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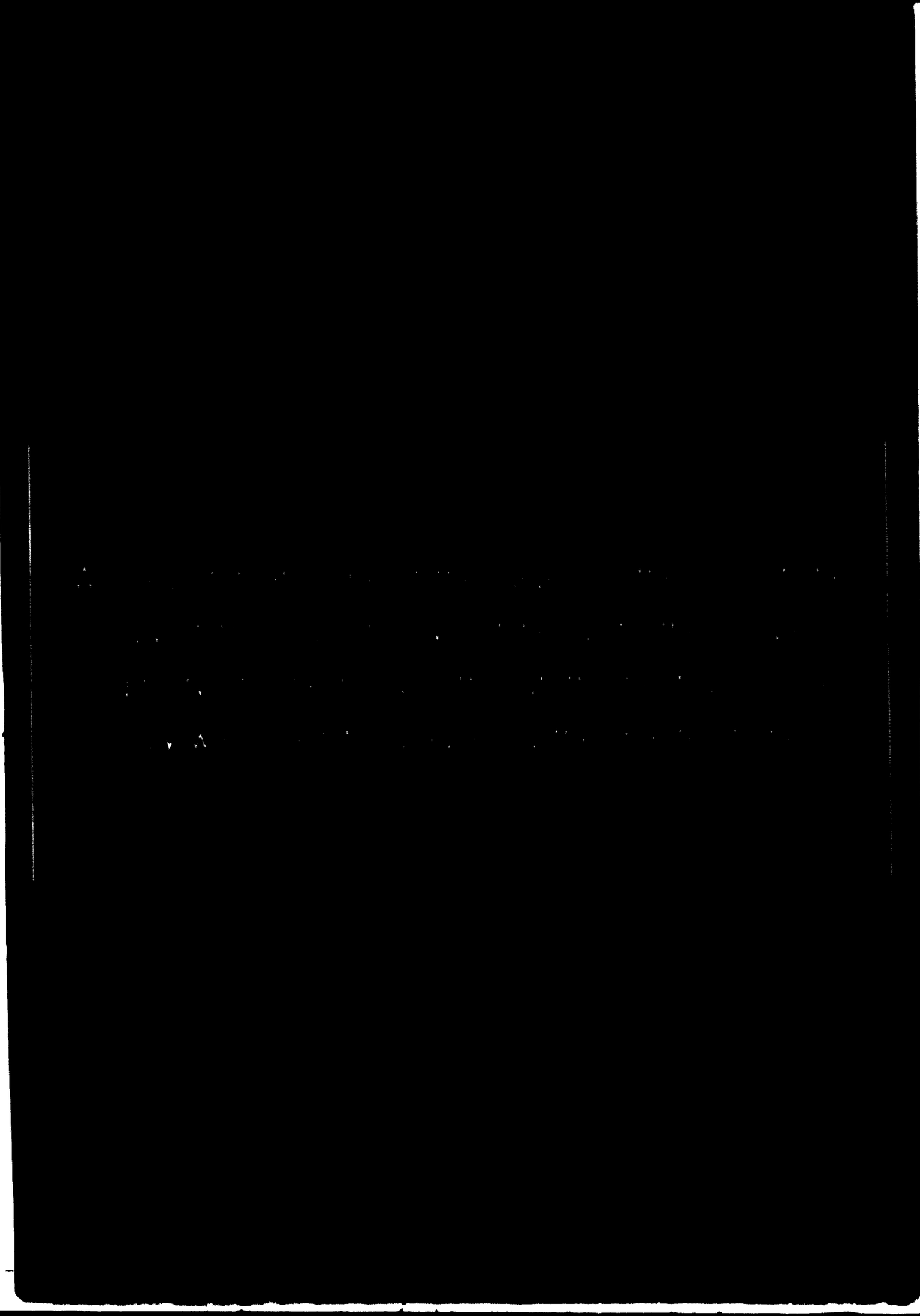

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on the Production and Promotion of Pesticides
and on Sub-Regional/Regional Co-operation
in the Pesticide Industries

Bangkok, Thailand
1 to 7 February 1977

M A L A T H I O N
AN INDUSTRY PROFILE 1/

by

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CONTENTS

SUMMARY

Malathion is a widely used insecticide all over the world in the fields of agriculture and public health. The increased use for this pesticide is due to its inherent safety -- as a matter of fact, it is one of the safest insecticides commercially available today in the market. For this reason, its use in developing countries is by far the most important and desirable because of almost total absence of sophisticated application equipment and users' ignorance about possible hazard involved in the use of pesticidal compounds. Its use in health is already on the increase in some developing countries where the vector resistance to DDT and BHC has been observed. Such trend has been observed in India, Sri Lanka, Indonesia and to a lesser extent in Nepal. Requirements, in 1977, for health programme alone for these countries would be around 3,200 M.T. and larger quantities thereafter. Malathion requirements for Philippines, Thailand, Indonesia and Malaysia were estimated at 84 M.T. for 1972-73, most probably for agriculture, by Messrs. C. Pope and W.J. Magee (UNIDO/ITD 250 - UNIDO/FAO Prefeasibility survey of pesticide production and use in certain countries in ECAFE region). Perhaps, the requirement of Malathion was lumped together with other insecticides in this investigation and as such figure for Malathion alone was on a much lower side.

As mentioned earlier, Malathion is a safe insecticide and does not pose undue toxicity and residue problems. Its use, therefore, has not been restricted nor is it likely to be restricted in the foreseeable /future.

future. As a matter of fact, its use should increase in view of toxicity and application hazards posed by some other pesticides for which it presents a good substitute. In addition, the development of ultra-low volume formulation and odour-less basic Malathion material should go a long way in its ready acceptance and increased use. The manufacture (medium scale plants of about 500 M.T.) of this insecticide, therefore, can be taken up in selected countries where the agricultural and health requirements can justify such a plant on economic basis.

Developing countries in Asia & Pacific region except India do not have the basic raw materials for manufacture of Malathion. Whether or not it is economically feasible to start manufacturing facilities in any of the developing countries, the establishment of formulating facilities would be a most prudent step in view of cheaper labour, availability of inerts, savings in freight etc.

Phosphorous pentasulphide, Methanol, Toluene, Maleic Anhydride and Ethyl alcohol are the major raw materials required for manufacture of Malathion. The prevailing prices for these and other materials are provided as obtained in India. Three major steps involved in its manufacture are:

1) Manufacture of DTA
2) Manufacture of DEM
3) Manufacture of Malathion, washing, solvent stripping and drying of Malathion.

A Flow Diagram is given in the report for better understanding of the various steps in Malathion manufacture.

/ The

The capital cost for a 500 T.P.A. plant under Indian conditions is worked out to be around Rs. 15.5 million. The detailed list of equipment, construction costs, offsite facilities etc. is provided in the report. Similarly, data is provided on the cost of production taking into account man-power requirements, utility rates, maintenance costs, depreciation, etc. The cost of production for a 500 T.P.A. plant works out to be around Rs. 24,000/M.T.

The disposal of by-products & effluents does not pose a major problem. The only by-product, Hydrogen sulphide gas, obtained during Malethion manufacture is either burnt or recovered by absorbing it in Caustic Soda solution. Liquid effluents can be disposed of by neutralisation, chemical treatment and bio-oxidation. The solid effluents can be disposed of by combustion and H_2S the gaseous effluent, can be recovered or disposed of by combustion.

The Indian Standard Institution (ISI) and W.H.O. specifications for a product of 95 per cent purity are given. It will be observed that these two specifications are fairly similar and all the production in India meets the ISI specifications.

Patents for manufacture of Malathion have expired the world-over and as such many new companies are manufacturing or contemplating to manufacture Malathion. Of the nine known manufacturers of Malathion, four are located in India. Except for the Cyanamid plant, all other plants in India are based on local technology. Technology at least

/from

from one of the manufacturers i.e. M/s. Excel Industries (and they have sold their technology to two Government owned companies in India including Hindustan Insecticides Limited) will be available for sale to other developing countries. The cost of acquiring such technology for a 500 T.P.A. plant is known to be around Rs. 800,000 for know-how, Rs. 1,000,000 for detailed engineering and a royalty of 2.5 per cent on sales for ten years. When contacted, M/s. Chemineva, Denmark and Sumitomo, Japan showed no interest in sale of technology.

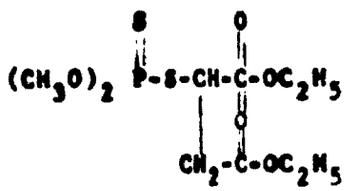
In conclusion, it may be said that since the product is relatively safe; is needed for agriculture and health programmes; its technology is available for transfer, design, engineering and equipment fabrication facilities are available within the developing countries, and raw materials are also available in the region, its manufacture in consuming countries may be seriously considered.

/CHEMISTRY

CHEMISTRY & INSECTICIDAL ACTIVITY

Malathion (O, O-Dimethyl S-(1,2 - dicarbethoxyethyl) phosphorodithionate; or O, O-dimethyl phosphorodithioate of diethyl mercaptosuccinate) is an organo-phosphorus compound with a very low toxicity to man and other animals (LD 50 - rats; oral 1375 mg/kg, dermal 4100 mg/kg).

Technical grade material is clear to amber liquid with a garlic odour. It has a specific gravity of 1.23 at 25°C; melting point 2.85°C; vapour pressure 4×10^{-5} mm Hg at 30°C; flash point 163°C; water solubility 145 ppm. It is miscible in most organic solvents but of limited solubility in petroleum oils. Premium grade Malathion is a low odour product.



Malathion when used according to directions does not leave any toxic residues on food or forage crops. It works fast on the pests and its residues disappear quickly. It is chiefly a contact poison but also acts as a stomach poison and shows slight fumigation activity. It is very useful against wide range of sucking insects and mites.

/Because

Because of its safety to man, wide spectrum of efficacy and lack of harmful residuesm it is s most preferred insecticide in agricultura, public health, dairies, food processing plants and for man and animal.

Malathion is particularly useful in aerial application and also in treatment of tall trees to avoid likely hazards in such oparations. It is also an insecticide of choice in plantation crops like tea, coffee and sugarcane.

In cereal crops, Malathion is generally used for the control af rice hispa, leaf and plant hoppers, swarming caterpillars, gall flies, mealy bugs, rice bugs, ear cutting caterpillars, leaf rollars, flea beetles, aphids, army worms, hairy caterpillars, thrips, grey weavil, earhead bugs etc.

In fibre crops, it has been used to control jassids, aphids, thrips, red cotton bugs, grey weevils, semi-loopers, mites etc.

Malathion has also been used against the pests of plantation crops particularly sugarcane white fly, mealy bugs, pyrillas, mites, scale insects, flush worms, tea mosquitoes, leaf miners etc.

In fruit crops, Malathion is commonly used for the control of white fly, aphids, mealy bugs, leaf miners, psyllas, cottony cushion scale, woolly aphid, sanjose scale, mango hopper, mango fruit flies etc.

In vegetable crops, it has successfully controlled aphids, jassids, diamond back moth, semiloopers, tobacco caterpillars, spotted

/boll

boll worms, thrips, mites, white flies, fruit borers, epilachna beetles and pumpkin beetles etc.

For veterinary pests, Malathion is commonly used against fowl mites, poultry lice, poultry ticks, stick tight fleas, horn flies, cattleticks, swine lice etc.

For storage pests, it is commonly used for spraying in the grain stream and on storage structures against major stored grain pests.

FORMULATION & MARKETING

Malathion is generally formulated as an emulsifiable concentrate (50 per cent), wettable powders (25 per cent and 50 per cent), dusting powders (5 per cent and 10 per cent) and a ULV concentrate (95 per cent) for use in agriculture and public health. These formulations can be made in other formulation facilities which exist in the developing countries for similar formulations of other products. However, ULV formulation is rather difficult to make and its technology is not easily available nor are the adjuvants/emulsifying agents readily available.

The most popular formulation in agriculture is emulsifiable concentrate and wettable powders are used in health programmes. Dusts are mostly used in vegetables, food-grain crops and low odour Malathion, manufactured by patented processes is the preferred material for use in treatment of food-grains, homes and animals.

The present demand for Malathion for health programmes alone in the developing countries of Asia is estimated at around 3,200 TPA. The agricultural requirements at present would be another 2,000 M.T. in these countries. India has licensed (to manufacturers) a capacity of 4,400 TPA but the installed capacity as of today is around 2,300 TPA. Additional capacity of 5,000 TPA for licensing in India is under consideration. The total demand both for agriculture and health programmes in India today is being met from local production. The new

/entrepreneurs,

entrepreneurs, however, have export markets in mind to dispose of their production in addition to increasing market for agriculture and health programmes at home.

DESCRIPTION OF PROCESS FOR MALATHION

Malathion Technical can be manufactured by any of the following methods.

1. The condensation reaction of DTA (which is obtained from reaction of Phosphorous Pentasulphide with Methanol in presence of toluene) with Diethyl Maleate (considered available) under specific temperature conditions. Crude Malathion is purified by treatment with chemicals and is filtered and dried. The hydrogen sulphide evolved during DTA manufacture is absorbed in caustic soda solution to form sodium hydrogensulphide.

2. This method involves direct phosphorylation reaction between Phosphorous pentasulphide, methanol and ethyl maleate under suitable temperature conditions and subsequent enrichment of the technical crude Malathion (by thin layer vaporisation) to yield crude Malathion (95 per cent to 96 per cent). The Hydrogen sulphide gas evolved is destroyed by combustion.

3. This method involve three stages:

(a) Preparation of DTA by the reaction of phosphorous pentasulphide with CH_3OH. The H_2S evolved is absorbed in caustic

/soda

soda solution. (b) Preparation of DEM by the esterification reaction of Maleic anhydride with ethyl alcohol. (c) Condensation reaction of DTA with DEM to get crude Malathion.

The first two methods are based on the technology developed in developed countries. The technology for the third method is availeble in India and is available for sale to other developing countries. The details of this method are as under.

The process involves three major steps

(a) Manufacture of DTA.

(b) Manufacture of DEM.

(c) Manufacture of Malathion, Washing, Solvent stripping and drying of Malathion.

(a) Manufacture of DTA.

Phosphorous Pentasulphide is reacted with Methanol in presence of toluene. The Hydrogen sulphide evolved is absorbed in caustic soda solution. The cool product is then transferred by vacuum to a setting tank.

(b) Manufacture of DEM.

Maleic Anhydride, Ethyl alcohol, Benzene and a catalyst are refluxed continuously and the layer which consist of water and small quantities of ethyl alcohol and benzene is drawn off by use of a separetor. The upper layer is allowed to go back into the reactor. The excess solvent is distilled and reused. The DEM is then passed in Na_2CO_3 and finally purified by vacuum distillation.

/(c) Manufacture

(a) Manufacture of Malathion.

DEM and DTA are condensed in a reactor for 24 to 30 hours, cooled washed with Na_2CO_3 solution and treated with H_2O_2. The crude Malathion is then stripped with steam and the product is dried under vacuum and stored.

RAW MATERIAL REQUIREMENT PER KG. OF PRODUCT

1.	Maleic Anhydride.	0.37 kg.
2.	Ethyl Alcohol.	0.50 kg.
3.	Sulphuric Acid.	0.04 kg/kg.
4.	Phosphorous Pentasulphide.	0.492 kg/kg.
5.	Methanol.	0.395 L/kg.
6.	Toluene.	0.04 L/kg.
7.	Soda Ash.	0.113 kg/kg.
8.	Benzene.	0.06 L/kg.
9.	Hydroquinone.	0.0035 kg/kg.
10.	Caustic Soda 40%.	0.25 kg.
11.	Hydrogen Peroxide.	0.04 kg.

REQUIREMENT OF RAW MATERIALS, UTILITIES AND PACKING MATERIAL

(Basis 500 tonnes per annum/300 days per year)

1. Raw Materials	Quantities/annum
Maleic Anhydride.	185 Tonnes.
Ethyl Alcohol.	250 K.L.
Sulphuric Acid.	2.0 Tonnes.
Phosphorous Pentasulphide.	246 Tonnes.
Methanol.	197.5 Tonnes.
Toluene.	20 K.L.
Soda Ash.	56.25 Tonnes.
Benzene.	30 K.L.
Hydro Quinone.	1.75 Tonnes.
Caustic Soda 100%.	50 Tonnes.
Hydrogen Peroxide.	20 Tonnes.
2. Utilities	
Water.	26000 M^3
Steam.	3600 Tonnes.
Power.	1900 x 1000 [illegible].
3. Packing.	
250 litres containers (lined inside)	2000 Nos.

UTILITIES

Utility	Specification	Requirement	Application	Equipment required
Process water	Softened to 45 to 50 ppm hardness limit	2200 gph	Washing of crude DEM and Malathion Preparation of sodium carbonate solution	Softener 500 gph (This will also soften the boiler feed water)
Cooling water (make-up)	- do -	1300 gph	Cooling H_2S absorption unit, solvent recovery unit and reactors	
Cooling water	- do -	2200 gph (Recirculation)	Cooling H_2S absorption unit, solvent recovery unit and reactors	a) Cooling tower b) Circulating pumps - 3 Nos. 2700 gph 75 ft. head (2 Nos. + 1 standby) c) Basc tank 5000 gals. capacity
Steam	10 psig and 35 psig	13 tonnes/day	Required in DEA and DEM reactors, distillation of DEM, stripping of toluene from Malathion etc.	a) Boiler 100 kg/h capacity. Feed water specifications: Hardness 10 ppm, Dissolved solids 200-1000 ppm / litre b) Oil & water storage tanks c) Steam pressure regulating station d) Hydraulic pressure test pump
Power		17,28,000	For main plant agitators, pumps, lighting, etc. and for utilities public amenities etc.	400 KVA transformer

contd.....

Utility	Specification	Requirement	Application	Equipment required
Hot-oil		Heating HEM	Heating HEM distillation units	Hot oil system of recirculating type 8 Heaters of 4 MM 100 GPM gear pump of 7.5 HP with 20 ft. head.
Refrigeration		-	Required at most steps of manufacture	2 brine units each of 25 tonnes capacity. Each unit will comprise the followings: a) 3 Nos. Freon compressors of total 25 tonnes capacity b) 3 Nos. condensers and receivers c) Chilling tank with coils d) 1 Chilling water circulated pump.

CAPITAL COST

		(Rs. in thousands)
1.	Land and land development (20 acres)	2,000.00
2.	Equipment cost including Effluent treatment plant	9,000.00
3.	Plant building and civil, structure.	800.00
4.	Painting and Insulation.	500.00
5.	Erection.	800.00
6.	Know-how and Detailed Engineering.	2,000.00
7.	Commissioning.	300.00
	Total:	15,400.00

ESTIMATED FOR OFFSITES FACILITIES & MISCELLANEOUS EXPENDITURE

		(Rupees in thousands)
1.	Water Over Head Tank 20M^3 & construction water supply	40.00
2.	Power receiving & distribution system including emergency power	2,000.00
3.	Water softening plantcapacity 2.5M^3/hr.	100.00
4.	Instruments Air 5 NM^3/hr.	75.00
5.	Refrigeration capacity 50 tonnes temp 5° to 10°C	400.00
6.	Cooling system tower	400.00
7.	Yard pipings	350.00
8.	Compound wall & fencing Rs.100/- per running ft.	150.00
9.	Road as per layout	50.00
10.	Time office, change room, welfare	85.00
11.	Canteen	100.00
12.	Dispensary	50.00
13.	Laboratory	235.00
14.	General Store	65.00
15.	Administration block	450.00
16.	Transport vehicles	80.00
17.	Security & Guard room	30.00
18.	Material handling equipment	230.00
	Storages	
19.	Under ground storages	
	i. Methanol ii. Ethanol iii. Toluene iv. Benzene	450.00
20.	Caustic soda & sulphuric acid storage	50.00
21.	Raw material and drum storage	50.00
22.	Fuel oil storage	100.00
23.	Malathion (Technical) storage	50.00
24.	Steam convertor plant capacity 1.5 tonne	350.00
25.	Miscellaneous	
	i. Preliminary expenses	200.00
	ii. Pre-operative expenses	1,600.00
	iii. Contengencies	500.00
	iv. Interest during construction	1,200.00
		9,410.00

SUMMARY OF CAPITAL OUTLAY

		(Rs. in thousands)
1.	Land and land development	2,000.00
2.	Main plant and Equipment including erection and commissioning	13,480.00
3.	Services, Offsite facilities and Miscellaneous expenditure	9,410.00
4.	Margin on working capital	800.00
5.	Miscellaneous	2,155.00
	TOTAL:	27,845.00

COST OF PRODUCTION

(Per tonne of Malathion Technical)

	Description	Unit	Quantity per annum	Rate per Unit	Annual Cost Rs. in thousand
1.	Raw Material				
	a. Maleic anhydride	Tonnes	185	9180	1698.00
	b. Ethyl alcohol	K.L.	250	3025	0756.00
	c. Sulphuric acid	Tonnes	2.0	600	12.00
	d. Phosphorous penta-sulphide	Tonnes	246	11000	2706.00
	e. Methanol	K.L.	197.5	3620	715.00
	f. Toluene	K.L.	20	4300	86.00
	g. Soda Ash	Tonnes	56.25	1200	68.00
	h. Benzene	K.L.	30	3860	116.00
	i. Hydroquinone	Tonnes	1.75	81200	140.00
	j. Caustic Soda	Tonnes	50	1640	82.00
	k. Hydrogen peroxide	Tonnes	20	5500	110.00
2.	Utilities				
	Water	M^3	25000	0.75	19.00
	Power	1000 KwH	1728	90	156.00
	Fuel oil	Tonnes	312.5	800	250.00
3.	Consumable	-	-	-	77.00
4.	Labour and Overheads	-	-	-	782.00
			Total direct operating cost		= 7821.00

FIXED COST

1.	Maintenance at 5% on erected plant cost	110.00
2.	Depreciation @ 15% on plant cost	1350.00
3.	Interest @ 18% on working capital	2556.00
		4016.00
	Total annual cost. 7821.00 + 4016.00 = 11837.00	11837.00
	Cost of Production of Malathion/tonne unpacked	23.67
	Cost of packing 500 tonnes of Malathion	333.00
	Net annual cost	12166.00
	Cost of Production of Malathion/tonne packed	24.12

LIST OF PROCESS EQUIPMENT

Sr.No.	Equipment	M.O.C.	No.	Capacity (litres)
1	Reaction kettle DTA	Sp.Alloy	1	1250
2.	Reaction kettle DEM	Glass-lined	3	2500
3.	Condensation kettle (Malathion)	Glass-lined	3	1250
4.	Distillation still(DEM)	Glass-lined	1	850
5.	Storage tanks			
	a) Methanol	MS	2	8500
	b) Toluene	MS	1	8500
	c) DTA	Sp.Alloy	1	1250
	d) Caustic soda	MS	2	8500
	e) Ethanol	MS	2	8500
	f) Benzene	MS	1	8500
	g) Washed DEM	Glass-lined	1	3000
	h) Purified DEM	Glass-lined	1	4500
	i) Washed Malathion	Sp.Alloy	1	4500
	j) Stripped Malathion	Sp.Alloy	1	1700
	k) Malathion		2	1700
	l) Malathion (purified)		1	8500
6.	Batch tanks			
	a) Methanol	MS	1	500
	b) Toluene	MS	1	500
	c) Ethenol	MS	1	850
	d) Benzene	MS	1	450
	e) DTA	Sp.Alloy	1	1250
	f) DEM	Sp.Alloy	1	850
	g) Caustic soda (for deletion)	MS	1	1250
	h) Sodium carbonate	MS	1	1500
7.	Scrubber	MS	1	4500
8.	Washing tanks			
	Crude DEM	Sp. Alloy	1	1700
	Crude Malathion	Sp. Alloy	1	3500
9.	Distillation still	MS	1	4000
10.	DEM receiver	Sp. Alloy	1	450
11.	Solvent receiver	MS	1	3500
12.	Drier	Sp. Alloy	1	1700

/Contd.

Sr.No.	Equipment	M.O.C.	No.	Capacity (litres)
13.	Lower layer storage	MS	1	2500
14.	Toluene water	Sp. Alloy	1	850
15.	Receiver for Malathion(dry)	Sp. Alloy	2	500
16.	Drier (Malathion)	Sp. Alloy	1	315
17.	Toluene washing & distillation	MS	1	850
18.	Vesaal for Toluene recovery	MS	1	850
19.	Heat Exchangers	MS	2	259981
20.	Recovery unit ehtenol	MS	2	1250
21.	Ethenol receiver	MS	1	850
22.	Condensate receiver	Sp. Alloy	1	250
23.	Stripping column	Sp. Alloy	1	-
24.	Pumps	Sp. Alloy	8	-
25.	Vacuum pumps	-	10	-
26.	Reflux system	-	3	-
27.	Blowers	Sp. Alloy	2	-
28.	Filter pump	Sp. Alloy	1	-
29.	Piping structural (electricity)	-	-	-
30.	Rota meters	SS	4	-
31.	Flow indicators	-	6	-
32.	Temp. recorders	-	6	-
33.	Pressure indicator	-	6	-
34.	Vacuum gauge fitting	-	2	-
35.	Level gauge fitting	-	4	-
36.	Manometers	-	2	-
37.	Sight glass fitting	-	12	-
38.	Temperature indicator	-	6	-
39.	Temperature recorder controller		-	-
40.	Temperature controller	-	-	-

SPECIFICATIONS OF THE END PRODUCT

Indian Standard Specifications - IS-1832-1961

REQUIREMENTS FOR MALATHION, TECHNICAL

Sl. No.	Characteristics	Requirement
1.	S-(1,2-bis (ethoxycarbonyl) ethyl) O,O-dimethyl phosphorodithioate (Malathion) content, per cent by weight, Min.	95.0
2.	Water content, per cent by weight, Max.	0.1
3.	Acidity (as H_2SO_4), per cent by weight, Max.	0.4
4.	Material insoluble in acetone per cent by weight, Max.	0.5
5.	Specific gravity at $25^{\circ}/25^{\circ}C$ Min.	1.23

W.h.O. SPECIFICATIONS-WHO/SIF/IORI

TABLE-II-REQUIREMENTS FOR MALATHION,TECHNICAL

Sl. No.	Characteristics	Requirement Min.	Max.
1.	O,O-Dimethyl S-(1,2-di-(ethoxy-carbonyl) ethyl) phosphorodithioate content per cent by weight	95.0	-
2.	Acidity, per cent by weight (calculated as H_2SO_4)	-	0.4
3.	Solid material insoluble in acetone per cent by weight	-	0.5
4.	Water content, per cent by weight	-	0.1
5.	Sp. gravity at $25^{\circ}/25^{\circ}C$	1.23	-

BY-PRODUCTS AND EFFLUENTS

1. By-Products

The only by-product which is found during the reaction of Phosphorous Pentasulphide with Methanol is Hydrogen sulphide gas. This gas is either burnt or is recovered by absorbing it in caustic soda solution.

2. Effluents

The effluent produced in the plant resulting from the above process are expected to be of the order of 26,000 litres/day. The effluent before treatment is acidic in nature due to traces of sulphuric acid and also contains small quantities of organics including traces of Malathion. Also small quantity of solid residue is expected to be produced from the DTA plant.

The liquid effluent from Malathion washing unit contains traces of Malathion and is acidic in nature. This is chemically treated with chlorine/hydrochloride to destroy Malathion completely. The acidic effluent containing organics is treated with lime slurry to neutralise the acidity. The partially treated effluent containing organics is sent to bio-oxidation unit where the BOD is reduced and is brought to the specified level.

The insignificant quantity of solid which is harmless, is disposed of either by combustion or by disposing off in the usual manner. The gaseous effluent viz. H_2S is either recovered by absorbing in sodium hydroxide solution to produce sodium bi-sulphide or is disposed off by combustion.

The treated effluent disposed of, fulfils the specifications laid down in IS-specifications No. 2490-1974 for disposal of Industrial Wastes into Inland surface water.

MAN POWER REQUIREMENT

Sr. No.	Personnel	Nos.
1.	General Manager	1
2.	Prod. Superintendent	1
3.	Maintenance Supdt.	1
4.	Accounts Officer	1
5.	Purchase Officer	1
6.	Administrative Officer	1
7.	Stores Officer	1
8.	Security Officer	1
9.	Accountants	2
10.	Personnel Assistant	1
11.	Receptionist	1
12.	Typist/clerks	4
13.	Driver	1
14.	Helpers	2
15.	Peon	1
16.	Watchmen	6
17.	Shift supervisors	4
18.	Maintenance Foremen	3
19.	Plant Operators	5
20.	Skilled workers	10
21.	Unskilled workers	14
22.	Chemists	2
23.	Boiler Attendants	4
24.	Refrigeration Attendants	4
25.	Fitter/Welder/Electrician Instrument mechanic	4

BASIC MANUFACTURERS OF MALATHION WITH ADDRESS

1. AMERICAN CYANAMID COMPANY
   AGRICULTURAL DIVISION, P.O. BOX 400
   PRINCETON, NEW JERSEY, U.S.A. - 08540
   TELEPHONE: (609) - 799-0400

2. CHEMINOVA
   P.O. Box 9 DK 7620 LEMV, DENMARK
   TELEPHONE: (07) 83-41-00

3. CYANAMID INDIA LIMITED
   AGRICULTURAL DIVISION
   P.O. BOX NO. 9109
   BOMBAY, INDIA - 400 025
   TELEPHONE: 45-5211

4. EXCEL INDUSTRIES LIMITED
   184/87, S.V. ROAD, JOGESHWARI
   BOMBAY - INDIA - 400 060
   TELEPHONE: 57-1431

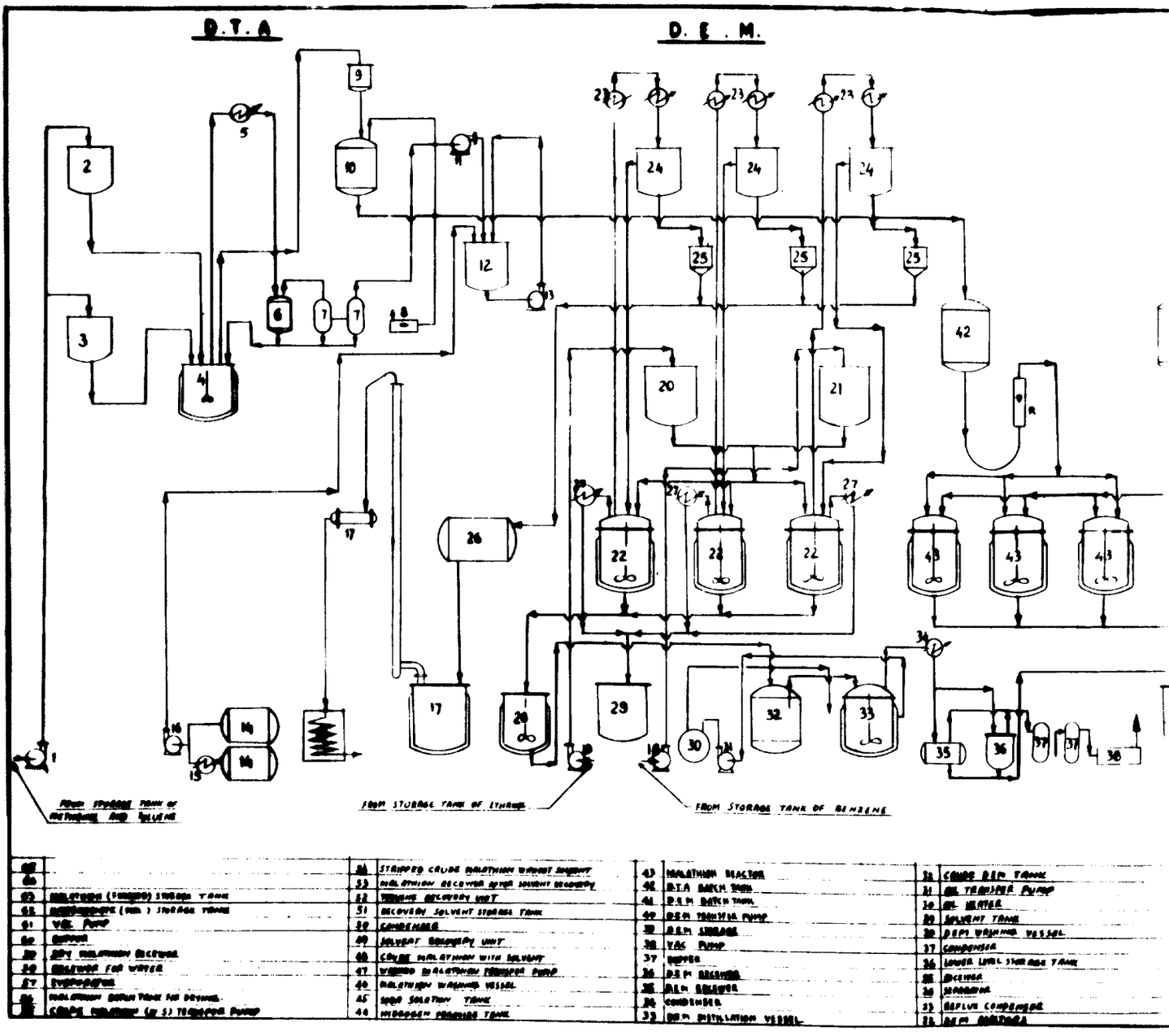
5. SNIA VISCOSA S.P.A. (ITALY)
   CHEMICAL DIVISION, VIA MONTEBELLO - 18
   20121, MILANO, ITALY
   TELEX: 34503-35402-MILAN

6. SUMITOMO CHEMICAL CO. LTD. (JAPAN)
   155, CHOME, KITHAMA
   HIGASHI - KU, OSAKA, JAPAN
   TELEPHONE: (06) 220-3211

7. BHARAT PULVERISING MILLS LTD.
   HEXAMAR HOUSE
   28, SAYANI ROAD, BOMBAY - INDIA - 400 025
   TELEPHONE: 29-2877

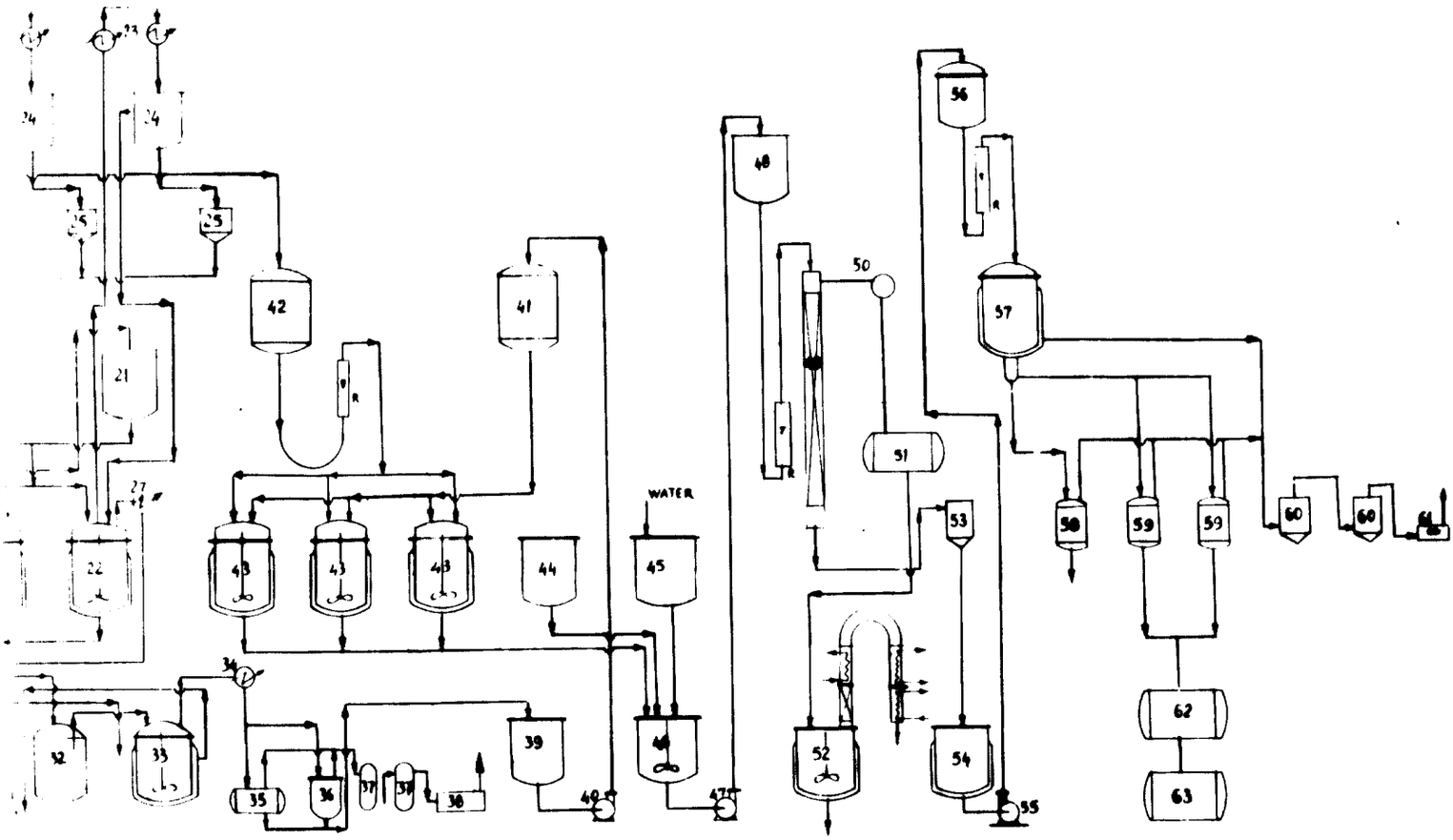
8. PESTICIDES INDIA
   P.O. BOX 20
   UDAIPUR, INDIA
   TELEPHONE: 796

9. PESTICIDES & BREWERS LTD.
   CHITTABAR MANPADE
   S.V. ROAD, P.O. BOX No. 42
   THANA, BOMBAY, INDIA - 400 067


D.T.A
D. E. M.
From storage tank of Ethylene
From storage tank of Benzene

M.

MALATHION



STORAGE TANK OF BENZENE

REACTOR	32	CRUDE BEN TANK	31	ALCOHOL BATCH TANK	10	D.T.A SETTLING TANK
TANK	31	OIL TRANSFER PUMP	30	BENZENE BATCH TANK	9	FILTER
TANK	30	OIL HEATER	29	BENZENE TRANSFER PUMP	8	VAC PUMP
A PUMP	29	SOLVENT TANK	28	ETHANOL TRANSFER PUMP	7	BUFFER
	28	DEPT WASHING VESSEL	27	ALCOHOL & BENZENE RECOVERY UNIT	6	BUFFER
	27	CONDENSER	26	CAUSTIC TRANSFER PUMP	5	HEAT EXCHANGER
	26	LOWER LEVEL STORAGE TANK	25	CONDENSER	4	D.T.A REACTOR
VER	25	HEATER	24	CAUSTIC STORAGE TANK	3	METHANOL BATCH TANK
WER	24	EVAPORATOR	23	CAUSTIC TRANSFER PUMP	2	MALATHION BATCH TANK
	23	REFLUX CONDENSER	22	CAUSTIC ABSORPTION TANK	1	METHANOL & TOLUENE TRANSFER PUMP
ATION VESSEL	22	DEPT HEATERS	21	ALCOHOL	S.NO	DESCRIPTION

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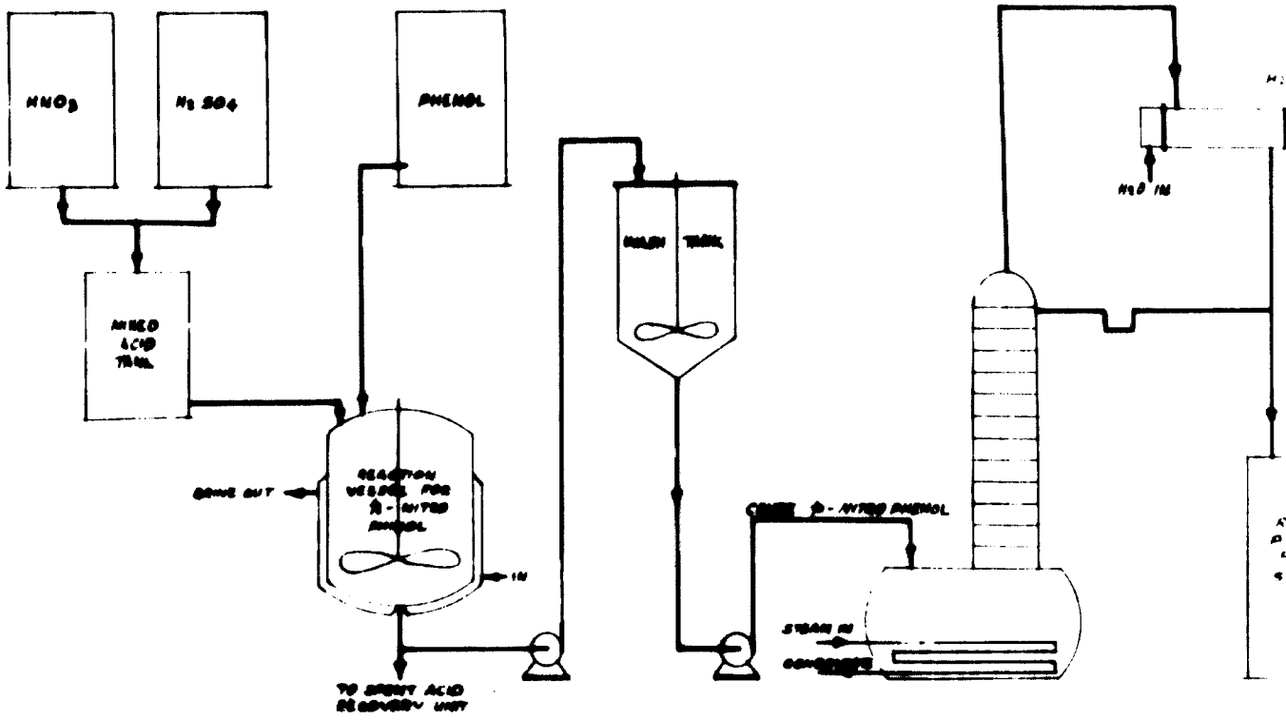
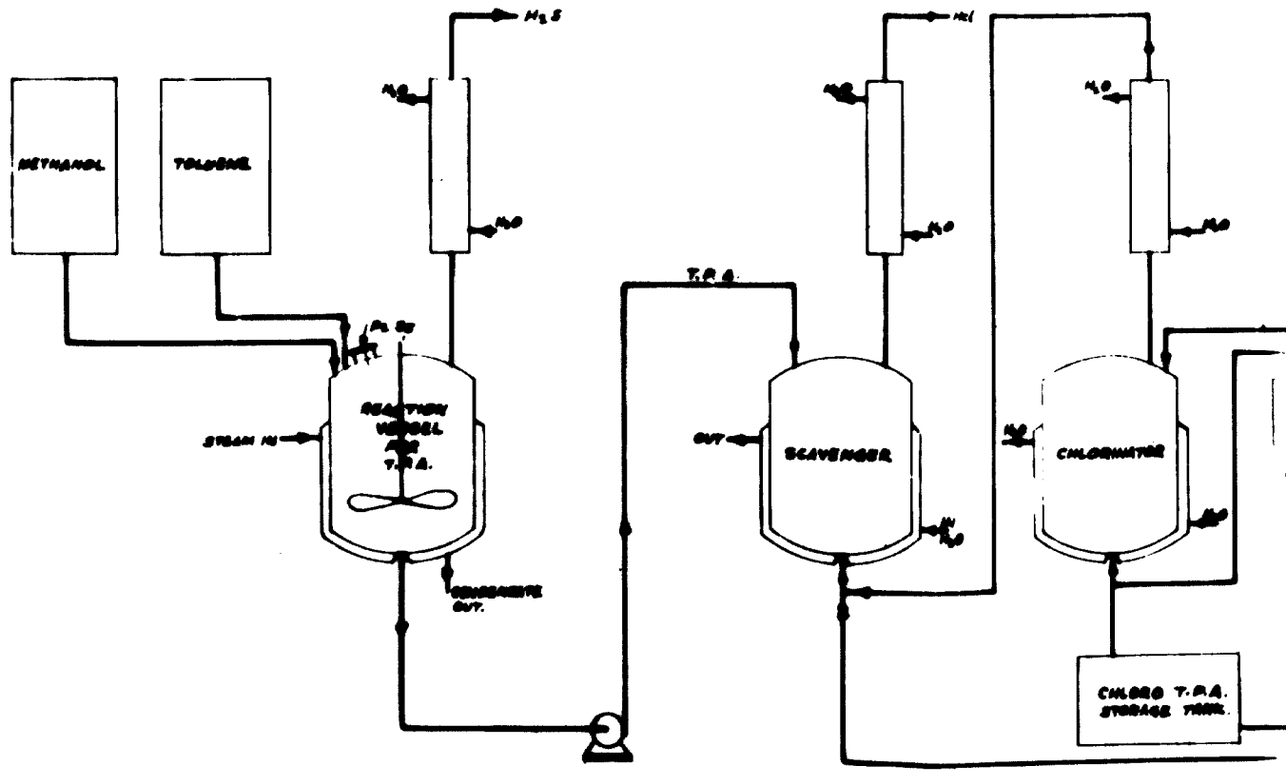
MANUFACTURE OF P-NITRO PHENOL SOD



MANUFACTURE OF METHYL PARATHIO



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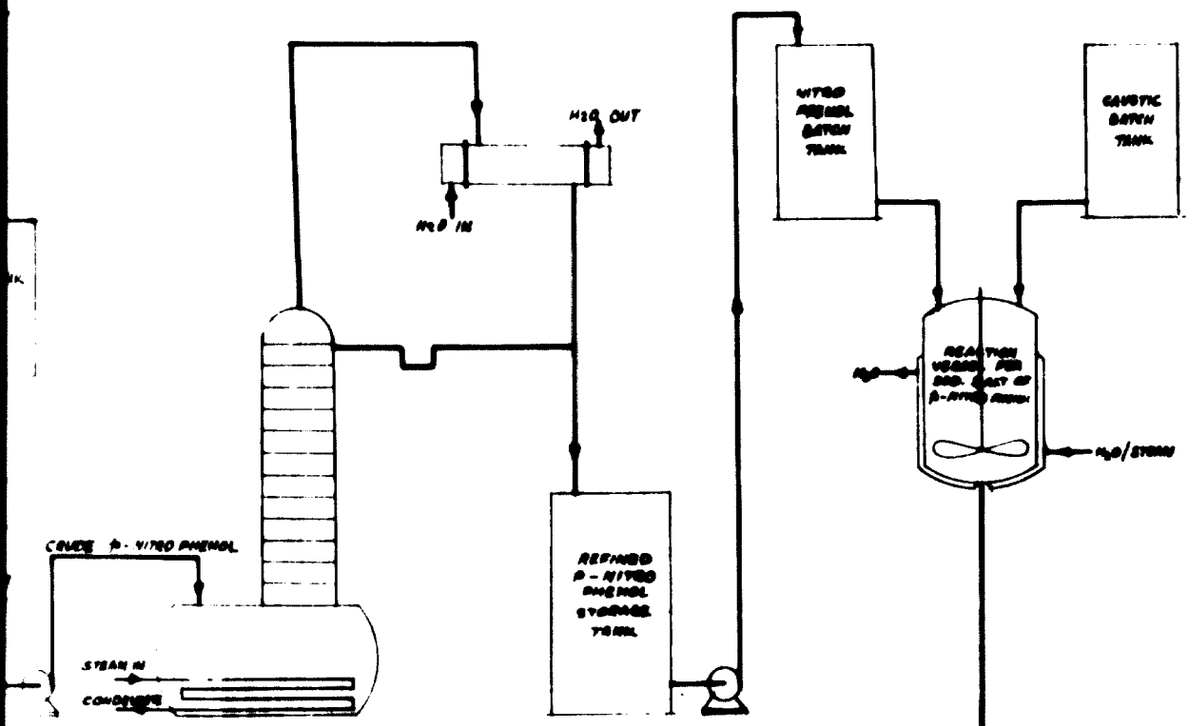
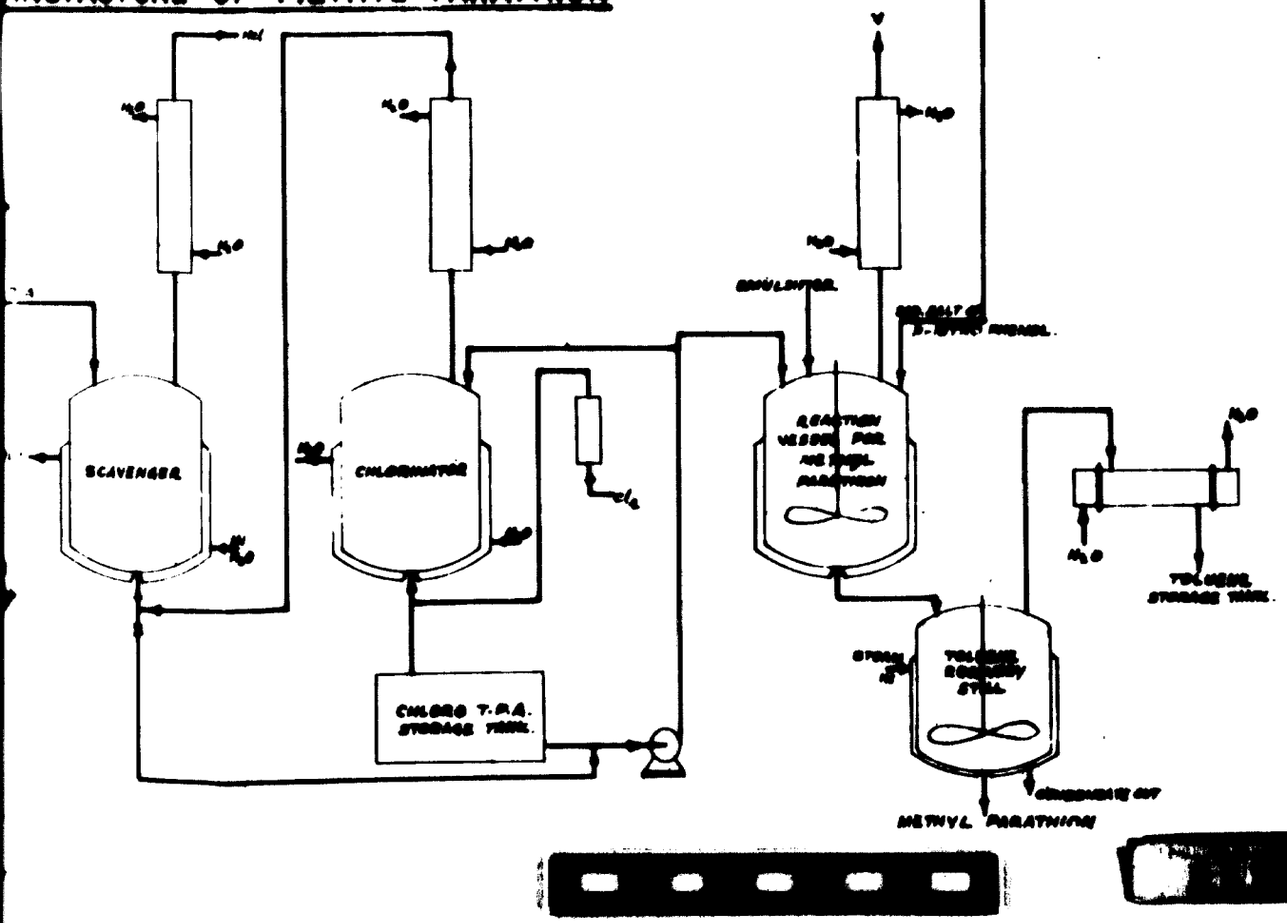
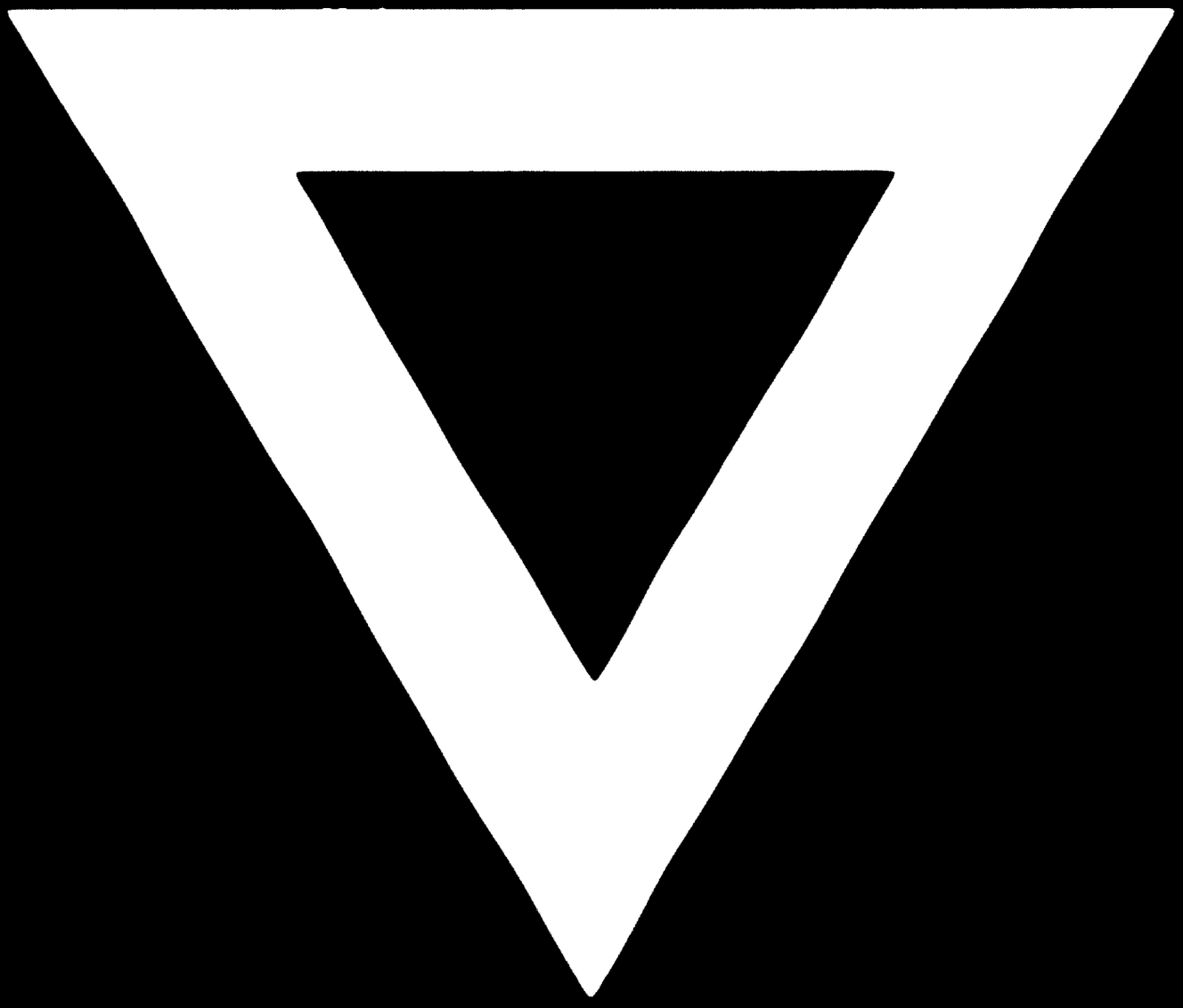
TURE OF P-NITRO PHENOL SODIUM SALT



NUFACTURE OF METHYL PARATHION



C-669



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