 25% in 1984.

6. Foreign exchange savings amount to $12 million for the 1980-1984 period.

7. Plant location has been envisaged in the north-west area of Turkey, in Orhangazi (İznik lake).



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INTRODUCTION

The increased consumption of fungicides in Turkey led the Turkish Government to request UNDP aid for establishing a local production of DTC derivatives. The initial request of the Turkish Government was for a zineb and maneb production but after this request they wanted to consider the manufacturing of mancozeb too.

Owing to the technical possibility of producing the three fungicides in the same plant, this feasibility study will consider this additional request, according to the agreement of UNIDO.

The requirement of these fungicides is very important for the country, since they are widely used in the protection of tobacco, an important export cash crop, against peronospora tabacina, and vineyards and orchards.

Current annual imports in these products amount to more than $500,000 ($680,000 in 1975 and $580,000 in 1976), so their production has been included in the third Five-Year Development Programme in the "Future Ingredient Production Facilities" section of the recommendations of the Agricultural Sub-Committee.

No work was carried out by UNIDO in the same field previously in Turkey.

The Turkish Government has decided to examine the possibility of a local manufacturing of DTC fungicides, consequently on 21 December 1976 requested expert assistance from UNDP in carrying out a feasibility study of zineb and maneb production in Turkey.

In response to this request UNDP approved the request on 21 April 1977 and set up a project DP/TUR/76/061/B/01/37 entitled "Assistance for zineb and maneb production", with UNIDO as the executing agency and TZDK of the Ministry of Agricultural, Government of Turkey, as the Government counterpart.

Therefore, Mr. C.A. Peri, UNIDO consultant, undertook a two months mission, beginning from 23 November 1977, to assist TZDK in the feasibility study of such a production. The whole study would have been carried out by two UNIDO experts (Mr. Peri and Mr. Sartori) but Mr. Sartori, expert in tender specifications, did not accept the job. So, this study does not deal with this last item. During the various meetings with TZDK managers, they agreed to first carry out the feasibility study and to get the tender specifications after the examination of the feasibility study.

The objective of the project was to examine the feasibility of establishing a plant for DTC manufacturing in Turkey.

I. THE MARKET

The demand and the offer of the last five years

Zineb, maneb and mancozeb are imported in Turkey, both as finished products and as technical active ingredients. In this second case they are formulated by local companies. In comparison to previous years, importation of these DTC fungicides has increased in the last five years. Table 1 shows the total amount of imported zineb, maneb and mancozeb.

Table 1. DTC imported in Turkey in the last five years (Tons of active ingredient)

Year	Zineb	Maneb	Mancozeb
1972	416.8	144.4	16.6
1973	526.4	-	-
1974	170.5	35.9	36.0
1975	460.1	56.0	60.0
1976	604.1	40.0	36.0

According to the programmes stated by the Turkish Agricultural Protection Agency (Zirai Mücadele ve Karantina Genel Müdürlügü) the calculated requirements for the last five years should have been as shown in table 2.

Table 2. DTC needed according to the agricultural protection programme (Tons of active ingredient)

Year	Zineb	Maneb	Mancozeb a/
1973	284.0	211.2	371.6
1974	256.0	94.5	673.6
1975	455.9	223.2	531.4
1976	373.0	263.4	910.4
1977	557.0	271.2	1145.6

a/ Mancozeb figures are based on the hypothesis that this fungicide should have been used as a substitute for mercury seed dressing chemicals.

Capacity of the DTC plant

The capacity of the DTC plant has been established by TZDK on the following basis:

Mercury seed dressing chemicals will be prohibited in the near future, according to international rules

In the case of a local DTC production the current usage of 55-60% for the main applications, i.e. spraying tobacco, vineyards and orchards, will be increased up to 100%

Turkish Government is ready to take all measures so that zineb, maneb and mancozeb local production will be used instead of imported fungicides

Especially mancozeb will be encouraged because of its synergist activity in combined application with other fungicides

Zineb, maneb and mancozeb will be used against the following pathogen fungi and bacteria on fruits, vegetables, industrial crops and cereals: Venturia, Gymnosporangium, Monilia, Glasterosporium, Alternaria, Uromyces, Peronospora, Bremia, Phytohthora, Botrytis, Septaria, Cercospora, Plasmopora, Xanthomanus Tillatia, Ustilago.

Taking into account all these considerations, TZDK has established the following requirements and plant capacities:

Table 3. Capacity of the DTC plant
(Tons of active ingredients)

Year	Zineb	Maneb	Mancozeb	Total	Percentage coverage of crops
1980	525	300	1 300	2 125	65
1981	600	350	1 500	2 450	75
1982	675	375	1 700	2 750	85
1983	725	400	1 800	2 925	90
1984	800	450	2 000	3 250	100

II. GENERAL SCHEME OF THE MANUFACTURING OF ZINEB, MANEB AND MANCOZEB

Zineb

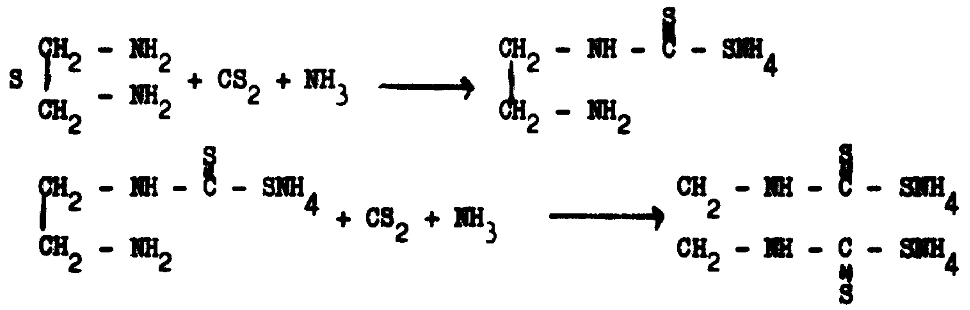
Zineb is the zinc salt of the etylene-bisdithiocarbamic acid.

Main reactions

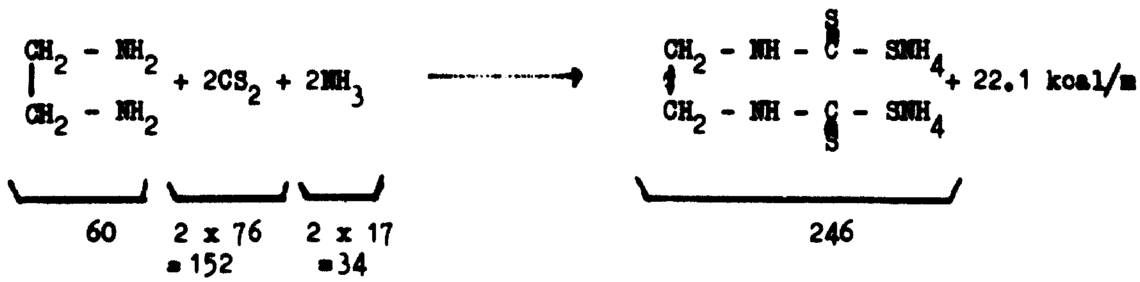
Synthesis of NH_4DTC

By reaction among CS_2, EDA and a stronger base.

The reactions occur through two main steps:

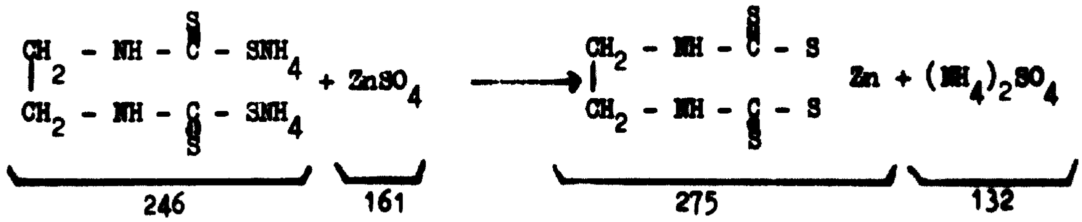


The global reaction is as follows:



Precipitation of zineb

The reaction of the NH_4DTC and a zinc salt provides the product and ammonium sulphate as by-product:



Side reactions

Under some conditions the following other reactions might occur:

Reaction between CS_2 and NH_3 with the formation of ammonium dithiocarbamate:

$$CS_2 + 2NH_3 \dashrightarrow NH_2-\underset{\underset{S}{\|}}{C}-SNH_4$$

This reaction occurs when a large excess of ammonia or insufficient EDA are present.

Decomposition of the aforesaid ammonium dithiocarbamate:

$$2NH_2-\underset{\underset{S}{\|}}{C}-SNH_4 \dashrightarrow (NH_4)_2S + NH_4SCN + CS_2$$

The decomposition occurs in alcali ore medium.

Reaction between ammonium sulphide and CS_2 with formation of ammonium trithiocarbonate:

$$(NH_4)_2S + CS_2 \dashrightarrow (NH_4)_2CS_3$$

This product may give red colour to the solution of the NH_4DTC.

Decomposition of the ethylene-monothiocarbamic acid to ethylene-thiourea

$$\begin{matrix} CH_2-NH-\overset{\overset{S}{\|}}{C}-SH \\ | \\ CH_2-NH_2 \end{matrix} \dashrightarrow \begin{matrix} CH_2-NH \diagdown \\ | \qquad\quad C=S \\ CH_2-NH \diagup \end{matrix} + H_2S$$

This dangerous reaction can be avoided operating in alcali ore medium and with an excess of CS_2.

Partial decomposition of the NH_4DTC by ammonia and formation of the β-isothiocyanoethylammoniumcarbamate:

$$\begin{matrix} CH_2-NH-\overset{\overset{S}{\|}}{C}-SNH_4 \\ | \\ CH_2-NH-\underset{\underset{S}{\|}}{C}-SNH_4 \end{matrix} + NH_3 \dashrightarrow \begin{matrix} CH_2-NH-\overset{\overset{S}{\|}}{C}-SNH_4 \\ | \\ CH_2-N=C=S \end{matrix} + (NH_4)_2S$$

Large excess of NH_3 should be avoided during the reaction.

Maneb

Maneb is the manganese salt of the ethylene-bisdithiocarbamic acid.

Main reactions

Synthesis of NH_4DTC

See under zineb.

Precipitations of maneb

The precipitation occurs by reaction of NH_4DTC and a manganese salt:

$$\underbrace{\begin{matrix} CH_2-NH-\overset{\overset{S}{\|}}{C}-SNH_4 \\ | \\ CH_2-NH-\underset{\underset{S}{\|}}{C}-SNH_4 \end{matrix}}_{246} + \underbrace{MnSO_4}_{151} \dashrightarrow \underbrace{\begin{matrix} CH_2-NH-\overset{\overset{S}{\|}}{C}-S \diagdown \\ | \qquad\qquad\qquad\qquad Mn \\ CH_2-NH-\underset{\underset{S}{\|}}{C}-S \diagup \end{matrix}}_{265} + \underbrace{(NH_4)_2SO_4}_{132}$$

The by-product is again ammonium sulphate.

Side reactions

See under zineb.

Mancozeb

Mancozeb is a complex of zinc and maneb containing about 20% manganese and 2.5% zinc.

Main reactions

Synthesis of NH_4DTC

See under zineb.

Precipitation of mancozeb

The precipitation occurs by reaction of NH_4DTC and manganese/zinc salts to form the complex

$$\left[-S-\underset{\underset{S}{\|}}{C}-NH-CH_2-NH-\underset{\underset{S}{\|}}{C}-SMn\right]_x (Zn)_y$$

Side reactions

See under zineb.

III. RAW MATERIALS

For zineb, maneb and mancozeb production the following raw materials are needed:

Carbon disulphide
Ammonia
EDA
Sulphuric acid
Zinc sulphate
Manganese sulphate
Hexamethylene-tetramine (stabilizer for maneb)

Alternatives and motivation for the choice

Carbon disulphide. This product has no alternatives.

Ammonia. Ammonia can be supplied both as anhydrous ammonia and in the form of 20% aqueous solution. In this second case the storage space requirement is bigger, but less expensive than in the first case, because for storing anhydrous ammonia pressurized containers are required. Handling of ammonia solution is less dangerous than handling dry ammonia. It is possible to use NaOH too, but the by-product form using ammonia $(NH_4)_2SO_4$ is more useful and valuable than Na_2SO_4. The recommended choice is aqueous ammonia solution.

EDA. It is possible to work also with a mixture of EDA and higher diamines, like diethylene-diamine, triethylene-triamine, triethylene-poliamine and so on; but the usage of this mixture gives rise to several physical forms of zineb, and it is not suitable in the case of maneb. So, it is suggested that technically pure EDA be used.

Sulphuric acid. There are no problems, because sulphuric acid is required only in small amounts to correct the pH value during the preparation of zineb and is locally available.

Zinc sulphate. This reagent can be used both in solid state and in 12% water solution. In the first case a special equipment is required to prepare the water solution; in the second case the cost of transportation increases. So it is suggested to use the reagent as a solid. In the zineb and maneb synthesis zinc chloride and manganese chloride can be used instead of the sulphates; in this case the by-product is NH_4Cl. It is felt that it would be more attractive to have $(NH_4)_2SO_4$ as a by-product because of the possibility to recover it (evaporating mother liquors) and producing a useful fertilizer. This recovery of ammonium sulphate is not dealt with in this report, but it is recommended, both from an economic point of view and from the point of view of waste disposal. Therefore, the use of zinc sulphate is recommended instead of zinc chloride.

Manganese sulphate. For this product see the above considerations applied to the zinc sulphate.

Hexamethylene-tetramine. Several products can be used as stabilizer, such as calcium or zinc bromide, alumina, silica gel, calcium sulphate etc. Hexamethylene-tetramine is suggested because it is best tested.

Specifications for raw materials

Carbon disulphide

Distilled liquid
Purity: about 99%
Boiling point: 46°-47°C
Density: 1.265 at 20°C
Residue to evaporation: max. 50 ppm
H_2S: absent

Ammonia water solution

Liquid
Purity: about 20%
Density: 0.92 at 20°C

EDA

Liquid
Purity: 98-99%
Melting point: 9°-11°C
Boiling point: 115°-119°C
Density: 0.89 - 0.90 at 20°C
Flash point: 40°C

Sulphuric acid (water solution)

Liquid

Purity: 30%

Density: 1.22 at 20°C

Zinc sulphate

Solid

Formula: $ZnSO_4 \cdot 7H_2O$

Purity: 98-99%

Impurities: Na 1%; calcium, iron, arsen, lead, manganese, less than 0.5%

Particle size: 0.5 mm max.

Manganese sulphate

Solid

Formula: $MnSO_4 \cdot H_2O$

Purity: 98-99%

Impurities: calcium, iron, arsen, lead, zinc, less than 0.5%

Hexamethylene-tetramine

Pure grade

Specific raw material requirements

In table 4 the stiochiometric figures for zineb and maneb are reported, in table 5 the actual raw material requirements for one ton product are listed.

Table 4. Stoichiometric raw material requirements per ton of product

Product	Raw material							
		Ammonia			$ZnSO_4$		$MnSO_4$	
	CS_2	100%	As 20% solution	EDA	Dry	$7H_2O$	Dry	As $1H_2O$
Zineb	0.550	0.123	0.615	0.217	0.585	1.041	-	-
Maneb	0.573	0.128	0.64	0.226	-	-	0.569	0.636

Table 5. Specific raw material requirements per ton of product

Raw material / Product	CS_2	Ammonia		EDA	Sulphuric acid		Zinc sulphate		Mn sulphate		Stabilizer
		100%	As 20% solution		98%	As 30% solution	Dry	As $7H_2O$	Dry	As $1H_2O$	
Zineb	0.600	0.130	0.650	0.235	0.032	0.104	0.600	1.070	-	-	-
Maneb	0.635	0.135	0.675	0.245	-	-	-	-	0.570	0.638	0.03
Manocozeb	0.675	0.142	0.710	0.253	-	-	0.073	0.130	0.536	0.600	-

Sources and prices of raw materials

A survey has been made on the sources of raw materials needed for zineb, maneb and mancozeb production.

Carbon disulphide. This raw material is produced in Turkey by Sümerbank at Gemlik, but only for captive use. The quantity needed is about 1,700 t/year. The international price is about $0.22 per kg. Other major producers (for example) are Stauffer Chem. Co. (USA), PPG Industries (USA), Baker J.T. Chem. Co. (USA), FMC Corp. (USA), Snia Viscosa (Italy).

Ammonia. It will be produced in Turkey by Azot Sanayii at Gemlik, within one year. In Turkey other producers use ammonia for fertilizer plants. The quantity needed is about 380 t/year (100% basis). The price is about LT 2.8/kg (100% basis).

EDA. This raw material is not produced in Turkey. The quantity needed is about 700 t/year. The international price is about $1.4 per kg. The main producers are Montedison (Italy), Dow Chem. (USA), Union Carbide (USA), BASF (Federal Republic of Germany).

Sulphuric acid. It is produced in Turkey by Etibank at Bandirma, with a capacity of 120,000 t/year. The quantity needed is about 20 t/year (98% basis). The price now is LT 2.2/kg.

Zinc sulphate. It is produced in Turkey by Kemal Göknur, Sinai Maddeler at Bandirma. The quantity needed is about 530 t/year (100% basis). The international price is about LT 6.5/kg (100% basis). Other producers (only as an example) are: Ashland Chem. Co. (USA), United Mineral and Chem. Co. (USA), Sherwin-Williams Ch. Div. (USA), Zindler (Italy), Hoechst (Federal Republic of Germany).

Manganese sulphate. It is not produced now in Turkey, but if the demand will increase there is a possibility to produce it at Antalya or Bandirma. The quantity needed is about 1,120 t/year (100% basis). The international price is about $0.4/kg. Producers (only as an example) are Diamond Shamrock (USA), United Mineral and Chem. Co. (USA), Hoechst (Federal Republic of Germany).

Hexamethylene-tetramine. It is produced in Turkey by Karbokimya Endustrive Ticaret AS. at Istanbul. The quantity needed is about 10 t/year. The price is about LT 30/kg.

IV. THE MANUFACTURE OF ZINEB, MANEB AND MANCOZEB

NH_4DTC plant

The plant has been considered for the continuous manufacturing of a water solution of the NH_4DTC, which is the basic intermediate for the metal salts of DTC. The plant has to be considered a multipurpose plant, which could produce other DTC, if necessary, by changing some raw materials (for example by using NaOH instead of ammonia it is possible to produce nabam, another member of the DTC family). See annex I for the flow-sheet for the continuous manufacturing of the NH_4DTC water solution.

Precipitation of zineb, maneb and mancozeb

This section of the plant has been studied for the continuous manufacturing of metal salts of DTC, starting from the aforesaid NH_4DTC water solution. Its work-plan should be as follows (based on figures of 1984 demand):

87 days/year using $ZnSO_4$ to produce zineb
37 days/year using $MnSO_4$ to produce maneb
176 days/year using $MnSO_4$ and $ZnSO_4$ to produce mancozeb

The plant has a high flexibility, so the quantities of DTC may be changed according to the market requirements. The flow-sheet of the continuous manufacturing of zineb, maneb and mancozeb is also shown in annex I.

NH_4DTC production process

NH_4DTC is manufactured in aqueous solution by a continuous reaction of CS_2, EDA and ammonia. The main equipment consists of three reactors (total utilized volume 3,400 litres) set up at descending levels and joined through side tubes set near the top of each vessel. In the first of these reactors the following reagents are introduced at the same time:

CS_2, 202 l/h
Water, 205 l/h
EDA, 115 l/h
20% ammonia, 321 l/h

The right ratio among the reagents, pH, temperature, stirring and contact time must be strictly controlled. The contact time is arrived at by dividing the total useful reactor volume by the total reagent's volume per hour.

The liquid product which flows through the side-tube of the third reactor is continuously transferred into a static liquid/liquid separator, where the unreacted CS_2 is collected and recycled to the process.

The upper layer, through all intermediate storage vessel and a pump, is continuously transferred into a heat-exchanger and a stripping column where some residual CS_2 is eliminated by an inert gas stream. The product coming out from the bottom of the column consists of NH_4DTC water solution with the following properties:

NH_4DTC: 45-47%
pH: 8-8.5
D_{20}: 1.165-1.169

The productivity of the plant is 860 l/h of NH_4DTC water solution. This amount corresponds to about 2.8 kg of NH_4DTC (100%) per each litre of reactor in 24 hours. For the required 1984 DTC production this section of the plant must work about 300 days/year.

Zineb production process

Zineb is manufactured in aqueous medium by a continuous reaction between NH_4DTC and $ZnSO_4$. The $ZnSO_4$ water solution is prepared in a suitable vessel in which the salt is dissolved in water or in mother liquors of zineb washings, the amounts of water and $ZnSO_4$ must be exactly controlled.

The precipitation of zineb takes place continuously in a reactor (total utilized volume 2,450 litre)equipped with a side tube set near the top of the reactor. The following reagents are introduoed at the same time in a continuous way:

NH_4DTC water solution, 656 l/h
$ZnSO_4$ water solution 12%, 1,760 l/h
Sulphuric acid 30%, 28 l/h

The right ratio among the reagents, pH, temperature, stirring and contact time (1 h) must be exactly controlled.

The slurry of zineb and mother-liquors flow through the side tube into a second reactor, which has the same shape and volume as the first, in which the amorphous zineb's particles change their physical properties to crystalline. The slurry coming out from this reactor is continuously filtered in a rotary vacuum filter, in which a large part of the mother liquor is removed.

The composition of the slurry is roughly as follows:

Before first filtration		After first filtration		
Zineb	14%	Cake:	Zineb	42%
$(NH_4)_2SO_4$	8%		$(NH_4)_2SO_4$	5%
$ZnSO_4$	0.1%		$ZnSO_4$	not determined
By-products	0.9%		By-products	2%
Water	77%		Water	51%
		Mother-liquors:	$(NH_4)_2SO_4$	10.5%
			Others	0.5%
			Water	89%

While the mother-liquors could be sent to the recovery of $(NH_4)_2SO_4$, the cake is continuously diluted with water in a screw-conveyor and filtered again in a second rotary vacuum filter, which has the same shape and capacity as the first.

The composition of the product is roughly as follows:

Before second filtration		After second filtration		
Zineb	15%	Cake:	Zineb	45.2%
$(NH_4)_2SO_4$	2%		$(NH_4)_2SO_4$	0.3%
By-products	1%		Others	1.5%
Water	82%		Water	53%
		Mother-liquors:	Water	98%
			Salts	2%

The cake of zineb is continuously sent by a belt-conveyor into another equipment, in which water is added (or recycled mother-liquors) so that a new slurry is formed, whose composition is as follows: zineb 30%, water 70%. This last slurry is dryed in a spray-dry special equipment and zineb is collected.

The dried technical grade zineb has the following average composition:

Zineb	94-95%
Water	2%
$(NH_4)_2SO_4$	less than 1%
Others	2-3%

The capacity of the plant is about 375 kg of zineb per hour. This amount corresponds to about 3.7 kg of technical grade zineb per each litre of reactor in 24 hours. For the required 1984 zineb production the plant shall work about 87 days/year.

Maneb production process

Maneb is manufactured in aqueous medium by a continuous process between NH_4DTC and $MnSO_4$. For details about the equipment for precipitation and volumes see under zineb process. The reagents are:

NH_4DTC water solution, 885 l/h
$MnSO_4$ water solution 16.2%, 1,530 l/h
(Neither sulphuric acid (30%) nor the second filtration are needed).

The composition of the slurry coming into the filter is roughly as follows:

Before filtration			After filtration	
Maneb	18%	Cake:	Maneb	71%
$(NH_4)_2SO_4$	8.5%		$(NH_4)_2SO_4$	1%
$MnSO_4$	0.5%		Water	28%
Water	73%	Mother-liquors:	$(NH_4)_2SO_4$	11.5%
			$MnSO_4$	0.4%
			Maneb	0.1%
			Water	88%

While the mother-liquors could be sent to the recovery of $(NH_4)_2SO_4$ the cake is continuously diluted with water to which a stabilizing agent is added, so that the composition of the slurry becomes: maneb 30%, stabilizer 1%, water 69%. After spray drying the technical grade maneb has the following average composition:

Maneb	92%
Water	0.5%
$(NH_4)_2SO_4$	1%
Others	6.5%

The output of the plant is about 490 kg of maneb per hour. This amount corresponds to about 4.8 kg of technical grade maneb per litre of reactor in 24 hours. For the projected 1984 maneb requirement the plant must work about 37 days/year.

Mancozeb production process

On the basis of the information supplied by UNIDO and other sources, but not by personal experiences, mancozeb can be manufactured by a similar procedure. The reagents are as follows:

NH_4DTC water solution, 862 l/h
$ZnSO_4$ water solution 12%, 255 l/h
$MnSO_4$ water solution 16.2%, 1,340 l/h

For filtration and drying see under maneb process.

The output of the plant has been considered to be about 472 kg of mancozeb per hour. This amount corresponds to about 4.6 kg of technical grade mancozeb per each litre of reactor in 24 hours. For the projected 1984 mancozeb requirement the plant must work about 176 days/year.

V. PLANT LOCATION

The selection of a suitable location for the plant should take into account the following considerations:

Availability of utilities, services (electricity, water, steam) and effluent disposal facilities

Proximity to markets, such as the formulation plants in which DTC are formulated

Other pesticide factories

Price of land

Availability of raw materials and labour

As far as this last item is concerned, for a DTC production unfortunately a large part of raw materials has to be imported, since some are not in local production now. So, the availability of raw materials has been considered only as a future possibility, assuming that the most important raw materials could become available with the expansion of the CS_2 Sümerbank plant (Gemlik) and the creation of an EDA plant, starting from dichlorethan, now produced by Organic Chemical Company (Gemlik). This last alternative is highly recommended.

On the basis of the aforesaid considerations it was felt that the DTC plant should preferably be located in the north-west of the country, close to the İzmit industrial area. In this choice an important consideration was given to the suggestion of this area for a 2,4-D plant, by a UNIDO study. It was felt that it would be more convenient for the Turkish Government to establish a single factory, in which not only DTC, but various pesticides could be manufactured. In this case services for waste disposal, training of workers, chemical and analytical laboratories, social and other services could be provided at the same time and with the same effort.

Taking into account all these factors the expert recommends the choice of the Orhangazi area for the DTC plant.

This area is close to the İznik lake. Obviously water is very conveniently available from the lake; as far as power is concerned there is a high tension transmission line passing through the area and already supplying power to an iron foundry located in this region. Mother-liquors can be discharged into a channel which carries overflow from the lake into Marmara sea. It is important that waste waters of the DTC plant don't contain dangerous contaminating materials. The main by-product is $(NH_4)_2SO_4$, which can be recovered only by evaporating the water, followed by crystallization. This procedure is highly recommended, both for obtaining a useful fertilizer and for decreasing the waste disposal problems. The price of the land in this region also seems to be quite reasonable at about LT 200 per m^2. From all these considerations Orhangazi area seems to be very well situated for locating a DTC plant.

VI. PLANT MANAGEMENT

The capacity of the plant has been planned for a continuous manufacturing of DTC based on the projected 1984 demand and over 300 working days. The initial operating capacity has been planned on the basis of the 1980 demand, that is zineb 525 t, maneb 300 t and mancozeb 1,300 t. (Total 2,125 t of DTC, i.e. 65% of the planned capacity.)

The work will be organized on three shifts, five days/week basis. Table 6 shows the labour requirements and cost. The figure below shows the organizational chart of the plant.

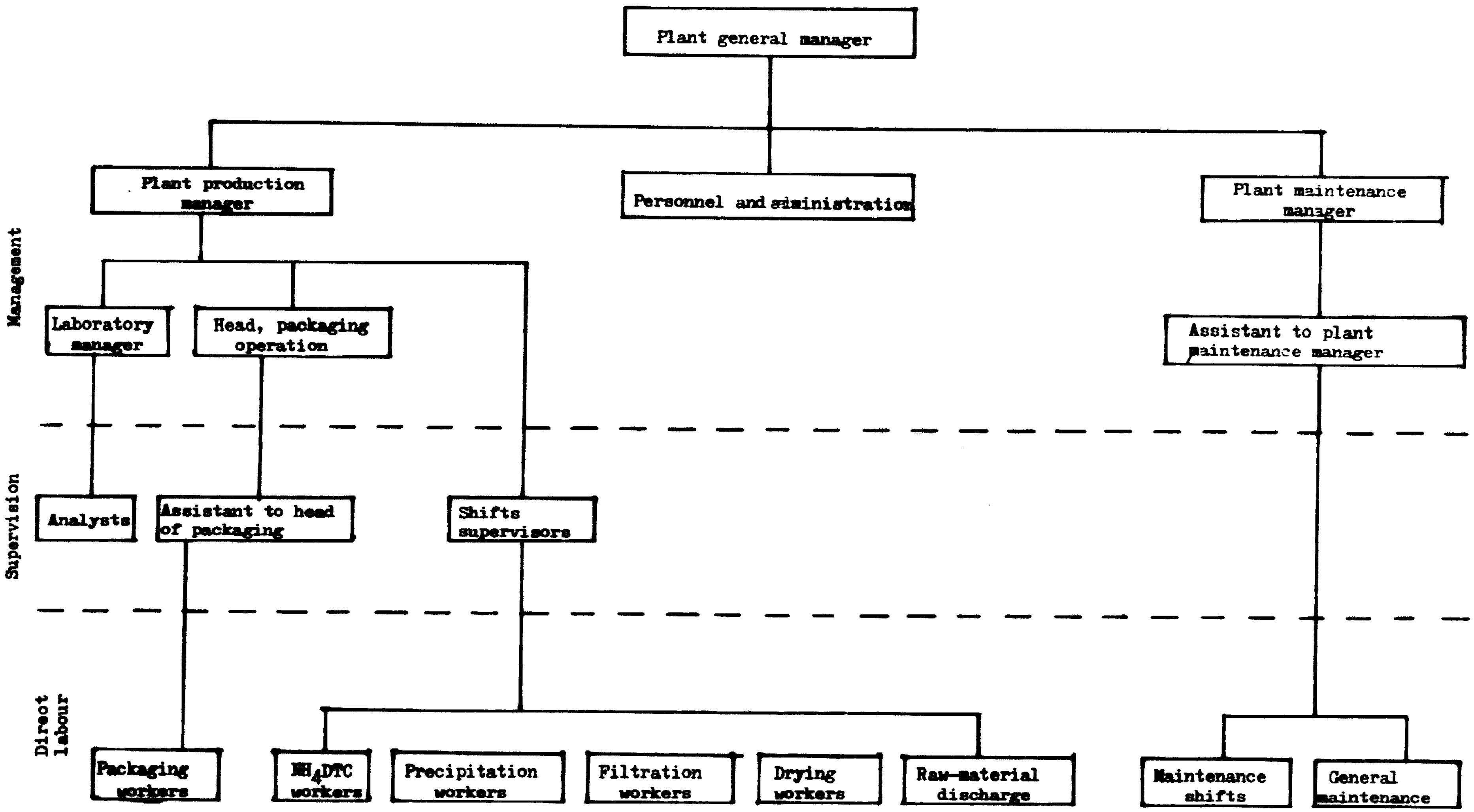
Table 6. Labour requirements and cost

Post title	Number	Qualifications	Monthly salary (LT)	Total monthly expenses (LT)
Management				
Plant general manager	1	Senior chemical engineer	18 000	18 000
Plant production manager	1	Chemical engineer	15 000	15 000
Personnel and administration	1	Administrative	15 000	15 000
Plant maintenance manager	1	Mechanical engineer	15 000	15 000
Laboratory manager	1	Chemistry graduate	8 000	8 000
Head packaging operation	1	Mechanical technologist	8 000	8 000
Assistant to plant maintenance manager	1	Mechanical technologist	8 000	8 000
Subtotal	7			87 000
Supervision				
Analysts	2	Skilled workers	6 000	12 000
Assistant to packaging	1	Skilled workers	6 000	6 000
Shifts supervisors	3	Skilled workers	6 000	18 000
Subtotal	6			36 000

Table 6 (continued)

Post title	Number	Qualifications	Monthly salary (LT)	Total monthly expenses (LT)
Direct labour				
Packaging	3	Workers	4 800	14 400
NH_4DTC	3	Workers	4 800	14 400
Precipitation	3	Workers	4 800	14 400
Filtration	3	Workers	4 800	14 400
Drying	3	Workers	4 800	14 400
Raw-material discharge	2	Workers	4 800	9 600
Maintenance, shifts	3	Workers	6 000	18 000
General maintenance	2	Workers	6 000	12 000
Leave/sickness cover	2	Workers	4 800	9 600
Subtotal	24			121 200
Total	37			244 200

ORGANIZATIONAL CHART



VII. ECONOMIC CONSIDERATIONS

Cost of raw materials

In table 7 the cost of raw materials for 1 t zineb, 1 t maneb and 1 t mancozeb production is reported. (The quantities of raw materials needed for 1 t production have been reported in table 5.) For zineb production the foreign raw materials cost is 65% of the total raw materials' cost. For maneb production the cost of foreign raw materials is 90% of the total raw materials' cost. For mancozeb production the cost of foreign raw materials is 94% of the total raw materials' cost.

Table. 7 Cost of raw materials for zineb, nameb and manooozeb production

	Cost of raw materials		Cost of raw materials for production of					
			Zineb		Mareb		Mancozeb	
	LT/kg	$/kg	LT/t	$/t	LT/t	$/t	LT/t	$/t
CS_2	4.23	0.22	2 538	131.84	2 686	139.53	2 855	148.31
Ammonia a/	2.8	0.14	364	18.91	378	19.63	397	20.62
EDA	27	1.40	6 345	329.61	6 615	343.63	6 831	354.85
H_2SO_4 a/	2.2	0.11	704	36.57	-	-	-	-
$ZnSO_4$ a/	6.5	0.34	3 900	202.59	-	-	474	24.62
$MnSO_4$	7.7	0.40	-	-	4 389	228	4 127	214.38
Hexamethylene-tetramine a/	30	1.56	-	-	900	46.75	-	-
Total			13 851	719.52	14 968	777.54	14 684	762.78

a/ Available in Turkey.

Cost of utilities

The consumption and the costs of the utilities for the DTC production is given in table 8.

Table 8. Cost of utilities

Utilities	Quantity required	Unit price (LT)	Cost per ton of DTC (LT)
Electricity	0.6 kWh/kg	0.66/kWh	396
Water	0.6 m^3/kg	0.55/m^3	330
Steam	6 kg/kg	0.19/kg	1 140
Fuel	0.3 m^3/kg	10/m^3	600
Nitrogen	0.01 m^3/kg	15/m^3	150
K-refrigeration	0.36/kg	0.7/kg	250
Total			2 866

Cost of direct labour and supervision

The cost of direct labour and supervision, per ton of DTC is reported. For the monthly labour expenses see table 6.

At 1980 production level of 2,125 t/year the costs will be as follows:

	LT
Yearly direct labour cost	1,454,400
Yearly supervision cost	432,000
	1,886,400
Welfare benefits (30%)	565,920
Total	2,452,320

Direct labour and supervision cost per ton of DTC will be LT 1,154 (2,452,320 ÷ 2,125).

Direct cost of production

In table 9 the direct cost of production per ton of zineb, maneb and mancozeb is reported.

Table 9. Direct cost of production of zineb, maneb and mancozeb (LT/ton)

Product	Raw materials	Utilities	Direct labour and supervision	Total
Zineb	13 851	2 866	1 154	17 871
Maneb	14 968	2 866	1 154	18 988
Mancozeb	14 684	2 866	1 154	18 704

Working capital calculations

	LT
2 months of salaries (2 x 244,200)	488,400
3 months of raw materials a/	7,712,800
1 month finished products b/	4,500,000
	12,701,200

a/ Raw materials for:

Zineb 525 t (13,851 x 525)	7,271,775
Maneb 300 t (14,968 x 300)	4,490,400
Mancozeb 1300 t (14,684 x 1,300)	19,089,200
Total yearly (1980)	30,851,375 ÷ 4 = 7,712,843

b/ Yearly production:

Zineb 535 t
Maneb 300 t
Mancozeb 1,300 t
Total 2,135 : 12 = 177 t/month x 25.000 LT/t(average cost for 3 products) = about 4,500,000

Fixed capital investment calculations

		LT
1.	**Installed plant cost estimation:**	
A.	Cost of equipment at site	
	(a) Cost of local equipment	29,000,000
	(b) Cost of imported equipment	14,726,000 ($765,000)
	(c) Duties and customs (75% on (b))	11,044,700
	(d) Inland cost of transportation (1% on (a) + (b))	437,200
	Total	55,207,900
B.	Cost of piping and instrumentation:	
	20% on total A	11,041,580
	Total	11,041,580
C.	Cost of projection and installation:	
	(a) Projecting: 10% on total A	5,520,790
	(b) Installation: 20% on total A	11,041,580
	Total	16,562,370
	Total (A + B + C)	82,811,850
2.	**Cost of buildings**	
	Plant, laboratory, offices, warehouses, social facilities etc.	8,500,000
3.	**Cost of land**	
	6,000 m^2 at LT 200/m^2	1,200,000
	Total fixed capital investment	92,511,850 ($4,805,810)

Indirect cost of production

Table 10 shows the indirect cost of production.

Total cost of production

Table 11 gives the total cost of production.

Table 10. Indirect cost of production (LT)

Item	Yearly cost	Cost of 1 t DTC				
		1980 (production 2,125 t)	1981 (production 2,450 t)	1982 (production 2,750 t)	1983 (production 2,925 t)	1984 (production 3,250 t)
Maintenance						
4% of installed plant cost	2 208 316	1 039	901	803	755	679
Insurance						
1.5% of installed plant cost	828 118	389	338	301	283	254
1.5% of cost of buildings	127 500	60	52	46	43	39
Plant depreciation						
10% of installed plant cost	5 520 790	2 598	2 253	2 007	1 887	1 698
Buildings depreciation						
3% of cost of buildings	255 000	120	104	92	87	78
Interest on capital						
12% long term loan interest [a/]	5 550 711	2 612	2 265	2 018	1 897	1 708
12% on working capital	1 524 144	717	622	554	521	469

table 10 (continued)

Item	Yearly cost	Cost of 1 t DTC				
		1980 (production 2,125 t)	1981 (production 2,450 t)	1982 (production 2,750 t)	1983 (production 2,925 t)	1984 (production 3,250 t)
Management overhead						
Yearly salaries of management	1 044 000	491	426	379	357	321
20% expenses on management salaries	208 000	98	85	76	71	64
Indirect cost of production total	17 266 579	8 124	7 046	6 276	5 901	5 310

a/ Based on 50% of the total fixed capital investment.

Table 11. Total cost of production per ton of zineb, maneb and mancozeb (LT)

Zineb	1980 (production 525 t)	1981 (production 600 t)	1982 (production 675 t)	1983 (production 725 t)	1984 (production 800 t)
Direct cost of production	17 871	17 871	17 871	17 871	17 871
Indirect cost of production	8 124	7 046	6 276	5 901	5 310
Total	25 995	24 917	24 147	23 772	23 181
Maneb	1980 (production 300 t)	1981 (production 350 t)	1982 (production 375 t)	1983 (production 400 t)	1984 (production 450 t)
Direct cost of production	18 988	18 988	18 988	18 988	18 988
Indirect cost of production	8 124	7 046	6 276	5 901	5 310
Total	27 112	26 034	25 264	24 889	24 298
Manoozeb	1980 (production 1 300 t)	1981 (production) 1 500 t)	1982 (production 1 700 t)	1983 (production 1 800 t)	1984 (production 2 000 t)
Direct cost of production	18 704	18 704	18 704	18 704	18 704
Indirect cost of production	8 124	7 046	6 276	5 901	5 310
Total	26 828	25 750	24 980	24 605	24 014

Imported DTC prices

According to the information of TZDK the average c.i.f. imported prices for zineb, maneb and mancozeb in 1977 were as follows:

Zineb, $765 per ton (LT 14,726)

Maneb, $1,632 per ton (LT 31,416)

Mancozeb, $1,960 per ton (LT 37,730)

(The imported prices of the technical grade Mancozeb (active ingredient) has been estimated taking into account the price of the 80% formulated fungicide (about $1,600 per ton) and considering the value of the formulating agents 1/10 of the active ingredient's value.)

Profitability of the investment

Return on investment against imported prices for 1980 is as follows:

Zineb: 525 t x LT 25,995 = LT 13,647,375 (total cost of production)
525 t x LT 14,726 = LT 7,731,150 (total sales return)
Gross loss LT -5,916,225

Maneb: 300 t x LT 27,112 = LT 8,133,600 (total cost of production)
300 t x LT 31,416 = LT 9,424,800 (total sales return)
Gross profit LT 1,291,200

Mancozeb: 1,300 t x LT 26,828 = LT 34,876,400 (total cost of production)
1,300 x LT 37,730 = LT 49,049,000 (total sales return)
Gross profit LT 14,172,600

Overall profitability: -5,916,225
1,291,200
14,172,600
LT 9,547,575

1980 return on investment: $\frac{9,547,575}{92,511,850} \times 100 = 10.32\%$

A return on investment against imported prices for 1984 is as follows:

Zineb: 800 t x LT 23,181 = LT 18,544,800 (total cost of production)
800 x LT 14,726 = LT 11,780,000 (total sales return)
Gross loss LT -6,764,000

Maneb: 450 t x LT 24,298 = LT 10,934,100 (total cost of production)
450 t x LT 31,416 = LT 14,137,200 (total sales return)
Gross profit LT 3,203,100

Mancozeb: 2,000 t x LT 24,014 = LT 48,028,000 (total cost of production)
2,000 t x LT 37,730 = LT 75,460,000 (total sales return)
Gross profit LT 27,432,000

Overall profitability: -6,764,000
3,203,100
27,432,000
LT 23,871,100

1984 return on investment: $\frac{23,871,100}{92,511,850} \times 100 = 25.8\%$

Foreign exchange savings

Case of a local production:	Dollars
Foreign equipments cost	765,000
Five years 12% interest	459,000
Five years foreign raw materials cost	8,818,327
Total foreign exchange to be paid	10,042,327
Case of finished products imports	
Five years zineb (3,325 t x $765)	2,543,625
Five years maneb (1,875 t x $ 1,632)	3,060,000
Five years mancozeb (8,300 t x $1,960)	16,268,000
Total foreign exchange to be paid	21,871,625

Foreign exchange savings in the case of a local production:

21,871,625
-10,042,327
$11,829,298 for the 1980-1984 period

VIII. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

From this feasibility assessment the following main conclusions can be drawn.

1. The domestic demand of DTC fungicides is expected to increase from 680 t (1976) to 3,250 t (1984) and a local DTC production will encourage the enlargement of the use owing to a wider availability of the products.

2. The envisaged production plant is suitable to produce different DTC fungicides by changing only some raw materials: the main intermediate (NH_4DTC) is the same for zineb, maneb and mancozeb. The plant could be considered a multipurpose one, because of the possibility of producing other DTC, if required. Idle periods should be avoided, so that maximum advantage and cost benefit could be obtained from the continuous process design.

3. Main raw materials for manufacturing DTC have to be imported (about 65% for zineb, 90% for maneb, 94% for mancozeb).

4. As far as the process is concerned, there are several producers who could supply the know-how: no problems of royalties for patents are likely to arise.

5. A suitable plant location has been suggested in the north-west of Turkey, near Orhangazi area, not very far from some formulation plants. The cost of the land in the proposed area is about LT 200 per m^2.

6. The plant management has been considered on a basis of 300 working days: the initial operating capacity (1980) is about 65% of the planned capacity. Three shifts for five days/week have been suggested for the first year of production.

7. The total cost of production on 1980 basis is roughly:

   Zineb LT 26,000 per t (selling price LT 14,700 per t)
   Maneb LT 27,000 per t (selling price LT 31,400 per t)
   Mancozeb LT 27,000 per t (selling price LT 37,000 per t)

8. The economic analysis has pointed out that only the zineb production doesn't show profitability, owing to the very low selling price of imported product. In spite of the estimated loss on zineb production, the overall return on investment is about 10% at the start-up time, and will reach 25% when the design capacity will be reached (1984).

9. In the period 1980-1984 under consideration a local DTC production shows a foreign exchanges savings of about $12,000,000.

Recommendations

On the basis of the above conclusions it is recommended:

1. To proceed with the implementation of the plant establishment and with the preparation of tender specifications.

2. To consider the possibility of establishing a DTC factory in the same area where 2,4-D will be manufactured. Considerable advantages will be obtained from an economic point of view as far as the common management, laboratory and other services are concerned.

This suggestion considers a long term possibility of manufacturing other pesticides, besides DTC and 2,4-D, for the future requirements of Turkish agriculture.

The purchase of the suggested area should take into consideration a potential expansion in manufacturing activities.

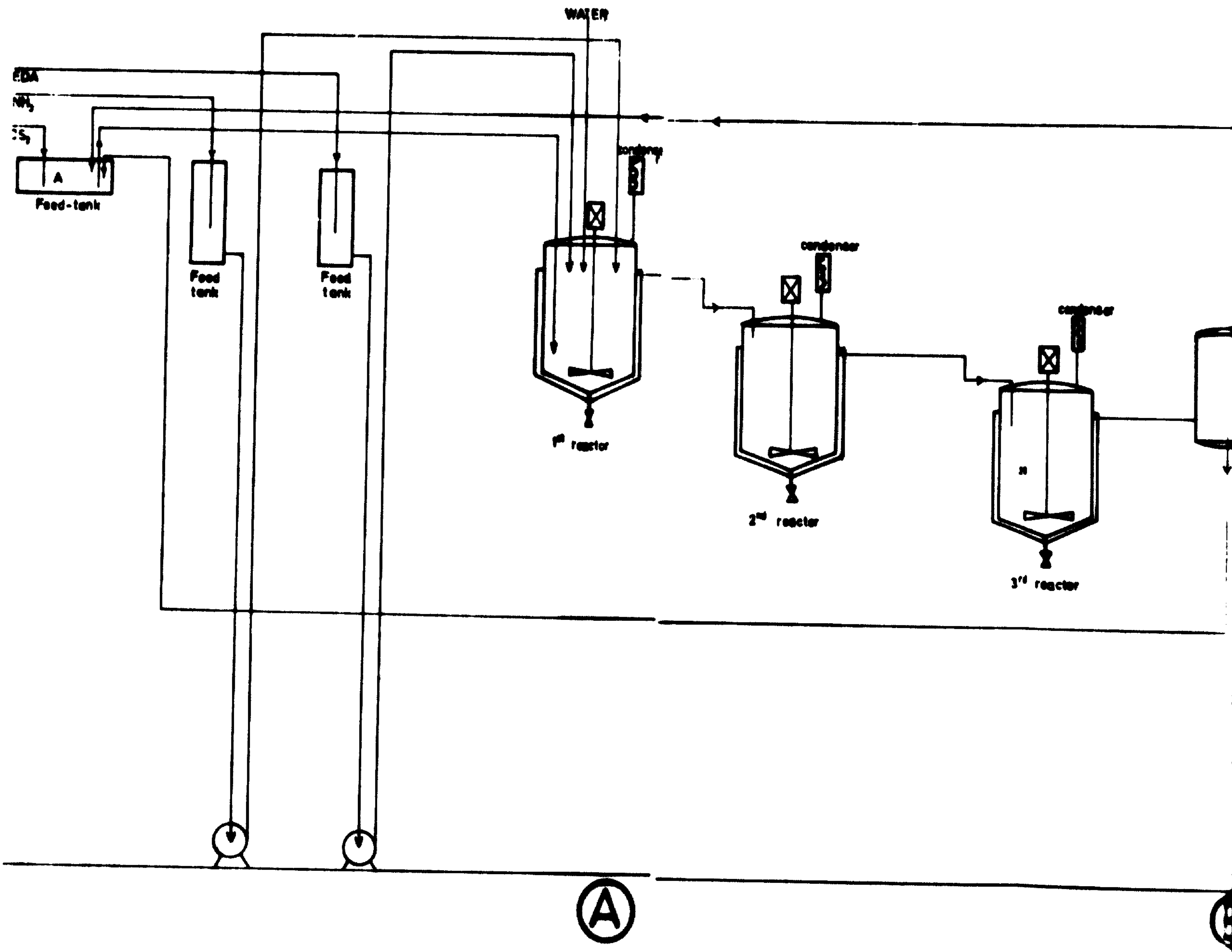
3. Foreign raw materials have a great influence on the foreign exchange requirements of DTC production. It is suggested that studies be carried out on an expansion of the existing CS_2 plant and the establishment of an EDA local production plant using locally available dichloroethane as raw material.

4. It is strongly recommended to set up a training programme for technical people, especially devoted to organic technology required in DTC production.

5. In a future development of the DTC project it is suggested to consider the realization of $(NH_4)_2SO_4$ recovery unit.

Annex I

DRAWINGS OF THE PLANT



Annex I

DRAWINGS OF THE PLANT

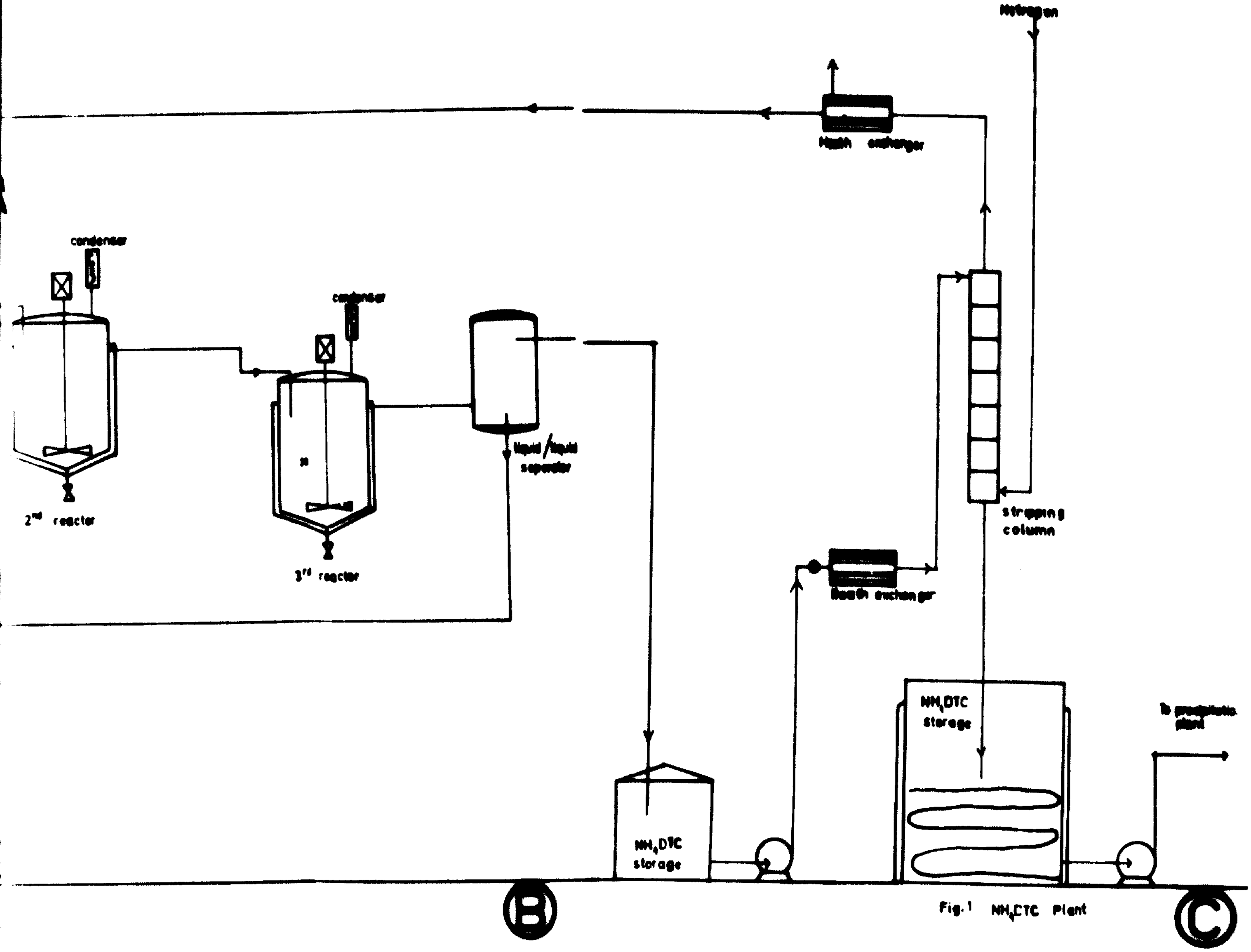
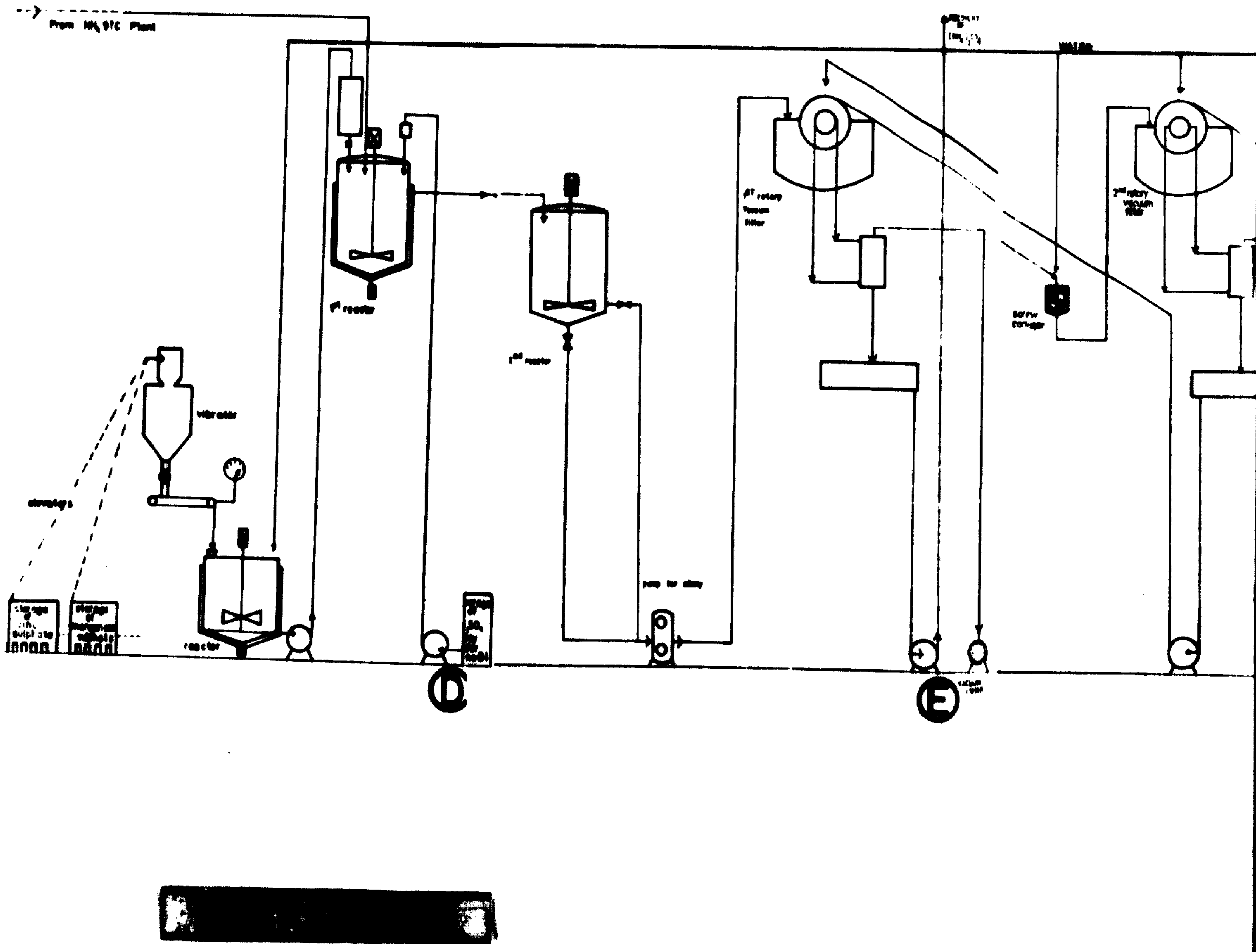


Fig. 1 NH_4CTC Plant


reactor
1st reactor
2nd reactor
D
E
WATER

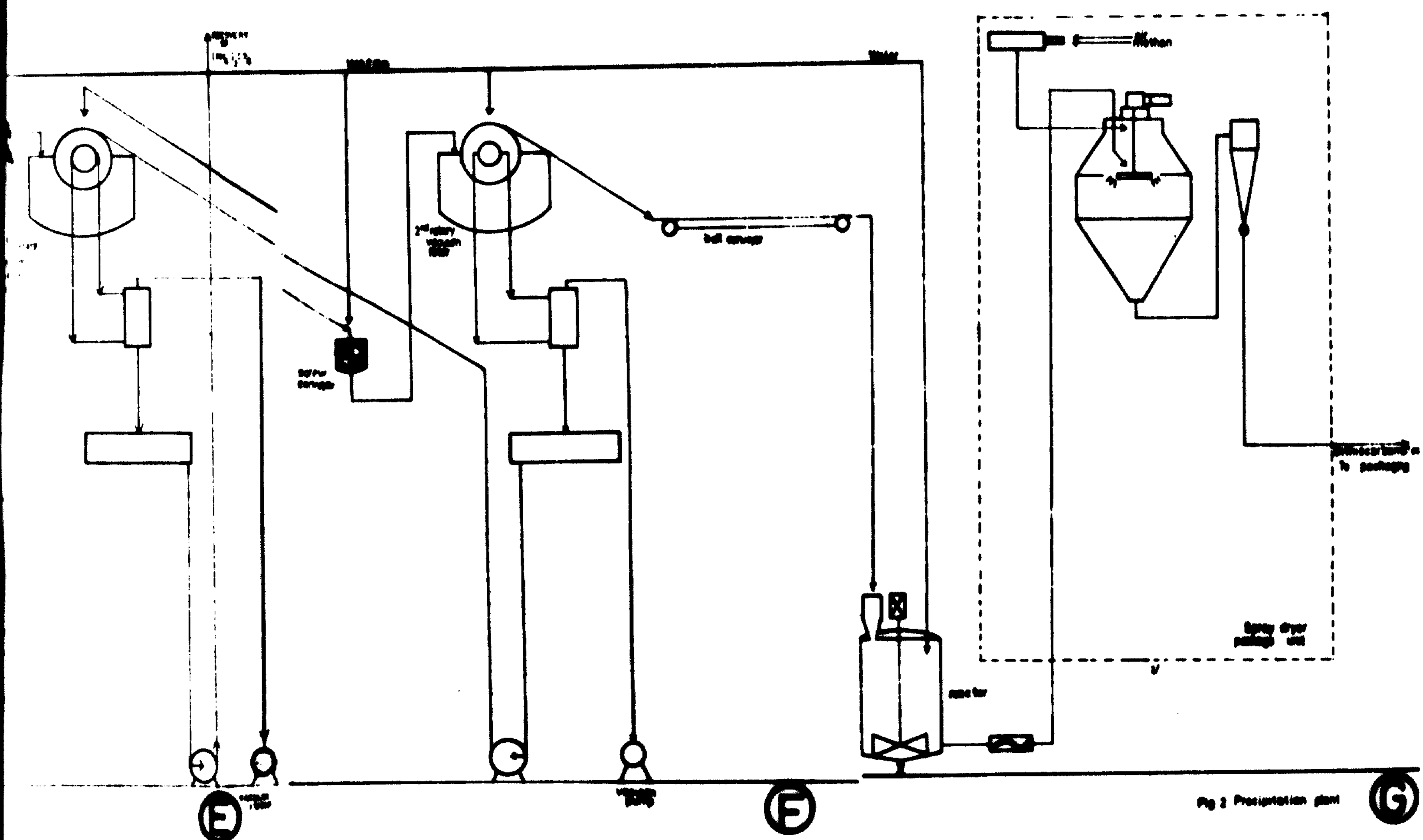


Fig 2 Precipitation plant

Annex II

PROCESS EQUIPMENT COST SUMMARY AND LIST

Process equipment cost summary

	Local equipment cost (LT)	Imported equipment cost ($)	Total cost (LT)
Storage	20 800 000	-	20 800 000
NH_4DTC plant	3 100 000	45 000	3 966 000
Precipitation plant	5 100 000	720 000	18 960 000
	29 000 000	765 000	43 726 000
			($2 271 500)

Local equipment, 66%

Imported equipment, 34%

Equipment list

Liquid raw materials storage

	Local (LT)	Imported ($)
20% ammonia tanks, steel, 150,000 l (n.3)	6,500,000	-
EDA tanks, steel, 100,000 l (n.3)	4,200,000	-
H_2SO_4 tank, steel, 8,000 l	100,000	-
CS_2 tanks, steel, underwater, 200,000 l (n.3)	10,000,000	-
	20,800,000	-

NH_4DTC plant

20% ammonia feed tank, steel, 1,200 l	17,000	-
EDA feed tank, steel, 500 l	7,000	-
CS_2 feed tank, steel, 1,000 l	14,000	-
Jacketed reactors, (stirrer, motor), stainless-steel, 1,500 l (n.3)	-	45,000
Condensers, steel (n.3)	160,000	-

Liquid/liquid separator, steel, 1,500 l	21,000	-
Storage vessel, steel, 1,500 l	21,000	-
Heater exchanger, steel, 900 l/h	200,000	-
Stripping column, Rashig 700 l	20,000	-
Heater exchanger, steel, 100 l/h	150,000	-
Jacketed storage vessel, steel, 25,000 l	350,000	-
Refrigeration equipment	2,000,000	-
Pumps	140,000	-
	3,100,000	45,000

<u>Precipitation plant</u>

Feed vibrator, steel, 500 l	-	30,000
Elevators and belt conveyers (n.4)	400,000	-
Jacketed reactor (stirrer, motor), steel, 3,000 l	150,000	-
Feed tank, steel, 200 l	3,000	-
Jacketed reactor (stirrer, motor), stainless-steel, 3,000 l	-	30,000
Jacketed reactor (stirrer, motor), stainless-steel, 100 l	-	1,000
H_2SO_4 feed tank, PVC, 20 l	2,000	-
Reactor (stirrer, motor), stainless-steel, 3,000 l	-	29,000
Rotary vacuum filter (package unit) 0.5 t/h (n.2)	-	130,000
Pumps, belt screw conveyers	245,000	-
Reactor (stirrer, motor), steel 500 l	100,000	-
Spray-drier (package unit) 0.5 t/h	-	400,000
Finished products tanks, steel, 100,000 l (n.3)	4,200,000	-
Packaging unit	-	100,000
	5,100,000	720,000

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