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ASSISTANCE IN THE ESTABLISHMENT OF A MULTIPURPOSE PESTICIDE PILOT PRODUCTION UNIT FOR ORGANO-PHOSPHORUS INSECTICIDES IN THE ARAB REPUBLIC OF EGYPT*

TS/EGY/78/005/11-01/32.1.G.

REPORT

Prepared for the Government of the Arab Republic of Egypt
by the United Nations Industrial Development Organization

Based on the work of E. Haidegger
UNIDO Consultant

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1.0 Project Background

Big quantities of pesticides are yearly imported by the Arab Republic of Egypt at an estimated value of more than 80 millions US-$. Only a small quantity of active material is produced in the country. From imported active material the bulk is formulated into end products in Egypt.

The National Research Centre carried out extensive research work in the field of the production of organophorphorus insecticides. Under the heading of Professor Mahmoud M. Sidky processes for the production of the organophosphorus compounds most important in the country have been developed at laboratory scale.

For the utilization of these effords in the industry, pilot plant tests are essential. This is why the UNIDO, at Government request, prepared a report in 1975, entitled "Study on a Multipurpose Pilot-Plant for Pesticide Technology Development in the Arab Republic of Egypt" (IS/EGY/75/005/11/37/30.5.00) with the cooperation of Mr. Ram S. Hamsagar. He inspected six locations where a pilot plant could be built aimed at producing the following organophosphorus pesticides:

Malathion	Cyolane
Dimethoate (Roger)	Phosvel
Parathion	Diptrex (Trichlorvos)
Dursban	DDVP (Dichlorvos)

After due considerations and examinations the Nashr Chemical Co. in Gizeh was suggested in his report for the location of the pilot plant.

For carrying out pre-investment studies a three-man mission was set up by the UNIDO composed of Messrs. M. El-Halfawy, K Szabo and the drafter of this study. Consultations were carried out in Egypt from 25th January to 1st February 1979, to select a site for the pilot plant and to establish budget requirements.

2.0 Status of the Pesticide Industry

2.1 Import of Pesticides

The value of imported pesticides to the Arab Republic of Egypt is more than 80 millions US-$ p.a. Mainly due to the increased consumption of malathion the share of organophosphorus pesticides increased by about 20 % related to total consumption in the last years.

The organophosphorus pesticides have been introduced in the sixties to combat the cotton leaf worms. Nowadays there are organized chemical and technical control systems set up by the Ministry of Agriculture.

2.2 Production of Pesticides in the Arab Republic of Egypt

The manufacture of active material is limited to a few products, the most important being the manufacture of 600 tpa

dichlorophenyltrichloroethan, DDT which is carried out by the Pesticides & Chemicals Co. in Kafr El Zayat. At present the production is temporarily suspended due to a lack of chlorine.

Much more important is the formulation where the works in Kafr El Zayat has a leading position.

The factory was founded in 1960 and after an initial turnover of E£ 200.000 the value of production was increased in 1978 to E£ 8,000.000.

All kinds of formulations are manufactured in the form of powders and emulsions. The most important products contain malathion and dimethoate. About 600-700 t of malathion are imported from abroad and the factory produces the formulated end products.

Dimethoate is imported at about the same rate and formulated into an end product at Kafr El Zayat.

In recent research work in the Dyestuffs & Chemical Co. in Kafr El Dawar bench scale technologies for the manufacture of the pesticides triazin, simazin and atrazin have been developed.

2.3 Pertinent Research Activities

The research relating to the production of organophosphorus pesticides has been carried out mostly in the National Research Centre (NRC) under Prof. M.M. Sidky and was supported by the Academy for Scientific Research and Technology.

The research has been in progress for over 20 years. Bench-scale studies have been carried out by highly qualified graduates (Ph.D and MSc.) who have valuable experience in the synthesis of organophosphorus pesticides. These experts could afford a valuable assistance in the operation of the proposed pilot plant.

Experiments are also being carried out in various production units. As already mentioned the production of triazines has been a subject of trials in the Dyestuffs & Chemicals Co., while in the Kafr El Zayat Pesticides & Chemicals Co. the production of various chlorinated compounds has been attempted.

3.0 Discussions

The purpose of discussions was to obtain information about the views of various administrative authorities, institutes and specialists and to inspect the proposed sites for a pilot plant.

3.1 National Research Center (NRC) Cairo

The discussion was held on January 25, 1979.

Present were Prof. Dr. M.M. Sidky (NRC)
Dr.Eng. M.J. Abd Ellatif, Deputy General Director (GOFI)
and the three members of the UNIDO-mission

First the various organophosphorus pesticides used in the Arab Republic of Egypt were reviewed and based on consider-

ation of economy and simplicity of construction of a pilot plant preference was given to start the production of two active materials i.g. malathion and dimethoate on a pilot scale. Later extensions of the pilot plant would also make the production of other organophosphorus pesticides possible. The above mentioned two products are extensively used in the Arab Republic of Egypt, and NRC has experience in their synthesis.

It was agreed that independently of the future location of the pilot plant, a research group, under Prof. Dr. Sidky, should continue its collaboration in the development of the pilot scale production of organophosphorus chemicals.

3.2 General Organization for Industrialization (GOFI)
Cairo, Carden City, 6 Khalit Aga Street

The discussion was held on January 27th, 1979.

Present were from GOFI Chem. Aida El-Zarka, General Director Industrial Research Department

Dr.Eng. M.J. Abd Ellatif, Deputy General Director

and members of the UNIDO-mission

Based on previous investigations either Kafr El Zayat or Kafr El Dawar were suggested as sites by GOFI for the erection of the pilot plant. Advantages and disadvantages were discussed for both alternatives. The location of the pilot plant should be decided by the economy and speed of realization. GOFI declared that the organizat ... is ready to finance all expenses which should arise in the Arab Republic of Egypt.

3.3 Pesticides & Chemical Co., Kafr El Zayat

Discussion was held on January 28th, 1979.
Present were Chem. J.A. Kamel, Chairman of the company
Chem. Aida El-Zarka (GOFI)
Dr.Eng. M.J. Ellatif (GOFI)
and members of the UNIDO-mission

Information about the company was obliged as required (see report on Works Inspection 7.2).

The company would welcome if the pilot plant were built there. As mentioned they have good contacts to the Ministry of Agriculture and to the consumers and they also are the biggest producer (formulator) of pesticides in the Arab Republic of Egypt.

3.4 Dyestuffs & Chemical Co., Kafr El Dawar

Discussion was held on January 29th and 30th, 1979.
Present were Eng. I.F. El-Mohtasseb, Chairman and Marketing Director
Eng. J.F. El-Khatab, Product Manager
Dr.Eng. H.S. Mahmoud, Research Manager
Chem. Aida El-Zarka (GOFI)
Dr.Eng. M.J. Ellatif (GOFI)
and members of the UNIDO-mission

After introductory talks there was a inspection of the works, the laboratories, a.s.o. The factory would be very interested in building a pilot plant because it has free capacities in production.

3.5 United Nations Development Programme (UNDP)

Discussion was held on January 31, 1979 in Cairo.
Present were G. Pennacchio, Resident Representative of UNDP
T.H. Sabri, Programming Officer of UNDP
and members of the UNIDO-mission

The UNDP was informed about the events and asked to support this project in the future.

4.0 Factors affecting the choice of site

The considerations which influence the decision concerning the site of the pilot plant can be divided into two groups

a) fundamental conditions (infra structure) and

b) capital investment requirement.

As for the infra structure the following requirements would have to be met:

Trained personnel
Space
Utilities (electricity, water, steam)
Possible future growth area for the production of pesticides
Accomodation (by local authorities)
Adequate waste disposal facilities

Savings in the investment costs can be achieved by appropriate and useful

buildings
equipment and
servicing units (e.g. workshops)

quality control and research laboratories
general use of installations e.g. compressed air, vacuum unit, cooling system, instrument air, etc.

5.0 Recommendations

On the basis of information available the UNIDO mission recommends to build the pilot plant on the site of Dyestuffs & Chemical Co. in Kafr El Dawar. This suggestion is based upon the following arguments:

a) There are two building sections which are suitable not only for the pilot plant but also for a future expanded production unit.

b) A large variety of equipment would be available for the pilot plant, and so the investment costs could be kept lower.

c) Manufacture and installation of certain items of new equipment could be carried out in the factory workshop resulting in a reduction of investment requirements in convertible foreign currency.

d) Compressed air, vacuum unit, cooling system and instrument air are available in sufficient quality.

e) Waste disposal facilities seem to be adequate to handle the effluents of the pilot plant.

All the above mentioned conditions would make it possible to build also an expanded production unit in a second phase of development within short time and with relatively little investment cost. In this way the final aim, the realization

of an industrial production of selected pesticides in the Arab Republic of Egypt could easily be accomplished.

The realization of these plans requires optimal planning. According to our suggestion the active ingredients should be produced by the Dyestuffs & Chemical Co. and then delivered to the Pesticides & Chemical Co. in Kafr El Zayat for formulation, packing and commercialization. The latter has experience in this field and is in close cooperation with the Ministry of Agriculture, the authority for the regulation of pesticides usage in Egypt.

The following forms of cooperation among the agencies involved are recommended:

a) GOFI shall overall coordinate the project both in administrative and financial terms.

b) Kafr El Dawar shall operate the pilot plant for the production of the selected organophosphorus active materials, Kafr El Zayat shall formulate and distilate the products. These both companies will share in the economic gains by the project.

c) NRC should act as a consultative and advisory body and place its experience and knowledge in this field at the disposal of the parties concerned.

6.0 Areas for further UNIDO assistance

UNIDO assistance is required in the following actions:

a) Detailed design by a group of specialists who have experience in malathion and dimethoate technology. The equipment at Dyestuffs & Chemicals Co. should be a basis for this. The supplementary equipment should be specified, so that they could be built according these data. This activity would include not only the detailed engineering, but also the detailed costing, PERT planning and tender specifications.

b) Tendering, tender scrating and contracting the production of supplementary equipment.

c) Assignment of a project manager for 18 months. He should stay in the factory 6 months during the installation and 12 months after the start-up.

7.0 Appendices

7.1 Description of the Dyestuffs & Chemical Co. in Kafr El Dawar

The company is headed by Eng. Ibrahiem F. El-Mohtasseb, Chairman, who has wide experience in the field of organic chemistry. He spent several years in Europe at various

companies and universities. The factory manager is Mr. Mohamed Lofty Khatab, Chem., and the research manager Dr. Eng. Hassan Said Mohmoud.

Formerly the factory was located in Ismailia but was destroyed during the war. The erection at the present site - 25 km away from Alexandria - started in 1970 and operation commerced in 1973. The area is 400.000 m2.

In the factory about 60 various dye-stuffs are produced and process descriptions are available for further 70 products. The turn-over is about E£ 3 Mio. and at present 30 % of the total capacity is used.

The company consists of the following sections:

		No.of grad.eng. and/or chemists
Production		70
Section "A":	(equipped with Polish equipment) Products: Naftol, Sulfur dye-stuffs, Phosgene, different intermediates	
Section "B":	(equipped with Italian equipment) 9 organic products 10 different types of dye-stuffs	
Research and development		16
Commercial section		18
Including quality control and customer services		
Workshop		

The following unit operations are used in production:

Chlorination
Nitration
Bromination
Mixing
Filtration
Emulsification
Distillation
Grinding
Centrifugation
Refrigeration (every department has its own refrigerator system and laboratory)

The capacity of the workshop is much higher than present needs. The workshop works regularly for outside customers. It is in a position to produce storage-, washing-, settling- and measuring vessels of mild steel.

The research department is very well equipped and is headed by Mr. Mahmoud, who also hold a position at the University. Infrared and ultraviolet spectrophotometers as well as a gas-liquid chronomatograph are available. The plant has a good reference library.

The total number of employees is 1700 who work in three shifts.

At present a photochlorination pilot plant is in erection with 100 l reactor.

Water and energy supplies for the factory are as follows:

Water capacity:	25.000 m3/day
Temperature:	winter min 10^{O} C
	summer max. 35^{O} C

pH:	6,5 - 7
Turbidity:	1 formazirturbidity unit
Alkalinity as $CaCO_3$:	150 ppm
Steam:	produced by central boilers. It is in surplus
Electricity:	the factory is combined with a power transmission line. There is practically unlimited electricity available.
Compressed air:	Air is supplied through oil filters at a working pressure of 2,5 - 4 atm.
Vacuum system:	The buildings are equipped with a central water ring vacuum pump with a capacity of 400 Nm3/h. Vacuum lines are available at any point.
Inert gas:	The pilot plant could be supplied with nitrogen gas at -5° C, pressure range 2,5 - 3,5 kp/cm2, capacity 150 Nm3, oxygen content 1 - 3 ppm.
Waste treatment and disposal:	adequate

For the pilot plant a whole building having two floors could be used. Its height is 11 m. Three halls are available with dimensions of 6,5 x 24 m, 6 x 6 m, and 6 x 6 m.

According to the information received the company could provide an adequate number of the following type of equipments for the planned pilot plant.

Stirred vessels with jacket

Material	Volume l
glass lined MS	150
rubber lined MS	500
brick lined MS	500
brick lined MS	1000
enamelled MS	000
enamelled MS	1600
enamelled MS	2000

Storage tanks

Material	Volume l
lead lined MS	500
MS	500
epoxy coated MS	1000
rubber lined MS	1000

Pumps

Material	Volume l/h
Dosing pumps PVC	120
Dosing pumps borosilicate	300
Centrifugal pumps borosilicate	3000
Centrifugal pumps SS	2000
Centrifugal pumps SS	5000

Distillation column

With a reactor of 100 l volume, 2 packed columns, equipped with all necessary instruments, feeding and receiving vessels, product cooler, etc. made of borosilicate glass.

Filters

	Filtering area m2
Nutsch filter	1,5
plate and frame filter press	5,0
filter press	6,0

Chlorination

For the purpose of pilot plant work the new photochlorination unit would also be available.

7.2 Description of the Kafr El Zayat Pesticides & Chemical Company

The company is headed by Mr. Chem. J.A. Kamel, Chairman, who has abroad and outstanding experience in the field of pesticides. The product manager is Mr. Abd El Fattah Ismail Abon Zaid, Chem.Eng.,also with a strong background in pesticide production.

The company is closely cooperating with the Ministry of Agriculture and foreign pesticides producers and has know-how concerning regulations and the marketing of pesticides. The factory area is located 600 m away from the river Nile with an area of 150.000 m2.

The company is mostly concerned with the formulation, respectively the production of power and emulsion end products from imported active ingredients.

The conmany consists of six sections:

Department:	No.of grad.eng. and chemists
Production	4 (26 foremen)
Maintenance	10
Development, quality control	6
Financial department	
Commercial department	
Administration	

The total number of employees is 640.

The mechanical equipment consists of:

- air milling
- hammer milling
- granulating system
- grinding unit for micronized powder production
- packing units for three dimensions - big, middle and small
- 2 compressors
- aerosol production unit
- 2 boilers, oil heated
- workshop for maintenance of the machines and equipment

The development and quality control department is modern and well equipped (e.g. an infrared spectrophotometer and a liquid chromatograph are available).

The storage area is more than 16.000 m2

There are dining and washing rooms for the workers.

As part of the medical care and control there is a possibility of medical assistance every day from 9 a.m. to 5 p.m. Every 20 days workers are medically controlled and the results are recorded.

The disposal of wastes is carefully organized. The sewage water is neutralized with $Ca(OH)_2$ or $CaCO_3$ and after the determination of pH, BOD and oil content it is pumped through an overhead tank and a PVC-pipeline into the Nile.

The used packing material as for instance the paper-, PVC-polyethylene- and other sacks are storaged in one corner of the area and then burned in a kiln.

Used drums are shipped to Alexandria where they are remelted.

Water and energy supplies in the factory are as follows:

Water:	artesian temperature 25° C pH 7,7 suspended materials 220 ppm chemical oxygen demand 4,5 biological oxygen demand 25 alkalinity as $CaCO_3$ 118 ppm chlorides -
Steam:	The water is purified by filtration and ionexchange. 18 t.p.h. steam is produced with a pressure of 7 atm. The consumption is much smaller so that free capacity is available.
Electricity:	The factory is combined with two power transmission lines. It is possible to take off 1 MW, present need is 0,5 MW.
Compressed air:	There are two independent central pipe line systems for compressed air.
Vacuum system:	There is no central system. If vacuum is required it is produced by local steam.

Inert gas: It is produced by burning of coal and has the following composition: N_2 80 vol.%
O_2 5-11 vol.%
CO_2 9-15 vol.%

For the pilot plant the building which is presently used as storage area was envisaged. One hall has the dimensions of 20 x 20 m and is 5,5 m high. Three halls, each of 400 m2 area would be at disposal.

According to the information the company could provide the following apparatus, machines and equipment for the planned pilot plant.

Stirring vessel with jacket (glass lined steel) vol. 2 m3
Batchtank (mild steel) vol. 2 m3
Batchtank (stainless steel) vol. 4 m3
Filter complete with 30 extra filter tubes
Heat exchangers, cooling area
1 10 ft2
1 20 ft2
1 40 ft2
Pumps (Worthington):
6 centrifugal made of Hostelloy
15 centrifugal made of stainless steel

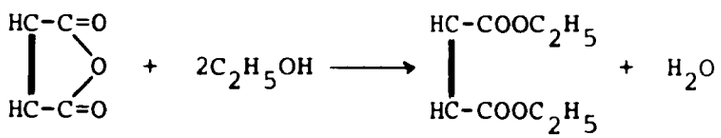
For cooling a compressor with ammonia could be used.

7.3 Short description of the processes involved in the production from malathion and dimethoate

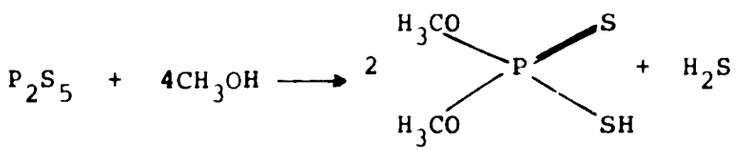
Malathion

The following steps are involved in the process:

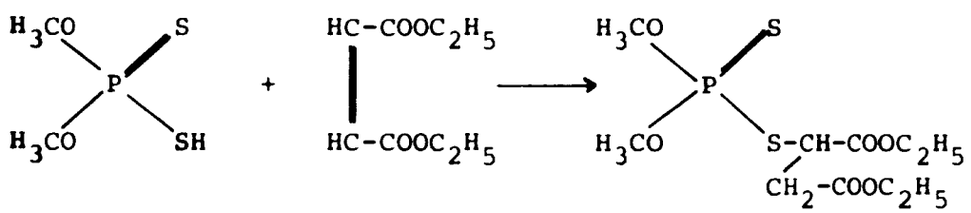
Basic chemical reactions

1) 

maleic anhydride — ethanol — diethyl maleic ester

2) 

phosphorus pentasulphide — methanol — dimethyldithiophosphoric acid (DMDPA)

3) 

DMDPA — diethyl maleic ester — malathion

The first reaction takes place in the esterification reactor. The reaction mass is heated and the solvent, excess ethanol, and water distilled through a column.

The residue is cooled and transferred to a neutralization vessel.

The product is transferred to a distillation unit, where the ester is distilled under vacuum.

The ester is reacted with methanol and P_2S_5 in the synthesis unit.

The cold reaction mixture is filtered in an enamelled filter.

The crude malathion is transferred to a washing vessel. After adequated agitation the mixture is allowed to separate. Three consecutive washings are carried out.

After the last washing the malathion passes through a filter in a decantation vessel.

Approximate specific raw material requirements/t product:

Maleic anhydride	470	kg
Ethanol	550	kg
Benzene	90	kg
Methanol	390	kg
Sulfuric acid (96 %)	30	kg
Sodium carbonate (99 %)	440	kg
Phosphorus pentasulfide (98 %)	610	kg
Sodium hydroxide (96 %)	140	kg

Dimethoate

The following steps are involved in the process:

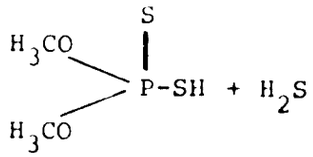
Basic chemical reactions

1) $Cl\text{-}CH_2\text{-}COOH + CH_3OH \longrightarrow ClCH_2 - COOCH_3 + H_2O$

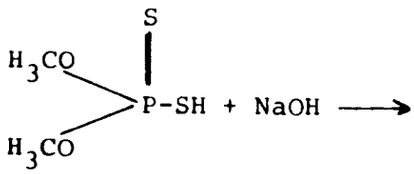
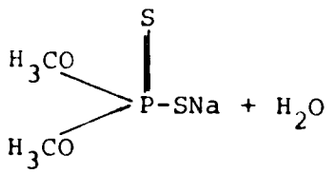
monochloro-acetic acid — methanol — methyl monochloro-acetate (MMCA)

2) $Cl - CH_2COOCH_3 + CH_3NH_2 \longrightarrow ClCH_2 - CONHCH_3 + CH_3OH$

MMCA — methylamine — N-methylmonochloro-acetamide (MCAA)

3) $P_2S_5 + 4CH_3OH \longrightarrow 2$  $+ H_2S$

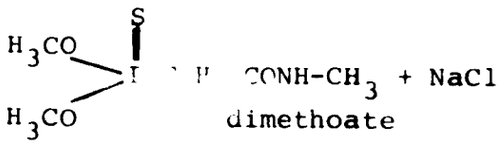
phosphorus pentasulphide — methanol — dimethyldithiophosphoric acid (DMDPA)

4)  $+ NaOH \longrightarrow$  $+ H_2O$

DMDPA — sodium salt of DMDPA (DMDPNa)

By condensation of DMDPNa with MCAA in toluene, or methyl isobutyl ketone, dimethoate is obtained:

DMDPNa + MCAA ——→

5) 

dimethoate

The resulting mixture was held at 80° C for one hour with continued stirring, then cooled to room temperature and filtered. The filtrate was washed twice with water, dried over anhydrous sodium sulfate, and filtered. The filtrate was heated under vacuum to remove the methyl isobutyl ketone. The residual product, S-carbamylmethyl O,O-dimethyl dithiophosphate, was a colorless crystalline solid melting at 60° to 62° C.

The first reaction takes place in the esterification reactor.

The reaction products which are in the vapour state are condensed in the separator.

The crude MMCA passes to a neutralization vessel.

The neutralized MMCA is introduced to the amidation reactor.

Meanwhile the dimethyldithiophosphoric acid being paralelly prepared in the synthesis reactor.

After filtration the filtrate is transferred in the neutralization vessel and the prepared sodium salt is forwarded in the synthesis reaktor.

As soon as the reaction is finished the reaction mass is transferred to the washing and separation vessel.

After a second washing and separation the organic phase is distilled.

If solid product is required the solution is placed in a crystallization bottle equipped with cooling mantle.

The solid dimethoate is separated by filtration.

The washed crystals are discharged into a drying unit, where the crystals are dried under vacuum.

Approximate specific raw material requirements/t product:

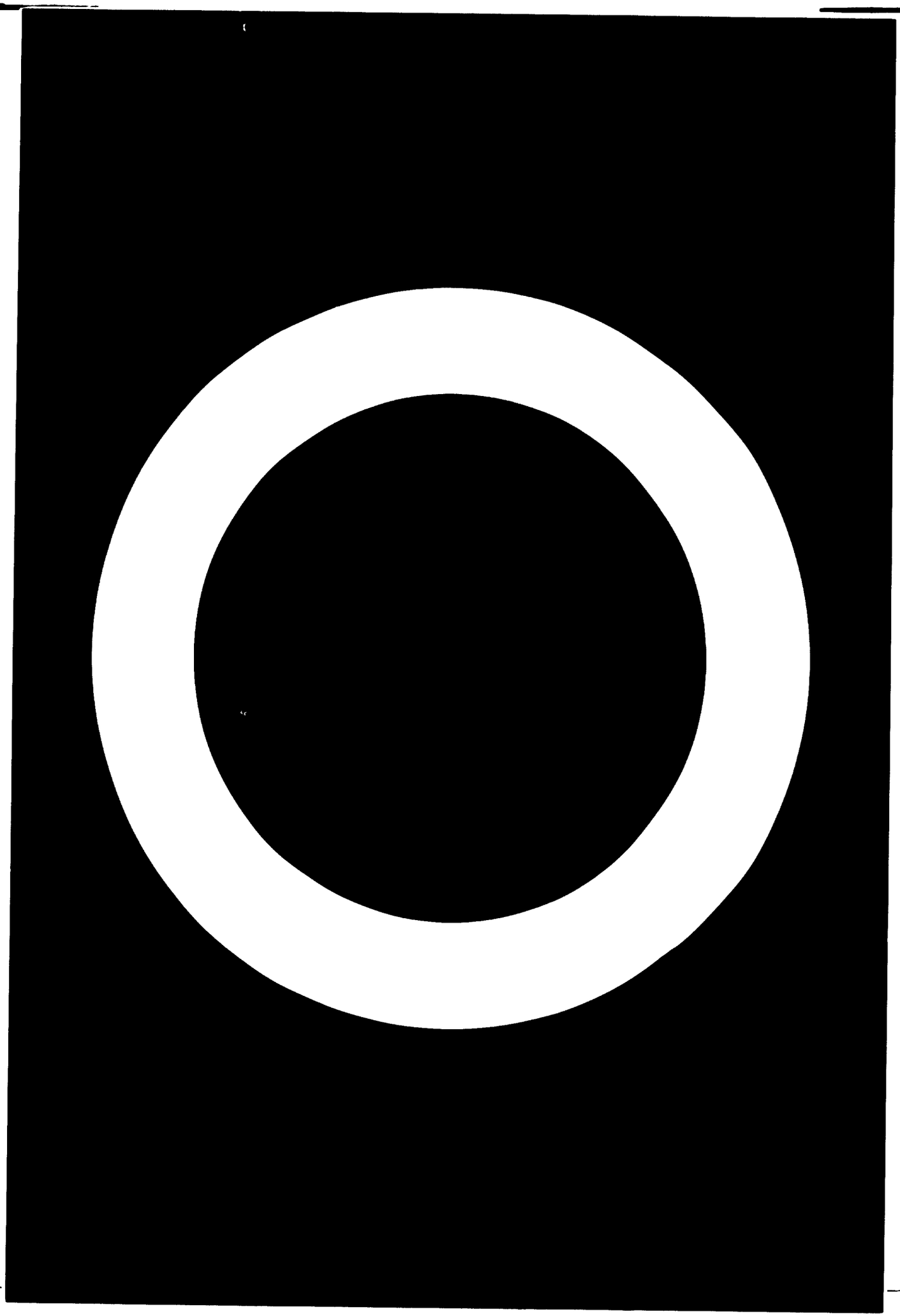
Monochloroacetic acid (98 %)	1.300	kg
Methanol	1.250	kg
Sulphuric acid (96 %)	60	kg
Sodium bicarbonate	130	kg
Methylamin (30 %)	1.350	kg
Phosphorus pentasulfide (98 %)	1.400	kg
Kerosene	250	kg
Sodium chloride	150	kg
Sodium hydroxide (96 %)	350	kg
Toluene	650	kg
Extraction kerosene	700	kg

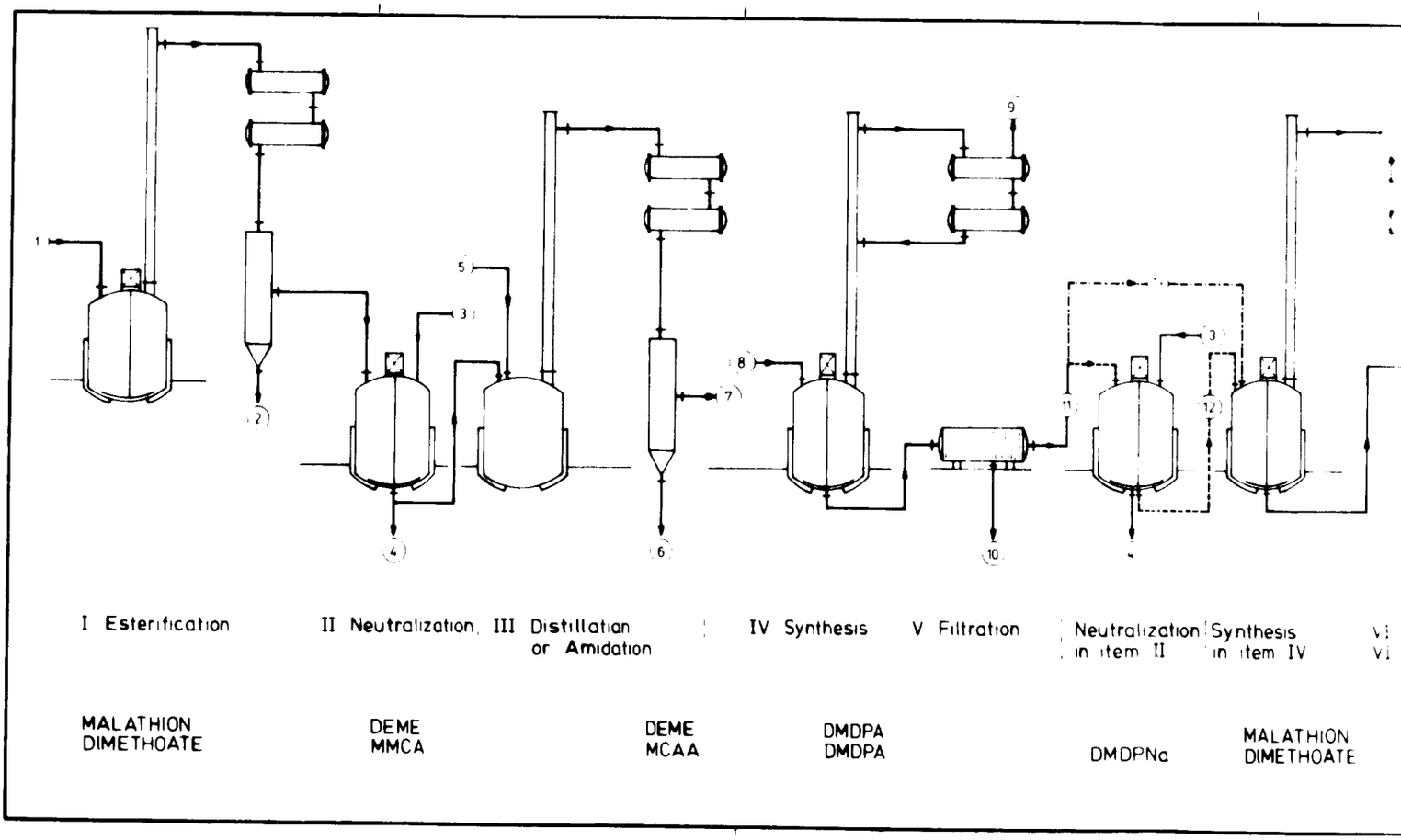
It could take place that the second reaction - due to a side-reaction between the methylamine and Cl group of MMCA - has a low yield. In that case DMDPNa could be synthesized with MMCA and after that aminated with methylamine.

7.4 Flow diagram

The flow sheet for the pilot plant is shown in figure. As mentioned, the same plant can be used for the production of malathion and dimethoate.

The figure shows the data of the used raw materials and solvents, formed intermediates, the end-, and waste products in the different stages of the production:

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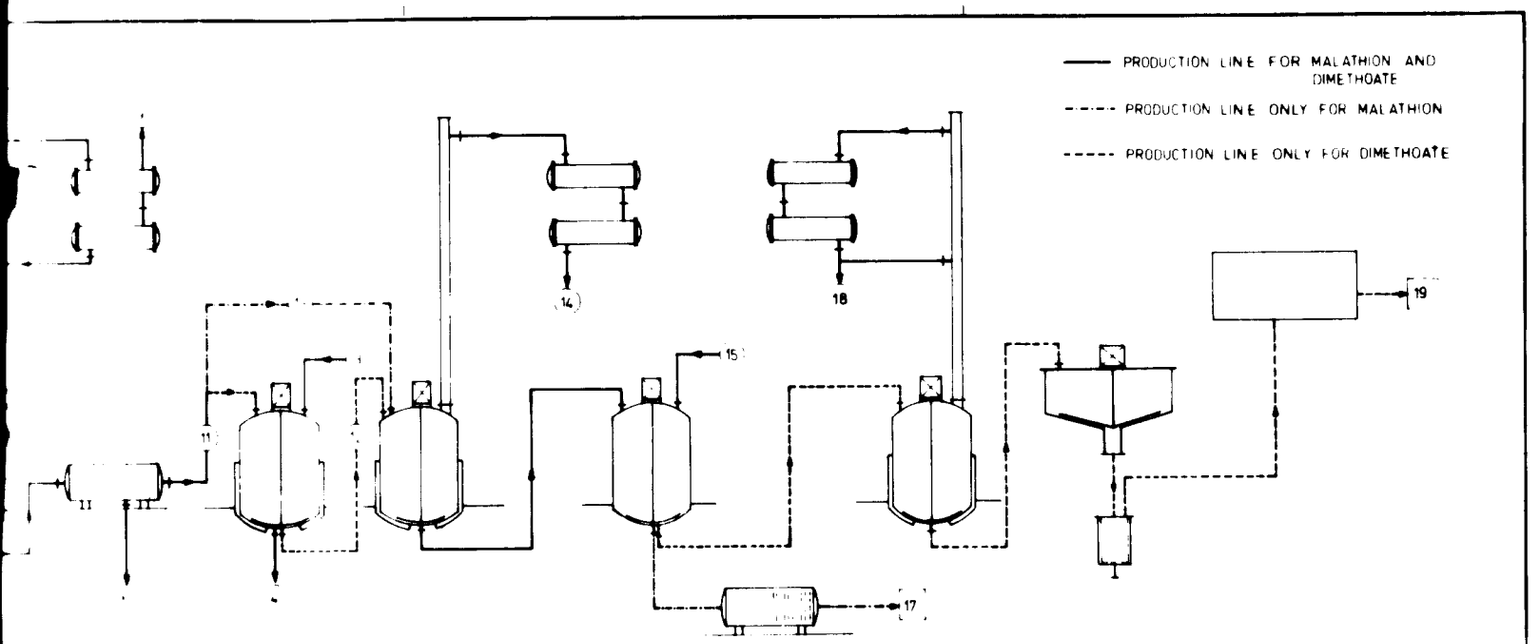
12
I Esterification
II Neutralization
III Distillation or Amidation
IV Synthesis
V Filtration
Neutralization in item II
Synthesis in item IV
MALATHION DIMETHOATE
DEME MMCA
DEME MCAA
DMDPA DMDPA
DMDPNa
MALATHION DIMETHOATE

SECTION 1



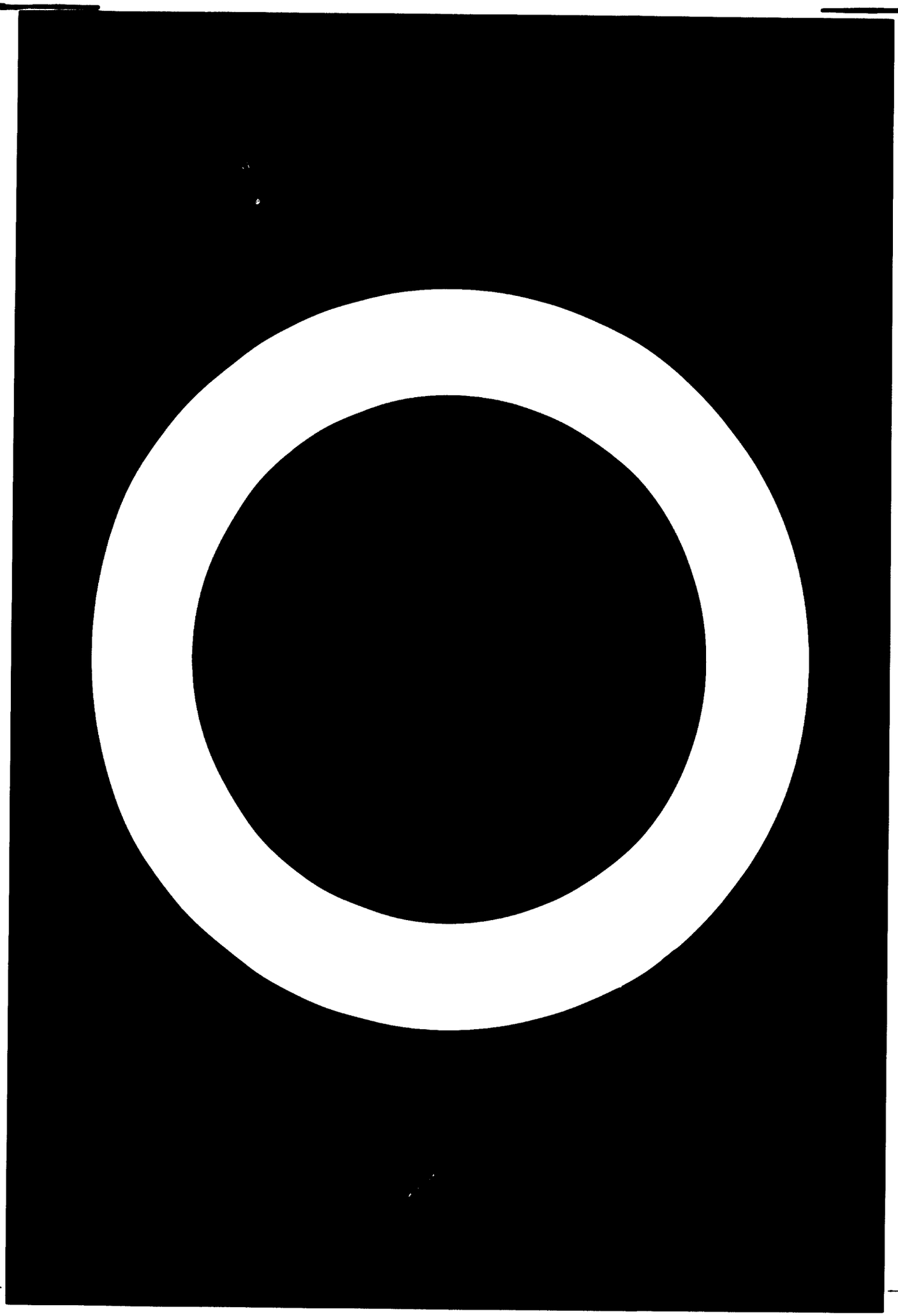
V Filtration | Neutralization Synthesis in item II | Synthesis in item IV | VI Washing and VII Separating | VIII Filtration | Distillation in item III | IX Crystallization | X Drying

DMDPNa

MALATHION
DIMETHOATE

FLOWSHEET OF A PILOT PLANT CAPACITY 300 tpa MALATHION OR DIMETHOATE 1979

SECTION 2



	1	2	3	4	5
Malathion:	maleic anhydride benzene ethanol conc. H_2SO_4	solvent reused	aqueos sodium carbonate	waste water	
Dimethoate:	monochloroacetic acid methanol	waste water	aqueos sodium carbonate	waste water	methylamine

	6	7	8	9	10
Malathion:		DEME	methanol P_2S_5 toluene	H_2S methanol toluene	unreacted P_2S_5
Dimethoate:	methanol reused	MCAA	methanol P_2S_5 toluene	H_2S methanol toluene	unreacted P_2S_5

	11	12	13	14	15
Malathion:	DMDPA		DMDPA DEME toluene	toluene reused	aqueos sodium carbonate and sodium chloride
Dimethoate:	DMDPA	DMDPNa	DMDPNa MCAA toluene	toluene reused	aqueos sodium carbonate and sodium chloride

	16	17	18	19
Malathion:	waste water	technn. malathion		
Dimethoate:	waste water		toluene	crystallized dimethoate

7.5 Equipment to be used in the pilot plant

The following unit operations are involved in the production of malathion and dimethoate and the following apparatus is necessary:

Item No.	Unit operation	Equipment
1	Esterification	Reactor
2	Neutralization	Vessel
3	Amidation or distillation	Reactor
4	Synthesis	Reactor
5	Filtration	Filter
6	Washing	Vessel
7	Separation	Decantation vessel
8	Filtration	Filter
9	Crystallization	Crystallization reactor
10	Drying	Dryer unit

A preliminary specification for the equipment above is given as follows:

Item 1 Esterification reactor

Capacity 1000 liter, complete with

- stirrer for the product with electric motor, explosion proof
- thermostatic jacket
- bottom valve
- rectification column
- cooler about 50 ft2 cooling area
- buffer vessels

The reactor and fittings are made of SS or enamelled steel for all parts in contact with the product.

Item 2 Neutralization vessel

Capacity 1000 liter, complete with

- stirrer for the product, with electric motor, explosion proof
- thermostatic jacket
- bottom valve

Reactor and fittings are of SS, or enamelled steel for all parts in contact with the product.

Item 3 Amidation reactor

It can also be used for distillation.
The same as item 1

Item 4 Synthesis reactor

The same as item 1 but supplemented with

- blower to remove the H_2S gas

Item 5 Filter

Pressure filter, filtering area 6 m2

Item 6 Washing vessel

Used also as a degasser. Capacity 2000 liter, complete with

- stirrer for the product, with explosion proof electric motor
- thermostatic jacket
- bottom valve

Vessel made from SS, or enamelled or hard rubber lined steel.

Item 7 Decantation vessel

Capacity 1000 liter, with conical bottom. Vessel made from SS, or enamelled or rubber lined mild steel.

Item 8 Distillation unit

Capacity 1000 liter, complete with

- stirrer for the product, with explosion proof electric motor
- thermostatic jacket
- bottom valve
- heat exchanger with cooling area of about 50 ft2
- azeotropic water separator
- distillation storage tanks
- fractionating column

The materials of construction are SS, glass lined steel, or glass.

Item 9 Crystallization unit

Capacity 1000 liter, closed pan type with scraper blades, jacket and cover tap of glass and with a solvent tank of 1000 l volume, made from SS.

Item 10 Dryer unit

to handle 200 kg wet product containing 50 % moisture.
Dryer, cabinet type, with thermostatic temperature controller and /N_2 purging between 25 to 100^{o} C, and with enamelled or SS trays and racks.

Auxiliary equipment should include:

Item 11 Tanks and buffer vessels for the storage of raw materials, intermediates, end products, and solvents to be recovered.

7.6 Classification of pilot plant items and cost estimates

Without a detailed engineering design only an approximate estimate can be given concerning the necessary investment costs. The limits of error in the estimates may reach 10 to 15 %. In the following list the plant items are classified in three groups

a) Existing
b) Those which could be manufactured in Egypt
c) To be bought abroad.

Nomenclature	existing equipment piece	price US-$ 1000	to be manufactured in Egypt Piece	Price US-$ 1000	to be imported piece	price US-$ 1000	total Piece	Price US-$ 1000
Pumps cap.1-2 a.5m3/h	8	36			14	63	22	99
Reactors vol.1m3,compl.	3	66					3	66
Reactor vol.1,6m3,compl.	1	23					1	23
Reactor vol.2m3,compl.	1	24					1	24
Fractionating columns, heat exchanger, storage tanks for the reactor					5	100	5	100
Tank for metering			6	24			6	24
Filter press	2	15					2	15
Washing vessels vol.1,1m3	3	66					3	66
c.o.		230		24		163		417

Nomenclature	Existing equipment Piece	Price US-$ 1000	to be manufactured in Egypt Piece	Price US-$ 1000	to be imported Piece	Price US-$ 1000	total Piece	Price US-$ 1000
c.f.		230		24		163		417
Decantation vessels vol.1m3, 0,5m3			10	35			10	35
Distillation unit					1	60	1	60
Cristallization unit					1	30	1	30
Dryer unit					1	25	1	25
Storage tanks vol.1,2,5,10,20m3	6	27	21	86			27	113
Total equipment price		257		145		278		680
Pipelines 8 %						54		54
Fittings 8 %						54		54
Instruments 8 %						54		54
Erection 15 %				102				102
Design, know-how						77		77
Project manager f.18 months à 4500						81		81
Consultants NRC				58				58
Contingency				80		30		110
		257		385		628		1.270

According to the estimate the total costs of the pilot plant would be US-$ 1.270,000.00. The foreign exchange needed for items to be imported is about US-$ 628,000.00. The difference could be covered from Egyptian sources as suggested by GOFI and a part of this investment is already present as "Existing equipment" (see above).

The realization of the above project as recommended by the UNIDO mission has the following advantages:

a) Substantial savings in foreign currency requirements for equipment.

b) Through the cooperation of experts who have knowledge in the manufacture of pesticides and production of organic intermediates the pilot plant could be put in operation within 2 years. In sizing the pilot plant equipment it has been taken into consideration that a 3-shift operation appreciable amounts of products should be obtainable in respect to Egyptian demand.

c) The pilot plant - after small changes - would also be suitable for the realization of other technologies concerning the production of organophosphorus pesticides.

d) The conditions at the site recommended for the pilot plant are favourable for a quick realization of scaling up and would also make it possible to lay the foundation for a large-scale industrial production of pesticides in Egypt.

8.0 Summary

Based on conclusion with representatives of Governmental-, Research- and Industrial Organizations in the Arab Republic of Egypt between 25th of January and 1st of February 1979 on the establishment of a multipurpose pilot plant for the production of organophosphorus pesticides, the following recommendations are made:

1) In view of the large imports of organophosphorus pesticides the construction of such a pilot plant would be fully justified.

2) As the most suitable location for the pilot plant the Dyestuffs & Chemicals Co. in Kafr El Dawar is suggested. The use of existing buildings and equipment would make a considerable contribution towards reducing investment costs.

3) Based on a preliminary estimate, the total fixed capital cost except building of the pilot plant project at the above site would amount to US-$ 1.270,000.00. Since some of the plant items are already on site and part of the equipment could be manufactured in Egypt, the foreign currency needed for buying equipment abroad would amount to US-$ 628,000.00 (in comparison the project would require about US-$ 1 mio. more in local and import costs if implemented at Kafr El Zayat).

4) Two products will be produced initially in the pilot plant, malathion and dimethoate.

The products should be handed over to the Pesticides & Chemicals Co. in Kafr El Zayat where these active materials will be formulated into final products, so that both companies may share in the benefits deriving from the project.

5) The General Organization for Industrialization (GOFI) will act in a coordinating and counterpart capacity during the erection and start-up of the pilot plant.

6) The National Research Centre (Prof. Dr. M.M. Sidky) will be consulting the project and will participate in such a capacity in the designing, start-up, operation and potential future expansion of the pilot plant.

7) The construction of the pilot plant will enable the production of appreciable amounts of organophosphorus pesticides with regard to current consumption and will help to lay the foundation for a large-scale production of pesticides in Egypt.

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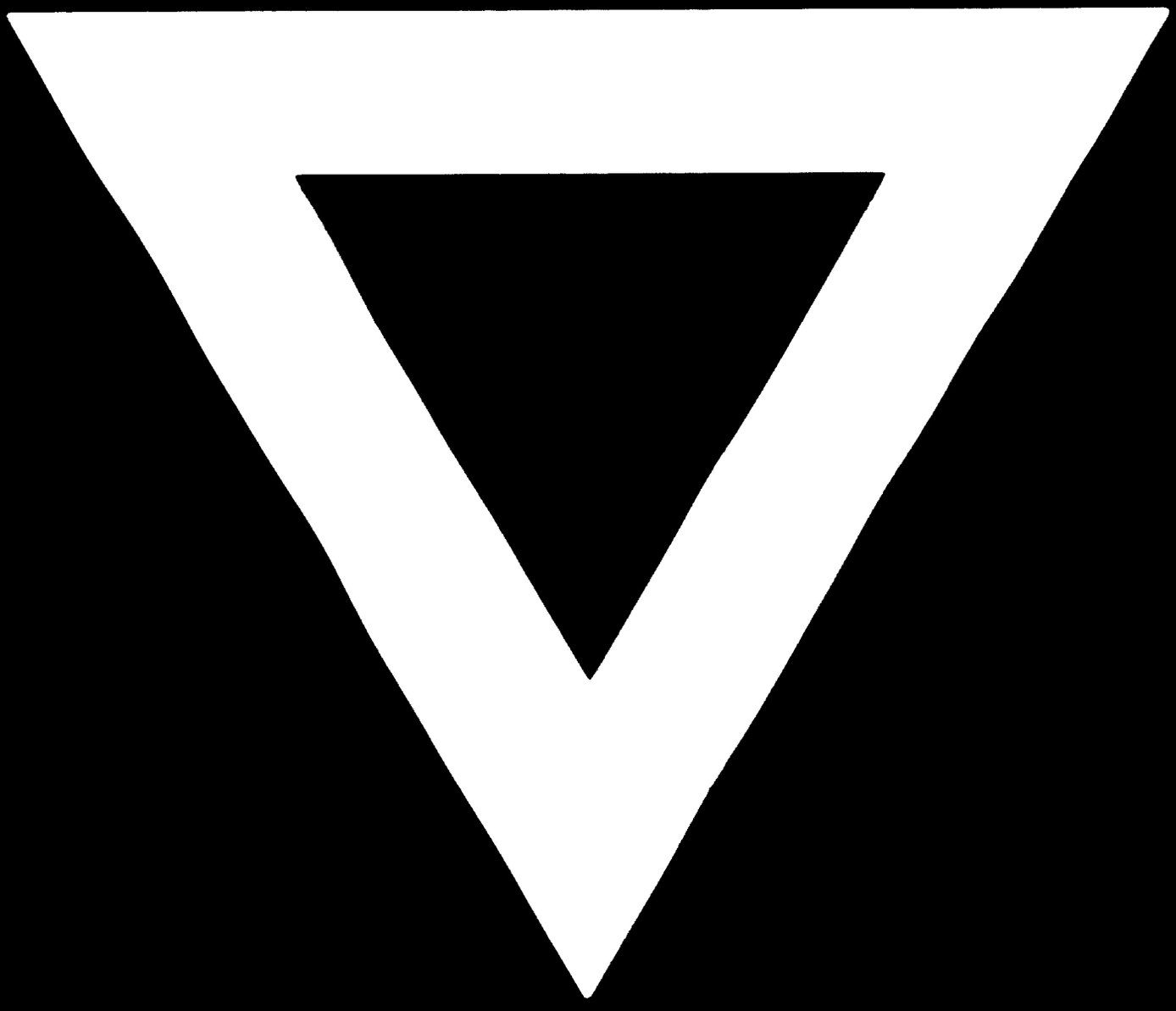

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