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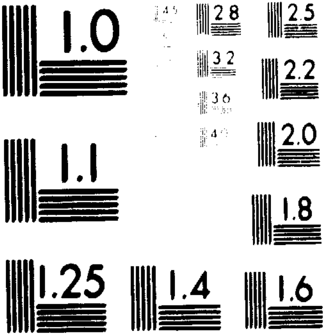
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FEASIBILITY STUDY FOR THE PRODUCTION OF PESTICIDES AND INSECTICIDES IN KUWAIT

10542

FINAL REPORT

Prepared for
UNITED NATIONAL INDUSTRIAL DEVELOPMENT ORGANISATION
by
CHEM SYSTEMS INTERNATIONAL LIMITED

May 1981

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CONTENTS

CONTENTS

6. Appendix

6.1. Equipment list- O,O Dimethyldithiophosphoric acid

6.2. Equipment list- Ethyl Maleate

6.3. Equipment list- Malathion

6.4. Equipment list- N-methylchloroacetamide

6.5. Equipment list- Dimethoate

6.6. Equipment list- Maneb/Zineb

6.7. Equipment list- 2,4 D amine salt

6.8. Equipment list- Offsite facilities

Annex 1 Revised Costs of production sheets

Annex 2 Safety

Annex 3 Packaging

I - SUMMARY and RECOMMENDATIONS

1 - INTRODUCTION

This report covers a study carried out under UNIDO contract number 79/35 TF/KUW/76/001 concerning the feasibility for the production of various pesticides in Kuwait.

The study area was defined as Egypt, Sudan, Syria, Iraq, Jordan, Saudi Arabia, Kuwait, Oman and the United Arab Emirates. The products covered in the study were grouped under three basic classifications: Insecticides, Fungicides and Herbicides.

The fieldwork was carried out during March and April 1979 and covered all of the above noted countries with the exception of the Oman and the UAE.

In the execution of the fieldwork, official government agencies and pesticide suppliers were contacted. The assistance provided by the multinational pesticide producers and suppliers was most useful in the completion of the study.

In the report the term "estimated" when used in relation to pesticide usage refers to a volume that was arrived at by discussion with suppliers, and government agencies taking into account official import and tender statistics etc.

2 - PESTICIDE MARKET

The pesticide market (insecticides, fungicides and herbicides) in the area of study was estimated to total 38 500 metric tons active ingredient in 1978. The market was dominated by Egypt and the Sudan which accounted for 78 percent of total consumption. The only other significant area was Iraq, Syria and Jordan making up for nearly 18 percent of the total. Kuwait and Saudi Arabia made up four percent or so of the total.

In terms of product, the major pesticides were fungicides 50 percent and insecticides 46 percent. Herbicides were relatively insignificant with only about four percent of the

Although insecticides are used in all the regions to a greater or lesser extent, fungicide consumption is concentrated in Egypt; this country alone accounts for 78 percent of the total use in 1978. The Sudan has negligible fungicide requirements due to the hot dry climate. Iraq, Syria and Jordan account for 15 percent of total fungicide use. Herbicide consumption is concentrated in Egypt and the Sudan, these two countries account for 94 percent of use.

In the regions under consideration, there is no production of active ingredients, with the possible exception of mineral oils in Egypt. All active materials are imported into the region, in the majority of cases as finished product. However formulation of certain simple pesticides is carried out in Egypt and the Sudan. Repackaging and dilution of concentrates for local and export use is also carried out in Kuwait and Saudi Arabia.

Demand for pesticides is forecast to rise from the current level of 38500 metric tons through 45 700 metric tons in 1983 to about 54 000 metric tons by 1988. Fungicides and insecticides will remain the major products with each accounting for nearly 50 percent of demand.

Although the pesticide market is highly complex with a vast number of active ingredients being formulated into an even greater number of products for use, an analysis of the products used leads to a listing of major active materials used in the region. The dominant active ingredients with their estimated offtake in 1983 and 1988 are outlined in the following table.

TABLE I-1

FORECAST CONSUMPTION OF MAJOR PESTICIDE MATERIALS

IN STUDY AREA FOR 1983 AND 1988

(metric tons active ingredient)

		1983	1988
INSECTICIDES			
Organophosphorous	Dimethoate	1 630	2 170
	Malathion	1 380	1 840
	Chlorpyriphos-ethyl	1 000	1 340
	Dichlorvos	750	1 000
	Triazophos	690	920
	Phosphamidon	500	670
	Parathions	310	420
Organohalogen	DDT	3 080	2 800
	Endosulphan	660	600
	Chlordane	440	400
Carbamates	Carbaryl	1 120	1 570
Others	Mineral Oils	7 000	8 000
FUNGICIDES			
Inorganic	Sulphur	21 630	25 070
Organics	Dithiocarbamates	630	770
HERBICIDES			
Aryloxyacids	2,4 D amines	520	600
Benzene	Nitrofene	460	560
	TOTAL	41 800	48 730

Although rodenticides are used in large volumes of finished product, the low concentration of active material, plus the large number of complex materials used precludes any consideration for local manufacture.

The feasibility of the local production of the major pesticides of each class was estimated. The production schemes actually analyzed are listed below:

- Insecticides : O,O dimethyldithiophosphoric acid + Ethyl maleate → Malathion
  O,O dimethyldithiophosphoric acid + N-methylchloroacetamide → Dimethoate
- Fungicides: Dithiocarbamates → Maneb/Zineb
- Herbicides: 2,4 dichlorophenol + Monochloroacetic acid + Dimethylamine → 2,4 D, DMA salt

Taking into account the estimated offtake in 1983 and 1984 presented in Table I-1, the following design capacities were selected:

- Malathion : 2000 metric tons per year (technical product)
- Dimethoate: 2500 metric tons per year (technical product)
- Maneb/Zineb: 1000 metric tons per year (technical product)
- 2,4 D acid: 600 metric tons per year (equivalent to 720 metric tons of 2,4D-DMA salt per year)

3 - PROCESS TECHNOLOGY

The overall pesticides plant is divides into 9 sections as follows:

Section 100 - O,O dimethyldithiophosphoric acid production unit

Section 200 - Ethylmaleate production unit

Section 300 - Malathion production unit

Section 400 - N-methyl chloroacetamide production unit

Section 500 - Dimethoate production unit

Section 600 - Maneb/Zineb production unit
Section 700 - 2,4 D- Dimethylamine salt production unit
Section 800 - storage
Section 900 - waste treatment unit

This plant is designed like most multipurpose fine chemical plants, i.e. the products are made batchwise and are processed in corrosion resistant, agitated, jacketed reactors. The products are not made campaignwise (the capacities are too large), however the pieces of equipment selected are quite flexible and almost any fine chemical or agrochemical product can be manufactured in this plant.

4 - ORGANIZATION and MANPOWER

Once the fundamental decisions on the project are taken (eg plant location and size) it is recommended that a full-time Project Manager be appointed, with a "steering committee" from the parties concerned to assist in the many detail matters which have to be arranged. The Project Manager should also have appropriate expert support and advice.

This structure of Project Manager plus steering committee should be adequate until the point of full approval for plant design and construction. From that time, establishment of the full operating organisation should commence. Figure I-40.1 shows the organisation recommended. It is expected that the Project Manager will remain with the project until hand-over by the contractor, and it is recommended that he should also have the title of Deputy General Manager with appropriate decision-making authority.

The estimated permanent manpower requirement is presented in Chapter 3, Section XIV.

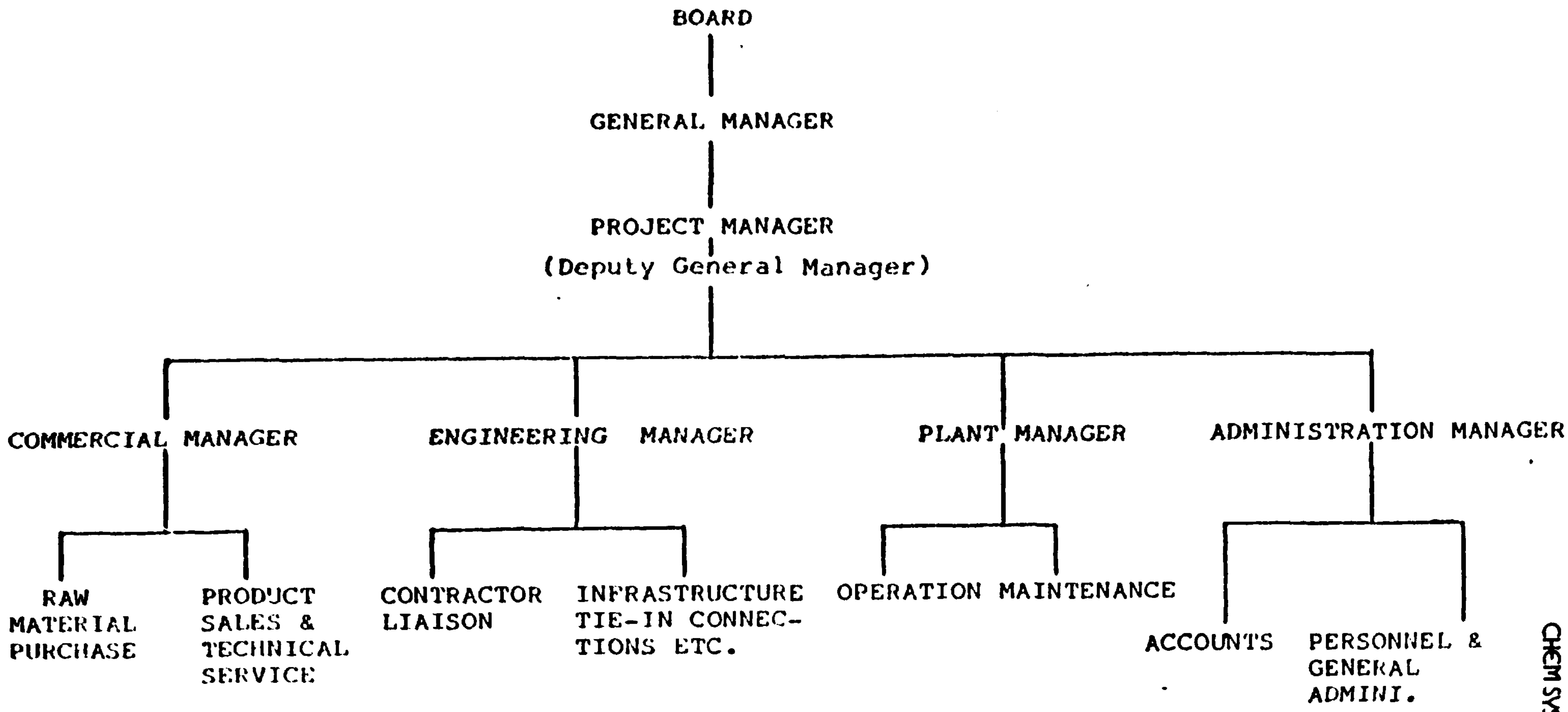


FIGURE I.40.1

OUTLINE OPERATING ORGANISATION

5 - IMPLEMENTATION PLAN

The overall schedule will be influenced by many activities other than design and construction, i.e. final site selection, product mix, ...

Definition of the project basis is the first step. This will involve partnership agreement (if any), final product mix, financial structure, choice of process route, ...

To achieve earliest practical implementation, it is recommended that the contractor be selected on the basis of general experience and capability, together with manhour rates, fees etc. The contract should be of the "convertable" type where the owner has the option to convert to a lump sum basis following preparation of a definitive estimate. This approach greatly reduces bidding time and costs and means that selection can proceed in parallel with preparation of process design by the licensor.

Assuming the above procedure is followed, the following is the earliest timing of the major events:

EARLIEST TIMING OF KEY EVENTS

Event	Earliest Date
• Select Process Licence(s) and award contract for basic design package	May 1982
• Select Contractor (Fee/convertable contract basis)	Sept 1982
• Completion of Definitive Estimate	Jan 1983
• Go-ahead for detail design and construction	March 1983
• Mechanical completion	March 1985
• Completion of commissioning	Sept 1985

6 - FINANCIAL ANALYSIS and RECOMMENDATION

In this feasibility study, preliminary economic/financial evaluations have been undertaken for the following purposes:

- To identify a short list of pesticides and insecticides which could be manufactured locally.
- To provide an overall plant capital cost estimate
- To appraise the financial viability of the venture

In these evaluations, the basic assumption is that the proposed plan will be competing in Arab markets with supplies from Europe. Performance data and Capital cost estimates developed in the course of the design work were adjusted for a Middle Eastern location (based on Chem System's experience of detailed cost estimate analysis in various countries of the world).

The local cost of the various raw materials and active ingredients was taken at the current European level. The shipping cost was not taken into account, since it was felt that for fairly large supply contracts, most suppliers would adjust their landed prices to the current European prices.

The analysis of the minimum sales prices (at zero ROI- see Table I.6.1) and of the European sales prices of the active ingredients show that no positive netback can be generated by just selling bulk active ingredients to local formulators.

This is mainly due to the high cost of raw materials, the small production scale and the fact that a new plant has to compete with old, completely depreciated plants in Western Europe and USA.

However a closer analysis of the European sales prices of the formulated products sold to distributors shows that a sizable margin exists for two of the four products selected:

Malathion and Dimethoate

Therefore, it seems that selling formulated Malathion and Dimethoate in small containers (10 liters for instance) to local distributors might be a profitable venture.

The only pending problem is the formulation plant. Formulated Malathion and Dimethoate are primarily sold as liquid solutions containing 400 to 500 g of active ingredient per liter. These pesticide formulation processes are mainly batch mixing operations. Packaging is described in Annex 3.

The desired active ingredient, the appropriate carrier or solvent, and the necessary additives are blended and milled in the ratios needed to give the desired active ingredient concentration and physical properties in the finished product.

An example of a liquid formulation plant is given in Figure I.6.1. The active ingredient is proportioned into a mixing tank with the correct amounts of solvent, such as xylène and emulsifying agent, and blended. Both weight and volume measurements are used to achieve the desired proportions.

The finished batch is normally stored in either the mixing tank or a hold tank until the material can be analyzed to ensure that it meets specifications.

As far as costs are concerned, the capital cost of a liquid formulation plant is less than a million US dollars and the formulation cost should not exceed 0.80-1.00 dollar per kg 100% active ingredient (with simple solvents like xylene and for 4500 metric tons/year of 100% active ingredients).

In conclusion, the likely netbacks for a "formulated Malathion/Dimethoate" plant are as follows:

	US cents/kg A.I. (100%)	
	Malathion	Dimethoate
• Minimum calculated transfer price (zero ROI)	241.62	392.37
• Minimum formulation cost (zero ROI)	100.00	100.00
• Minimum formulated sales price	341.62	492.37
• Sales expenses		
• European sales price (formulated product)	988.00	868.00
• Maximum Netback (without sales expenses)	646.38	375.63

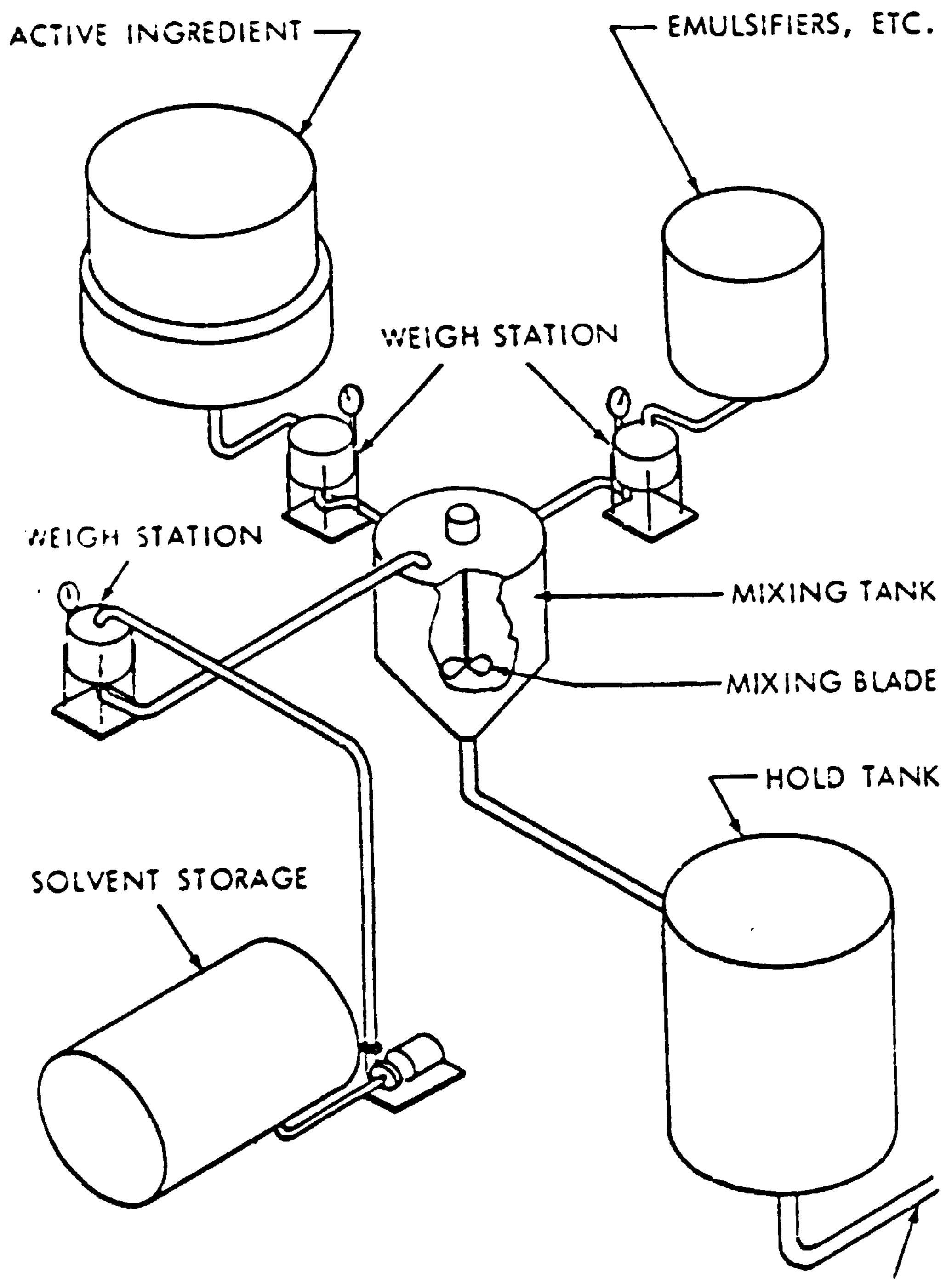
The total investment for melathion and dimethoate plants (and the intermediates required) is $14.37 million (see section XIV) plus say one million dollars for a formulation plant of the type depicted in figure I.6.1.

The yearly gross profit at full capacity for formulated melathion and dimethoate will be of the order of $22 million, and hence a pay-out time of less than one year can be expected. A more sophisticated analysis is not justified in view of the uncertainties in establishing raw material and sales prices. Nevertheless, even allowing for a reasonable rate of sales build-up over the first few years of operation, normal levels of selling costs, overheads, depreciation etc, a pay-out time of the order of one year should be achieved.

It is recommended that the project comprising formulated melathion and dimethoate be investigated in more detail with respect to a joint venture with an existing producer or a licence agreement comprising technical and selling assistance.

FIGURE I.6.1

LIQUID FORMULATION PROCESS



Source: Toxaphene Bulletin 621, Synthetics Department, Hercules, Inc., Wilmington, Delaware

TABLE 1.6.1

CAPITAL AND OPERATING COST ESTIMATES- Pesticide plant

(Third quarter 1979 US dollars)

Location: Kuweit

Product:	Malathion	Dimethoate	Zineb	2,4 D,DMA salt
Capacity: (metric tons/year)	2000	2500	1000	720 DMA salt or 600 2,4 D acid
Overall fixed investment: (million US dollars)	23.3	(includes intermediates production units-breakdown per unit: see chapter 2)		
Production costs (US cents per kg at effective annual capacity)				
• Raw materials	173.46	258.50	122.73	137.14
• Utilities	1.64	13.30	4.05	5.36
• Operating costs	18.66	23.07	60.62	62.36
• Overhead expenses	31.91	45.30	123.21	105.18
• Cost of production	225.67	340.17	310.61	310.04
• Return on Investment	–	–	–	–
• Interest on working capital(10%)	8.70	12.96	10.40	10.42
• Minimum sales price (X% technical product)	234.37	353.13	321.01	320.46 per kg of salt
• product purity-X% weight	97 %	90%	92 %	83 % acid
• minimum sales price (based on 100% product)	241.62	392.37	348.92	384.55 per kg acid equivalent
• European sales price (100% AI-bulk)	179.00	305.00	217.00	325.00
• European sales price (100% AI.)(formulated product equivalent)	988.00	868.00	280.00	392-400

• Annex 1 shows revised costs figures. Variations are so small (0 to 1 % max depending on product) that they do not affect the financial analysis and recommendation.

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7 - DIVERSIFICATION

It can be objected that Malathion and Dimethoate, production of which is analyzed here, and for which a profitability is formed here if formulation is included, are mature products.

But their manufacturing would provide a good basis for diversification into more modern specialties.

They are both based on dimethyldithiophosphoric acid which is therefore manufactured on an already reasonably large scale. This compound or its diethyl analog is also the basis for many other organophosphorous insecticides where various moieties are coupled to it.

For example Phosalone, a successful product for which a licence has been recently acquired by the USSR for building a large plant is based on diethyldithiophosphoric acid plus chloromethyl-chlorobenzoxazolone, itself resulting from condensation reactions between aminophenol, urea and formaldehyde.

The coupling between such a second moiety and dimethylthiophosphoric acid is a condensation reaction similar to the ones leading to malathion or dimethoate and could be carried out in the facilities which have been provided here.

Other families which have a significant market in the countries studied here could not provide a basis for satisfactory expansion.

The chlorocompounds have been banned in industrialized countries, but large plants are existing there which can easily serve all export markets still available.

Carbaryl and more generally all carbamates are related to phosgene chemistry which is a very special chemistry. Moreover, phosgene transportation is severely restricted, and starting from derivatives such as chloroformates would be uneconomical due to high prices for these already sophisticated compounds.

II BACKGROUND TO WORLD PESTICIDE INDUSTRY

Agricultural pesticides comprise insecticides, fungicides and herbicides, those used in Public Health usually include insecticides and rodenticides.

The estimated value of pesticide sales in 1978/79 worldwide was about US$8 000 million, of which nearly 40 percent was made in North America and 16 percent in Western Europe. Nearly 80 percent of pesticides originate from the 20 large chemical concerns, such as Bayer, Ciba-Geigy, Shell, Monsanto, etc. In 1976/77 Bayer's sales of pesticides were of the order of US$1 100 million,and those of Ciba-Geigy at US$860 million.

The big chemical corporations produce: original patented compounds, originating from their pesticide research facilities and patent lapsed or non patented pesticides, called commodity products, utilising intermediates produced by another division within the company. The producers after proving the usefulness of their products in the field market them internationally through, (depending on the country), wholly or part owned subsidiaries, or national distributors in countries where they have no subsidiary. Other producers of pesticide technical materials include: small manufacturers of commodity products, pharmaceutical companies, and heavy chemical manufacturers. All manufacturers formulate technical materials into finished products ready for use. Some producers sell technical materials and concentrates for formulation by other companies.

There are currently some 500 pesticide compounds, of which about 200 are in regular use, each one in the form of between one and twenty different formulations.

The usual distribution route is from the manufacturer to:

i local subsidiary company or local national distributor, in each country, who will buy the formulated product, or buy technical material and formulate locally ii dealers, cooperatives, or buying groups

iii farmers, growers and estates.

However there are exceptions to this generalisation including:

i manufacturers selling to traders, merchants, exporters and importers

ii sales on tender made directly to a Government authority or other important buyers. Large tenders attract low priced competition.

Manufacturers can control the pricing of patented products, with profit, more easily than on commodity products. For patented products they are concerned with the cost/price/benefit of the products compared to that of other products, but for commodity products their concern is with competitors' pricing of the same product. There is an international price for most commodity pesticides, particularly for those which are made and sold by more than two companies. For example phenoxy herbicides, parathions, and dithiocarbamates.

Before selling a product is it usually obligatory to register it with the appropriate national authorities. There are two types of tests and trials which must be undertaken and the results submitted to the authorities which are:

i toxicoligical data regarding the behaviour of the chemical in animals, crops, soils and water

ii biological efficacy data indicating the performance in controlling pests, diseases and weeds in the crops in which the product is to be used. In most countries local field trials must be performed to assess the effectiveness under local conditions. In some cases the local national authorities carry out these field trials before granting registration.

Although there is an international price for commodity pesticides and discounts are often made for large volume purchases, potential speciality products, while under patent, are normally controlled by the originator, in addition marketing and distribution is also controlled by the originator. Speciality products are distributed normally through closed channels, which are often the subsidiary companies of the originator and/or exclusive distributors. The manufacturer may and does offer the same speciality product at different prices to different countries dependent upon local circumstances, where the only problem the manufacturer seeks to prevent is an intermediary in one country buying at dealer or trade prices in another country, and selling the product in a third country at a price competitive to national distributors. Product registration, country by country, has tended to limit traders switching formulated products from one country to another.

Sales of pesticides in Western Europe in 1978 were estimated to be of the order of US$1 300 million. The major consumers were France, West Germany and Italy accounting for 26 percent, 21 percent and 15 percent respectively. Other significant consuming countries were Spain, the United Kingdom, Scandinavia and Benelux each accounting for about 7 to 8 percent of total sales. Estimates of the relative importance of sales volumes by country are outlined in the following table.

TABLE II.1

RELATIVE IMPORTANCE OF WESTERN EUROPEAN SALES VOLUMES-1978

Country	Percentage of Total Sales
France	26
West Germany	21
Italy	15
Spain	9
United Kingdom	8
Scandinavia	7
Benelux	6
Austria/Switzerland	3
Others	5
Total	100

Overall sales of pesticides were split as shown in the following table.

TABLE II.2.

RELATIVE IMPORTANCE OF PESTICIDE SALES BY TYPE, WESTERN EUROPE-1978

Type	Percentage of Total Sales
Herbicides	55
Fungicides	28
Insecticides	17
Total	100

Although herbicides dominated total sales, about twice as large as fungicides on a value basis, the split in consumption varied from region to region as shown below for selected countries.

TABLE II.3.

RELATIVE IMPORTANCE OF PESTICIDE SALES BY TYPE FOR SELECTED COUNTRIES-1978

(percentage of total sales)

Country	Herbicides	Fungicides	Insecticides
Scandinavia	80	10	10
United Kingdom	75	14	11
West Germany	66	26	8
Italy	36	39	25
Greece	36	31	33

The Western European pesticide business is well covered by a number of domestic producers. Major producers, in alphabetical order are listed below.

TABLE II.4.

MAJOR WESTERN EUROPEAN PESTICIDE PRODUCERS

BASF	West Germany
Bayer	West Germany
Ciba-Geigy	Switzerland
Fisons	United Kingdom
Hoechst	West Germany
ICI (Plant Protection)	United Kingdom
Montedison	Italy
Pepro	France
Procida	France
Rhone-Poulenc	France
Sandoz	Switzerland
Schering	West Germany
Shell	United Kingdom

In addition, the Western European market is serviced by imports from, for example, the USA. The Western European companies are also involved in worldwide export sales.

III THE PESTICIDE MARKET IN SELECTED ARAB STATES

The states selected for this study were Egypt, Sudan, Iraq, Syria, Jordan, Kuwait, Saudi Arabia, Oman and the United Arab Emirates. Because of the geography, climate, cropping patterns and pesticide consumption, certain countries fall into natural groups. These groups were delineated as follows:

i Egypt and the Sudan
ii Syria, Iraq and Jordan
iii Kuwait and Saudi Arabia
iv Oman and the United Arab Emirates

In 1978 total pesticide consumption was estimated to be about 38 000 metric tons active ingredient. Fungicides accounted for 50 percent of use, and insecticides 46 percent. Herbicides accounted for just under 4 percent. Estimates of the relative importance of the various pesticides is outlined in the following table.

TABLE III.1.

THE PESTICIDE MARKET IN SELECTED ARAB STATES-1978

Pesticide	Thousand metric tons Active Material	Percent of Total Consumption
Fungicides	19.4	50.3
Insecticides	17.7	46.0
Herbicides	1.4	3.7
Total	38.5	100.0

When the market is analysed on a geographical basis it can be seen that Egypt and the Sudan account for 78 percent of consumption, the next most significant area, Iraq, Syria and Jordan make up nearly 18 percent. The relative importance of the various regions are shown in the table below.

TABLE III.2.

PESTICIDE CONSUMPTION BY TYPE AND REGION-1978
(thousand metric tons active ingredient)

Region	Fungicides	Insecticides	Herbicides	Total Consumption	Percent of Total Consumption
Egypt, Sudan	15.18	13.39	1.33	29.90	77.7
Iraq, Syria, Jordan	2.88	3.82	0.08	6.78	17.6
Kuwait, Saudi Arabia	1.30 *	0.41	-	1.71	4.4
Oman, UAE	0.01	0.10	-	0.11	0.3
Total	19.37	17.72	1.41	38.50	100.0

* of which 1 200 metric tons is elemental sulphur

Insecticides

In volume terms the major insecticides used in the areas under study are mineral oils accounting for 35 percent of the market, closely followed by the organophosphorous derivatives with 32 percent share. Organohalogens make up 26 percent of use. Estimates of volume offtake by region by family of products are shown below.

TABLE III.3.

CONSUMPTION OF INSECTICIDES BY FAMILY BY REGION-1978
(metric tons active ingredient)

Region	Organo phosphorous	Organo halogen	Carbamates	Mineral Oils	Others	Total
Egypt, Sudan	3 866	2 368 *	785	6 000	366	13 385
Iraq, Syria, Jordan	1 404	2 294	48	69	7	3 822
Kuwait, Saudi Arabia	239	-	106	1	67	413
Oman, UAE	32	2	6	60	2	102
Total	5 541	4 664	945	6 130	442	17 722
Market Share Percent	32	26	5	35	2	100

* negligible in Egypt

Estimates of consumption by type of pesticide for the various families are outlined in the following tables.

TABLE III.4.

CONSUMPTION OF ORGANOPHOSPHOROUS INSECTICIDE BY REGION-1978
(metric tons active ingredient)

	Egypt, Sudan	Iraq, Syria Jordan	Kuwait Saudi Arabia	Oman UAE	Total
Dimethoate	1 076	32	40	7	1 155
Malathion	302	606	54	8	970
Chlorpyriphos-ethyl	695	-	1	-	696
Dichlorvos	-	500	51	5	556
Triazophos	500	2	-	-	502
Phosphamidon	350	-	-	-	350
Parathions	208	19	1	-	228
Phospholan	155	-	-	-	155
Trichlorfon	47	25	75	7	154
Monocrotophos	90	7	-	-	97
Diazinon	-	90	-	-	90
Mephospholan	89	-	-	-	89
Thiometron	85	-	-	-	85
Phenthoate	71	-	-	-	71
Formothion	57	10	-	-	67
Dicrotophos	56	-	-	-	56
Demeton-s-methyl	22	30	-	-	52
Profenophos	19	-	-	-	19
Pyrimiphos-methyl	-	2	-	5	7
Methamidophos	-	4	-	-	4
Others	44	77	17	-	138
Total	3 866	1 404	239	32	5 541

TABLE III.5.

CONSUMPTION OF ORGANOHALOGEN INSECTICIDES BY REGION-1978
(metric tons active ingredient)

	Egypt, Sudan	Iraq, Syria Jordan	Kuwait Saudi Arabia	Oman UAE	Total
DDT	1 540	1 560	-	2	3 102
Endosulphan	637	20	-	-	657
Chlordane	1	458	-	-	459
BHC	60	183	-	-	243
Endrin	82	2	-	-	84
Heptachlore	40	-	-	-	40
Toxaphene	-	40	-	-	40
Dieldrin	8	-	-	-	8
Others	-	31	-	-	31
Total	2 368	2 294	-	2	4 664

TABLE III.6.

CONSUMPTION OF OTHER INSECTICIDES BY REGION-1978
(metric tons active ingredient)

	Egypt, Sudan	Iraq, Syria Jordan	Kuwait Saudi Arabia	Oman UAE	Total
Carbamates					
Carbaryl	616	32	106	6	760
Methomyl	166	10	-	-	176
Others	3	6	-	-	9
Total	785	48	106	6	945
Others					
Dicofol	224	-	12	-	236
Pyrethroids	142	-	25	-	167
Mineral Oils	6 000	69	1	60	6 130
Others	-	7	30	2	39
Total	6 366	76	68	62	6 572

When the consumption data is analysed in detail, it can be seen that within each family certain products are consumed in relatively large volumes. Estimates of the tonnages involved by product type are aggregated in the following table.

TABLE III.7.

CONSUMPTION OF MAJOR INSECTICIDES IN ARAB STATES-1978
(metric tons active ingredient)

Organophosphorous	
Dimethoate	1 155
Malathion	970
Chlorpyriphos-ethyl	696
Dichlorvos	556
Triazophos	502
Phosphamidon	350
Parathions	228
Total	4 457
Organohalogen	
DDT	3 102
Endosulphan	657
Chlordane	459
BHC	243
Total	4 461
Carbamates	
Carbaryl	760
Others	
Dicofol	236
Mineral Oils	6 130
Total	6 366
Total	16 044

Fungicides

The major fungicide utilised in the regions under investigation is sulphur, which accounts for 96 percent of the total market. Dithiocarbamates make up for nearly three percent. Estimates of volume offtake by region by type of fungicide are shown below.

TABLE III.8.

CONSUMPTION OF FUNGICIDES BY FAMILY BY REGION -1978
(metric tons active ingredient)

Region	Sulphur	Dithiocarbamates	Copper	Others	Total
Egypt, Sudan	14 910	131	85	55	15 181
Iraq, Syria, Jordan	2 540	311	9	20	2 880
Kuwait, Saudi Arabia	1 201	75	-	20	1 296
Oman, UAE	10	-	-	-	10
Total	18 661	517	94	95	19 367
Market Share Percent	96.3	2.7	0.5	0.5	100

Estimates of consumption by type of material are shown in the following table.

TABLE III.9.

CONSUMPTION OF FUNGICIDES BY TYPE BY REGION-1978
(metric tons active ingredient)

	Egypt, Sudan	Iraq, Syria Jordan	Kuwait Saudi Arabia	Oman UAE	Total
Sulphur	14 910	2 540	1 201	10	18 661
Dithiocarbamates	131	311	75	-	517
Dichloran	27	-	-	-	27
Copper Salts	85	9	-	-	94
Others	28	20	20	-	68
Total	15 181	2 880	1 296	10	19 367

Herbicides

The herbicide market is dominated by the aryloxyacids, -2,4 D amines which account for 32 percent of total consumption. The next most significant family is benzene derivatives, in this case nitrofene which accounts for nearly 27 percent of total use. Although the "others" category is large with nearly 23 percent of the market, this sector includes a number of specialised materials used in low volumes. Estimates of volume offtake by region by family of product are shown below.

TABLE III.10.

CONSUMPTION OF HERBICIDES BY FAMILY BY REGION-1978
(metric tons active material)

Region	2,4D	Benzene	Urea	Carbamates	Others	Total
Egypt, Sudan	420	375	152	106	274	1 327
Iraq, Syria, Jordan	29	-	-	-	46	75
Kuwait, Saudi Arabia, Oman, UAE	-	-	-	-	-	-
Total	449	375	152	106	320	1 402
Market Share Percent	32	26.8	10.8	7.6	22.8	100

Estimates of consumption by type of fungicide for the various families are shown in the table below.

TABLE III.11.

CONSUMPTION OF HERBICIDES BY TYPE BY REGION-1978

(metric tons active ingredient)

	Egypt, Sudan	Iraq, Syria Jordan	Kuwait, Saudi Arabia Oman, UAE	Total
Aryloxyacids				
2,4D amines	420	29	-	449
Benzene				
Nitrofene	375	-	-	375
Urea				
Fluometuron	152	-	-	152
Carbamates				
Molinate	76	-	-	76
Drepamon	30	-	-	30
Diazines				
Bentazone	48	-	-	48
Organohalogen				
Dalapon	45	-	-	45
Others				
Propanil	25	12	-	37
Trifluraline	-	16	-	16
Ametryne	15	-	-	15
Paraquat	-	15	-	15
Others (inc not specified)	141	3	-	144
Total	1 327	75	-	1 402

Rodenticides

Rats pose health and food loss problems in all the countries under investigation. Needless to say the various national authorities are aware of this problem and large quantities of rodenticides are imported for pest control. However most of the modern rodenticides commonly used are formulated at very low levels of concentration, often less than one percent active ingredient, and consequently the total volume of the various active ingredients employed is minimal. In addition several types of active material are used, such as warfarin, zinc phosphide, red squill, sulphur quinoxiline, and coumatetralin etc.

Fumigants are also used in grain stores for pest control and the main product employed is methyl bromide, about 250 metric tons in the region. Small volumes of aluminium phosphide are also used.

IV EGYPT

1. Agricultural Sector

The entire arable land available is of the order of 5.5 million feddans (one feddan equals 4 200 square metres). The extension of this area through reclamation has been slow, difficult and costly. The increasing pressure of people on the land has led to an intensification of cultivation, almost without parallel anywhere. Dams, barrages, pumps and an intricate network of canals and drains bring perennial irrigation to almost the whole area. The strict pursuit of crop rotation, lavish use of commercial fertiliser and pesticides, and the patient application of manual labour, not only make multiple cropping possible, but also raise land yields to except.onally high levels. By using multiple cropping techniques the total area cultivated in 1978 was about 12.0 million feddans. Land reclamation should lead to an increase of 1.0 million feddans in agricultural area by the early 1980s, which in turn with the use of multiple cropping patterns will lead to an increase in cultivated area of about 2.0 million feddans.

The major crops grown in terms of land area are clover, maize, wheat, cotton, rice and vegetables. Estimates of current crop areas are shown in the following table. By 1980 a new crop, sugar beet will account for a further 50 000 feddans.

TABLE IV.1.

MAIN CROP AREAS - EGYPT 1978

Crop	Thousand Feddans
Clover	2 863
Maize	2 238
Wheat	1 381
Rice	1 031
Barley	114
Cotton	1 189
Flax	69
Soya Beans	82
Ground Nuts	31
Sesame	23
Sunflower	9
Vegetables	952
Broad Beans	239
Onions	65
Lentils	36
Green Beans	33
Lupinus	6
Orchards	338
Sugar Cane	249
Plants for Perfumes and Essences	64
Total	11 012

Agricultural land in Egypt is farmed by government supervised cooperatives and private farmers. Cotton being a major export earner is controlled by the government, land areas are specified by the State, and also the spray programmes for pest control.

Growth in the agricultural sector is hampered by lack of good arable land, and special attention is being paid to increasing the area. In view of the fact that the land to be reclaimed is often arid desert, reclamation is a costly process requiring substantial capital outlays and the question has to be asked whether new investment should not be directed to the development of manufacturing industry instead, where returns to the scarce capital may well be higher. An interesting recent development has been the proposed irrigation of land area near Cairo to grow vegetables under the control of Pepsi-Cola Inc of the USA. This farming venture appears to be a quid pro quo, for permission by the Egyptian Government to permit the US company to set up a bottling plant. As far as known initial trials appear to be running well. The technique (to be used by Pepsi-Cola) involving the use of pivot irrigation systems appears to have found favour with the government which is thinking of extending the area by several thousand feddans.

2. Pesticide Business

The use of agrochemicals is controlled by the government in two ways:

i all products used in Egypt must be cleared by the Ministry of Agriculture, after three years of trials, and the products selected must be cost effective, and

ii all products are imported on an annual open tender put out by The Tenders Department, Buying Committee of the Ministry of Agriculture. The Ministry of Agriculture allocates the necessary foreign exchange to permit the imports, but distribution is covered by the Agriculture Credit Bank which gives credit to farmers to enable them to purchase the necessary spray chemicals.

The 1954 Act restricted the importation and marketing of pesticides to State owned companies, such as The Tractor and Engineering Company.

Foreign companies choose their representative from amongst these governmental companies, who submit their offers (including commission) against tenders issued by the Buying Committee of the Ministry of Agriculture. Although no active materials are produced in Egypt (except some mineral oils) there is some local formulation by companies owned by the Ministry of Industry.

Kaffr El Zayat which formulates methyl parathion, dimethoate, malathion, kalthane, karathane, ekatin, 2,4D and micronised sulphur, and repacks other products such as Sevin and Saturn etc.

Aba Zabal, a small concern formulates 2,4D and zinc phosphides.

As agriculture plays a very important role in the country's economy the Ministry of Agriculture produces a recommended treatment schedule for most crops. In the case of cotton the Ministry obliges the growers to use pesticides as and when necessary. For other crops the use of pesticides is left to the grower. The treatment schedule put out by the Ministry of Agriculture outlines the approved products, the application rate per feddan, the recommended number of applications per growing season by crop and disease. There appears to be no rigid treatment schedule for weed control, as this is left entirely to the farmer. Promotion of the use of herbicides appears to rest with the supplying companies. Consumption of herbicides is rising steadily as farmers realise the effectiveness of the products, coupled with the rise in wage rates. 2,4D and other hormone types are not freely used, due to overspray affecting other crops. These types of herbicides are however used by the Ministry of Irrigation for the control of water hyancinth.

Although pesticides are used to a greater or lesser degree on all crops, the most important in terms of pesticide use are cotton, maize and soya beans.

In Egypt, crops are divided into three basic categories:

i General Crops: cotton, rice, soya beans, wheat, etc
ii Orchards: citrus, table grapes, mangos, pears, etc
iii Vegetables: tomatoes, potatoes, broad beans, water melons, peas, onions etc

The major problems affecting these groups of crops are as follows:

General Crops

Leafworms, Bollworms, Aphids, Spiders, Nematodes

Leafspot, Powdery Mildew, Downey Mildew, Anthracrose, Blast, Scabs

Orchards

Scales, Mites, Bugs, Mediterranean Fly, Stem Borers, Nematodes

Powdery Mildew, Downey Mildew, Leafspot, Anthracrose

Vegetables

Cotton Leaf Worms, Cut Worms, Aphids, Spiders, White Fly, Thrips

Powdery Mildew, Downey Mildew, Anthracrose, Blight, Rust

Although weeds are treated in all crops to a greater or lesser extent, some farmers do not spray, because the weeds are used as fodder for animals, and hence have an economic value in general agriculture.

3. Pesticide Consumption

In 1978 estimated consumption of pesticides was of the order of 25 000 metric tons active ingredient. Fungicides accounted for about 60 percent of use, with insecticides and herbicides making up for 38 percent and 2 percent respectively. However in the fungicide sector nearly 15 000 metric tons or 60 percent of total pesticide volume was accounted for by inorganics, mainly sulphur. The following table outlines the relative importance of the various pesticide types.

TABLE IV.2.

PESTICIDE CONSUMPTION-EGYPT 1978
(percentage of total consumption)

Fungicides	60
Insecticides	38
Herbicides	2
Total	100

Insecticides

Within the insecticide sector the dominant product was mineral oil, accounting for an estimated 6 000 metric tons. The next most significant groups were organophosphorous derivatives with nearly 2 300 metric tons and carbamates accounting for 700 metric tons active ingredient. Estimates of insecticide consumption by type are shown below.

TABLE IV.3.

INSECTICIDE CONSUMPTION BY TYPE-EGYPT 1978
(metric tons active ingredient)

Organophosphorous	
Chlorpyriphos-ethyl	695
Triazophos	500
Dimethoate	350
Parathion, ethyl and methyl	168
Phospholan	155
Malathion	112
Mephospholan	89
Phenthoate	71
Dicrotophos	56
Trichlorfon	47
Profenofos	19
Others	4
Total	2 266
Carbamates	
Carbaryl	531
Methomyl	164
Total	695
Carbinols	
Dicofol	224
Pyrethroids	
Fenviralate	81
Others	61
Total	142
Organohalogen	
Endrin	82
Others	
Mineral Oil	6 000
Total Insecticide	9 409

Fungicides

In volume terms fungicide consumption was the largest category standing at nearly 15 200 metric tons active material. However the inorganics; sulphur dust and wettable powder plus small amounts of copper salts accounted for nearly 15 000 metric tons. The second most significant group was the dithiocarbamates at 130 metric tons. Estimates of fungicide consumption by type are outlined below.

TABLE IV.4.

FUNGICIDE CONSUMPTION BY TYPE-EGYPT 1978
(metric tons active ingredient)

Inorganics	
Sulphur	14 910
Copper oxychloride (as copper)	60
Total	14 970
Dithiocarbamates	
Mancozeb	131
Organohalogen	
Dichloran	27
Others	28
Total Fungicide	15 156

Herbicides

Herbicide offtake was the smallest category standing at about 370 metric tons. Herbicide consumption is low because weeds are often removed by hand, the government does not force growers to use them, and possibly most important is farmers often use the weeds as an additional source of fodder for cattle. Most significant materials are the aryloxyacids and carbamates each accounting for about 120 metric tons. Estimates of herbicide consumption by type are shown below.

TABLE IV.5.

HERBICIDE CONSUMPTION BY TYPE-EGYPT 1978
(metric tons active ingredient)

Aryloxyacids	
2,4D	120
Carbamates	
Molinate	76
Drepamon	30
EPTC	5
Total	111
Diazines	
Bentazone	48
Urea	
Fluometuron	32
Others	
Propanil	25
Ametryne	15
Others	21
Total	61
Total Herbicide	372

V THE SUDAN

1. Agricultural Sector

Cultivable land area was estimated to be of the order of 200 million feddans (one feddan equals 4 200 square metres). About 10 percent of the cultivable land is used in agriculture, with some four million feddans under irrigation. Half of this area is in the Gezira scheme (with its Managil extension), and the rest is irrigated by the flood waters of two small rivers in eastern Sudan, Gash and Baraka, by the flood waters of the Nile and by pumps.

The major crops grown in terms of land area are sorghum, sesame, groundnuts, cotton and maize. Estimates of current crop areas are shown in the following table.

TABLE V.1.

MAIN CROP AREAS-SUDAN 1978

Crop	Thousand Feddans
Wheat	899
Maize	146
Rice	19
Sorghum	6 500
Millet	500
Sesame	1 850
Groundnuts	1 750
Castor	51
Sugar Cane	88
Vegetables and Fruit	155
Cotton	1 217
Kenaf	5
Others	5
Total	13 185

Sudanese agricultural land is farmed by State Corporations and private farmers. The State Corporations manage and farm large areas of land and are in the process of developing and irrigating large tracts for the production of staple crops in several regions - see below.

i The Gezira Scheme

This corporation is responsible for over 1.6 million feddans of crops, which include cereals, groundnuts, sorghum, cotton and vegetables. Estimates of cropped area are shown in the following table.

TABLE V.2.

CROPPED AREA-GEZIRA SCHEME 1978

Crop	Thousand Feddans
Cotton	588
Wheat	435
Rice	16
Dura (Sorghum)	300
Groundnuts	216
Vegetables	Variable

ii The Rahad Scheme

This scheme is being developed in two phases:

Phase I 300 000 feddans, of which 150 000 feddans is in operation with the remainder starting production during the 1979/80 season. In Phase I the crops are rotated and the cropping pattern is as follows:

Cotton	140 000 feddans
Groundnuts	93 000 feddans
Vegetables	20 000 feddans
Fallow	47 000 feddans

Phase II comprises 520 000 feddans, and is due to be in production during the period 1980-1985.

iii The Public Agricultural Corporation

This corporation includes rain fed, irrigated land and other state schemes such as the White and Blue Nile Corporations. Regions under the auspices of the PAC include the following:

El Girba
Suki
Gash and Tokar Deltas
Nuba Mountains
Northern Provinces
Equatorial Provinces
White and Blue Nile Schemes

The PAC produces many crops for local sales and exports, however the main crop is cotton, short staple (in the rain fed areas), and medium and long staple (in the irrigated areas). Total known crop patterns are as follows:

TABLE V.3.

PUBLIC AGRICULTURAL CORPORATION CROP PATTERN-1978
(thousand feddans)

	Total	Total Rotated	Cotton	Wheat	Groundnuts	Dura	Sesame	Dukhun
Girba	450	110	110	110	110	-	-	-
Suki	90	85	40	70	40	-	2	-
Gash	700	250	50	-	-	35	36	-
Torka	406	70	50	-	-	75	36	-
Nuba Mountains	15 000	80	325	-	60	300	100	35

iv The General Corporation for Mechanisation

This corporation controls some 400 000 feddans, including Public Sector demonstration farms. The Corporation has a five year plan to fertilise nearly 3.0 million feddans in the Public and Private Sectors. The regions involved in this plan include:

Kabala Province	874 000 feddans
South Blue Nile	1 028 000 feddans
South Kordofan	559 000 feddans
Upper Nile Province	410 000 feddans
Darfour	110 000 feddans
Total	2 981 000 feddans

v Sugar Production Schemes

In addition cane sugar production is being expanded with new refineries, either planned or in the construction phase. Estimates of the crop area and refinery status are shown in the following table.

TABLE V.4.

CURRENT AND PLANNED SUGAR CANE PRODUCTION
(thousand feddans)

Region	Area	Refinery Status
Guneid	21	Operating
Khasham El Girba	27	Operating
West Sennar	40	Operating
Kenana	100	Under Test
Hajar-as-Salaya	17	Under Test
Melut	19	Under Construction
Mangalla	17	Project

2. Pesticide Business

The use of spray chemicals is controlled by the Government in two ways:

i all products used in the Sudan must be cleared by the Pest and Disease Committee, and

ii all products are imported by the State on the basis of an international tender published once a year

The international pesticide tender is put together by The Supplies Department of The Sudan Gezira Board at Barakat. This Board takes the requests from the other Boards and collects them on the basis of the products required and mode and place of delivery. In the tender there are many products which have similar activity and hence there are "either/or" categories, so the whole tender is never filled as such.

In addition to the normal agricultural pests there exists the so called National Problems, which are dealt with by the Plant Protection Adminstration, these problems include:

i Birds Quelea Quelea
ii Locusts
iii Water Hyacinth
iv Storage Pests

Pesticides are sold and distributed in the Sudan by local companies and foreign suppliers through their own branch offices often with research backup facilities. Although no active materials are produced in the Sudan there is some local formulation by:

Shell Chemical Company at Maringan (Gezira) producing mainly liquid emulsifiable concentrates such as Dieldrin, DDT, Chlordane and Dichlorvos

Sudanese Chemical Corporation at Khartoum producing mainly dusting powder formulations such as BHC and DDT

Farmers Training Guide at Khartoum (a private company currently distributing pesticides) plans to build a formulating plant in the near future

Outside of the normal pesticide selling business, three companies; Ciba-Geigy, Shell and Rhone-Poulenc, have so called package deals with cotton growing establishments. The company with a package deal guarantees the crop yield and supplies its own chemicals and machinery (often aircraft). Products used in the package deal are not included in the annual tender. The most important package deal company is Ciba-Geigy. The areas under the control of the various companies is set out below.

TABLE V.5.

AREA TEATED BY PACKAGE DEAL COMPANIES-SUDAN COTTON 1978

Company	Thousand Feddans
Ciba-Geigy	180
Shell	15
Rhone-Poulenc	15

The package deal scheme is now in its second season, and it is planned to extend coverage to larger areas, however, some or all of the companies have lost money in the last season.

Pesticides consumed in the Sudan are used mainly on cotton and wheat, and are predominantly insecticides and herbicides. Use of fungicides is low * because the hot, dry climate tends to reduce the incidence of fungal infection. The following section outlines the major pests affecting crops, and shows the type of product used for its control.

* The 1978/79 and 1979/80 tenders do not list any fungicide.

Cotton	
Termites	Seed dressing, BHC, Aldrin
Jassids	DDT and any systemic
White Fly	Systemic organophosphorous, Dimethoate, Monocrotophos
Flea Beetle	DDT
American Bollworm	DDT
Pink Bollworm	Hostathion
Egyptian Bollworm	Sevin, Endosulphan, Monocrotophos
Egyptian Leafworm	Endosulphan, Monocrotophos, Sevin
Aphids	Dimethoate
Black Arm	Mercury based seed dressing
Sorghum	
Black Smut	Seed dressing, Thiram
Termites	Seed dressing, BHC, Aldrin
Stem Borer	Not much trouble
Aphids	Not treated
Birds	Quilotox (Lebaycid)
Sugar Cane	
Smut	Important, but not treated very much
Sesame	
Blood Disease	Try to grow resistant varieties
Groundnuts	
Leaf Spot	Not treated
Aspergillis Flavas	Fumigation with methyl bromide
Maize	
Termites	No treatment
Stem Borers	No treatment
Date Palms	
Scales	White oil emulsions, some systemics
Vegetables	
Powdery Mildew	Thiocarbamates
Aphids	Dimethoate, Malathion
Wheat	
Aphids	Organophosphorous and systemics
Birds	Quilotox
Rice	
Aphids	No treatment
Kenaf	
Flea Beetle	) treated together with
Ammerican Bollworm	) for example DDT
Millet	
Termites	Seed dressing BHC
Smut	Not much treatment
Birds	Quilotox

In addition, depending on the year, most crops can suffer attack from locusts and grasshoppers. Locust control is exercised by the Plant Protection Administration.

Herbicides are used on certain crops, the major single material is 2,4D amine salt. Other more sophisticated and specific products such as Cotoran, Ronstar, Saturn, Stomp, Toke and Basagran are being used in increasing quantities.

3. Pesticide Consumption

In 1978 estimated consumption of pesticides was of the order of 4 960 metric tons active ingredient. Insecticides accounted for about 80 percent of use, with herbicides making up for nearly 20 percent of the total, see following table.

TABLE V.6.

PESTICIDE CONSUMPTION-SUDAN 1978
(percentage of total consumption)

Insecticides	80.0
Fungicides	0.5
Herbicides	19.5
Total	100.0

Insecticides

Within the insecticide sector the dominant products are the organohalogen derivatives accounting for about 2 300 metric tons active material followed by organophosphorous derivatives making up for about 1 600 metric tons; carbamates are insignificant at 90 metric tons. Estimates of insecticide consumption by type are shown below.

TABLE V.7.

INSECTICIDE CONSUMPTION BY TYPE-SUDAN 1978
(metric tons active ingredient)

Organohalogen	
DDT	1 540
Endosulphan	637
BHC	60
Heptachlore	40
Dieldrin	8
Chlordane	1
Total	2 286
Organophosphorous	
Dimethoate	726
Phosphamidon	350
Malathion	190
Monocrotophos	90
Thiometron	85
Formothion	57
Demeton-s-methyl	22
Parathions	40
Others	40
Total	1 600
Carbamates	
Carbaryl	85
Carbofuran	3
Methomyl	2
Total	90
Total Insecticide	3 886

Fungicides

Due to the high temperature and low humidity prevailing in the Sudan, the incidence of fungal infection in very low and consequently very little fungicides are used - about 25 metric tons active material in 1978, mainly inorganics such as copper compounds.

Herbicides

Consumption of herbicides was estimated to be of the order of 960 metric tons active material in 1978, the major products were benzene derivatives, 375 metric tons, aryloxyacids 300 metric tons and urea derivatives 120 metric tons - see following table.

TABLE V.8.

HERBICIDE CONSUMPTION BY TYPE-SUDAN 1978
(metric tons active ingredient)

Benzene	
Nitrofene	375
Aryloxyacids	
2,4D amines	300
Urea	
Fluometuron	120
Organohalogens	
Dalapon	45
Others	
Various	115
Total Herbicide	955

The more sophisticated and specific herbicides have only been used to any extent in the last two to three years. 2,4D salts are used mainly to control water hyacinth, a continuing problem in the Sudan. The other herbicides are used in general cropping programmes.

In addition to the above noted materials, about 350 metric tons of seed dressings are used per year. These materials are usually based on organomercury/organohalogen mixtures. Methyl bromide fumigation is used in storage facilities. Rodents which cause widespread problems are controlled with warfarin and zinc phosphide based materials. The Weaver bird is controlled with Quilotox (fenthion), an insecticide with avian toxicity.

VI SYRIA

1. Agricultural Sector

Agriculture is still the mainstay of the Syrian economy in spite of the existence of a traditionally strong trading sector and relatively successful efforts at industrialisation in recent years. It accounts for about one-fifth of the GDP and employs two-thirds of the labour force. The main areas of cultivation are a narrow strip of land along the coast from the Lebanese to the Turkish frontiers which is extremely fertile and produces fruit, olives, tobacco and cotton. East of this strip lies the northward continuation of the Lebanon range of mountains, which falls sharply on the east to the Orontes river valley whose marshes were recently reclaimed to form one of Syria's most fertile areas. This valley joins in central Syria the 160 kilometre wide steppe-plain which runs from the Jordanian borders northeastwards towards the Euphrates valley and is separated from the plains' northern reaches by a range of hills. The plain is traditionally Syria's major agricultural area, producing mainly grains. The importance of this plain is being rivalled by the Jezira area which lies between the Euphrates in Syria and the Tigris in Iraq. The Jezira only came into its own in the early 1950s when large scale cotton cultivation was introduced in former pasture lands. This area will vastly increase in importance on the completion of long term irrigation and land reclamation projects linked with the Euphrates dam project.

The major products after cotton and cereals are tobacco, sugar beet, sesame, olives, grapes, figs, apricots, apples, melon, pistachio nuts, walnuts, lentils, chick peas, vetch, broad beans, tomatoes, onions, garlic, potatoes, egg plant, and other soft vegetables. Stockraising is another important branch of agriculture.

Estimates of major crop areas are shown in the following table.

TABLE VI.1.

MAIN CROP AREAS-SYRIA 1978

Crop	Thousand Hectares
Wheat	1 530
Barley	1 020
Maize	20
Sesame	45
Millet	26
Lentils	180
Chick Peas	75
Beans	25
Other Pulses	75
Cotton	200
Groundnuts	14
Sunflower	4
Roots and Tubers	11
Vegetables	180
Olives	150
Fruit	100
Nuts	na

2. Pesticide Business

Pesticides are supplied by Private Sector companies and the Public Sector, Ministry of Agriculture and Agrarian Reform. The split in supply is about 50/50 between private and public enterprises. In the private sector there are about five importing companies acting on behalf of foreign producers. All products brought in by the private sector are used by farmers, but only about 50 percent imported by the Ministry gets used, the remainder is wasted due to poor government storage facilities. All imports made by the private sector are registered by the Ministry of Agriculture, however such statistical records tend to be inaccurate as there is considerable smuggling of materials into Syria from the Lebanon and Jordan.

3. Pesticide Consumption

In 1978 pesticide consumption was estimated to be of the order of 1 430 metric tons active material. Fungicides accounted for about 71 percent of total volume. Insecticides and herbicides made up 27 percent and 2 percent respectively. Although fungicide consumption stood at just over 1 000 metric tons, 860 metric tons was accounted for by sulphur. Estimates of the breakout in pesticide consumption are shown in the following table.

TABLE VI.2.

PESTICIDE CONSUMPTION-SYRIA 1978
(percentage of total consumption)

Fungicides	70.7
Insecticides	26.8
Herbicides	2.5
	100.0

Insecticides

In the insecticide sector the dominant family of products is the organohalogen derivatives accounting for 380 metric tons active material. The main product is DDT. Organophosphorous derivatives are the second most important group making up about 90 metric tons active material. Estimates of insecticide consumption by type are shown below.

TABLE VI.3.

INSECTICIDE CONSUMPTION BY TYPE-SYRIA 1978
(metric tons active ingredient)

Organohalogen	
DDT	160
BHC	33
Endosulphan	20
Chlordane	8
Toxaphene	40
Others	19
Total	280
Organophosphorous	
Dimethoate	24
Trichlorfon	20
Parathion	10
Malathion	6
Others	30
Total	90
Others	
Carbamates	4
Mineral Oils	9
Total	13
Total Insecticide	383

Fungicides

Fungicide consumption, in terms of active ingredient, is dominated by inorganic sulphur. Sulphur accounts for 85 percent of total fungicide volume. Dithiocarbamates make up 14 percent of total volume. The remaining one percent includes small amounts of copper oxychloride and aromatic derivatives. Estimates of fungicide consumption by type are shown below.

TABLE VI.4.

FUNGICIDE CONSUMPTION BY TYPE-SYRIA 1978
(metric tons active ingredient)

Inorganics	
Sulphur	855
Copper Compounds	5
Total	860
Organics	
Dithiocarbamates	140
Others	10
Total	150
Total Fungicide	1 010

Herbicides

This minor sector accounting for about 35 metric tons active material is dominated by aryloxyacids, 2,4D type materials. 2,4D accounts for 77 percent of total herbicide use. Other herbicides include dicamba and trifluraline etc. Estimates of herbicide consumption by type are shown below.

TABLE VI.5.

HERBICIDE CONSUMPTION BY TYPE-SYRIA 1978
(metric tons active ingredient)

2,4D derivatives	27
Others including dicamba and trifluraline etc	8
Total Herbicide	35

VII IRAQ

1. Agricultural Sector

Agriculture is the main source of employment and, next to oil, the most important sector. Although the 1974/79 development plan gave high priority to the oil industry, agriculture remains important; the aim is to produce an agricultural surplus for export by reducing dependence on weather conditions and solving the salinity problems which affect irrigated land.

The land tenure system is extremely complex embracing privately owned land, public land (mainly desert), waqfs (religious endowments) and three types of government owned land. By far the greater part of registered land is that which is government owned and previously without established tenancy.

The general system of cultivation is fallow farming, crop rotations are rare. The farm worker is concerned primarily with subsistence and grows crops and keeps animals to provide for himself and his family. Cash crops are grown by plantation farmers and peasant proprietors. The largest and most commonly grown crops are barley and wheat. Together with lentils and linseed they constitute the main winter crops. Summer crops are much smaller, but in recent years have shown increases in size. The principal summer crops includes, rice, dates, tobacco and sesame. Cotton is also grown on a small scale in central Iraq. Around the major towns a comparatively sophisticated market gardening organisation has developed.

Estimates of major crop areas are shown in the following table.

TABLE VII.1.

MAIN CROP AREAS-IRAQ 1978

Crop	Thousand Hectares
Wheat	1 300
Barley	700
Rice	63
Maize	30
Lentils	53
Beans	42
Chick Peas	15
Sesame	13
Sunflower	11
Cotton	26
Vegetables	113
Grapes	20
Other Fruits and Olives	na
Tobacco	17
Sugar Cane	4
Sugar Beet	3

2. Pesticide Business

The agrochemical business is 100 percent state controlled, all imports are initiated by the Directorate General for Agricultural Supplies in Baghdad.

3. Pesticide Consumption

In 1978 pesticide consumption was estimated to be about 4 600 metric ton active material. Insecticides accounted for 72 percent of consumption and fungicides 27 percent. In the fungicide sector, sulphur accounted for 1 100 metric tons active material. Estimates of the breakout in pesticide consumption are shown in the following table.

TABLE VII.2.

PESTICIDE CONSUMPTION-IRAQ 1978
(percentage of total consumption)

Insecticides	72.2
Fungicides	27.0
Herbicides	0.8
Total	100.0

Insecticides

In the insecticide sector, the dominant family of products is organohalogen derivatives accounting for 60 percent of consumption. The next most significant category with 39 percent of the market is organophosphorous derivatives. The main organohalogen derivatives are DDT 1 400 metric tons, chlordane 450 metric tons and BHC 160 metric tons. In the organophosphorous sector the main products are malathion and dichlorvos accounting for 600 metric tons and 500 metric tons respectively. Estimates of insecticide consumption by type are shown below.

TABLE VII.3.

INSECTICIDE CONSUMPTION BY TYPE-IRAQ 1978
(metric tons active ingredient)

Organohalogen	
DDT	1 400
Chlordane	450
BHC	150
Aldrin	6
Others	4
Total	2 010
Organophosphorous	
Malathion	600
Dichlorvos	500
Diazinon	90
Demeton-s-methyl	30
Formothion	10
Dimethoate	5
Others	45
Total	1 280
Carbamates	
Carbaryl	30
Total Insecticide	3 320

Fungicides

The fungicide market is dominated by the inorganic material, sulphur, accounting for nearly 90 percent of the total in 1978. The remainder is accounted for by dithiocarbamates, mainly mancozeb. Estimates of the breakout in consumption by type are shown below.

TABLE VII.4.

FUNGICIDE CONSUMPTION BY TYPE-IRAQ 1978
(metric tons active ingredient)

Sulphur	1 100
Dithiocarbamates	140
Total Fungicide	1 240

Herbicides

Herbicide consumption is insignificant at 36 metric tons active material. Demand for herbicides appears to be solely for specialised materials, as outlined in the following table.

TABLE VII.5.

HERBICIDE CONSUMPTION BY TYPE-IRAQ 1978
(metric tons active ingredient)

Paraquat	15
Propanil	12
Trifluraline	8
Others	1
Total Herbicide	36

VIII JORDAN

1. Agricultural Sector

Agriculture is the most important sector of the economy accounting for 20 percent of the gross domestic product and employing about 40 percent of the total labour force. Great improvements were achieved in the years prior to the 1967 war, but the war and the consequent instability in the East Bank resulted in almost complete disruption.

On the West Bank, the land is poor but well farmed, and at least until 1967 most of the cultivable land was cultivated, and about one-third of the area was sown with fruit and vegetables. On the East Bank, methods of farming have been less developed, and much of the land has suffered from erosion. The shortage of capital has been an obstacle to extensive irrigation and even to terracing; further development depends on the realisation of international schemes or irrigation.

In overall terms Jordanian land utilisation can be split out as follows:

TABLE VIII.1.

LAND UTILISATION-JORDAN 1978
(thousand hectares)

Pastures	7 500
Arable	1 070
Forest	125

The major crops grown, in terms of land area are cereals, tomatoes, courgettes, cucumbers, aubergines and pulses. Estimates of current crop areas are shown in the following table.

TABLE VIII.2.

MAIN CROP AREAS-JORDAN 1978

Crop	Hectares
Wheat	140 000
Barley	30 000
Tomatoes	10 000
Courgettes	5 000
Cucumbers	5 000
Aubergines	3 500
Lentils	21 000
Green Beans	3 500
Chick Peas	2 000
Broad Beans	1 000
Potatoes	1 500
Peppers	1 000
Grapes	5 000
Melons	4 000
Tobacco	4 000
Citrus)	
Bananas)	na
Olives)	

Farming is a 100 percent private sector business.

2. Pesticide Business

Pesticide supply and distribution is entirely in the private sector, although import licences must be granted by the Plant Protection Department of the Ministry of Agriculture. The Plant Protection Department also provides technical assistance to farmers and growers. Agrochemicals are imported by local Jordanian companies which represent the foreign producers. It is not unusual for an importing company to represent several competing suppliers.

3. Pesticide Consumption

In 1978 estimated consumption of pesticides was about 750 metric tons active ingredient. Fungicides accounted for some 84 percent of total volume, with insecticides making up 15.5 percent. Herbicides were insignificant at less then one percent. Although fungicide consumption stood at 630 metric tons, inorganics dominated by sulphur, accounted for 585 metric tons. Estimates of the breakout in pesticide consumption are shown in the following table.

TABLE VIII.3.

PESTICIDE CONSUMPTION-JORDAN 1978
(percentage of total consumption)

Fungicides	84.0
Insecticides	15.5
Herbicides	0.5
Total	100.0

Insecticides

In the insecticide sector the dominant family of products is the organophosphorous derivatives accounting for 34 metric tons active material, followed by carbamates with 13 metric tons. In the "others" sector mineral oils accounted for 60 metric tons. Estimates of insecticide consumption by type are shown below.

TABLE VIII.4.

INSECTICIDE CONSUMPTION BY TYPE-JORDAN 1978
(metric tons active ingredient)

Organophosphorous	
Parathions	9
Monocrotophos	7
Trichlorfon	5
Methamidophos	4
Dimethoate	3
Pyrimiphos-methyl	2
Triazophos	2
Others	2
Total	34
Carbamates	
Methomyl	10
Carbaryl	2
Propoxur	1
Others	1
Total	14
Organohalogen	
Endrin	2
Others	2
Total	4
Others	
Mineral Oils	60
Propargite	3
Cyhexatin	2
Others	2
Total	67
Total Insecticide	119

Fungicides

Fungicides accounted for 630 metric tons active material in 1978, with 585 metric tons being various forms of the inorgnic material, sulphur. The only significant organic derivative family was dithiocarbamate at 31 metric tons. Estimates of consumption by type are shown below.

TABLE VIII.5.

FUNGICIDE CONSUMPTION BY TYPE-JORDAN 1978
(metric tons active ingredient)

Inorganics	
Sulphur	585
Copper Salts (as copper)	4
Total	589
Organics	
Dithiocarbamates	31
Others	10
Total	41
Total Fungicide	630

Herbicides

Consumption of herbicides amounted to 4 metric tons active material in 1978, 50 percent of which was accounted for by 2,4D salts. Estimates of use by type are shown below.

TABLE VIII.6.

HERBICIDE CONSUMPTION BY TYPE-JORDAN 1978

(metric tons active ingredient)

2,4D Salts	2
Urea Derivatives	1
Bipyridal and Others	1
Total Herbicide	4

IX KUWAIT

1. Agricultural Sector

Owing to the present lack of water little food is produced in Kuwait, except for some vegetables and melons. The vast majority of food consumed in Kuwait has to be imported. The Government has done much to encourage animal husbandry amongst the Bedouin, and has interests in experimental farming projects. In the private sector there is a growing poultry and dairy industry.

2. Pesticide Business

Because of the insignificant size of the agricultural sector the majority of all pesticides are used for public health business. All insecticides and rodenticides purchased by public sector concerns in Kuwait must be approved by The Unit for Study and Control of Insects and Rodents, a department of the Ministry of Public Health. This department is probably the largest public sector buyer of pesticides. All requirements for public health programmes are submitted through the Ministry to the Central Tenders Committee.

Although no active materials are produced in Kuwait, many concentrates are imported and reformulated by the Ministry of Public Health, and in addition the Sharhan Company formulates and packs aerosols for sale on the domestic and export markets.

3. Pesticide Consumption

In 1978 pesticide consumption was estimated to be about 11 metric tons active material. About 7 metric tons of which was used in public health applications, the remainder was consumed in the agricultural sector.

In the agricultural sector all but 0.5 metric tons active ingredient was accounted for by insecticides. The 0.5 metric tons was sulphur, used as a fungicide. No herbicides appear to be used. Organophosphorous materials dominated the business, with parathions and dichlorvos being the main materials. Organohalogens were insignificant. In addition about 0.7 metric tons of mineral oil was used. Estimates of pesticide consumption are shown below.

TABLE IX.1.

CONSUMPTION OF PESTICIDES BY TYPE IN AGRICULTURE-KUWAIT 1978
(metric tons active ingredient)

Insecticides	
Organohalogen	0.2
Organophosphorous	
Parathion	1.0
Dichlorvos	1.0
Malathion	0.6
Mineral Oils	0.7
Fungicides	
Sulphur	0.5
Total Pesticide	4.0

In the public health sector pesticides are used to combat houseflies, mosquitos, fleas, lice, cockroaches and rodents.

Houseflies are controlled by two main methods - spraying and fogging. In spraying a 1.5 percent emulsion of dimethoate is employed. The solution is made up locally from an imported 50 percent emulsion concentrate. For fogging, dichlorvos, synergised with natural pyrethrum and piperonylbutoxide is used. However there is a trend away from this mixture to another formulaton based on one percent dichlorvos plus synthetic pyrethroids. The new formulation will be applied using ultra low volume equipment.

Mosquitos are controlled using a larvaecide such as Dursban 40 percent (chlorpyriphos-ethyl).

Fleas are combatted by the dusting of rat burrows with such products as lindane and diazinon, but there is a move to the use of Baygon propoxure one percent (2-iso-propoxyphenyl-N-methyl carbamate). There is no programme for lice control, treatment is carried out as and when required.

Cockroaches only pose problems in hospitals and hotels. The usual material employed is Baygon 10 percent. The product is imported as a 20 percent concentrate and let down to 10 percent locally.

Rodents (mainly rats) are controlled by the use of acute rodenticides and anticoagulants. Acute rodenticides include zinc phosphide two percent plus bait and red squill used at 0.033 percent and 0.5 percent concentrations. Anticoagulants used include sulphur quinoxiline 0.025 percent and coumatetralin 0.75 percent. All materials, with the exception of coumatetralin are imported as concentrates and let down to the required concentration locally. Estimates of the various pesticides used in the public health sector are outlined in the following table.

TABLE IX.2.

CONSUMPTION OF PESTICIDES BY TYPE IN PUBLIC HEALTH-KUWAIT 1978
(metric tons active ingredient)

Insecticides	
Dichlorvos	2.5
Dimethoate	2.0
Piperonyl Butoxide	1.4
Chlorpyriphos-ethyl	0.7
Propoxure	0.3
Pyrethrum	0.2
Rodenticides	
Various	0.1
Total Pesticides	7.2

X SAUDI ARABIA

1. Agricultural Sector

Cultivation is confined to oases and to irrigated regions comprising a mere 0.2 percent of the total land area. The remaining agricultural land is used for low grade grazing. The chief crops cultivated on irrigated or cultivated soil are: sorghum, wheat, millet, tomatoes, water melons, barley and maize, whilst fruits of several varieties, particularly dates, grow in abundance in oases. Production of wheat, which, after dates, was the second largest crop, provided only 25 percent of requirements in the early 1970s. However experiments with new wheat varieties, undertaken in collaboration with the FAO have shown that the yield can be doubled.

The Government has recognised the importance of developing agriculture as a means of reducing the dependence on imported food, and as a means of diversifying the economy and of raising rural living standards. Scarcity of water constitutes the main factor limiting agricultural development, and the Government has launched an ambitious programme to overcome the obstacle. Execution of this programme which includes surveys for underground water resources, construction of dams, irrigation and drainage networks, combined with distribution of fallow land, settlement of Bedouin and the introduction of mechanisation - is aimed at the eventual raising of agricultural production to the level of near self sufficiency in food. Consequently, budgetary allocations for the agricultural sector have increased several times since the mid 1960s.

In Saudi Arabia agricultural crop patterns are conveniently divided into two main sectors, permanent and temporary. Permanent crops include dates and grapes, etc, whilst temporary crops include cereals, vegetables and fodder crops grown on irrigated and non irrigated land during the Winter and Summer seasons. Total crop area is of the order of 5.9 million Donums in 1975/76 (one Donum equals 1 000 square metres). Estimates of crop areas are shown in Table X.1 and Table X.2 below.

TABLE X.1.

AREA OF PERMANENT CROPS 1976/76

Crop	Donum
Dates	604 131
Grapes	44 681
Citrus	34 496
Trees	32 514
Total	715 822

TABLE X.2.

AREA OF TEMPORARY CROPS 1975/76
(donums)

Crop	Winter Irrigated	Winter Not Irrigated	Summer Irrigated	Summer Not Irrigated	Total
Wheat	573 089	164 368	-	-	737 457
Barley	79 025	17 277	-	-	96 302
Maize	2 043	70 203	23 418	998	96 662
Sorghum	41 748	1 754 652	189 715	1 033 146	3 019 261
Millet	10 685	184 134	17 416	116 522	328 757
Sesame	1 189	23 518	792	12 592	38 091
Tomatoes	65 745	-	93 266	-	159 011
Potatoes	2 011	-	-	-	2 011
Onions	44 745	-	-	-	44 745
Carrots	3 267	-	-	-	3 267
Okra	12 757	68	-	-	12 825
Egg Plant	6 018	-	25 812	-	31 830
Squash	17 356	68	9 235	-	26 659
Melons	-	-	8 331	-	8 331
Water Melons	-	-	118 615	5 982	124 597
Other Vegetables	26 792	136	42 342	-	69 270
Alfalfa	-	-	94 734	-	94 734
Other Fodder	24 790	185 599	36 612	1 890	248 891
Total	911 260	2 400 023	660 288	1 171 130	5 142 701

2. Pesticide Business

The Saudi pesticide business can be divided into two sections - Agriculture and Public Health.

The agricultural market is split into public tenders and private buying. In the early 1960s about 95 percent of the agricultural chemicals were bought by the Ministry of Agriculture which provided them free to the farmers. However, with the subsequent growth in the agricultural sector, the quantities provided by the Ministry fell below demand and consequently the volume of private buying rose. At the present time the market is split about 50/50 between public and private buying.

The public health sector is split into two sections - Ministry of Municipalities and Ministry of Health. Most materials used in the public health sector are bought on annual tenders. The major problems dealt with in the public health sector are flies and mosquitos, followed by eye irritant insects with cause Trachoma and rodents especially in the ports of Jeddah and Dammam.

Products used in Saudi Arabia are either imported direct or supplied by local companies acting as agents for overseas producers. Although no active materials are produced in Saudi Arabia, there is a local formulation plant owned by Coopers (Wellcome) and local interests running on imported technical materials. The company basically dilutes and repackages pesticides for sale in the Kingdom.

3. Pesticide Consumption

In 1978 pesticide consumption totalled about 1 700 metric tons active material. All but 40 metric tons was used in the agricultural sector. Fungicides accounted for an estimated 1 300 metric tons or 76 percent of total consumption, however, of this volume 1 200 metric tons was accounted for by sulphur. Herbicide consumption was negligible. Estimates of the relative importance of pesticide types are shown in the table below.

TABLE X.3.

PESTICIDE CONSUMPTION-SAUDI ARABIA 1978
(percentage of total consumption)

Fungicides	76
Insecticides	24
Herbicides	neg
Total Pesticide	100

Insecticides

In the insecticide sector the dominant family of products are organophosphorous derivatives accounting for 230 metric tons active material. The next most important group being carbamates, with 106 metric tons active material. Estimates of consumption by type of product for agricultural and public health use are shown in the following two tables.

TABLE X.4.

CONSUMPTION OF INSECTICIDES BY TYPE IN AGRICULTURE-SAUDI ARABIA 1978
(metric tons active ingredient)

Organophosphorous	
Trichlorfon	75
Malathion	53
Dichlorvos	47
Dimethoate	38
Total	213
Carbamates	
Carbaryl	106
Sulphones	
Tetradifon	13
Carbinols	
Dicofol	12
Others	17
Total Insecticides	361

TABLE X.5.

CONSUMPTION OF INSECTICIDES BY TYPE IN PUBLIC HEALTH-SAUDI ARABIA 1978
(metric tons active ingredient)

Pyrethroids	25
Organophosphorous	17
Total Insecticides	42

Fungicides

Consumption of fungicides in 1978 accounted for nearly 1 300 metric tons active material. However 1 200 metric tons was accounted for by elemental sulphur in dusting and wettable powder forms. The only significant organic materials were dithiocarbamates accounting for 75 metric tons active material.

TABLE X.6.

CONSUMPTION OF FUNGICIDES BY TYPE-SAUDI ARABIA 1978
(metric tons active ingredient)

Inorganics	
Sulphur	1 200
Organics	
Dithiocarbamates	75
Others	20
Total	95
Total Fungicides	1 295

Herbicides

Negligible quantities of herbicides are used.

Rodenticides

About 1 000 metric tons of rodenticides are used in the ports of Jeddah and Damman. The products are usually of the anticoagulant type such as warfarin, coumatetryl and sulfaquinoxalin and accounted for 5 metric tons active ingredient.

XI OMAN AND THE UNITED ARAB EMIRATES

1. Agricultural Sector

In the Oman about 70 percent of the working population is engaged in agriculture. Although the Sultanate's long term plans for development foresee a considerable increase in agricultural production - at present subsistence farming dominates. Because of the limited rainfall and wide variations in rainfall from one year to another, farming is heavily dependent on irrigation. In the oases water is supplied by underground water channels, and on the coast irrigation is by pump from wells. About half of the estimated 36 000 hectares under cultivation are planted with dates. Other crops include lucerne, limes, mangoes, melons and bananas. Onions, tomatoes and cucumbers are being grown in increasing quantities. Some wheat is also grown in the interior. The Department of Agriculture runs several experimental farms and extension centres to promote agricultural production. In the Dhofar region which enjoys monsoon rains, cattle are raised on the hills; and coconut palms, and a wide range of vegetables are grown on the coastal plain.

The economy of the UAE is totally dominated by oil production. The increase in wealth has led to an expansion in the financial and commercial sectors. The UAE leaders have been anxious to diverisfy the economy, so the traditional activities of fishing and agriculture have been encouraged and modernisation projects undertaken to improve yields. However due to the very arid condition agriculture has yet to become a significant sector of the economy.

In 1978 total pesticide consumption in the Oman was estimated to be about 50 metric tons active ingredient, all but 10 metric tons were insecticides used in agriculture and public health. The main products used were the organophosphorous derivatives. Sulphur dust was used as a fungicide. Rodenticides probably accounted for no more than 0.5 to 1.0 metric tons of active material. Estimates of pesticide consumption are shown below.

TABLE XI.1.

CONSUMPTION OF PESTICIDES BY TYPE-OMAN 1978
(metric tons active ingredient)

Insecticides	
Malathion	8
Trichlorfon	7
Dimethoate	7
Pirimiphos-methyl	5
Dichlorvos	5
Carbaryl	6
Fungicides	
Sulphur	10
Rodenticides	
Various	0.5
Total Pesticides	48.5

Herbicide consumption appears to be negligible.

In the UAE all pesticides are used in the public health sector. Consumption in 1978 was estimated to total just over 60 metric tons active material. The main product appears to be mineral oil, used as a mosquito larvaecide. Estimates of consumption of pesticide by type are shown below.

TABLE XI.2.

CONSUMPTION OF PESTICIDES BY TYPE-UAE 1978
(metric tons active ingredient)

Mineral Oils	60
DDT	2
Others	2
Total Pesticides	64

Herbicide, fungicide and rodenticide consumption is of negligible importance.

XII FUTURE PESTICIDE CONSUMPTION

Total demand for pesticides in the regions under investigation is forecast to rise from the 1978 level of 38 500 metric tons active material to nearly 54 000 metric tons active material by 1988. The major pesticides used will continue to be fungicides and insecticides each accounting for nearly 50 percent of total volume. Herbicides will remain relatively insignificant in volume terms with about four percent of the market. Estimates of the total market are shown below.

TABLE XII.1.

FORECAST TOTAL PESTICIDE DEMAND IN ARAB STATES-1978 TO 1988
(thousand tons active ingredient)

	1978	1983	1988
Fungicides	19.4	22.5	26.1
Insecticides	17.7	21.5	25.6
Herbicides	1.4	1.7	2.1
Total	38.5	45.7	53.8

More detailed information including estimates of forecast consumption by major product are outlined in the following pages.

1. Egypt and the Sudan

Both Egypt and the Sudan have approximately the same cropped area, 11 million and 13 million feddans respectively. Cropping patterns are broadly similar leading to similar pest control techniques. In both countries cotton and cereals are major crops. The only exception to this broad generalisation of similarity is in the use of fungicides. Due to the dry climate experienced in the Sudan incidence of fungal attack is quite low, and use of fungicides is virtually non existent. On the other hand in Egypt about 60 percent of total pesticide active ingredient is accounted for by fungicides. However it should be noted that of the 15 200 metric tons of fungicide used in 1978 nearly 15 000 metric tons was accounted for by elemental sulphur.

It would be fair to state that Egyptian agriculture is more sophisticated in use of pesticides than the Sudanese, and hence a larger variety and volume of products are used in Egypt than in the Sudan. In both countries the Government exercises control over the types and volumes of products imported and used. In Egypt the Minstry of Agriculture actually states what products should be used on the controlled area of cotton planted. Herbicides appear to be of secondary importance in both countries, basically because insect and spiders cause the greatest nuisance, and weeds can easily be removed by hand. In some cases farmers actually use the weeds as an additional source of fodder for the animals.

In both countries lack of land is hampering agricultural production. The lack of cultivable land is due to lack of water, and not finite area. Both countries have embarked on large schemes for irrigation, but such projects require considerable capital outlays and also take time. Cropped areas are however being steadily expanded in Egypt and the Sudan.

Future growth in pesticide consumption will be geared mainly to the increase in cropped area. In addition a greater offtake of pesticides will also stem from an increase in the use of pesticides on crops that receive little or no treatment. However increased pesticide use in these areas will depend heavily on farmers' attitudes and more aggressive selling by the suppliers. Farmers have to be persuaded that expenditure on pesticides can be justified on the basis of increased yield. Education on the attributes of pesticides will also lead to an increase in usage. According to the suppliers operating in Egypt and the Sudan, more farmers are moving over to an increased use of pesticides and a gradual and continuous growth in offtake is foreseen. Perhaps one of the rapidly growing sectors is in the use of specialised herbicides, this is particularly true of the Sudan, where newer more specialised products have only been used for the last couple of growing seasons. 2,4D salts have however not lost out in volume terms. The newer products are additional and not replacements. Egypt, where the more specialised materials have been used for some time, is still showing an increase in consumption. This is due at least in part to farmers using herbicides in place of hand weeding which is now getting to be expensive.

2. Syria, Iraq and Jordan

Although these three countries have dissimilar cropped areas, Syria 3.7 million ha, Iraq 2.5 million ha, and Jordan 0.25 million ha, the major crops in each country are similar ie cereals, pulses, and vegetables. Cotton is however significant in Syria.

Iraq dominates the pesticide buisness in this sub-region with 68 percent of total use. Syria and Jordan account for 21 percent and 11 percent respectively. When the market is analysed on a product basis it can be seen that of the total 6 780 metric tons active ingredient consumed in 1978 insecticides make up 56 percent, fungicides 43 percent and herbicides one percent.

In the insecticide sector the dominant products are organohalogen derivatives and organophosphorous materials accounting for 2 300 metric tons and 1 400 metric tons respectively. Fungicide consumption is dominated by sulphur with 2 540 metric tons, followed by dithiocarbamates at 310 metric tons active material.

Over the years pesticide consumption has increased as farmers and growers have strived to increase production. Growth in use is expected to continue, but will depend not only on the education of farmers to use pesticides but also on injection of capital to improve and increase farm land, and in Iraq for example to encourage the farmers away from subsistence farming to producing more crops for sale. In Syria a market gardening sector has been started to flourish around the large conurbations, where farmers and growers sell their produce.

3. Kuwait and Saudi Arabia

Pesticide consumption in these two states is at a relatively low level because of the small size of the agricultural sector. Saudi Arabian agricultural pesticide consumption appears significant at first sight at about 1 700 metric tons active ingredient, however, of this total, 1 200 metric tons was accounted for by sulphur for use as a fungicide. Insecticides accounted for nearly 400 metric tons active material. In comparison demand for all pesticides in Kuwait amounted to not much more than 12 metric tons active material. About 50 percent of this was used in public health programmes. Saudi Arabian public health sector accounted for just over 40 metric tons active material. Herbicide consumption in both countries was virtually non existent.

Growth in pesticide use is expected to increase steadily, but real rapid growth will depend on the extension of agricultural activities. This will take time due to the formidable problems associated with the lack of water in the region. Demand for pesticides in the public health sector will probably not move ahead very rapidly, because the market is already well covered and has been for some time. In the public health sector, although the volumes of formulated products used are high, the proportion of contained active material is very low, so it would require an enormous growth in the market to make any significant change in the volume of active materials employed.

4. Oman and the United Arab Emirates

Pesticide consumption in these two countries was estimated to be about nearly 120 metric tons active material, 60 metric tons of which was accounted for by mineral oil used as a mosquito larvaecide in the United Arab Emirates. In the Oman all but 10 metric tons of the total of 50 metric tons active ingredient were insecticides used in agriculture and public health control. The remaining 10 metric tons were fungicides, in this case sulphur, used in agriculture.

This sub-region is similar to Kuwait and Saudi Arabia, having minimum agricultural outlets for pesticides, but significant, in local terms, public health requirements. Growth in public health outlets will continue, but as stated earlier, the actual volume of active ingredient employed is small. Demand for pesticides in agriculture in the Oman could rise steadily if plans to modernise agriculture and move farmers away from subsistence farming can be achieved.

5. Total Market 1978 to 1988

As the basic objective of this study is to identify products that could be produced in Kuwait to serve the Arab market, the future growth in demand was estimated on the basis of the total market and not segmented down to countries or sub-regions.

Forecasting future demand for pesticides on total active ingredient basis can be very misleading because application rates vary with the materials being used. Some products for example require a higher rate of application per unit area than others to achieve the same result. A move to more active materials could actually lead to a decrease in the total volume of active ingredient employed, when in fact total control has been increased.

Over the years pesticides have been developed and more and more sophisticated and specialised materials are appearing in the market place. Some of these materials displace the older types, and in some cases, some of the old traditional materials drop out of favour, due to disease resistance or are banned because of toxicity considerations. This is especially true for the organohalogen insecticides. In Egypt demand for organohalogen insecticides has virtually disappeared from the agricultural scene, and in the Sudan, demand has decreased in absolute terms over the last few years. The decrease in the use of organohalogen insecticides has been made up for by an increase in the use of organophosphorous derivatives and to a lesser degree carbamates.

Forecasting pesticide consumption on a year by year basis is fraught with difficulty beacuse consumption from year to year depends on the incidence of disease which in turn often depends on climatic variations. In addition, in countries like Egypt and the Sudan the quantity of pesticides available does depend on the availability of foreign exchange to buy them. It is believed however that both these countries, and others like them with foreign exchange problems recognise the need for pesticides and will do their utmost to buy the necessary products.

Because no reliable statistics exist for the recent past, simple extrapolation of past trends cannot be made to evaluate the future growth mode. Growth forecasts presented in this section are based on discussions held with major suppliers in the region, and other experts in Western Europe.

Within each category only the major products have been isolated because of volume considerations, and also these products tend to be the older types where patents have run out or are running out. New products are under patent restriction and the companies owning the patents are most reluctant to consider licensing agreements. In fact licensing of new products can be ruled out and the know-how available for purchase is confined to the older well tried products.

Insecticides

On a total active ingredient basis the volume of insecticides is forecast to rise from the 1978 level of 17 700 metric tons through 21 500 metric tons in 1983 to around 25 600 metric tons by 1988. During the period consumption of all insecticides with the exception of organohalogen derivatives is expected to increase. Organohalogen derivatives are forecast to remain static, and could even decline in the long term, although the products are cheap and effective for locust control. The decrease in the relative importance of the organohalogens will be offset by the increase in use of other materials.

Estimates of demand growth by family of products are shown below.

TABLE XII.2.

FORECAST CONSUMPTION OF INSECTICIDES BY FAMILY IN ARAB STATES 1978 TO 1988
(metric tons active ingredient)

	1978	1983	1988
Organophosphorous	5 541	7 780	10 390
Organohalogen	4 664	4 600	4 200
Carbamates	945	1 390	1 950
Mineral Oils	6 130	7 000	8 000
Others	442	700	1 030
Total	17 722	21 470	25 570

More detailed estimates by type of product are shown in the following table.

TABLE XII.3.

FORECAST CONSUMPTION OF MAJOR INSECTICIDES IN ARAB STATES 1978 TO 1988
(metric tons active ingredient)

	1978	1979	1980	1981	1982	1983	1988
Organophosphorous							
Dimethoate	1 155	1 235	1 322	1 415	1 514	1 630	2 170
Malathion	970	1 040	1 116	1 198	1 285	1 380	1 840
Chlorpyriphos-ethyl	696	748	804	864	929	1 000	1 340
Dichlorvos	556	590	627	666	707	750	1 000
Triazophos	502	535	570	607	647	690	920
Phosphamidon	350	376	404	433	466	500	670
Parathions	228	242	257	273	290	310	420
Others	1 084	1 158	1 238	1 323	1 414	1 520	2 030
Organohalogen							
DDT	3 102	3 096	3 092	3 088	3 084	3 080	2 800
Endosulphan	657	660	660	660	660	660	600
Chlordane	459	454	450	447	444	440	400
BHC	243	236	232	228	224	220	200
Others	203	200	200	200	200	200	200
Carbamates							
Carbaryl	760	820	886	957	1 033	1 120	1 570
Others	185	200	215	232	250	270	380
Mineral Oil	6 130	6 295	6 465	6 640	6 820	7 000	8 000
Others	442	484	530	581	638	700	1 030
Total	17 722	18 369	19 068	19 812	20 605	21 470	25 570

Fungicides

Demand for fungicides in forecast to rise from the 1978 level of 19 400 metric tons active ingredient through 22 500 metric tons in 1983 to 26 100 metric tons by 1988. Sulphur will remain the major material with over 95 percent of the market. Dithiocarbamates will be the only significant organic material with a market share of about three percent. Estimates of consumption of fungicide by type for the period under review are shown in the following table.

TABLE XII.4.

FORECAST CONSUMPTION OF MAJOR FUNGICIDES IN ARAB STATES 1978 TO 1988
(metric tons active ingredient)

	1978	1979	1980	1981	1982	1983	1988
Inorganics							
Sulphur	18 661	19 220	19 780	20 390	21 000	21 630	25 070
Copper Salts *	94	97	99	103	106	108	120
Organics							
Dithiocarbamates	517	537	560	580	605	630	770
Others	95	100	105	110	115	120	150
Total	19 367	19 954	20 544	21 183	21 826	22 488	26 110

* mainly copper oxychloride expressed as copper

Herbicides

This minor sector of the pesticide market is expected to grow from about 1 400 metric tons active material in 1978 to just over 2 000 metric tons in 1988. Although 2,4D amines will remain the major material, other more specialised materials will be used in larger volumes. The share attributable to 2,4D will fall from the 1978 level of 32 percent to 29 percent by 1988. Most of the growth in demand will arise in Egypt and the Sudan, especially for the newer more specialised products. Estimates of future consumption by herbicide type are shown in the following table.

TABLE XII.5.

FORECAST CONSUMPTION OF MAJOR HERBICIDES IN ARAB STATES 1978 TO 1988
(metric tons active ingredient)

	1978	1979	1980	1981	1982	1983	1988
2,4D amines	449	460	475	490	505	520	600
Nitrofene	375	390	405	420	440	460	560
Fluometuron	152	158	164	170	178	185	225
Carbamates	106	110	115	120	124	130	160
Others	320	336	353	370	388	405	530
Total	1 402	1 454	1 512	1 570	1 635	1 700	2 075

XIII- PESTICIDE PRODUCTION PLANT - DEFINITION

The pesticide market (insecticides, fungicides and herbicides) in the area of study is forcasted to rise from the current level of 38500 metric tons through 45 700 tons to about 54 000 metric tons by 1988.

Although the market is made of a large number of various active ingredients, it is necessary to concentrate on the dominant products and to evaluate the feasibility of their production in a plant located in Kuwait.

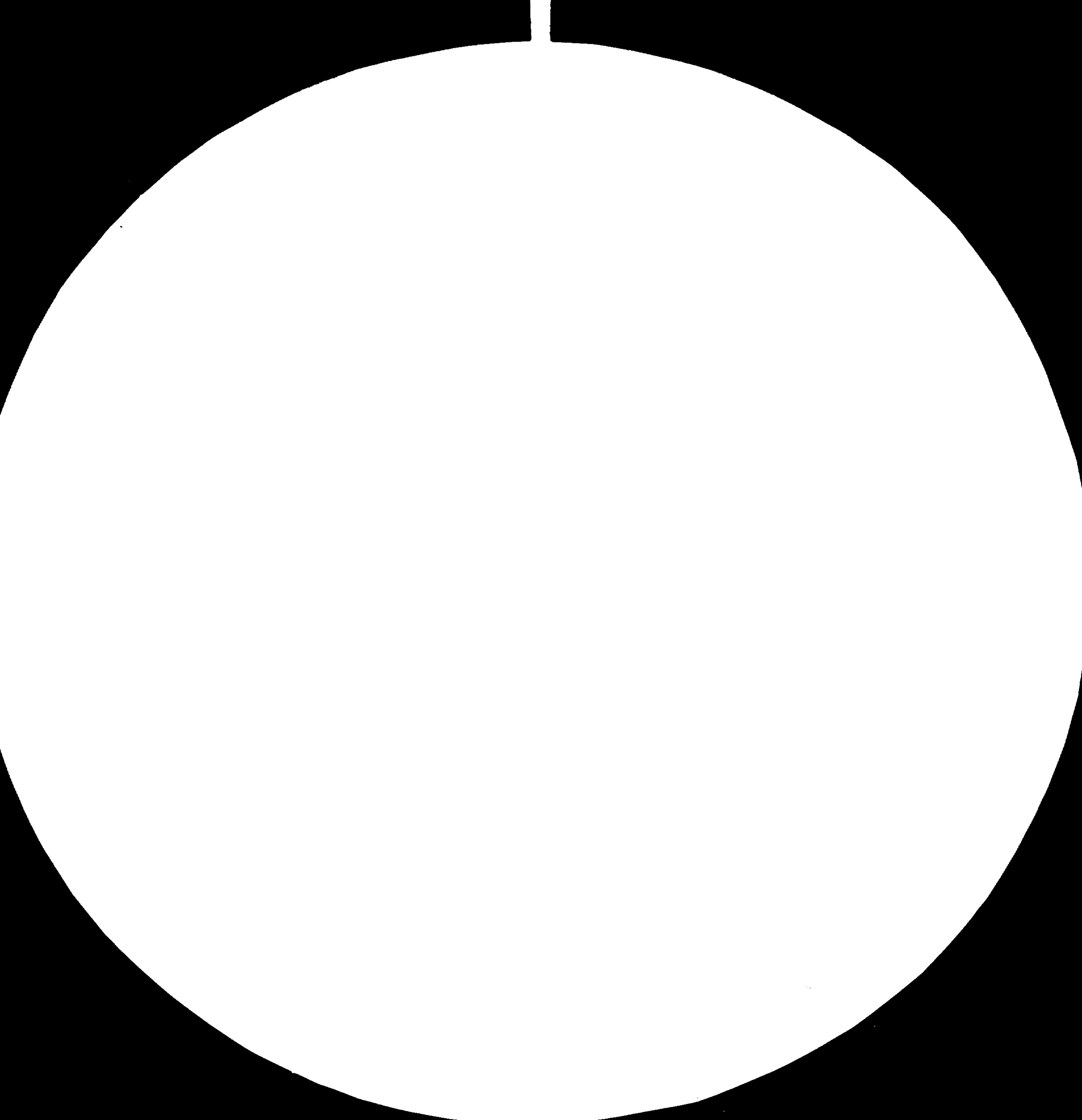
The forecast consumption of the selected products (see Table I-1) is presented below:

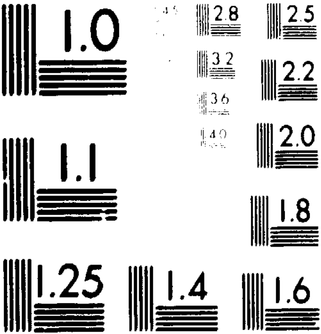
Forecast consumption of major pesticides
metric tons of active ingredients (1988)

. Insecticides :	- Dimethoate	2 170
	- Malathion	1 840
. Fungicides :	- Dithiocarbamates	770
. Herbicides :	- 2,4 D amines	600

The above mentioned active ingredients will be produced batch-wise in the multipurpose chemical plant defined in the following chapters.

82 05 05





MICROCOPY RESOLUTION TEST CHART

XIV- MANUFACTURING TECHNOLOGY AND ECONOMICS

1 - DESIGN BASIS

1.1 - PLANT LOCATION

Kuwait - Shuaiba Area Authority

1.2 - PRODUCTS SELECTED AND PLANT CAPACITY

- Insecticides :
  - Dimethoate: 2500 metric tons/year (technical product)
  - Malathion : 2000 metric tons/year (technical product)
- Fungicides :
  - Dithiocarbamates : 1000 metric tons/year (technical Maneb or Zineb)
- Herbicides :
  - 2,4 D acid: 600 metric tons/year (technical product)
  - 2,4 D-Dimethylamine salt: 720 metric tons/year (technical product)

1.3 - PLANT DESIGN

The plant is designed like most multipurpose fine chemical plants, i.e. the products are made batchwise and are processed in corrosion resistant agitated, jacketed reactors.

The capacity of the various units is too large to have all the products made compaignwise in the same pieces of equipment, however, the processing systems (batch reactor, overhead condensing equipment and receivers) are quite flexible and almost any fine chemical or agrochemical can be produced in these pieces of equipment.

The overall plant is divided into 9 sections as follows:

Section 100: 0,0 Dimethyldithiophosphoric acid production unit

Section 200: Ethyl maleate production unit

Section 300: Malathion production unit

Section 400: N-methylchloroacetamide production unit

Section 500: Dimethoate production unit
Section 600: Maneb/Zineb production unit
Section 700: 2,4 dichlorophenoxyacetic acid-amine salt production unit
Section 800: Storage
Section 900: Waste treatment unit

The production facilities are installed inside four different buildings so as to avoid cross-contamination of active ingredients of different groups.

The units are arranged as presented herebelow:

Building A : sections 100, 200 and 300
Building B : sections 400 and 500
Building C : section 600
Building D : section 700

1.4 - OFFSITE FACILITIES

. Storage capacity : - Raw materials: 15 days *
- Final products: 30 days

The liquid raw materials are supplied in shipping containers (owned by the company or the raw material manufacturer) and stored in fixed storage tanks.

The final products are packaged within the production facility and stored in ground level warehouses.

All the solids in 25 kg bags or the liquids in 200 l drums are received, stored and shipped on pallets. These pallets are stocked on 2 levels and are handled by fork lift trucks. Some of these fork lift trucks have to be designed for hazardous areas.

The overall warehouse area required is fairly large since it was estimated at 2000 m2. Good storage practices dictate that different pesticides be stored separately, or at least in well marked locations within a warehouse. Moreover, special case has to be taken to keep herbicides well segregated from fungicides and insecticides.

* In revised economics annexed to the final report Annex 1, both raw materials and products storage capacites have been expanded to 3 months.

. effluents : the liquid wastes containing toxic substances are collected in separate sewers and are treated in a neutralization-decantation section.

The liquid organic wastes are incinerated and the gaseous streams are treated in caustic scrubbers or burned (H_2S).

. Utilities : the utilities necessary for operating the processing units (steam, glycol, cooling water, inert gas, power, ...) are assumed to be available at the plant site. They are purchased from the public or private company running the industrial development area.

1.5 - SAFETY PRACTICES *

Safety practices are designed for both the protection of the workers and the containment of toxic chemicals. Coveralls, boots, gloves, respiratory devices are used to protect production workers. In addition, exhaust ventilation systems are used in all the production buildings. Medical facilities have to be provided.

As far as the containment practices are concerned, the production and bulk storage area are diked.

1.6 - SERVICES

In the total investment estimation, the services are included in the offsite battery limits capital cost. The Items included in the capital estimate are:

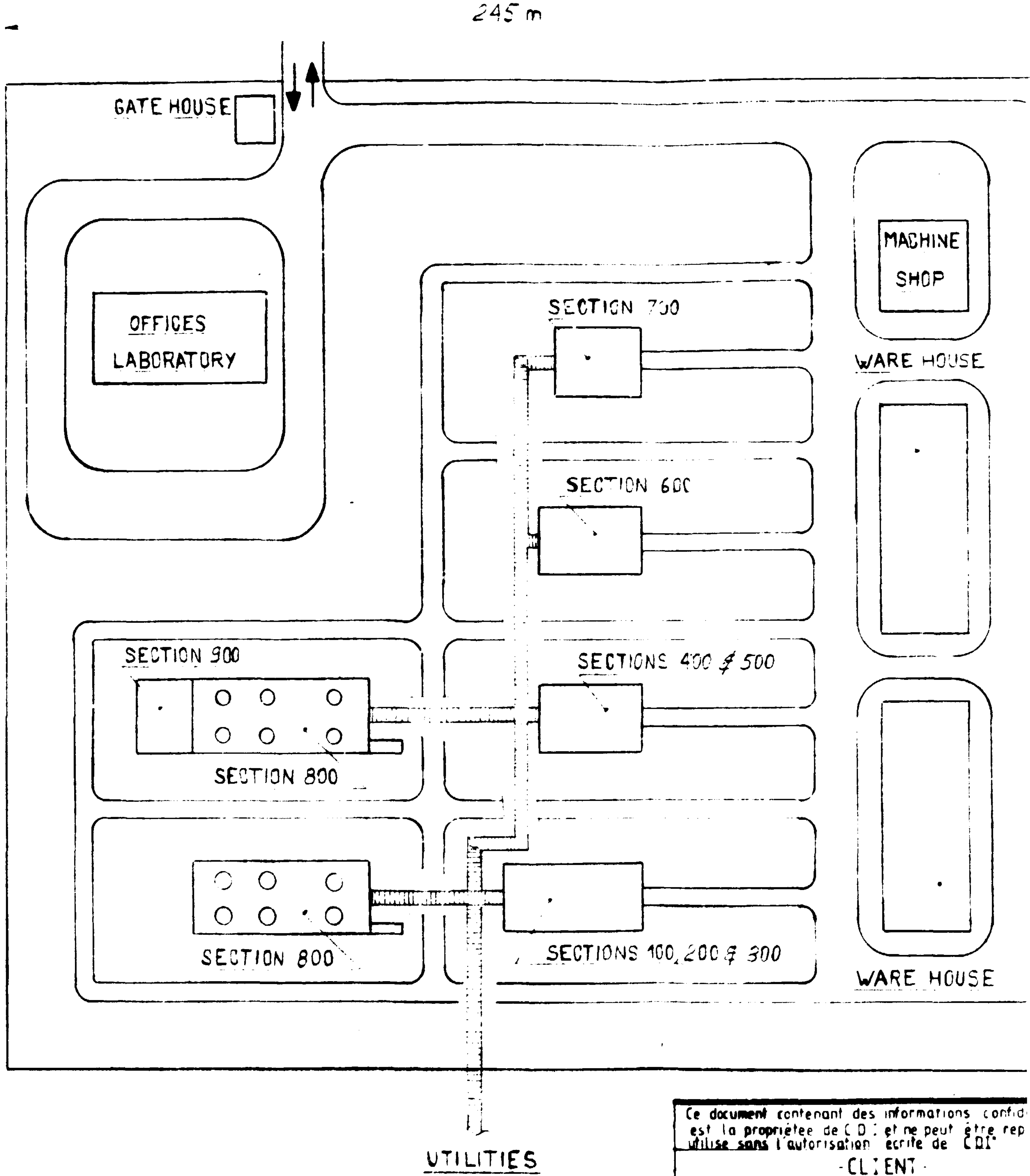
- offices, laboratories
- firefighting equipment
- medical facilities
- lunchrooms, change rooms, recreational facilities
- gatehouse, parking lots.

1.7 - PLOT PLAN

Figure 6002-I-001 is an overall plot plan of the production facilities.

The entire plant is located within a 245x215 meters rectangle i.e. requires an area of 5.3 hectares (or 13. acres)

* The safety aspects are more fully described in Annex 2.



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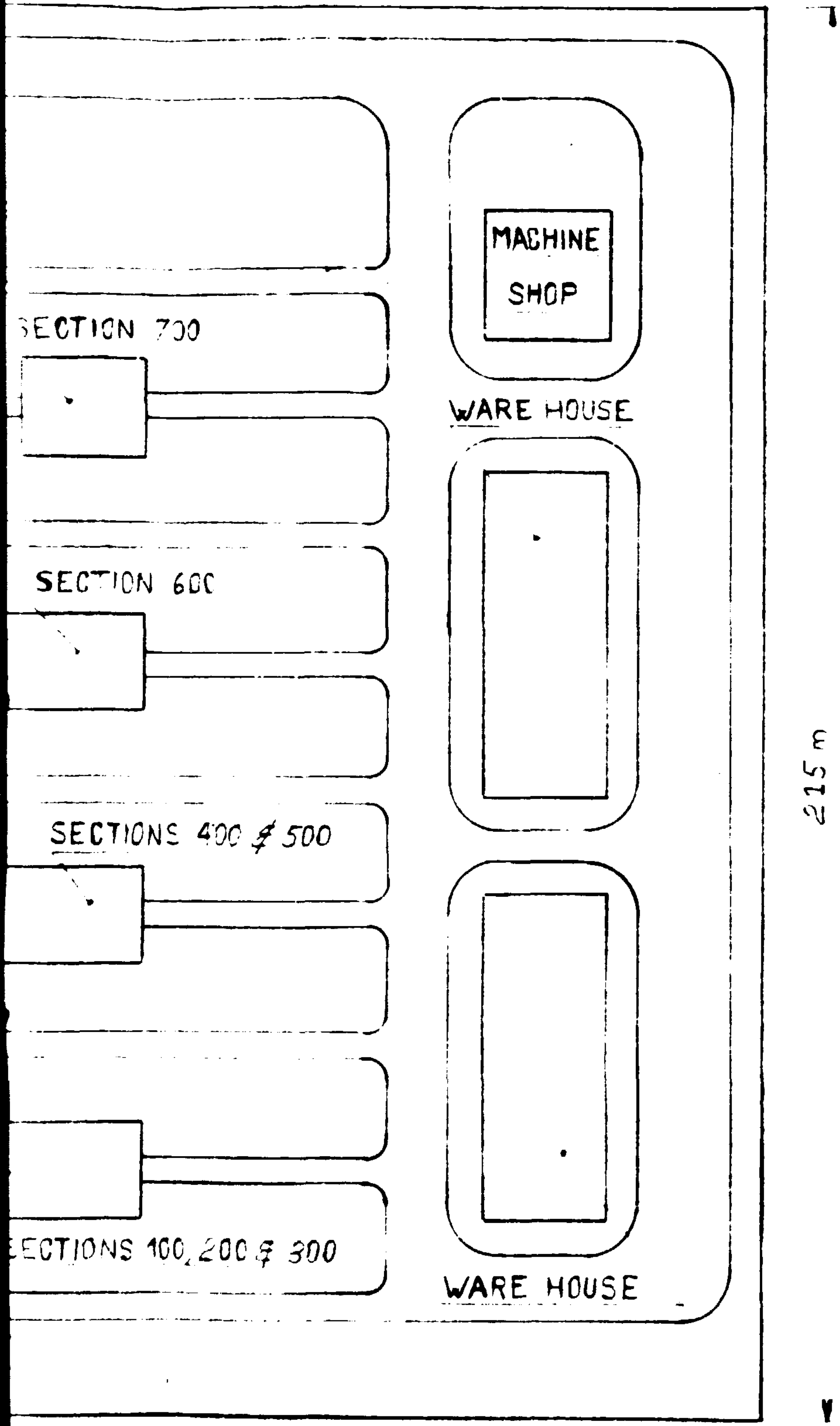
- UNITE -

PESTICIDES PRODUCTI[...]

PLANT



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SCALE : 1mm = 1 M

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- CLIENT - UNIDO	FIGURE 6002 - I - C01
- UNITE - PESTICIDES PRODUCTION PLANT	PLOT PLAN

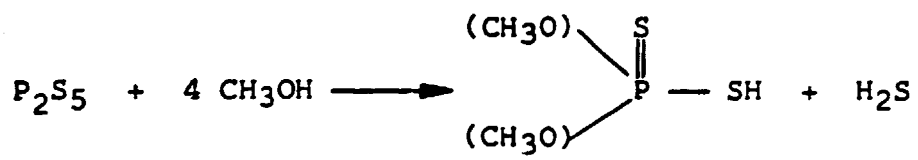
2- MANUFACTURING PROCESSES *

2.1 - O,O DIMETHYLDITHIOPHOSPHORIC ACID

2.11 Background and Chemistry

O,O Dimethyldithiophosphoric acid is the phosphorus compound used in the production of organophosphorous insecticides such as malathion and dimethoate.

The chemical reaction is fairly straightforward, i.e. phosphorus pentasulfide is reacted with methanol in a solvent like toluene. However, phosphorus pentasulfide must be added carefully, because of the highly exothermic nature of the reaction.



Hydrogen sulfide, formed as a by product, is sent to an incinerator where it is burned with much excess air and disharged as SO_2 in the atmosphere.

The biggest problem of O,O Dimethyldithiophosphoric acid production is safety** and in order to keep the reaction under control, good temperature measurements and effective interlock systems are required. Moreover, the reactors have to be installed inside reinforced concrete block cubicles.

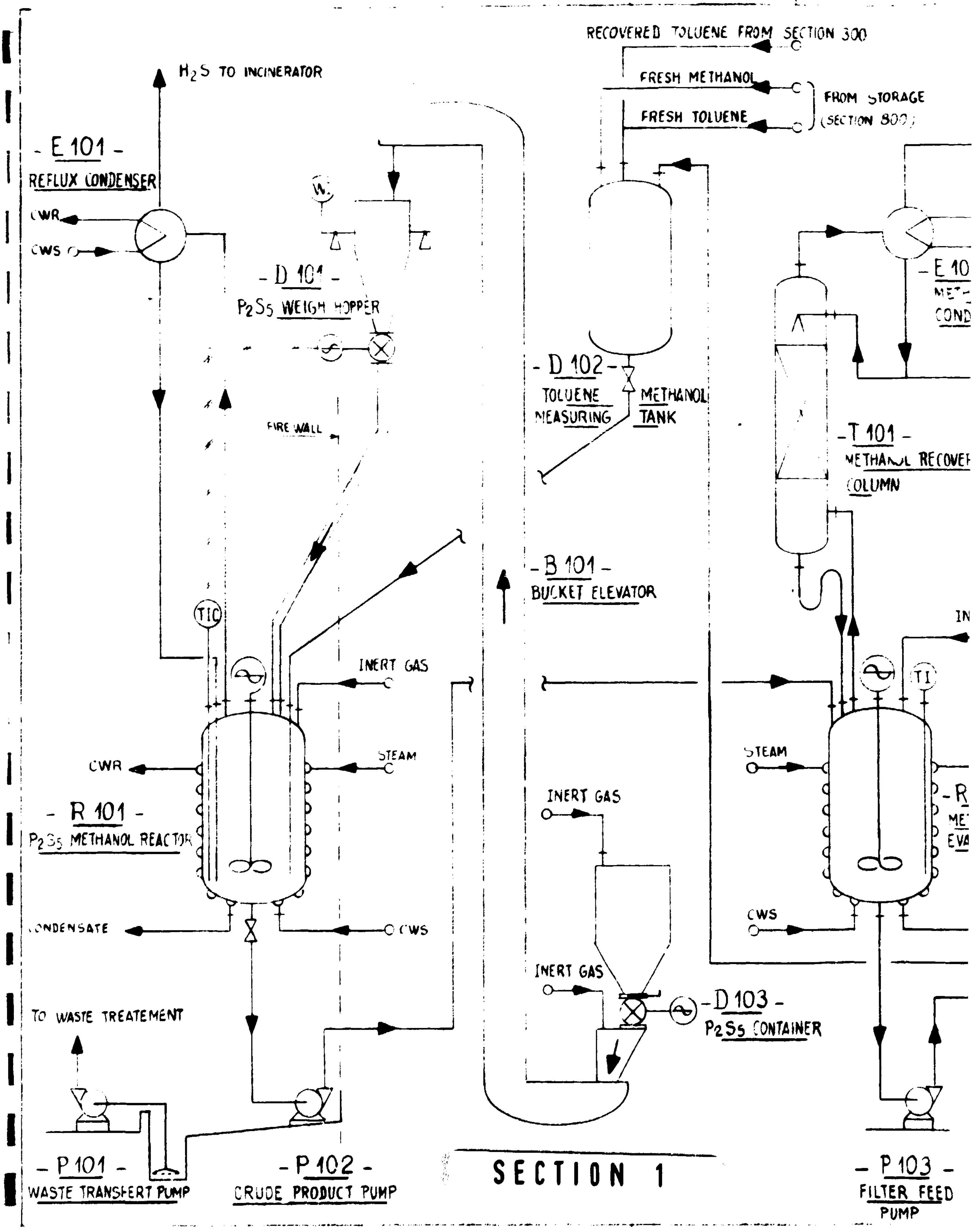
2.12 Process Design and Economics

Figure 6002-PX-100 is a flow sheet for the batch production of O,O Dimethyldithiophosphoric acid by the reaction of methanol with phosphorus pentasulfide. The design is based on three shifts per day, 7 days a week, 8000 hours per year schedule. According to the following production schedule, 4-6 hours- batches per day can be carried out.

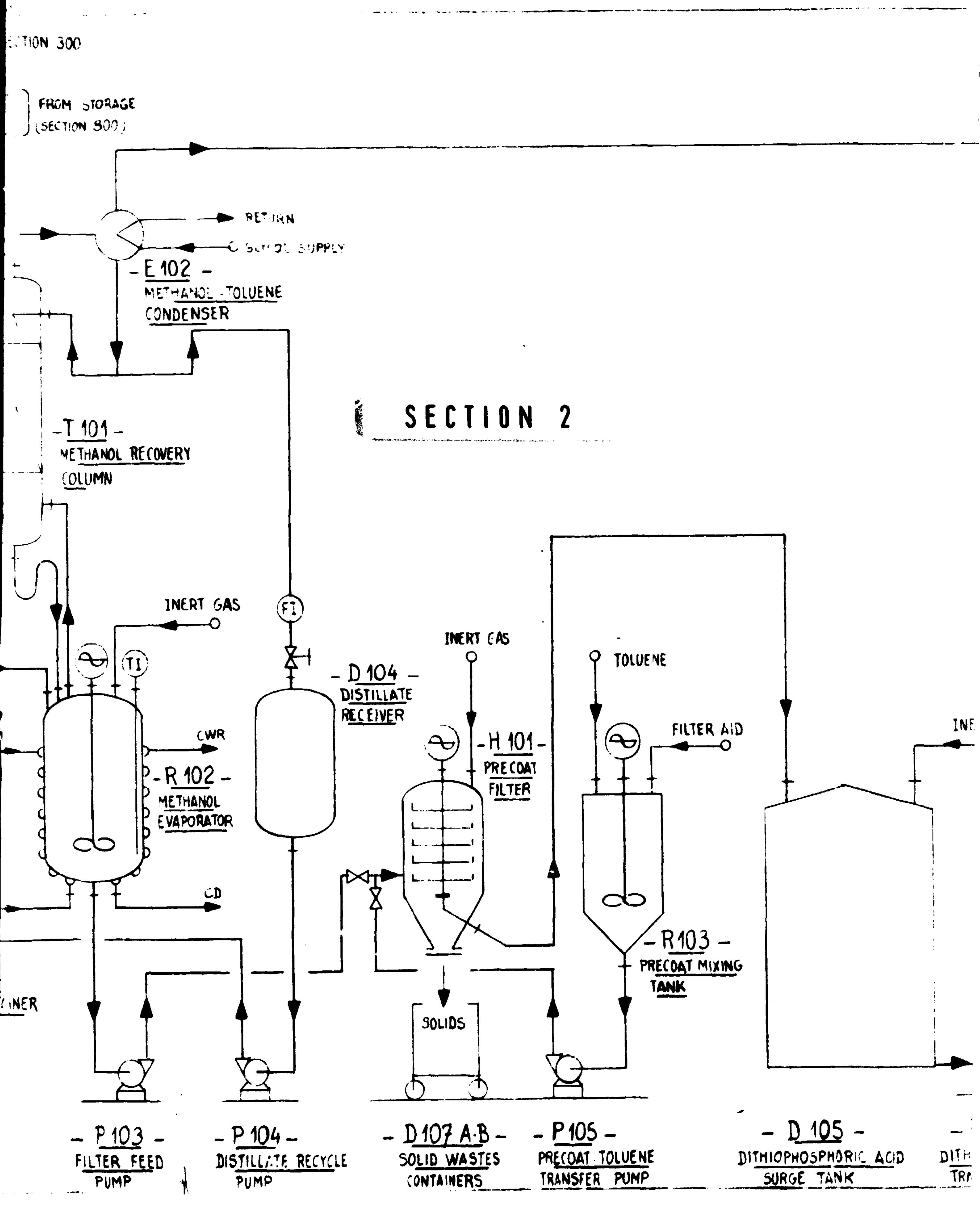
** The safety aspects are more fully described in Annex 2.

* See revised costs of production in Annex 1.

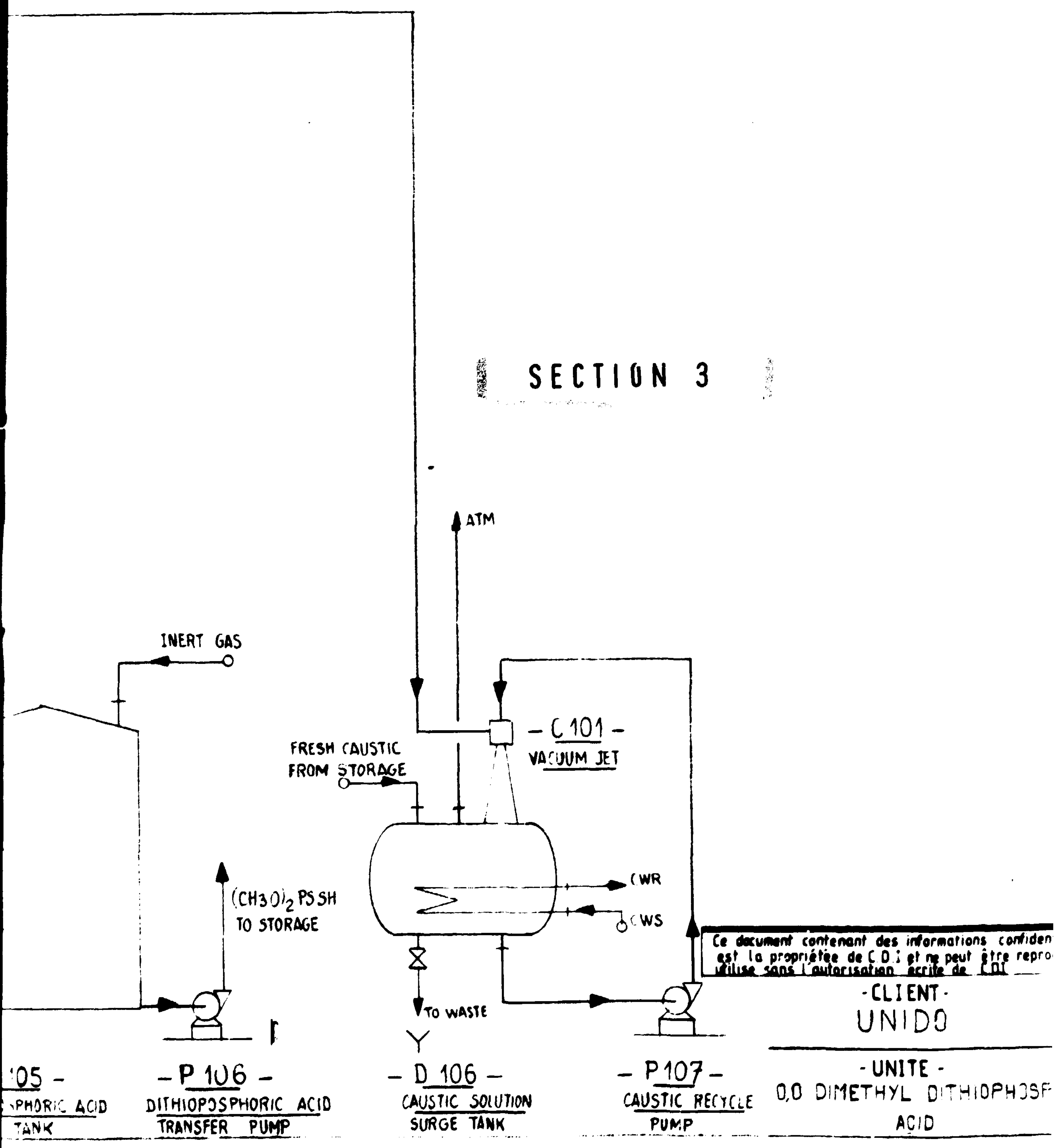
CHEM SYSTEMS INTERNATIONAL LTD.


RECOVERED TOLUENE FROM SECTION 300
H2S TO INCINERATOR
FRESH METHANOL
FRESH TOLUENE
FROM STORAGE
(SECTION 800)
- E 101 -
REFLUX CONDENSER
CWR
CWS
W
- D 101 -
P2S5 WEIGH HOPPER
- D 102 -
TOLUENE
MEASURING
METHANOL
TANK
FIRE WALL
- T 101 -
METHANOL RECOVER
COLUMN
- B 101 -
BUCKET ELEVATOR
TIC
INERT GAS
STEAM
CWR
- R 101 -
P2S5 METHANOL REACTOR
CONDENSATE
CWS
INERT GAS
INERT GAS
- D 103 -
P2S5 CONTAINER
TI
STEAM
CWS
TO WASTE TREATEMENT
- P 101 -
WASTE TRANSFERT PUMP
- P 102 -
CRUDE PRODUCT PUMP
- P 103 -
FILTER FEED
PUMP

SECTION 1


FROM STORAGE
(SECTION 300)
SECTION 2
- E 102 -
METHANOL -TOLUENE
CONDENSER
-T 101 -
METHANOL RECOVERY
COLUMN
INERT GAS
FI
TI
CWR
- R 102 -
METHANOL
EVAPORATOR
CD
- D 104 -
DISTILLATE
RECEIVER
INERT GAS
- H 101 -
PRECOAT
FILTER
TOLUENE
FILTER AID
- R 103 -
PRECOAT MIXING
TANK
SOLIDS
- P 103 -
FILTER FEED
PUMP
- P 104 -
DISTILLATE RECYCLE
PUMP
- D 107 A-B -
SOLID WASTES
CONTAINERS
- P 105 -
PRECOAT TOLUENE
TRANSFER PUMP
- D 105 -
DITHIOPHOSPHORIC ACID
SURGE TANK

SECTION 3



ATM
INERT GAS
FRESH CAUSTIC FROM STORAGE
– C 101 –
VACUUM JET
CWR
CWS
$(CH_3O)_2PSSH$ TO STORAGE
TO WASTE
'05 -
PHORIC ACID
TANK
– P 106 –
DITHIOPOSPHORIC ACID
TRANSFER PUMP
– D 106 –
CAUSTIC SOLUTION
SURGE TANK
– P 107 –
CAUSTIC RECYCLE
PUMP
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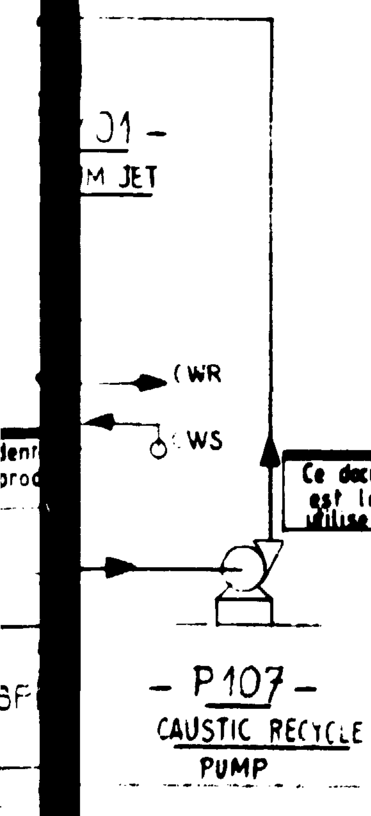
UNIDO
- UNITE -
0,0 DIMETHYL DITHIOPHOSF
ACID

SECTION 4



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-CLIENT- UNIDO	SECTION 100
-UNITE- 0,0 DIMETHYL D.THIOPHOSPHORIC ACID	FIGURE 6002 - PX - 100

TABLE 2.12.1

O,O DIMETHYLDITHIOPHOSPHORIC ACID PRODUCTION SCHEDULE

Operation	Time	Item n°
- Toluene is charged into reactor	1/2 hr	R101
- Methanol is charged into reactor and mixture is heated to 70-74°C	1/2 hr	R101
- Phosphorus pentasulfide is slowly added under temperature control	1 1/2 hrs	R101
- Reaction mixture is maintained at 82°C	2 to 3 hrs	R101
- Reaction mixture is transfered to methanol evaporator	1/2 hr	R101/R102
- Excess methanol and toluene are distilled under slight vacuum (760-220 mmHg)	2 hrs	R102
- Mixture is cooled down to 50°C	1 hr	R102
- Mixture is filtered and transfered to storage	2 hrs	R102/H101

Phosphorus pentasulfide solids (crystal size $\leqslant$ 1 mm) are added to an agitated, jacketed glass lined reactor containing a boiling methanol toluere mixture (T= 70-74°C). Since the reaction is exothermic, the solids are carefully added under temperature control. Moreover, cooling water is circulated through the reactor jacket to keep the temperature at 82°C. The mixture is kept at this temperature for 2-3 additional hours. H_2S produced is passed through a graphite reflux condenser and is sent to an incinerator.

The reaction mixture is then pumped to the methanol evaporation system which is made of an agitated, jacketed glass lined reactor and a packed column.

Methanol-Toluene azeotrope is distilled under slight vacuum (minimum absolute pressure: 220 mmHg) so as to keep the product solution at 80-85°C.

Methanol is totally vaporized, whereas some toluene is left with the acid (acid concentration at the end of the distillation step: 60 to 65 weight percent).

The distillate is collected in a receiver for recycle to the next batch.

The acid solution is cooled to 50°C by circulating cooling water through the reactor jacket.

In order to eliminate the traces of solids which might still be in the toluene-acid mixture, the solution is pumped through a precoat filter and collected in a surge tank. This mixture is then analyzed prior to its transfer to storage.

The solids recovered in the filter are removed mechanically, decontaminated with NaOH and buried with lye in an approved landfill.

The inside battery limits capital costs for a 3100 metric tons per year O,O dimethyldithiophosphoric acid plant is estimated at 1.33 million dollars (US) based on construction at a Kuweit location (Shuaiba Area) in the third quarter 1979. The components of the capital cost are summarized in Table 2.12.2 . Specifications of the individual pieces of equipment are shown in appendix 3.1.

TABLE 2.12.2

INSIDE BATTERY LIMITS CAPITAL COST

O,O DIMETHYLDITHIOPHOSPHORIC ACID

3100 metric tons/ yr

KUWEIT LOCATION - Third quarter of 1979

	1000 US Dollars
- Purchased Equipment	381
- Equipment handling	26
- Concrete and Steel	30
- Piping	111
- Instrumentation	88
- Electrical	60
- Insulation, paint and Misc.	50
- Buildings	181
- Direct cost	927
- Engineering	93
- Field construction,overhead & profit	185
- Base plant cost	1205
- Contingencies (including Contractors fee of 3%).	121
Inside Battery Limits Capital Cost	1326

 See revised table in annexe 1

TABLE 2.12.3

O,O DIMETHYLDITHIOPHOSPHORIC ACID PRODUCTION UNIT- SECTION 100

CAPITAL SUMMARY

BASIS		CAPITAL INVESTMENT	$ Million
-Location	: KUWEIT	Inside battery limits	1.33
-Capacity	: Third quarter 1979 3100 metric tons per yr	Outside battery limits	1.02
		Total fixed investment	2.35
		Working Capital*	1.35
-ON-Stream Time:	8,000 hours per yr		

PRODUCTION COST SUMMARY

RAW MATERIALS	Units per kg	Price ¢/unit	Annuel cost,$M	Cents per kg
Phosphorus Pentasulfide,kg	0.7960	108.24	2,671,000	
Methanol, kg	0.4911	21.00	320,000	
Solvents and chemicals			68,000	
Total raw materials			3,059,000	98.68
UTILITES				
Steam,150psig,metricton	0.00025	700.0	5,430	
Cooling water, m3	0.0252	1.0	800	
Glycol (-20°C),10^6kcal	0.00008	7100.0	17,610	
Power, KwH	0.02/2	1.0	750	
Total utilities			24,590	0.79
OPERATING COSTS				
Labor, 10 men @$16,000/yr	2 men per shift		160,000	
Supervision,5men @$22,000/yr	1 man per shift		110,000	
Maint.,material &Labor	6% of ISBL		80,000	
Total operating cost			350,000	11.29
OVERHEAD EXPENSES				
Direct Overhead	40 %(labor&sup.)		108,000	
General plant overhead	65 % Operating costs		227,000	
Insurance, property taxes	1.5% total invest.		35,300	
Depreciation	10 % total invest.		235,000	
Total overhead expenses			605,300	19.53
TOTAL COST OF PRODUCTION			4,038,890	130.29
BY-PRODUCT CREDIT				
Total by-product credit				
NET COST OF PRODUCTION			4,038,890	130.29
Return on Investment	30% Total investment		705,000	
Interest on Working Capital	10% working capit.		135,000	
Sales Expenses	-		-	
TRANSFER PRICE			4,878,890	157.38

(*equivalent to four months production costs)

PAGE	AFFAIRE	NUMERO	REV
	6002	100	

The cost of production of O,O dimethyldithiophosphoric acid from this facility is estimated at 130.29 ¢ /kg. Component costs are shown in Table 2.12.3 . The transfer price, including a 30 percent pretax return on investment and a 10% interest on working capital, is 157.38 ¢ /kg. This is based on a phosphorus pentasulfide cost of 108.24 ¢ /kg.

The structure of the cost of production is presented in table 2.12.4

TABLE 2.12.4

O,O DIMETHYLDITHIOPHOSPHORIC ACID

COST OF PRODUCTION BREAKDOWN

• Raw materials	75.7%
• Utilities	0.6%
• Operating costs	8.7%
• Overhead expenses	15.0%
Total cost of production	100.0 %

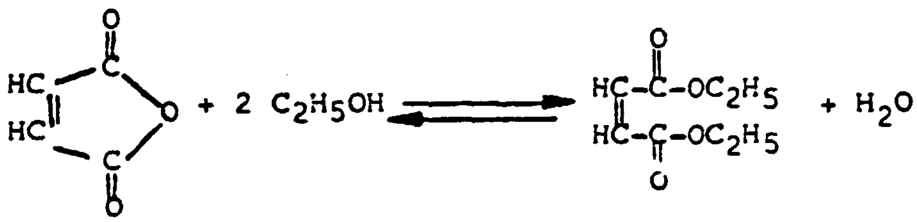
The cost of production and the transfer price are not very sensitive to capital cost, since a 20% increase of the capital cost would only increase the cost of production of 2.61 ¢ /kg (i.e. 2%) and the transfer price of 7.23 ¢ /kg (i.e. 4.6%). The cost of phosphorus pentasulfide accounts for 66% of the cost of production and for 55% of the transfer price.

It is, therefore, of paramount importance to find a reliable and low cost source of phosphorus pentasulfide.

2.2 - ETHYL MALEATE

2.21 Background and Chemistry

Ethyl maleate is an intermediate used in the production of malathion. The manufacturing process consists of reacting ethyl alcohol with maleic anhydride in a suitable solvent such as ethylene dichloride.



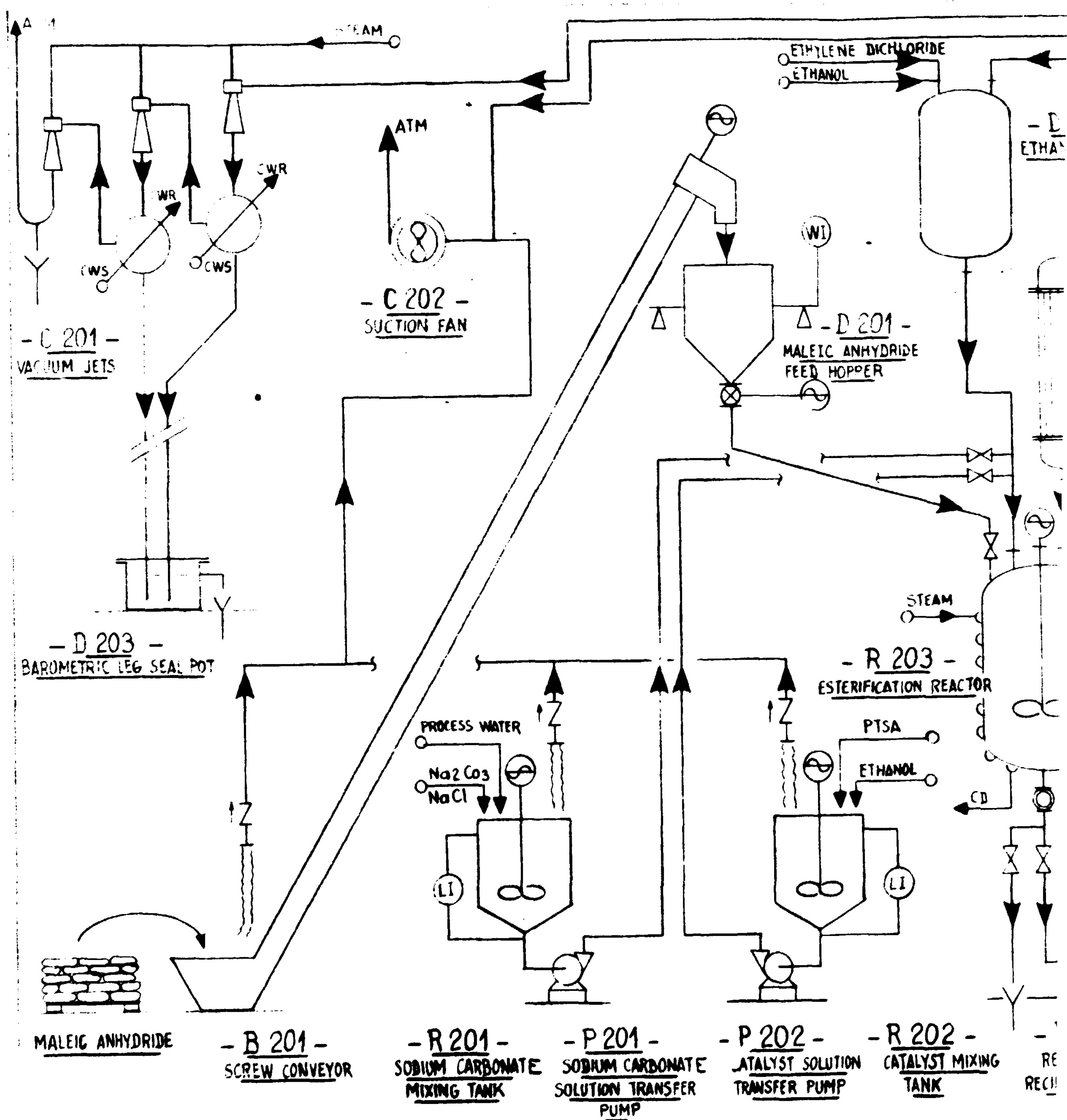
This reaction is a very standard esterification catalyzed by acids like sulfuric acid or p.toluene sulfonic acid (PTSA). In order to minimize corrosion and to reduce product degradation, PTSA is usaually selected.

The above mentioned reaction is an equilibrium and water has to be removed so as to get high conversion yields. This is achieved by solvents like ethylene dichloride or chloroform, which form ternary azeotrope with water and ethanol.

2.22 Process design and Economics

Figure 6002-PX-200 is a flow sheet for the batch production of ethyl maleate by the reaction of ethyl alcohol with maleic anhydride. The design is based on three shifts per day, 7 days a week, 8000 hours per year schedule.

According to the following production schedule, 1 batch per day can be carried out.



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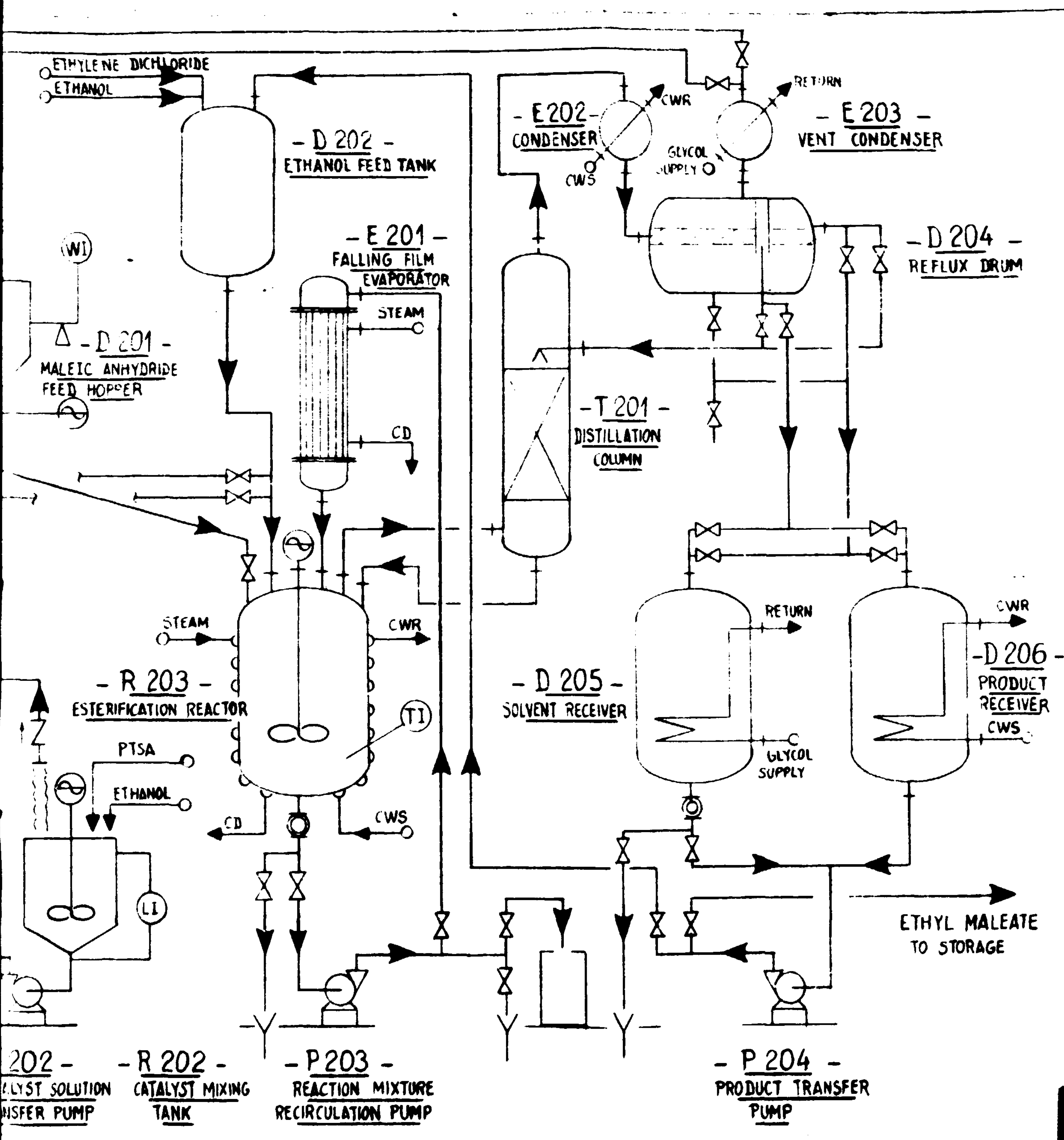

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-CLIENT- UNIDO	SECTION 200
-UNITE- ETHYL MALEATE	FIGURE 6002-PX-200

SECTION 2

TABLE 2.22.1

ETHYL MALEATE PRODUCTION SCHEDULE

Operation	Time	Item n°
- Ethanol and ethylene dichloride (fresh and recovered) are charged into reactor	1.0 hr	R 203
- Maleic anhydride flakes are charged into reactor and steam is opened into jacket	3/4 hr	R 203
- Catalyst is charged into reactor	1/4 hr	R 203
- Mixture is kept boiling by falling film evaporator and water is continuously removed from reaction mixture. System pressure is slowly decreased in order to keep the bubble point of the reaction mixture below 130°C	5.0 hrs	R 203
- Excess ethanol and ethylene dichloride are distilled under vacuum	3.0 hrs	R 203/D205
- Crude product is cooled down to 50°C	2.0	R 203
- Sodium carbonate salt solution is pumped into reactor and the two immiscible phases are thoroughly mixed	1/2 hr	R 203
- Agitator is stopped, heavy aqueous phase is decanted and drained	1.0 hr	R 203
- Salt solution is pumped into reactor and the two immiscible phases are thoroughly mixed	1/2 hr	R 203
- Agitator is stopped, heavy aqueous phase is decanted and drained	1.0	R 203
- Washed product is distilled under vacuum	8 1/2 hrs	R203/D206
- Final product is pumped to storage	1/2 hr	D 206

Ethanol and ethylene dichloride recovered from the previous batch are added to an agitated, jacketed reactor. Fresh ethanol and ethylene dichloride are then charged into the reactor to make up for the solvents lost and/or consumed during the preceding batch. The agitator is started and steam is opened into the reactor jacket. Maleic anhydride flakes are charged into the reactor and the recirculation pump is started as soon as anhydride is completely dissolved. Steam is opened into the shell side of the falling film evaporator and finally the catalyst (PTSA) is added to the mixture. The initial boiling point of the reaction mixture under atmospheric pressure is around 70°C however, as the reaction proceeds, ethanol is consumed, and the boiling point rises. System pressure is therefore slowly reduced to keep the solution boiling at a maximum temperature of 130°C. The ethanol/ethylene dichloride/water vapors are condensed overhead and the heterogeneous distillate is allowed to decant in the reflux drum. The water-rich light phase is discarded and the ethylene dichloride-rich heavy phase is refluxed.

The time required to reach very high yields (98-99%) is around 5 hours.

Excess ethanol and ethylene dichloride are distilled under vacuum and the circulatingq pump is stopped. The reactor jacket is purged and crude ethyl maleate is cooled down to 50°C by circulating cooling water through the jacket. In order to remove the catalyst, a sodium carbonate solution is pumped into the agitated mixture. The agitator is stopped and the heavy aqueous phase is drained to waste. The neutralized organic mixture is then washed by a sodium chloride solution which is also discarded. The organic phase is heated up and distilled under vacuum. Distilled ethyl maleate is finally pumped to storage. Overall ethyl maleate yield (based on maleic anhydride) is around 90%.

The inside battery limits capital costs for a 1100 metric tons per year ethyl maleate plant is estimated at 1.24 million dollars (US) based on construction at a Kuweit location (Shuaiba Area) in the third quarter 1979. The components of the capital cost are summarized in Table 2.22.2. Specifications of the individual pieces of equipment are shown in appendix 3.2.

The cost of production of ethyl maleate from this facility is estimated at 189.06 ¢ /kg. Component costs are shown in table 2.22.3. The transfer price, including a 30 percent return on investment, before income taxes, is 238.97 ¢ /kg. This figure is based on a maleic anhydride cost of 118 ¢ /kg.

The structure of the cost of production is presented in table 2.22.4.

The cost of production and the transfer price are not very sensitive to capital cost, since a 20% increase of the total fixed investment would only increase the cost of production of 5.58 ¢ /kg (i.e. 2.9%)and the transfer price of 14.49 ¢ /kg (i.e. 6.1 %).

The cost of ethanol accounts for 27.2% of the cost of production and for 21.6% of the transfer price. Similarly, maleic anhydride cost accounts for 39.4% of the cost of production and for 31.2% of the transfer price.

TABLE 2.22.2

INSIDE BATTERY LIMITS CAPITAL COSTS

ETHYL MALEATE

1100 metric tons/yr

KUWEIT LOCATION - Third quarter of 1979

	1000 US dollars
- Purchased equipment	399
- Equipment handling	24
- Concrete and steel	34
- Piping	112
- Instrumentation	50
- Electrical	40
- Insulation, paint and misc.	32
- Building	176
- Direct cost	867
- Engineering	87
- Field construction, overhead & Profit	173
- Base plant cost	1127
- Contingencies (including contractors fee of 3%)	113
Inside battery limits capital costs	1240

 See revised table in annexe 1

TABLE 2.22.3

ETHYL MALEATE PRODUCTION UNIT- SECTION 200

CAPITAL SUMMARY

BASIS		CAPITAL INVESTMENT	$ Million
-Location	: KUWEIT	Inside battery limits	1.24
-Capacity	: Third quarter 1979	Outside battery limits	0.36
	1100 metric tons per yr	Total fixed investment	1.60
		Working Capital*	0.69
-ON-Stream Time:	8,000 hours per yr		

PRODUCTION COST SUMMARY

RAW MATERIALS	Units per kg	Price ¢/unit	Annuel cost,$M	Cents per kg
Ethanol,kg	0.6905	74.6	566.700	
Maleic anhydride	0.6312	118.0	819,300	
Catalyst,solvents and chemicals			71,000	
Total raw materials			1,457,000	132,46
UTILITES				
Steam,150psig,metricton	0.0029	700.0	22,400	
Cooling water, m3	0.1340	1.0	1.500	
Power, KwH	0.0523	1.0	600	
Process water, m3	0.0013	19.0	300	
Total utilities			24,800	2,25
OPERATING COSTS				
Labor, 7,5 men @$16,000/yr	1,5 men per shift		120,000	
Supervision,1 man @$22,000/yr	1 man overall		22,000	
Maint.,material &Labor	6% of ISBL		74,400	
Total operating cost			216,400	19,67
OVERHEAD EXPENSES				
Direct Overhead	40 %(labor&sup.)		56,800	
General plant overhead	65 % Operating costs		140,700	
Insurance, property taxes	1.5% total invest.		24,000	
Depreciation	10 % total invest.		160,000	
Total overhead expenses			381,500	34,68
TOTAL COST OF PRODUCTION			2,079,700	189,06
BY-PRODUCT CREDIT				
Total by-product credit			2,079,700	189,06
NET COST OF PRODUCTION				
Return on Investment	30% Total investment		480,000	
Interest on Working Capital	10% working capit.		69,000	
Sales Expenses	-		-	
TRANSFER PRICE			2,628,700	238,97

(*equivalent to four months production costs)

TABLE 2.22.4

ETHYL MALEATE

Cost of production breakdown

• Raw materials	70.1 %
• Utilities	1.2 %
• Operating costs	10.4 %
• Overhead expenses	18.3 %
Total cost of production	100.0 %

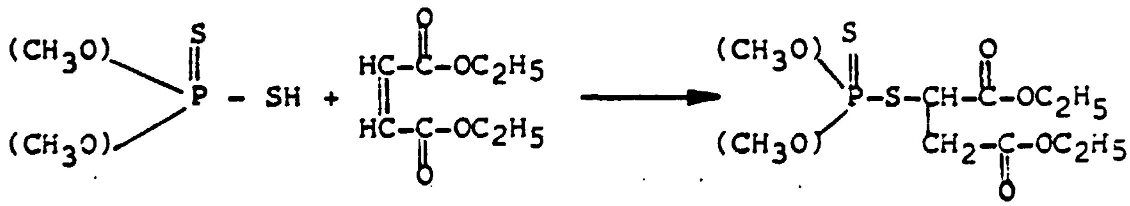
The costs of ethanol and maleic anhydride are the most significant factors of the cost of production. The price of maleic anhydride is closely related to unsaturated polyester demand and varies widely and rapidly. It is therefore very important to find reliable maleic anhydride suppliers.

2.3 - MALATHION

2.31 Background and Chemistry

Malathion or 0,0 Dimethylphosphorodithioate of diethyl mercapto succinate is a nonsystemic insecticide and acaricide having a fairly low mammalion toxicity. This very safe insecticide is a liquid of low volatily, which can cause skin irritation when its diethyl fumarate content is around 1 to 4 percent by weight. Malathion was developed by American Cyanamid which is one of the major producers.

Malathion is produced by reacting 0,0 dimethyldithiophosphoric acid with diethyl maleate:



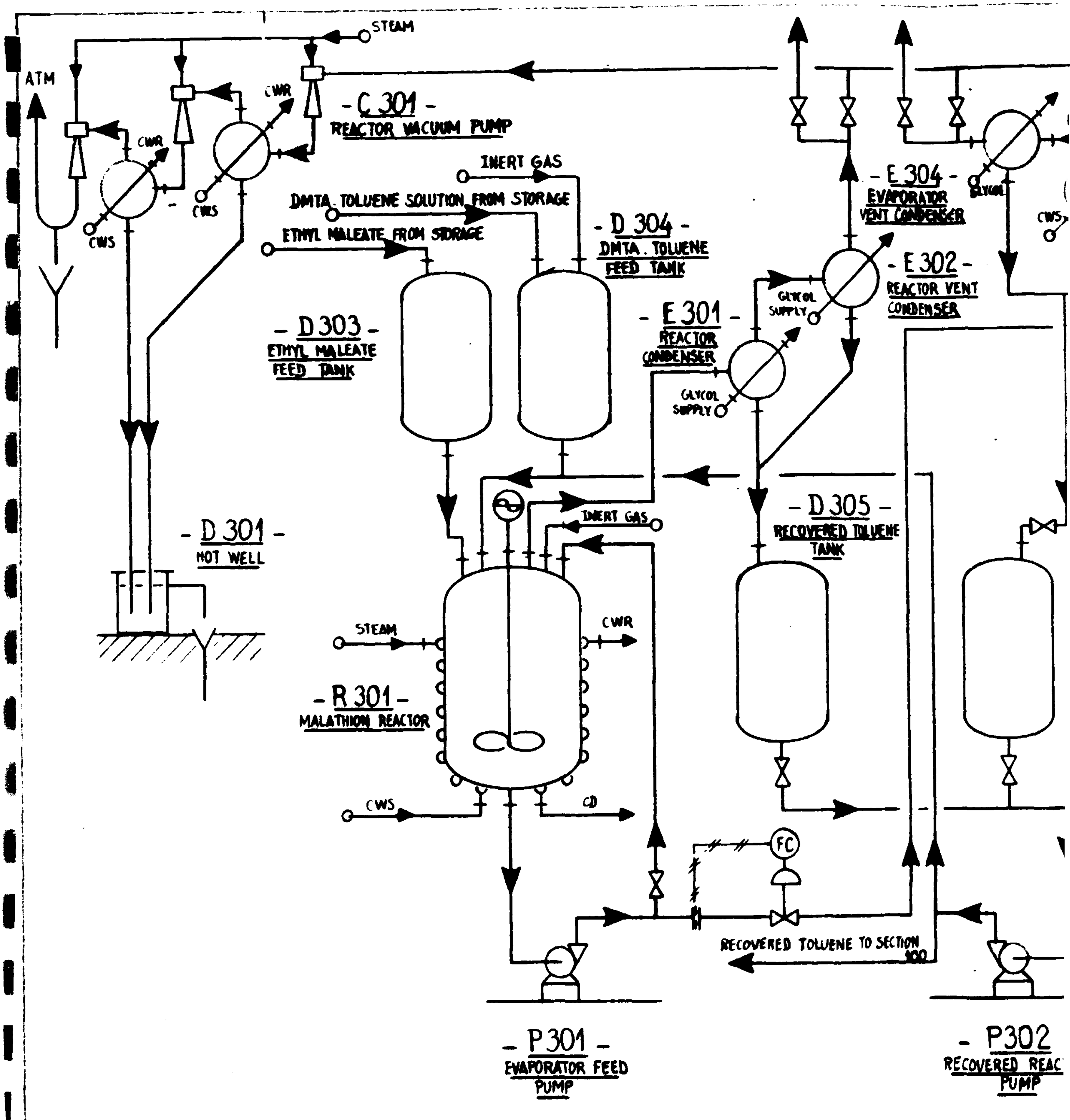
0,Odimethyldithio-phosphoric acid — Diethyl maletate — Malathion

In order to get a very low diethyl fumarate content, American Cyanamid improved the production process (see US Patent n° 3,463,841 - Aug 26,1969) by stripping off the conconverted reactants in a wiped film evaporator. This process is indeed very efficient since the conversion yield is around 94% (based on diethyl maleate).

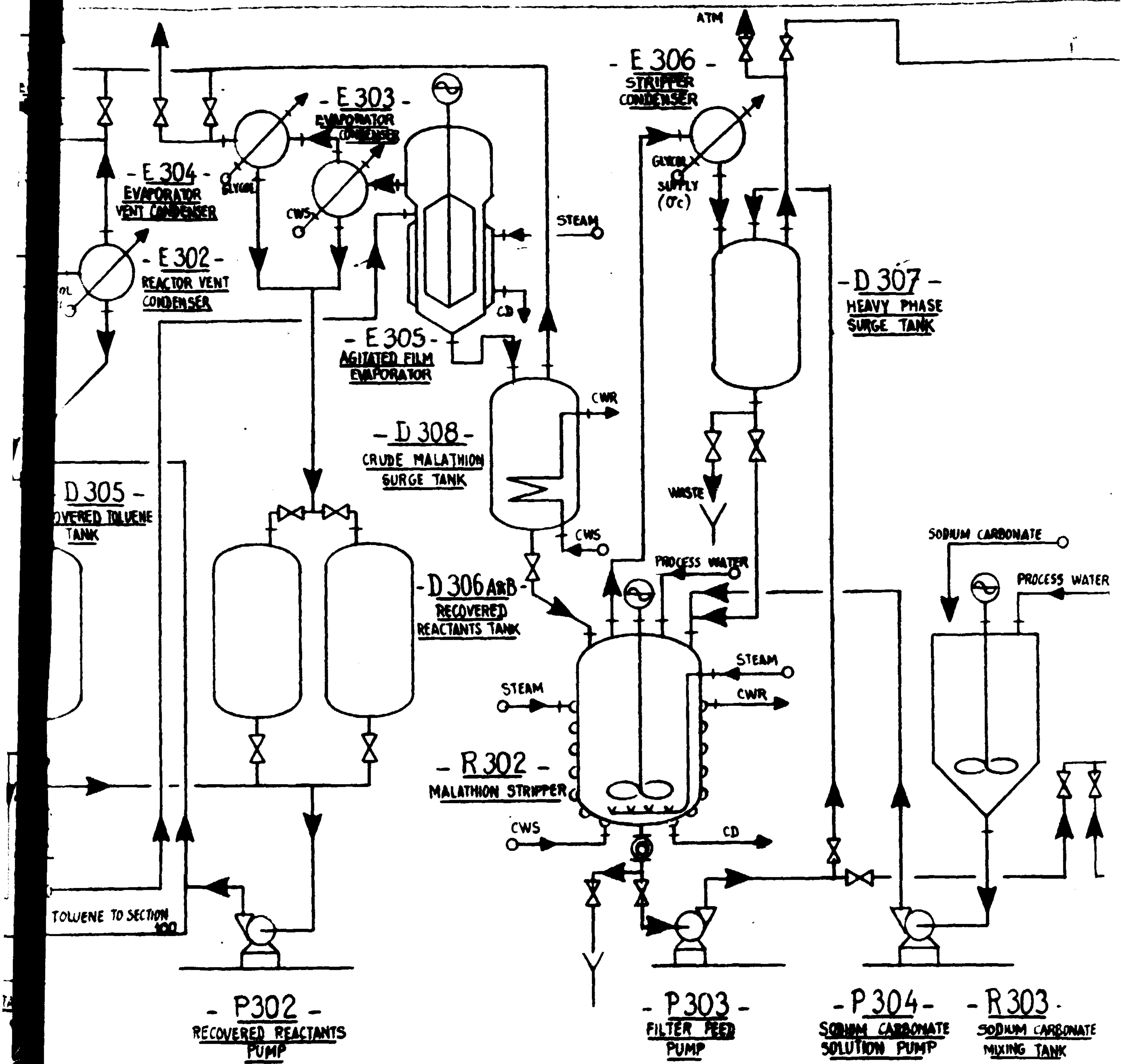
2.32 Process design and Economics

Figure 6002-PX-300 is a flowsheet for the batch production of malathion by the reaction of diethyl maleate with 0,0 dimethyl-dithiophosphoric acid in toluene. The design is based on three shifts per day, 7 days per week, 8000 hours per year schedule. The process in itself is based on the patent mentioned previou-sly.

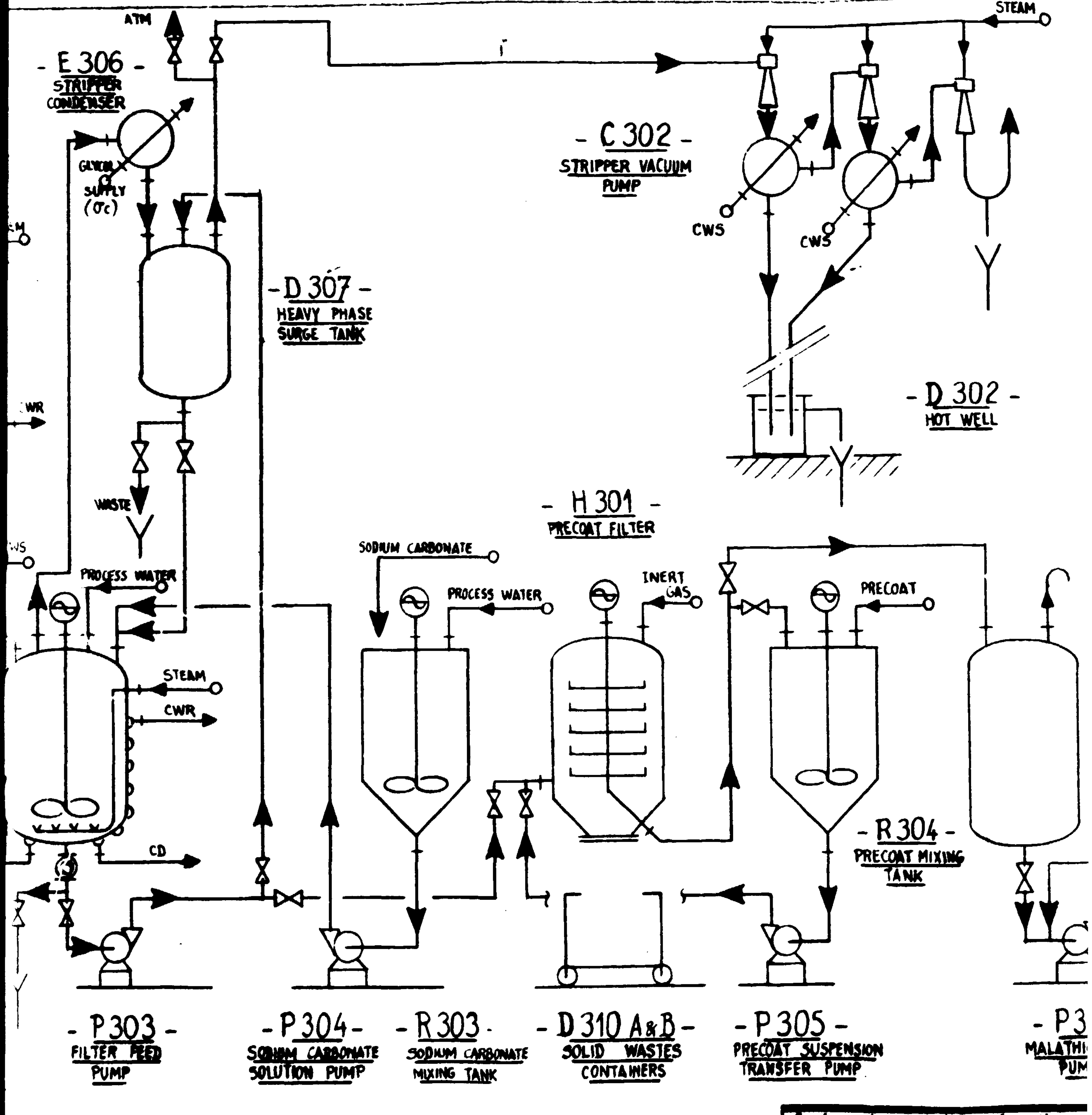
According to the following production schedule, 2x12 hours batches per day can be carried out.


STEAM
ATM
CWR
CWS
- C 301 -
REACTOR VACUUM PUMP
INERT GAS
DMTA. TOLUENE SOLUTION FROM STORAGE
ETHYL MALEATE FROM STORAGE
- D 304 -
DMTA. TOLUENE FEED TANK
- D 303 -
ETHYL MALEATE FEED TANK
- E 304 -
EVAPORATOR VENT CONDENSER
GLYCOL
- E 302 -
REACTOR VENT CONDENSER
GLYCOL SUPPLY
- E 301 -
REACTOR CONDENSER
- D 301 -
HOT WELL
- D 305 -
RECOVERED TOLUENE TANK
- R 301 -
MALATHION REACTOR
CD
FC
RECOVERED TOLUENE TO SECTION 100
- P 301 -
EVAPORATOR FEED PUMP
- P302
RECOVERED REAC
PUMP

SECTION 1


ATM
- E 306 -
STRIPPER CONDENSER
GLYCOL SUPPLY (0°C)
- E 303 -
EVAPORATOR CONDENSER
- E 304 -
EVAPORATOR VENT CONDENSER
GLYCOL
CWS
- E 302 -
REACTOR VENT CONDENSER
STEAM
CD
- E 305 -
AGITATED FILM EVAPORATOR
- D 307 -
HEAVY PHASE SURGE TANK
CWR
- D 308 -
CRUDE MALATHION SURGE TANK
CWS
WASTE
D 305 -
VERED TOLUENE TANK
- D 306 A&B -
RECOVERED REACTANTS TANK
PROCESS WATER
SODIUM CARBONATE
PROCESS WATER
STEAM
STEAM
CWR
- R 302 -
MALATHION STRIPPER
CWS
CD
TOLUENE TO SECTION 100
- P302 -
RECOVERED REACTANTS PUMP
- P303 -
FILTER FEED PUMP
- P304 -
SODIUM CARBONATE SOLUTION PUMP
- R 303 -
SODIUM CARBONATE MIXING TANK

SECTION 2



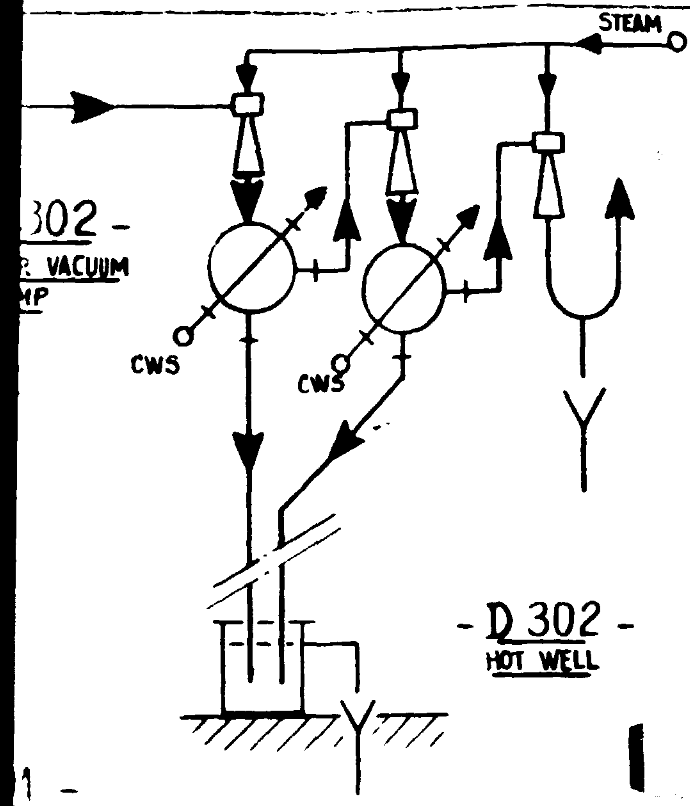
SECTION 3

-CLIENT-

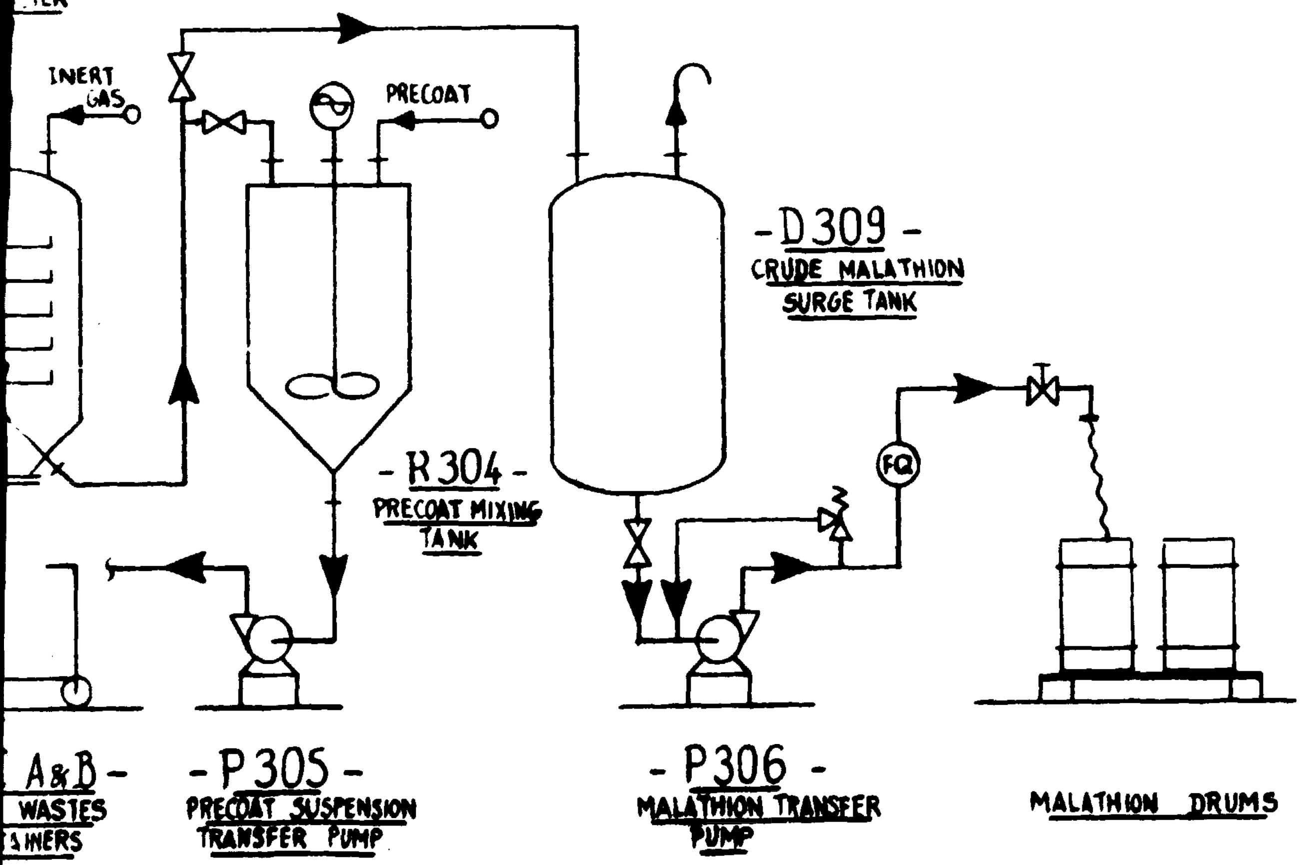
UNIDO

-UNITE-

MALATHION



SECTION 4



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- CLIENT - UNIDO	SECTION 300
- UNITE - MALATHION	FIGURE 6002 - PX - 300

TABLE 2.32.1

MALATHION PRODUCTION SCHEDULE

Operation	Time	Item n°
- Diethyl maleate is charged into reactor	0,5 hr	R 301
- Recovered reactants from previous batch are charged into reactor	0,5 hr	R 301
- Dithiophosphoric acid solution is charged into reactor	0,5 hr	R 301
- Reaction mixture is heated to 90-91°C	1,5 hr	R 301
- Temperature is maintained for three hours and pressure is reduced to 20 mmHg	3,0 hrs	R 301
- Mixture is cooled to about 71°C	1,0 hr	R 301
- Unconverted reactants are vaporized in agitated film evaporator-crude product is recovered in vacuum surge tank	4,0 to 5,0 hrs	R301/D308
- Crude product is cooled in surge tank	1,0 hr	D 308
- Crude product and sodium carbonate solution are charged into second reactor	0,5 hr	R 302
- Agitation is stopped and heavy organic phase is allowed to decant	1,0 hr	R 302
- Organic phase is transfered to surge tank and aqueous phase is sent to waste	0,75 hr	R302/D307
- Crude product and wash water are charged into reactor	0,5 hr	R 302
- Agitation is stopped and heavy organic phase is allowed to decant	1,0 hr	R 302
- Organic phase is transfered to surge tank and aqueous phase is sent to waste	0,75 hr	R302/D307
- Organic phase is transfered into reactor	0,5 hr	D307/R302
- Malathion is steam stripped at 50°C under vacuum (25 mmHg) malathion is cooled after steam stripping	4,0 hrs	R 302
- Malathion is pumped through a precoat filter and recovered is a surge tank	2,0 hrs	H301/D309

Recovered reactants from the previous batch and O,O dimethyldithiophosphoric acid solution (62% in toluene) are added to an agitated, jacketed reactor containing diethyl maleate (molas ratio: 1.02 to 1.1 moles dithiophosphoric acid per mole of diethylmaleate).

As soon as the reactants are well mixed, temperature is raised to 90-91°C. The condensation reaction is carried out at that temperature and it takes approximately 3 hours to convert 75%-90% of the reactants. During the reaction the absolute pressure of the reactor is slowly reduced to 20 mmHg and most of the toluene is vaporized. At the end of this 3-hour period, the mixture is cooled to about 70-71°C and is pumped under flow control to an agitated falling film evaporator, where most unconverted reactants are vaporized (Temperature:150°C Pressure: 10-12 mmHg).

Crude product is collected in a vacuum surge tank fitted with a cooling coil. The recovered reactants are recycled to the next batch. The crude product is charged into an agitated vessel, with a sodium carbonate solution. The heterogeneous mixture is thoroughly mixed and the acidic impurities are washed out of the organic phase. The two phases are separated and the organics are subjected to a water wash.

The washed malathion is then steam-stripped at 25 mmHg and 50°C in the same agitated vessel.

When the stripping is complete, cooling water is circulated through the vessel jacket in order to cool the product.

The organics vaporized during the stripping operation are not recovered, but are sent to waste.

The dry purified malathion is pumped through a precoat filter and oollected in a surge tank. The product is analyzed and finally charged into drums. In general, the product contains less than 0,5% diethyl fumarate.

The inside battery limits capital costs for a 2000 metric tons per year malathion plant is estimated at 1.72 million dollard (US) based on construction at a Kuweit location (Shuaiba Area) in the third quarter 1979. The components of the capital cost are summarized in Table 2.32.2. Specifications of the individual pieces of equipment are shown in appendix 3.3.

The cost of production of technical malathion (purity: 97% by weight) from this facility is estimated at 260.53 ¢ /kg. Component costs are shown in Table 2.32.3. The transfer price, including a 30% return on investment (before income taxes) and a 10% interest on working capital, is 306.73 ¢ /kg.

This is based on diethyl maleate and dithiophosphoric transfer prices calculated in the preceding chapters.

TABLE 2.32.2

INSIDE BATTERY LIMITS CAPITAL COST

MALATHION

2000 metric tons/yr

KUWEIT LOCATION - Third quarter of 1979

	1000 US dollars
- Purchased equipment	478
- Equipment handling	32
- Concrete and steel	38
- Piping	206
- Instrumentation	100
- Electrical	74
- Insulation, paint and Misc.	46
- Buildings	225
- Direct cost	1199
- Engineering	120
- Field construction, overhead & Profit	240
- Base plant cost	1559
- Contingencies (including contractors fee of 3%)	161
Inside battery limits capital cost	1720

 See revised table in annexe 1

TABLE 2.32.3

MALATHION PRODUCTION UNIT-SECTION 300

CAPITAL SUMMARY

BASIS		CAPITAL INVESTMENT	$ Million
-Location	: KUWEIT	Inside battery limits	1.72
-Capacity	: Third quarter 1979 2000 metric tons per yr	Outside battery limits	0.78
		Total fixed investment	2.50
		Working Capital•	1.74
-ON-Stream Time:	8,000 hours per yr		

PRODUCTION COST SUMMARY

RAW MATERIALS	Units per kg	Price ¢/unit	Annual cost,$M	Cents per kg
Dimethyldithiophosphoric acid , kg	0,5004	157.38	1,575,100	
Ethyl maleate, kg	0,5380	238.97	2,571,400	
Solvents and Chemicals			20,000	
Total raw materials			4,166,500	208.32
UTILITES				
Steam,150psig,metricton	0,0012	700,0	16,800	
Cooling water, m3	0,0429	1,0	900	
Glycol(-20°C),10^6kcal	0,0001	7100,0	14,200	
Power, KwH	0,0346	1,0	700	
Process water, m3	0,0004	19,0	200	
Total utilities			32,800	1,64
OPERATING COSTS				
Labor, 10 men @$16,000/yr	2 men per shift		160,000	
Supervision,5 men @ $22,000/yr	1 man per shift		110,000	
Maint.,material &Labor	6% of ISBL		103,200	
Total operating cost			373,200	18,66
OVERHEAD EXPENSES				
Direct Overhead	40 %(labor&sup.)		108,000	
General plant overhead	65 % Operating costs		242,600	
Insurance, property taxes	1.5% total invest.		37,500	
Depreciation	10 % total invest.		250,000	
Total overhead expenses			638,100	31,91
TOTAL COST OF PRODUCTION			5,210,600	260,53
BY-PRODUCT CREDIT				
Total by-product credit				
NET COST OF PRODUCTION			5,210,600	260.53
Return on Investment	30% Total investment		750,000	
Interest on Working Capital	10% working capit.		174,000	
Sales Expenses	-		-	
TRANSFER PRICE	97% Technical product		6,134,600	306,73

(•equivalent to four months production costs)

The structure of the cost of production is presented in Table 2.32.4

TABLE 2.32.4

TECHNICAL MALATHION (97%)

COST OF PRODUCTION BREAKDOWN

- Raw materials	80.0 %
- Utilities	0.6 %
- Operating costs	7.2 %
- Overhead expenses	12.2 %
Total cost of production	100.0 %

The cost of production and the transfer price are not very sensitive to capital cost, since a 20% increase of the capital cost would only increase the cost of production of 4.58 ¢ /kg (i.e. 1.8%) and the transfer price of 12.23 ¢ /kg (i.e. 4.0%).

The cost of dimethyldithiophosphoric acid accounts for 30.2% of the cost of production and diethyl maleate accounts for 49.3 % of the cost of production.

The most significant factors of the cost of production are, once again, the raw materials.

2.4 - N-METHYLCHLOROACETAMIDE

2.41 Backcround and Chemistry

N-methylchloroacetamide is one intermediate used in the production of Dimethoate.

This compound is produced in a two-step process involving monochloroacetic acid, methanol and monomethylamine.

In the first step, monochloroacetic acid is esterified by methanol. This intermediate is then reacted with monomethylamine to form N-methylchloroacetamide. The reaction are shown below:

$$ClCH_2 - COOH + CH_3OH \longrightarrow ClCH_2\text{-}COOCH_3 + H_2O$$

monochloroacetic acid — methylchloroacetate

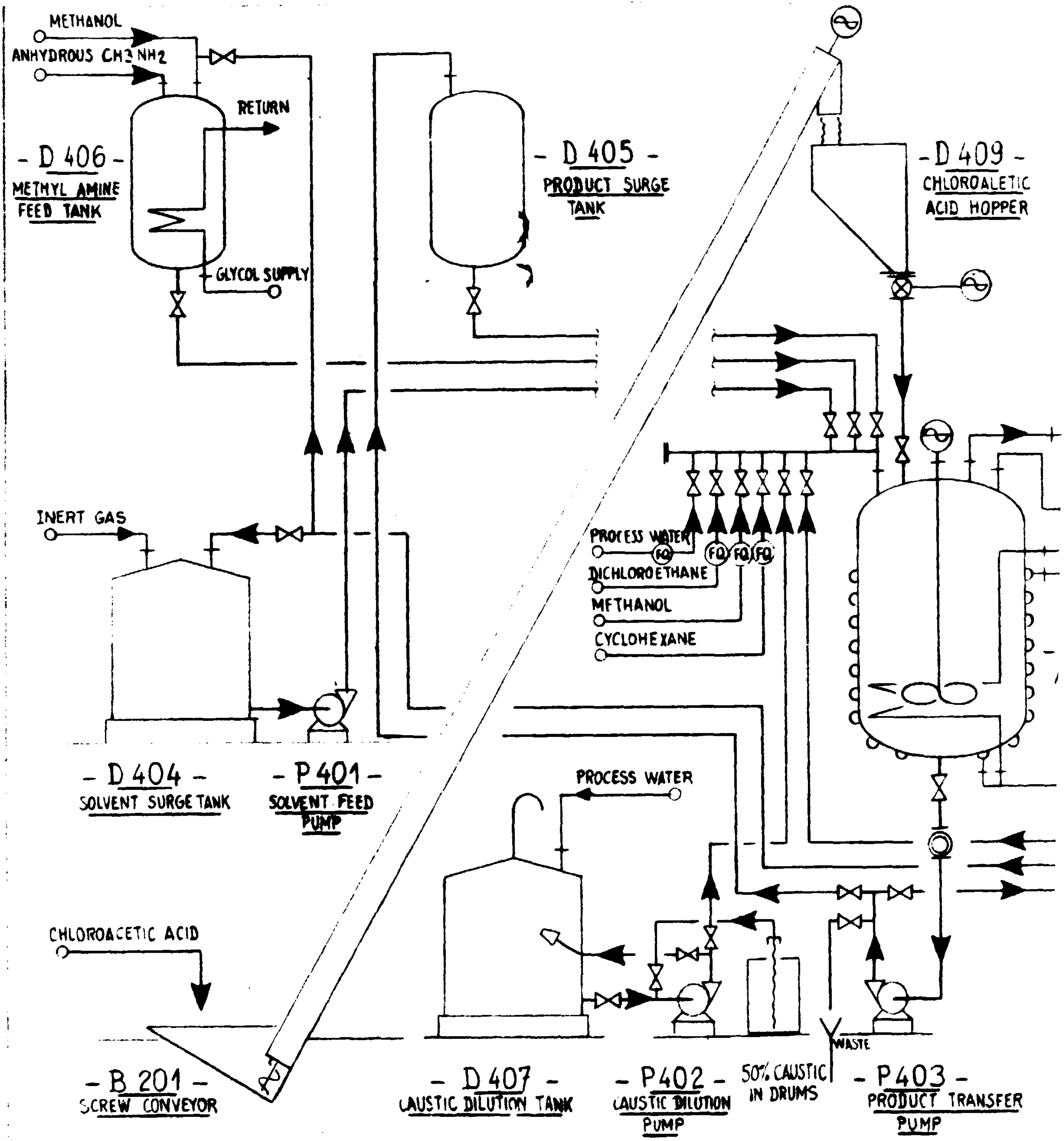
$$ClCH_2 - COOCH_3 + CH_3NH_2 \longrightarrow ClCH_2\text{-}\overset{\displaystyle O}{\overset{\|}{C}}\text{-}N\begin{matrix} \diagup H \\ \diagdown CH_3 \end{matrix} + CH_3OH$$

methylchloroacetate — monomethylamine — N-methylchloroacetamide

It should be noted that methanol is recycled and that the net consumption of methanol is only due to operational losses.

2.42 Process Design and Economics

Figure 6002-PX-400 is a flow sheet for the batch production of N-methylchloroacetamide. The design is based on three shifts per day, 7 days a week, 8000 hours per year schedule. According to the following production schedule, a complete batch can be carried out in 36 hours with only one reaction train.



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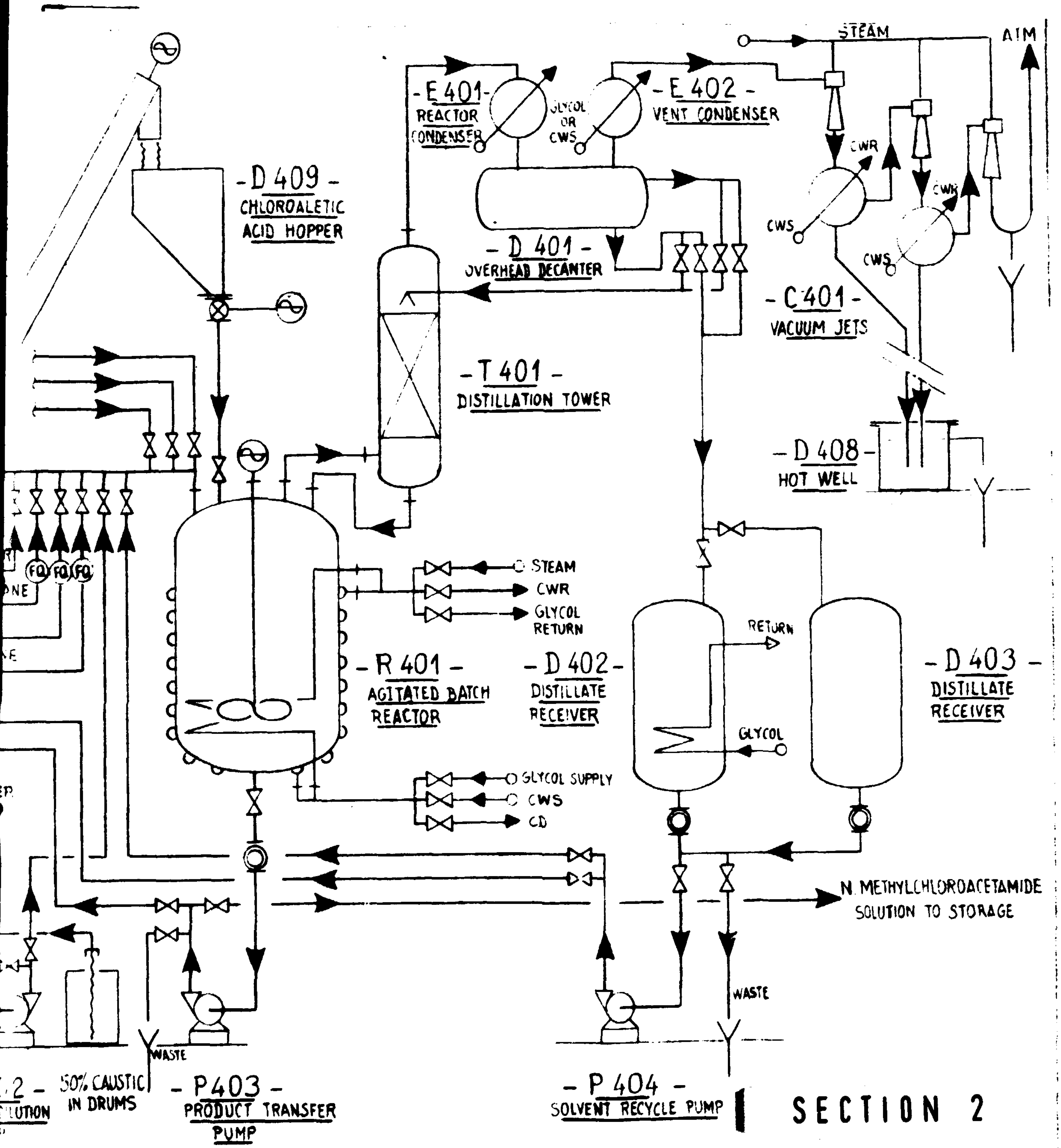
SECTION 1



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-CLIENT- UNIDO	SECTION 400
-UNITE- N-METHYL CHLOROACETAMIDE	FIGURE 6002-PX-400

TABLE 2.42.1

N-METHYLCHLOROACETAMIDE PRODUCTION SCHEDULE

Operation	Time	Item n°
- Cyclohexane and methanol are charged into reactor	0.5 hr	R 401
- Monochloroacetic flakes and PTSA are charged into reactor	1.0 hr	D409/R401
- Mixture is heated to its boiling point (50°C)	1.0 hr	R 401
- Mixture is kept boiling for 2 hours	2.0 hrs	R 401
- Methanolcyclohexane azeotrope is distilled off	3.0 hrs	R 401
- Water-cyclohexane azeotrope is distilled off	1.5 hrs	R 401
- Heavy phase of methanol-cyclohexane azeotrope distilled previously is charged into reactor	0.5 hr	R 401
- Mixture is heated and kept boiling	2.0 hrs	R 401
- Methanol-cyclohexane azeotrope is distilled off	2.5 hrs	R 401
- Water-cyclohexane azeotrope is distilled off	0.5 hr	R 401
- Crude ester is cooled to 60°C or below	2.0 hrs	R 401
- Dilute caustic solution is charged into reactor. The two phases are allowed to decant and the aqueous phase is discarded.	2.0 hrs	R 401
- Process water and organic phase are charged under agitation into reactor. The two phases are allowed to decant and the aqueous phase is discarded.	2.0 hrs	R 401
- Organic phase is charged into reactor	0.5 hr	R 401
- Excess cyclohexane is distilled off at 80°C	2.0 hrs	R 401
- Ester is cooled from 80°C to -10°C	4.0 hrs	R 401
- Methanol monoethylamine mixture is charged into reactor. Temperature is kept below 0°C	2.0 hrs	R 401
- Reaction mixture is kept at 0°C	0.5 hr	R 401
- Excess methanol is distilled off	3.0 hrs	R 401

TABLE 2.42.1 (cont'd)

N-METHYLCHLOROACETAMIDE PRODUCTION SCHEDULE

Operation	Time	Item n°
- Unreacted ester is distilled under vacuum	1.0 hr	R 401
- Product is cooled	1.0 hr	R 401
- Dichloroethane is charged into reactor- cooling is maintained	1.0 hr	R 401
- N-methylchloroacetamide solution is pumped to storage	0.5 hr	R 401

Fresh/recovered cyclohexane and methanol are charged into an agitated, jacketed stainless steel reactor. Monochloroacetic acid flakes and p-toluene sulfonic acid (PTSA-esterification catalyst) are added to the solvents. Steam is opened into the jacket and reaction mixture is heated to its boiling point. In order to reach high ester yields, water produced by the reaction has to be removed. Unfortunately, the methanol/methylchloroacetate/water azeotrope has a lower boiling point than the cyclohexane/water azeotrope. Therefore, it is necessary to distill the cyclohexane/methanol binary first and then the cyclohexane/water azeotrope. In practice, this procedure is carried out two times in a row and conversion yields (based on monochloroacetic acid) higher than 90% are achieved.

When the yield is high enough, the reaction mixture is cooled by circulating cooling water through the reactor jacket. The acid esterification catalyst (PTSA) is then removed by contact with a dilute caustic solution. The neutralized organic phase is water washed and excess cyclohexane is distilled off under slight vacuum to keep the temperature below 80°C.

The temperature of methyl chloroacetate is then reduced to minus 10°C by circulating a cold glycol solution through the reactor jacket. Monomethylamine in solution in methanol is slowly added with stirring over a period of about 2 hours. During the methylamine addition the batch temperature is kept between minus 5°C and 0°C.

The reaction mixture is kept below 0°C for 30 additional minutes. Excess methanol and unreacted ester are distilled off under vacuum (17 mmHg at a maximum temperature of 115°C) and N-methylchloroacetamide is slightly cooled).

Dichloroethane is added to the reactor and the resulting solution is cooled to 50°C or below by circulating cooling water through the jacket.

Finally, the N-methylchloroacetamide solution is transfered to storage.

The inside battery limits capital costs for a 1700 metric tons per year N-methylchloroacetamide plant is estimated at 1.76 million dollars (US) based on construction at a Kuweit location (Shuaiba Area) in the third quarter of 1979. The components of the capital cost are summarized in Table 2.42.2. Specifications of the individual pieces of equipment are shown in appendix 3.4

The cost of production of N-methylchloroacetamide from this facility is estimated at 181.81 ¢ /kg. Component costs are shown in Table 2.42.3 . The transfer price including a 30% return on investment (before income taxes) and a 10% interest on working capital, is 232.86 ¢ /kg.

This is based on a monochloroacetic acid cost of 90 ¢ /kg and on a monomethylamine cost of 80 ¢ /kg.

The structure of the cost of production is presented in Table 2.42.4

TABLE 2.42.2

INSIDE BATTERY LIMITS CAPITAL COSTS

N-METHYLCHLOROACETAMIDE

1700 metric tons/yr

KUWEIT LOCATION - Third quarter of 1979

	1000 US Dollars
- Purchased equipment	582
- Equipment handling	32
- Concrete and steel	44
- Piping	163
- Instrumentation	76
- Electrical	64
- Insulation, paint à Misc.	51
- Buildings	218
- Direct cost	1230
- Engineering	123
- Field construction, overhead & Profit	246
- Base plant cost	1599
- Contingencies (including contractors fee of 3%)	160
Inside battery limits capital cost	1759

 See revised table in annexe 1

TABLE 2.42.3

N- METHYLCHLOROACETAMIDE PRODUCTION UNIT- SECTION 400

CAPITAL SUMMARY

BASIS		CAPITAL INVESTMENT	$ Million
-Location	: KUWEIT	Inside battery limits	1.76
	Third quarter 1979	Outside battery limits	0.79
-Capacity	: 1700 metric tons per yr	Total fixed investment	2.55
		Working Capital*	1.03
-ON-Stream Time:	8,000 hours per yr		

PRODUCTION COST SUMMARY

RAW MATERIALS	Units per kg	Price ¢/unit	Annual cost,$M	Cents per kg
Monochloroacetic acid,kg	1.0124	90.0	1,549,000	
Monomethylamine;kg	0.364	80.0	495,100	
Catalyst, solvents and chemicals			169,900	
Total raw materials			2,214,000	130.24
UTILITES				
Steam,150psig,metricton	0.0035	700.0	41,700	
Cooling water, m3	0.1339	1.0	2,300	
Glycol(-20°C),10^6 kcal	0.0006	7100.0	72,500	
Power, kwh	0.0620	1.0	1,100	
Process water, m3	0.0010	19.0	400	
Total utilities			118,000	6,94
OPERATING COSTS				
Labor, 7,5 men @$16,000/yr	1,5men per shift		120,000	
Supervision,1man @$22,000/yr	1 man		22,000	
Maint.,material &Labor	6% of ISBL		105,600	
Total operating cost			247,600	14,57
OVERHEAD EXPENSES				
Direct Overhead	40	%(labor&sup.)	56,800	
General plant overhead	65	% Operating costs	161,000	
Insurance, property taxes	1.5%	total invest.	38,300	
Depreciation	10	% total invest.	255,000	
Total overhead expenses			511,100	30,06
TOTAL COST OF PRODUCTION			3,090,700	181,81
BY-PRODUCT CREDIT				
Total by-product credit				
NET COST OF PRODUCTION			3,090,700	181,81
Return on Investment	30%	Total investment	765,000	
Interest on Working Capital	10%	working capit.	103,000	
Sales Expenses	-		-	
TRANSFER PRICE			3,958,700	232,86

(*equivalent to four months production costs)

PAGE	AFFAIRE	NUMERO	REV
	6002		

TABLE 2.42.4

N-METHYLCHLOROACETAMIDE

COST OF PRODUCTION BREAKDOWN

• Raw materials	71.6 %
• Utilities	3.8 %
• Operating costs	8.0 %
• Overhead expenses	16.6 %
Total cost of production	100.0 %

The cost of production and the transfer price are not very sensitive to capital cost, since a 20% increase of the capital cost would only increase the cost of production of 5.5 ¢ /kg (i.e. 3.0%) and the transfer price of 14.69 ¢ /kg (i.e. 6.3%)

The cost of monochloroacetic acid accounts for 50.1% of the cost of production and monomethylamine accounts for 16.0% of the cost of production.

The most significant factors of the cost of production are the raw materials.

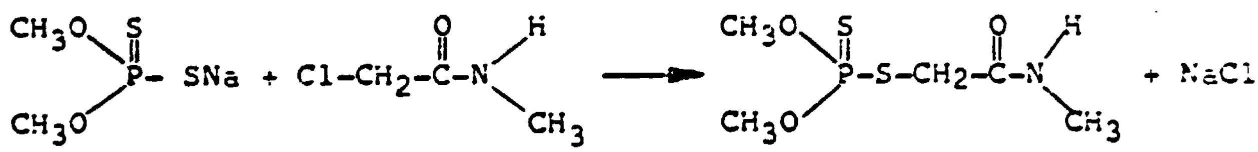
2.5 - DIMETHOATE

2.51 Background and Chemistry

Dimethoate or O,O dimethyl S-carbamoylmethyl phosphorodithioate is a systemic and contact insecticide.

It is a white solid (m.p. 51-52°C) moderately soluble in water. Dimethoate was developed by American Cyanamid and Montecatini which are important producers.

Dimethoate is produced by reacting the sodium salt of O,O dimethylphosphorodithioc acid with N-methylchloroacetamide:



Sodium salt of O,Odimethyldithiophosphoric acid — N-methylchloroacetamide — Dimethoate

In theory, the reaction is very simple, but in practice dimethoate may react further with sodium dimethylphosphorodithioate to yield O,O,S-trimethylphosphorodithioate. The result is a low yield and a product difficult to purify.

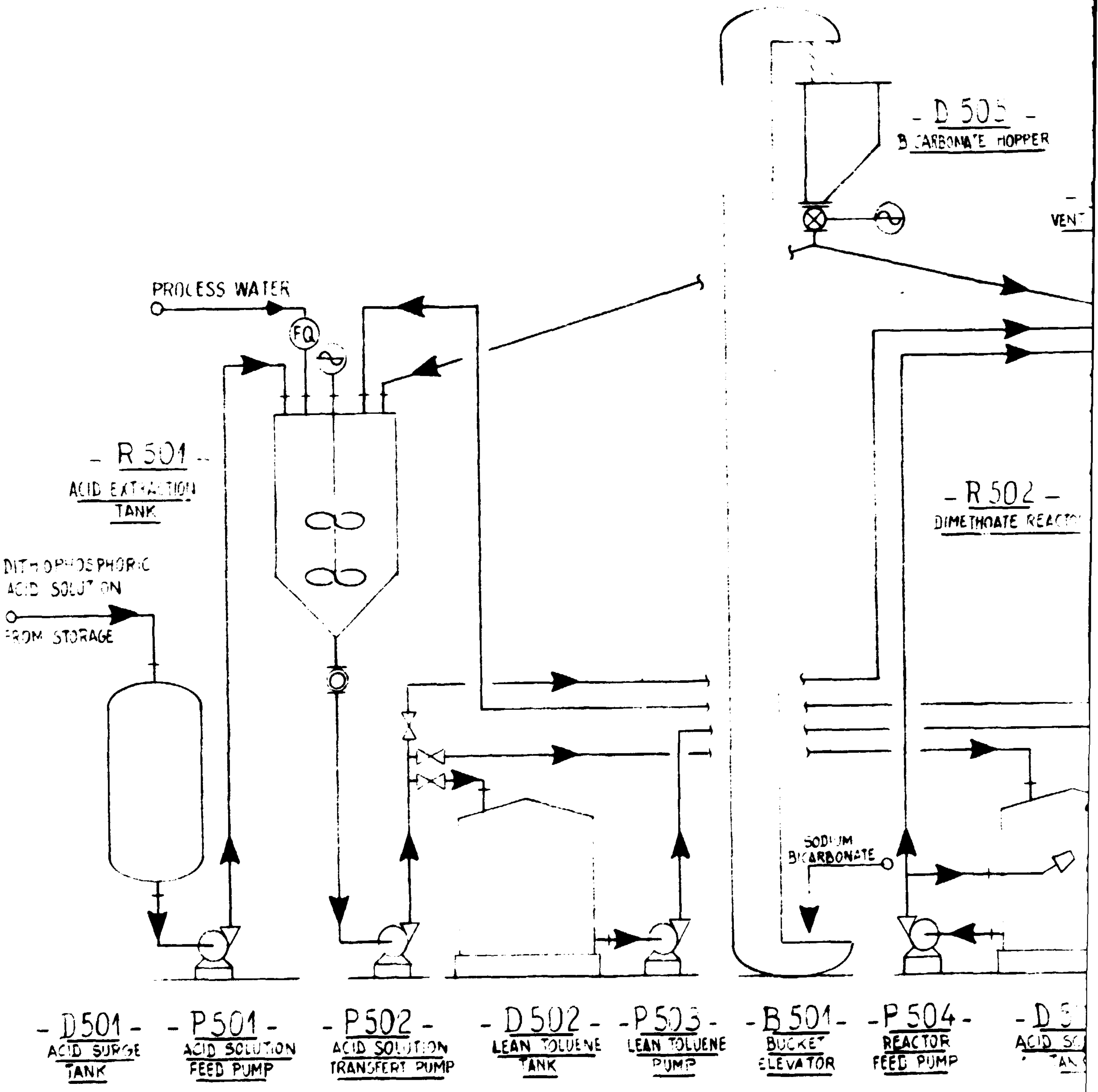
In order to minimize this problem, various companies (American Cyanamid, Fisons) have developed two phase reaction system, whereby the dimethoate is extracted into the organic phase as it is formed.

Various water immiscible solvents and/or solvent mixtures have been used, however, a chlorinated solvent/cyclohexanone mixture was selected because it seems to give satisfactory yields (see U.S.Patent 2,959,608-1960).

2.52 Process Design and Economics

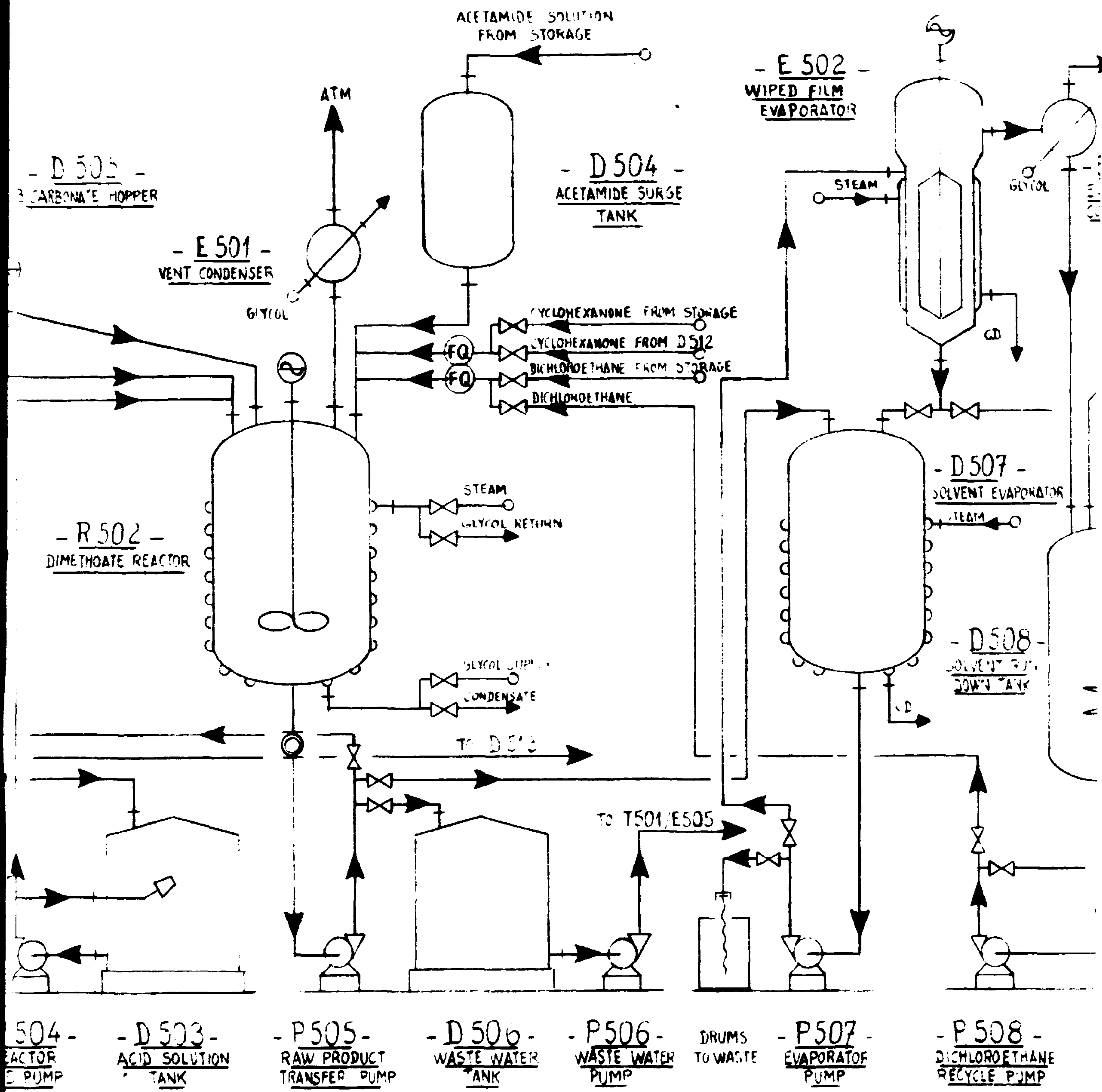
Figure 6002-PX-500 A/B is a flow sheet for the batch production of technical dimethoate (90% purity) by the reaction of N-methylchloroacetamide with O,O dimethyldithiophosphoric acid.

The design is based on three shifts per day, 7 days a week, 8000 hours per year schedule. According to the following production schedule, one batch can be carried out in 12 hours.

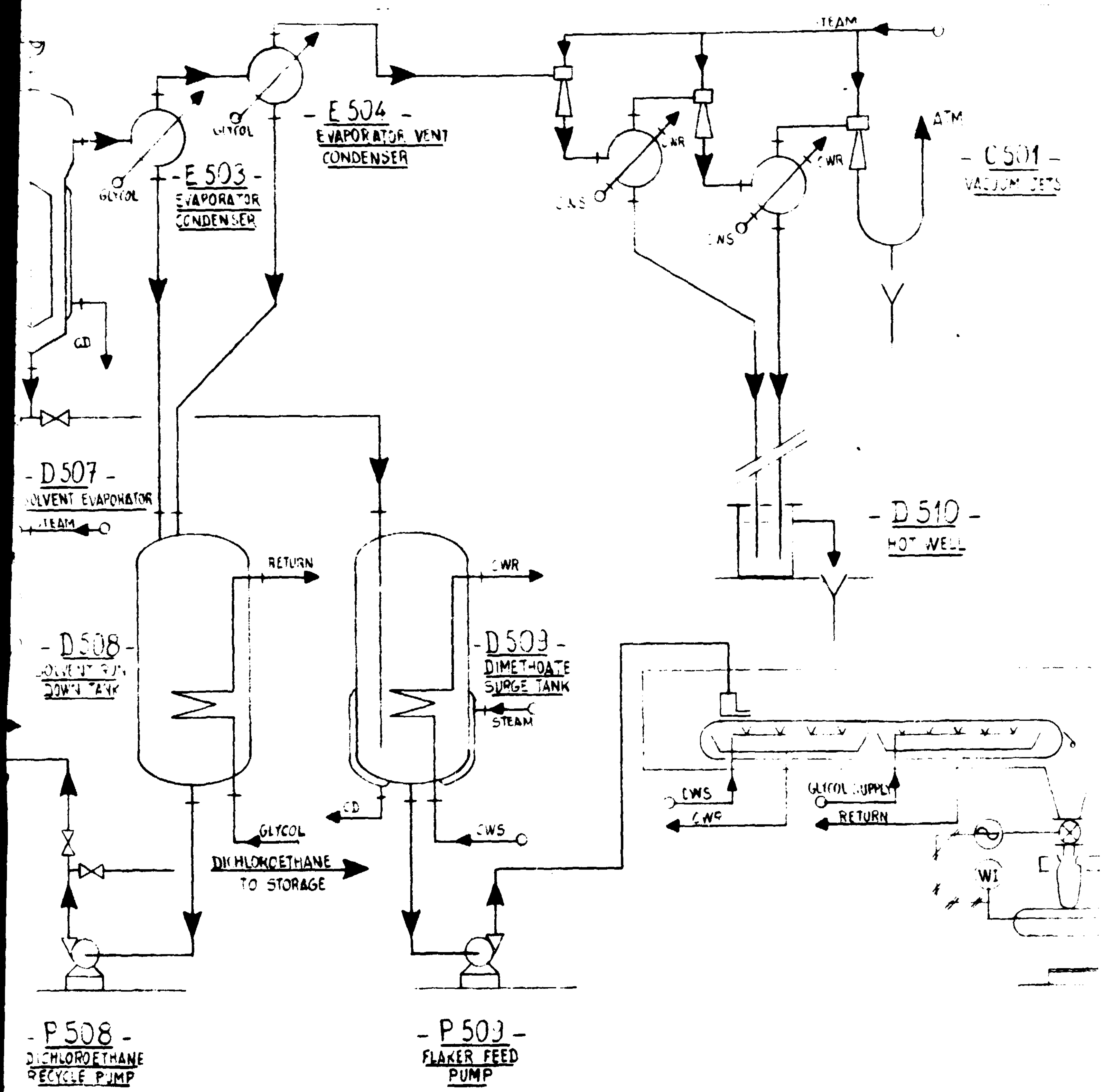


PROCESS WATER
FQ
- D 505 -
BICARBONATE HOPPER
VENT
- R 501 -
ACID EXTRACTION TANK
- R 502 -
DIMETHOATE REACTOR
DITHIOPHOSPHORIC ACID SOLUTION FROM STORAGE
SODIUM BICARBONATE
- D501 -
ACID SURGE TANK
- P501 -
ACID SOLUTION FEED PUMP
- P502 -
ACID SOLUTION TRANSFERT PUMP
- D502 -
LEAN TOLUENE TANK
- P503 -
LEAN TOLUENE PUMP
- B 501 -
BUCKET ELEVATOR
- P 504 -
REACTOR FEED PUMP

SECTION 1


ACETAMIDE SOLUTION FROM STORAGE
ATM
- E 502 -
WIPED FILM EVAPORATOR
- D 504 -
ACETAMIDE SURGE TANK
CARBONATE HOPPER
- E 501 -
VENT CONDENSER
GLYCOL
STEAM
CYCLOHEXANONE FROM STORAGE
CYCLOHEXANONE FROM D512
DICHLOROETHANE FROM STORAGE
DICHLOROETHANE
FQ
- D 507 -
SOLVENT EVAPORATOR
- R 502 -
DIMETHOATE REACTOR
GLYCOL RETURN
CONDENSATE
- D 508 -
TO T501/E505
- D 503 -
ACID SOLUTION TANK
- P 505 -
RAW PRODUCT TRANSFER PUMP
- D 506 -
WASTE WATER TANK
- P 506 -
WASTE WATER PUMP
DRUMS TO WASTE
- P 507 -
EVAPORATOR PUMP
- P 508 -
DICHLOROETHANE RECYCLE PUMP

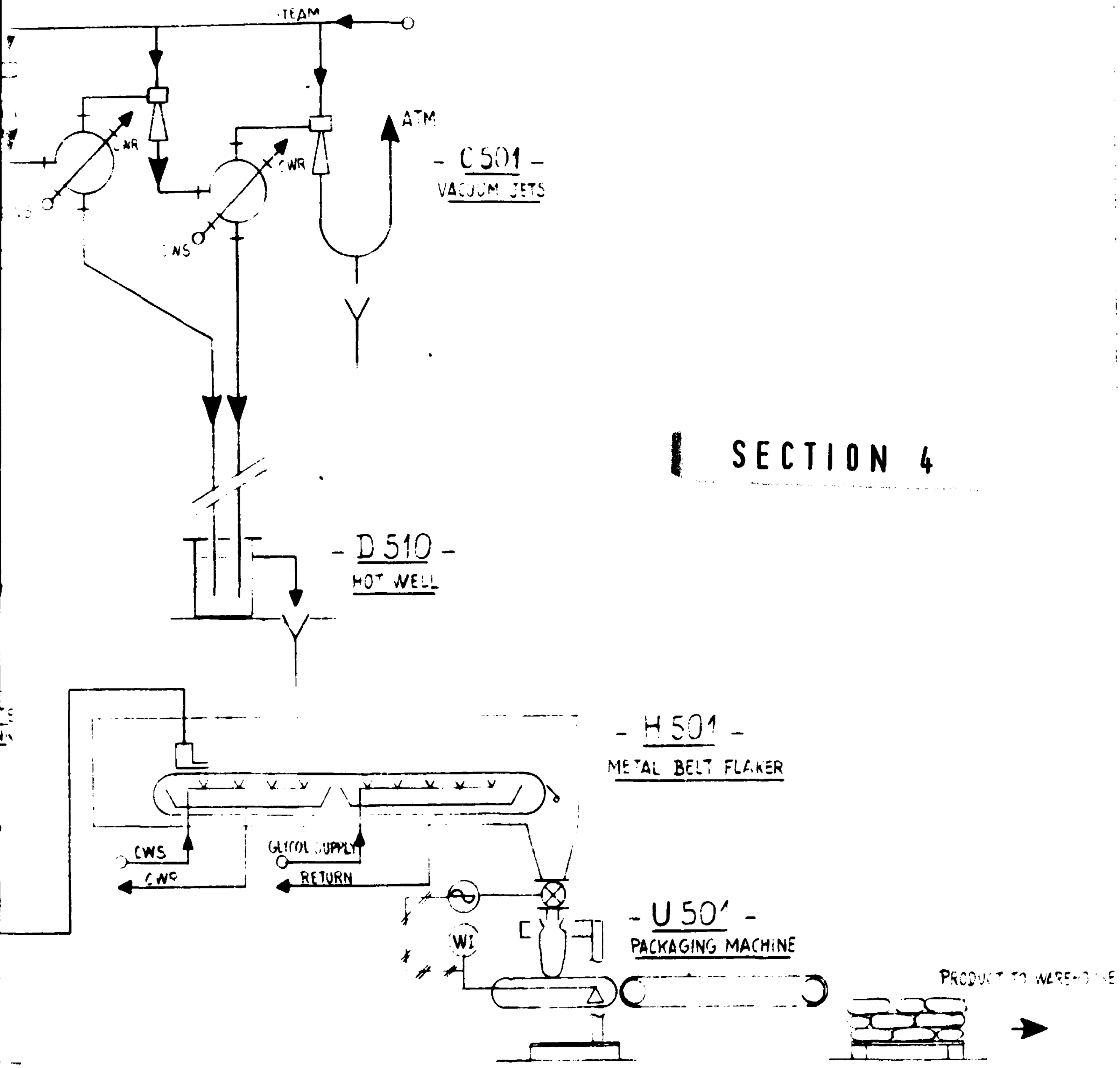
SECTION 2



SECTION 3

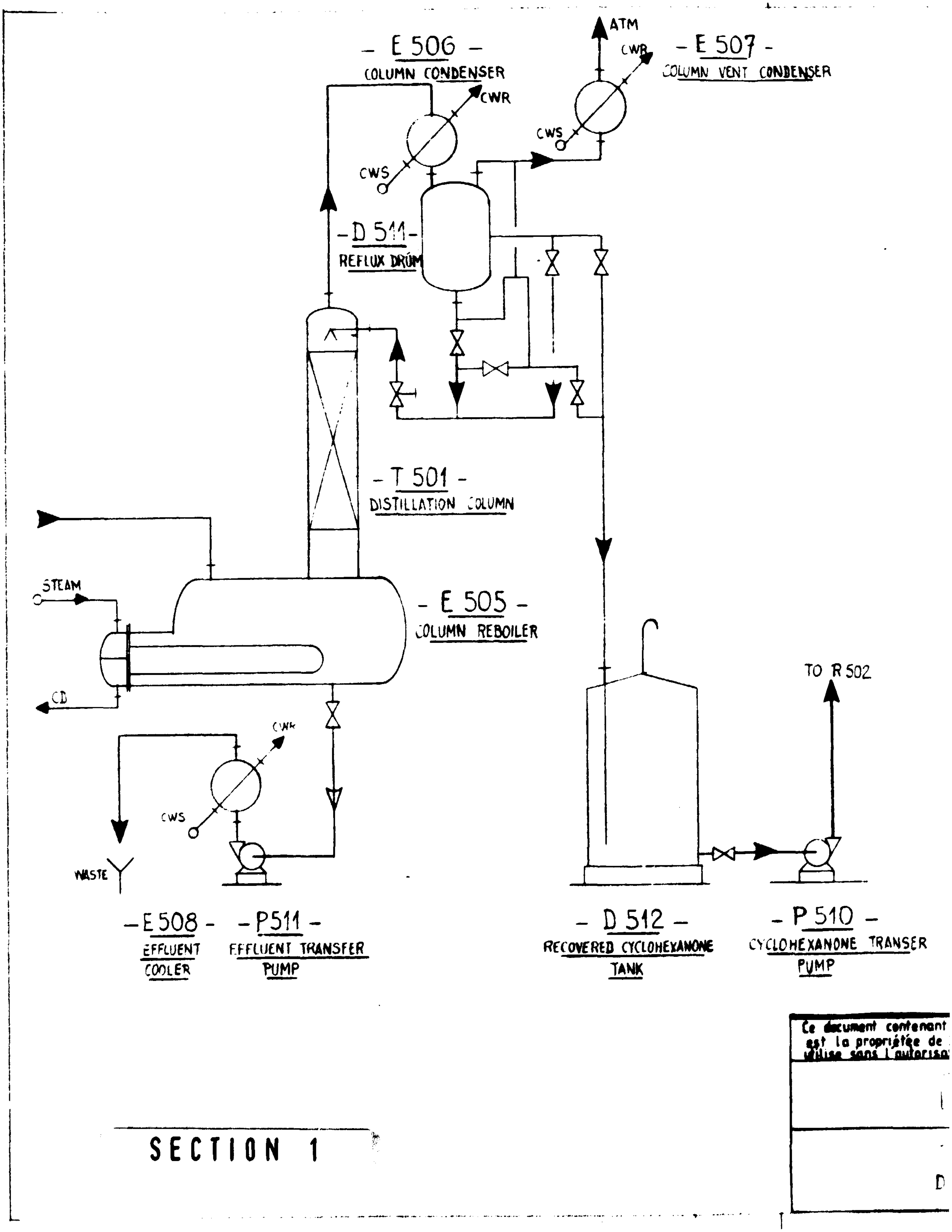
- CLIENT -
UNIDO

- UNITE -
DIMETHOATE



SECTION 4

	CHIMIE DEVELOPPEMENT INTERNATIONAL 42 rue Legendre PARIS 17e Tel 766-29-10
-CLIENT- UNIDO	SECTION 500
-UNITE- DIMETHOATE	FIGURE 6002-PX-500A



ATM
CWR
- E 507 -
COLUMN VENT CONDENSER
- E 506 -
COLUMN CONDENSER
CWR
CWS
CWS
-D 511-
REFLUX DRUM
- T 501 -
DISTILLATION COLUMN
STEAM
- E 505 -
COLUMN REBOILER
CD
CWR
CWS
WASTE
TO R 502
-E 508 -
EFFLUENT COOLER
- P511 -
EFFLUENT TRANSFER PUMP
- D 512 -
RECOVERED CYCLOHEXANONE TANK
- P 510 -
CYCLOHEXANONE TRANSER PUMP
Ce document contenant
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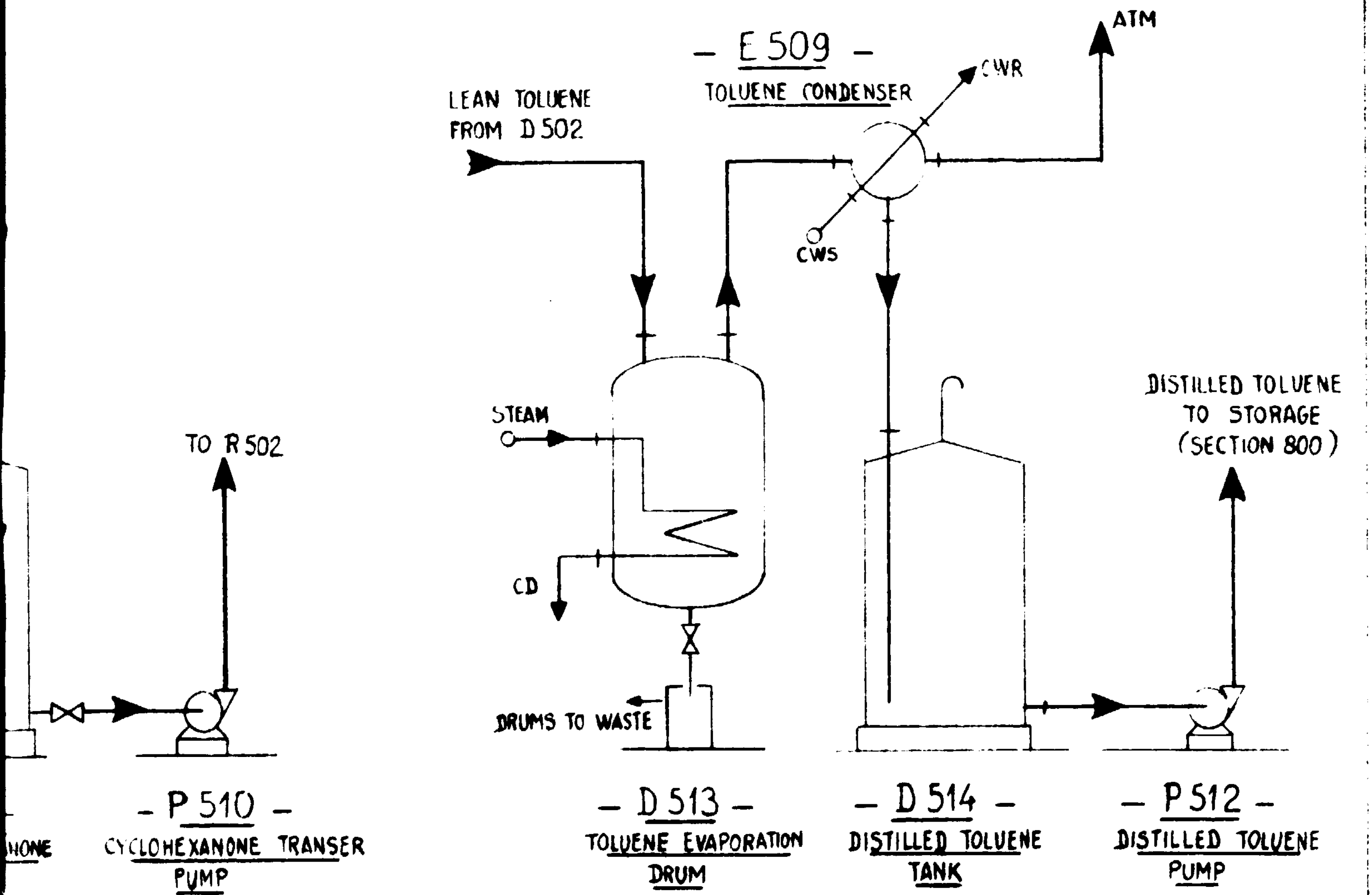
SECTION 1

- E 507 -
MN VENT CONDENSER

SECTION 2



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-CLIENT- UNIDO	SECTION 500
-UNITE- DIMETHOATE	FIGURE 6002-PX-500 B

TABLE 2.52.1

TECHNICAL DIMETHOATE PRODUCTION SCHEDULE

Operation	Time	Item n°
- Dithiophosphoric acid solution is charged into extraction tank	0,5 hr	R 501
- First extraction:process water is added to acid solution; acid is extracted from organic phase; aqueous phase is transfered to surge tank	2,0 hrs	R 501/D503
- Second extraction: same procedure as first extraction	2,0 hrs	R501/D503
- Third extraction: same procedure as first extraction	2,0 hrs	R501/D503
- Rich aqueous phase and sodium bicarbonate are charged into reactor	1,0 hr	R 502
- Dichloroethane, cyclohexanone and chloroacetamide solution are added to reactor	0,5 hr	R 502
- Reaction mixture is heated to 55°C	1,5 hrs	R 502
- Temperature is maintained at 55°C	3,0 hrs	R 502
- Reaction mixture is cooled to 20°C	1.5 hrs	R 502
- Agitation is stopped-the two phases are allowed to decant	1,0 hr	R 502
- Aqueous phase is pumped to surge tank; organic phase is added to extraction tank containing a sodium bicarbonate solution	1,0 hr	R502/R501
- Organic phase is washed by bicarbonate solution- organic phase is pumped back to reactor containing process water	2.5 hrs	R501/R502
- Organic phase is water washed in reactor. Aqueous phase is pumped to surge tank; organic phase is transfered to solvent evaporator	2.0 hrs	R502/D507
- Crude product is heated up and vacuum pump is started.	1,0 hr	D507/C501
- Solvents are distilled off under vacuum	4,0 hrs	D507/D508
- Final traces of solvents are distilled off and molten product is pumped to metal belt flaker	6,0 hrs	D507/D509/ H501

The extraction, the reaction and the concentration steps are carried out in parallel.

The O,O dimethyldithiophosphoric acid solution is extracted three times with process water. The resulting normal acid solution is mixed with sodium bicarbonate so as to keep the pH of the aqueous phase in the range 3,5-10 during the reaction. N-methylchloroacetamide and dichloroethane containing 10% by volume of cyclohexanone are added to the reactor containing the rich aqueouse phase. The mixture is heated to 55°C and maintained at 55°C for three hours.

The two phases are cooled to 20°C and are allowed to decant. The lean aqueous phase is pumped into a surge tank prior to solvent recovery. The organic layer is washed with a saturated aqueous sodium bicarbonate and with water. The aqueous phases are transfered to the waste water surge tank and the organic phase is pumped to the solvent evaporator.

The organics are recirculated on a wiped film evaporator and the solvents are distilled off under vacuum. The resulting molten product is collected in the dimethoate surge tank and pumped to the flaking/packaging system.

After extraction, the lean toluene is vaporized, recovered in the distilled toluene tank and pumped to storage. Cyclohexanone is recovered from the various aqueous phases in a batch distillation column consisting of a steam heated kettle reboiler, packed column and overhead condensation equipment. The recovered cyclohexanone is collected in a surge tank for recycle to the next batches.

The inside battery limits capital costs for a 2500 metric tons per year technical dimethoate (dimethoate content 90% weight) plant is estimated at 3.78 million dollars (US) based on construction at a Kuweit location (Shuaiba Area) in the third quarter 1979. The components of the capital costs are summarized in Table 2.52.2. Specifications of the individual pièces of equipment are shown in appendix 3.5.

TABLE 2.52.2

INSIDE BATTERY LIMITS CAPITAL COSTS

DIMETHOATE

2500 metric tons/yr

KUWEIT LOCATION - Third quarter of 1979

	1000 US Dollars
- Purchased equipment	1170
- Equipment handling	70
- Concrete and steel	99
- Piping	374
- Instrumentation	199
- Electrical	152
- Insulation, paint & Misc.	95
- Buildings	480
- Direct cost	2639
- Engineering	264
- Field construction, overhead & Profit	528
- Base plant cost	3431
- Contingencies (including contractors fee of 3%)	344
Inside battery limits capital cost	3775

 See revised table in annexe 1

TABLE 2.52.3

DIMETHOATE PRODUCTION UNIT- SECTION 500

CAPITAL SUMMARY

BASIS		CAPITAL INVESTMENT	$ Million
-Location	: KUWEIT	Inside battery limits	3.78
	Third quarter 1979	Outside battery limits	1.59
-Capacity	: 2500 metric tons per yr	Total fixed investment	5.37
		Working Capital*	3.24
-ON-Stream Time:	8,000 hours per yr		

PRODUCTION COST SUMMARY

RAW MATERIALS	Units per kg	Price ¢/unit	Annual cost,$M	Cents per kg
O,O dimethyldithiophosphoric acid, kg	0.8219	157.38	3,233,800	
N-methylchloroacetamide,kg	0.6710	232.86	3,906,300	
Solvents and chemicals			544,400	
Total raw materials			7,684,500	307.38
UTILITES				
Steam,150psig,metricton	0.0072	700.0	126,000	
Cooling water, m3	0.1965	1.0	5,000	
Glycol(-20°C),10^6 kcal	0.0011	7100.0	195,300	
Power, kwh	0.1148	1.0	2.900	
Process water,m3	0.0066	19.0	3.200	
Total utilities			332,400	13,30
OPERATING COSTS				
Labor, 15 men @$16,000/yr	3 men per shift		240,000	
Supervision,5men @ $22,000/yr	1 man per shift		110,000	
Maint.,material &Labor	6% of ISBL		226,800	23.07
Total operating cost			576,800	
OVERHEAD EXPENSES				
Direct Overhead	40 %(labor&sup.)		140,000	
General plant overhead	65 % Operating costs		375,000	
Insurance, property taxes	1.5% total invest.		80,600	
Depreciation	10 % total invest.		537,000	
Total overhead expenses			1,132,600	45.30
TOTAL COST OF PRODUCTION			9,726,300	389.05
BY-PRODUCT CREDIT				
Total by-product credit				
NET COST OF PRODUCTION			9,726,300	389.05
Return on Investment	30% Total investment		1,611,000	
Interest on Working Capital	10% working capit.		324,000	
Sales Expenses	-		-	
TRANSFER PRICE	90% technical product		11,661,300	466,45

(*equivalent to four months production costs)

PAGE	AFFAIRE	NUMERO	REV
	6002		

The cost of production of technical dimethoate (90% purity) from this facility is estimated at 389.05 ¢ / kg. Component oosts are shown in Table 2.52.3. The transfer price, including a 30% return on investment (before income taxes) and a 10% interest on working capital, is 466.45 ¢ /kg. This is based on the transfer prices of 0,0 dimethyldithiophosphoric acid and of N-methylchloroacetamide, calculated in the preceding chapters.

The structure of the cost of production is presented in Table 2.52.4.

TABLE 2.52.4

TECHNICAL DIMETHOATE

COST OF PRODUCTION BREAKDOWN

. Raw materials	79.0
. Utilities	3.4
. Operating costs	5.9
. Overhead expenses	11.7
Total cost of production	100,0 %

The cost of production and the transfer price are not very sensitive to capital cost, since a 20% increase of the capital cost would only increase the cost of production of 7.9 ¢ /kg (i.e. 2%) and the transfer price of 21.0 ¢ /kg (i.e. 4.5 %).

The cost of 0,0 dimethyldithiophosphoric acid accounts for 33,2% of the cost of production and N-methylchloroacetamide for 40,2% of the cost of production. These raw materials are indeed the most significant factors of the cost of production.

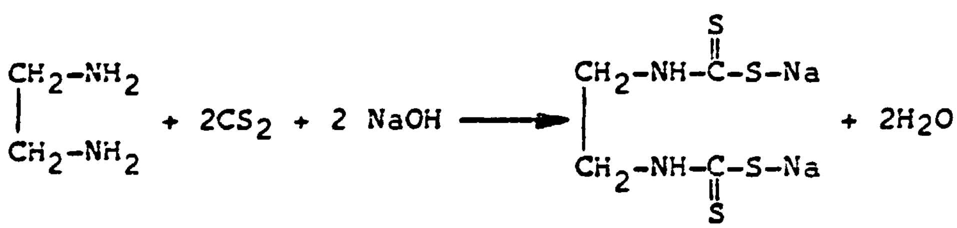
2.6 - MANEB/ZINEB

2.61 Background and Chemistry

Ethylene bis-dithiocarbamates (EBDC) fungicides are one of the older classes of organic fungicides, having been developed by Rohm and Haas in the late 1940's. These fungicides are salts of a dithiocarbamate produced by reacting one mole of ethylene diamine and two moles of carbon disulfide. The most important EBDC salts are zinc (Zineb), manganese (Maneb) and the manganese/zinc complex (Mancozeb).

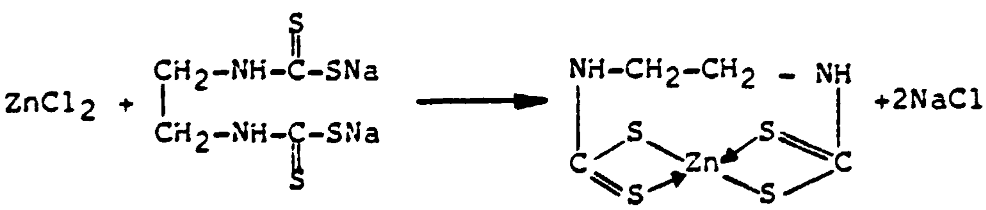
EBDC manufacture involves (1) preparation of the sodium salt of EBDC (Nabam) by the reaction of ethylene diamine, carbon disulfide and caustic soda and (2) preparation of the desired zinc, manganese or other EBDC salt by reaction of sodium EBDC with a soluble salt containing the desired cation.

The reaction equation for the initial step is as follows:

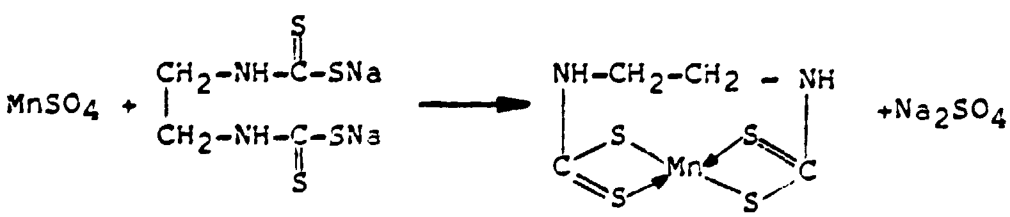


ethylene diamine Nabam

The reaction equation for the final steps are as follows:



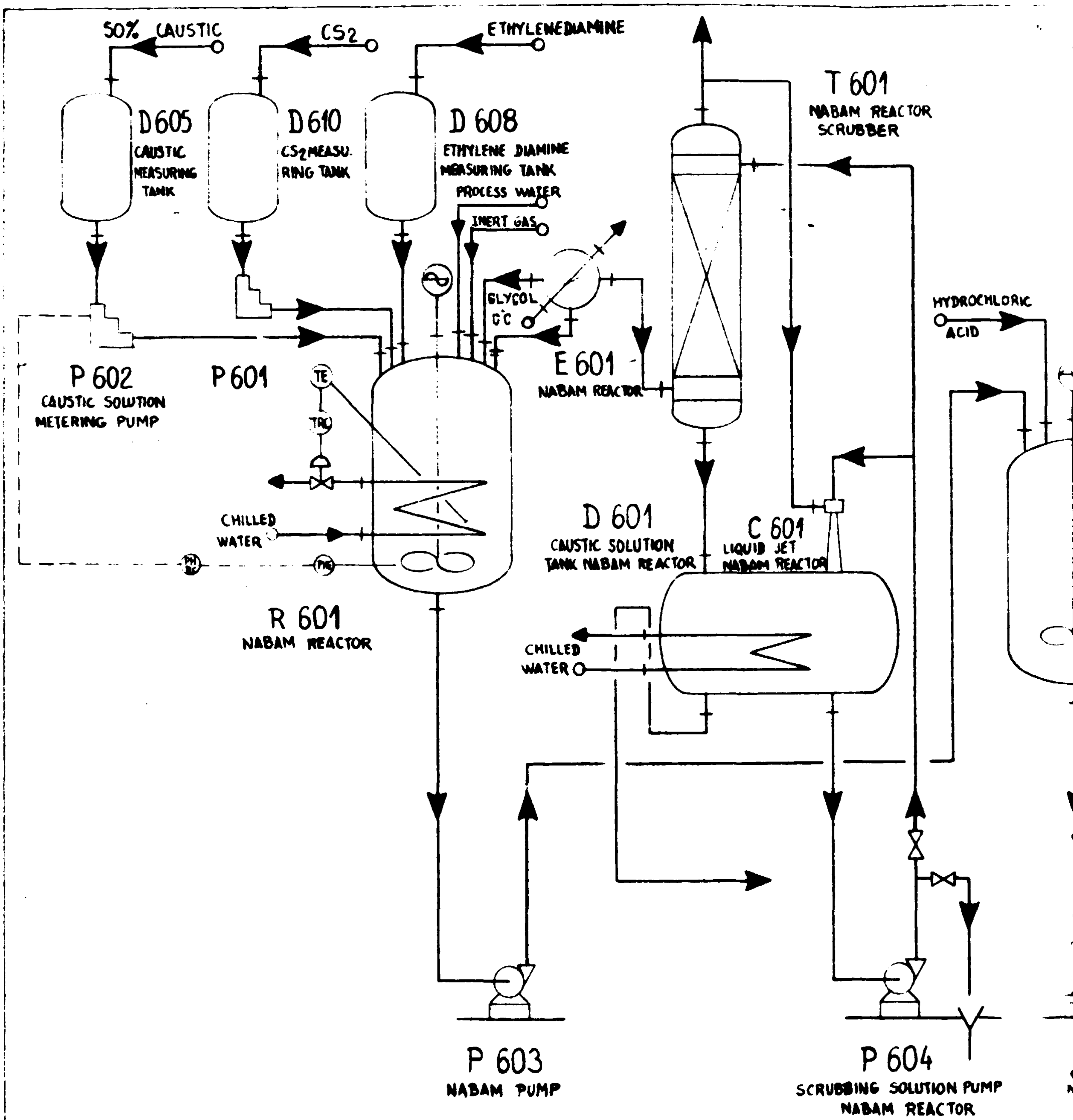
Nabam Zineb



The overall Maneb/Zineb production process is fairly straight-forward, however the stability and purity of the products are greatly improved if the temperature and the pH of the reaction mixtures are closely controlled.

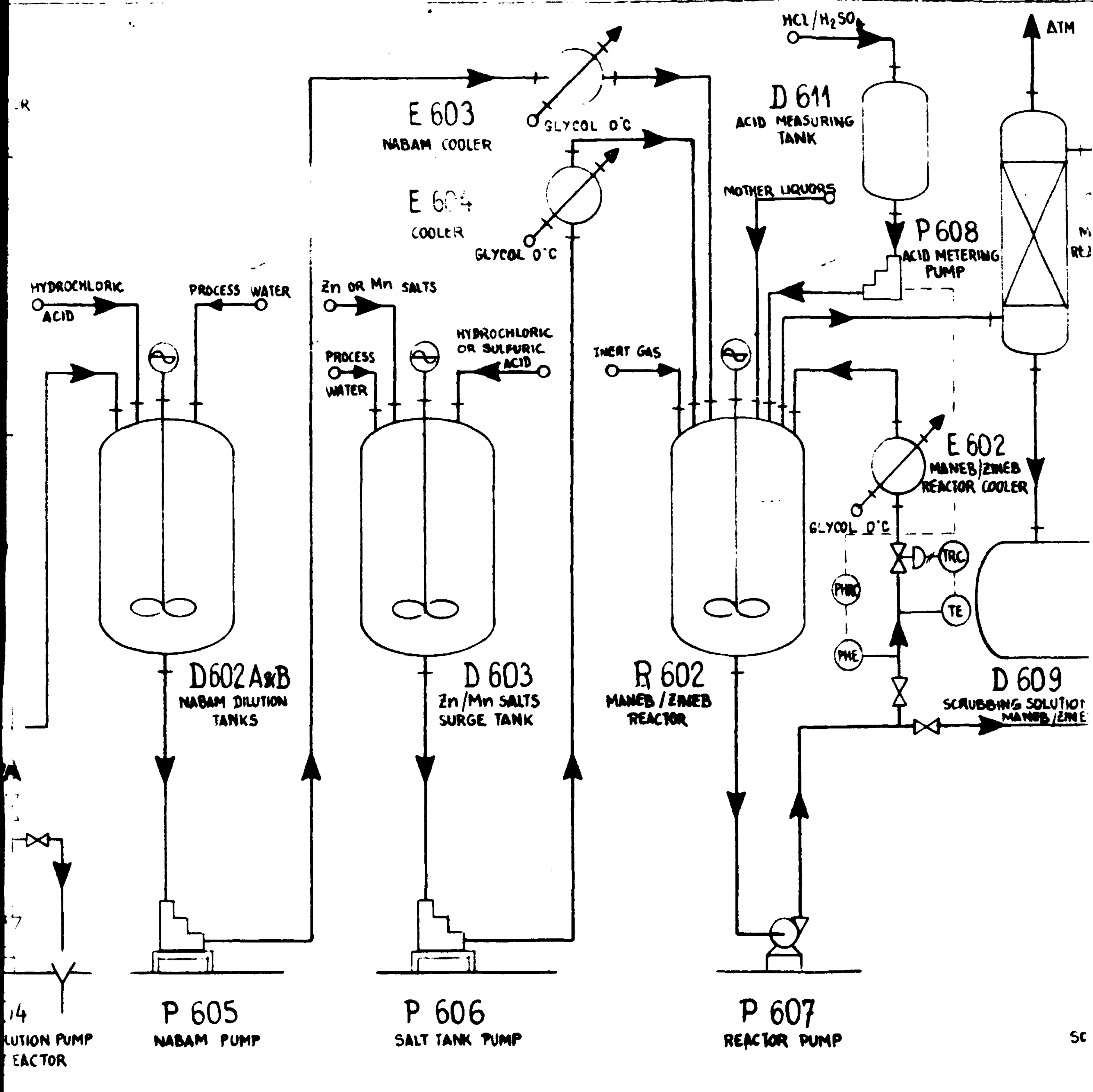
2.62 Process Design and Economics

Figure 6002-PX-600 is a flowsheet for the batch production of Zineb (or Maneb) from ethylene diamine, carbon disulfide and zinc chloride (or Manganese sulfate). The design is based on three shifts per day, 7 days a week, 8000 hours per year schedule. According to the following production schedule, one batch can be carried out in 15 hours.



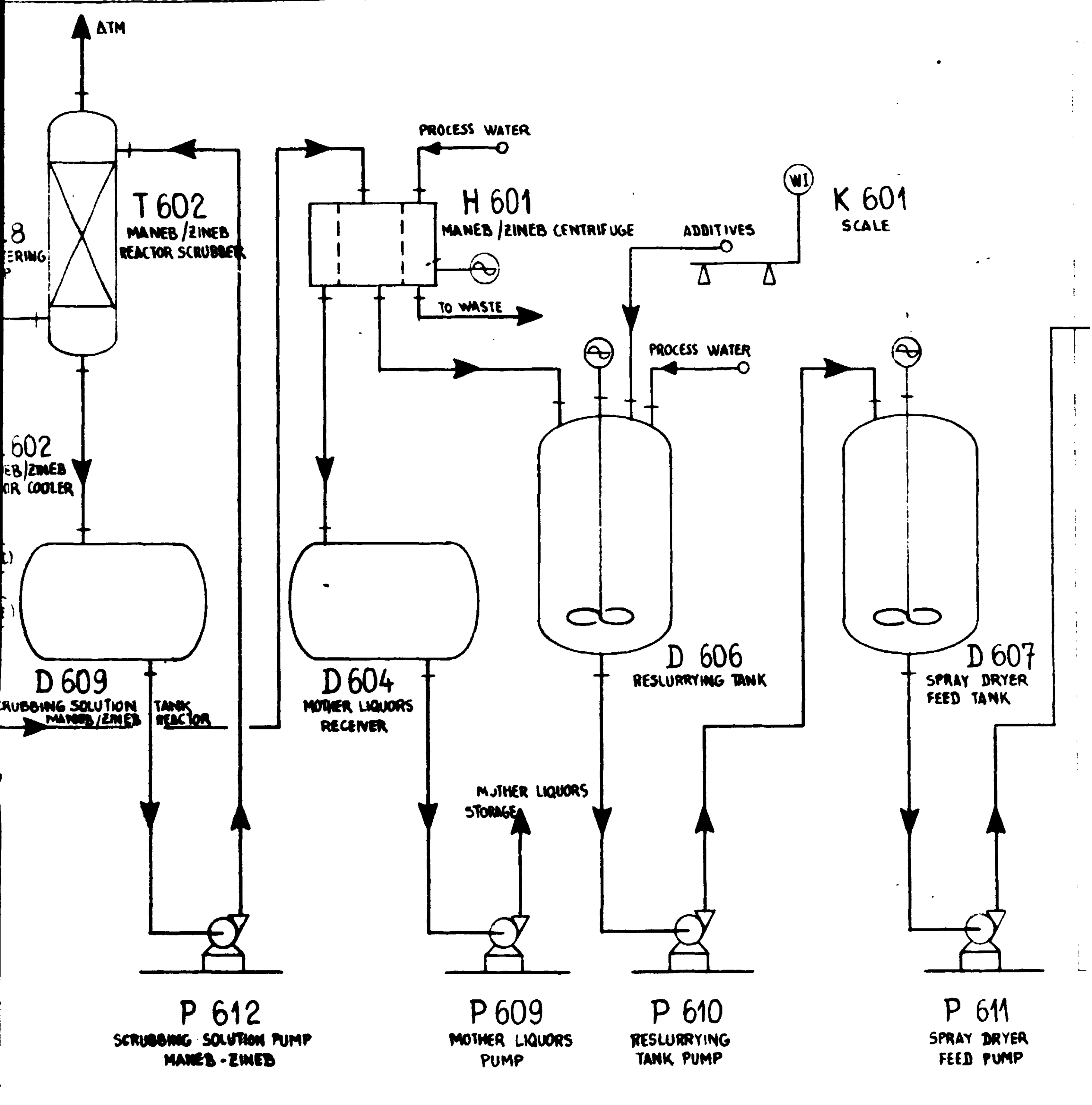
50% CAUSTIC
CS2
ETHYLENEDIAMINE
D605
CAUSTIC MEASURING TANK
D610
CS2 MEASURING TANK
D 608
ETHYLENE DIAMINE MEASURING TANK
PROCESS WATER
INERT GAS
GLYCOL
T 601
NABAM REACTOR SCRUBBER
HYDROCHLORIC ACID
P 602
CAUSTIC SOLUTION METERING PUMP
P 601
TE
TRC
E 601
NABAM REACTOR
CHILLED WATER
D 601
CAUSTIC SOLUTION TANK NABAM REACTOR
C 601
LIQUID JET NABAM REACTOR
R 601
NABAM REACTOR
CHILLED WATER
P 603
NABAM PUMP
P 604
SCRUBBING SOLUTION PUMP NABAM REACTOR

SECTION 1


HCl/H_2SO_4
ATM
E 603
NABAM COOLER
GLYCOL 0°C
D 611
ACID MEASURING TANK
E 604
COOLER
GLYCOL 0°C
MOTHER LIQUORS
P 608
ACID METERING PUMP
HYDROCHLORIC ACID
PROCESS WATER
Zn OR Mn SALTS
PROCESS WATER
HYDROCHLORIC OR SULFURIC ACID
INERT GAS
E 602
MANEB/ZINEB REACTOR COOLER
GLYCOL 0°C
TRC
PHRC
TE
PHE
D602 A&B
NABAM DILUTION TANKS
D 603
Zn/Mn SALTS SURGE TANK
R 602
MANEB/ZINEB REACTOR
D 609
P 605
NABAM PUMP
P 606
SALT TANK PUMP
P 607
REACTOR PUMP

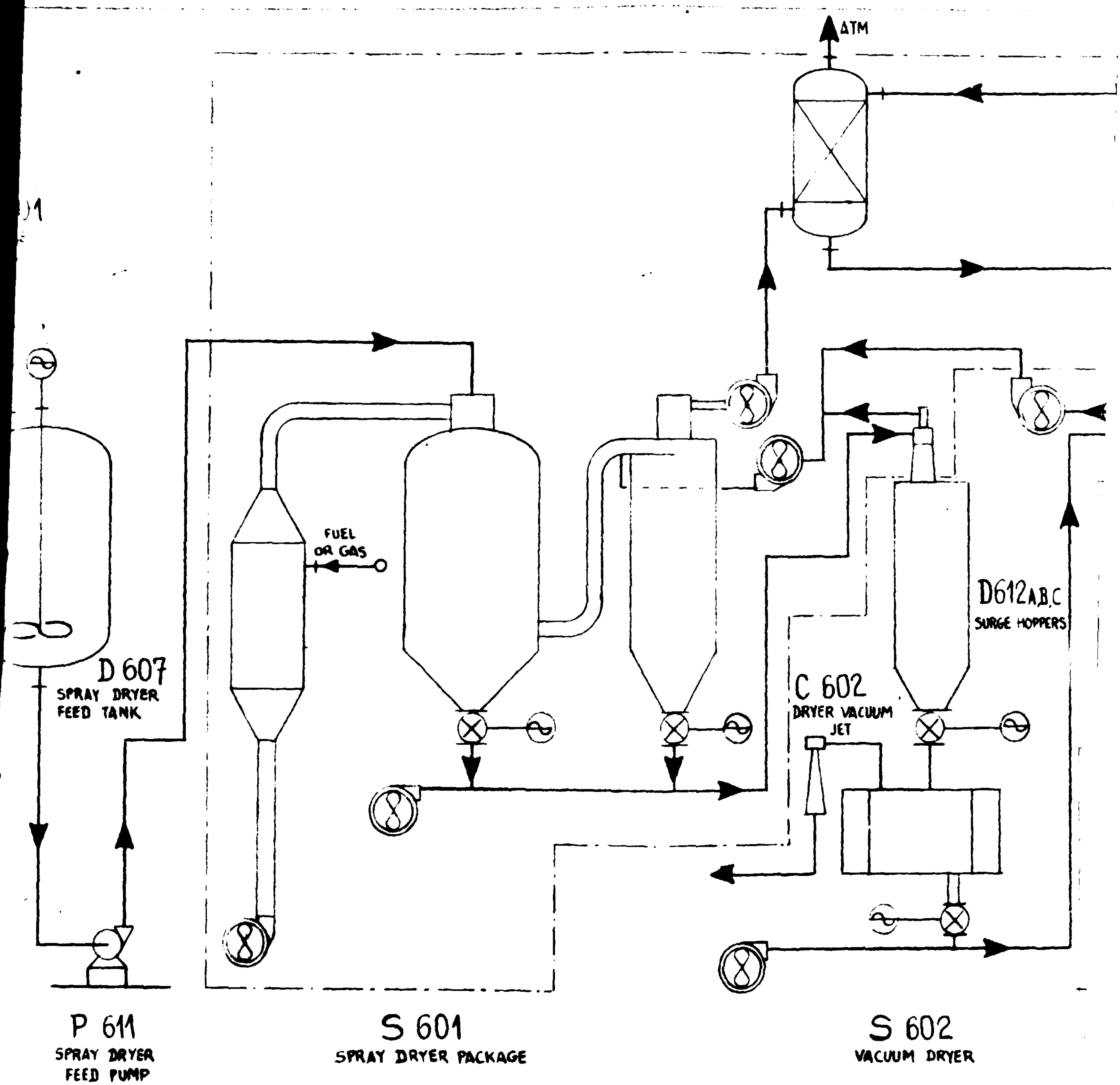
SECTION 2

1



ATM
T 602
MANEB / ZINEB REACTOR SCRUBBER
PROCESS WATER
H 601
MANEB / ZINEB CENTRIFUGE
TO WASTE
ADDITIVES
WI
K 601
SCALE
PROCESS WATER
602
COOLER
D 609
SCRUBBING SOLUTION TANK
MANEB / ZINEB REACTOR
D 604
MOTHER LIQUORS RECEIVER
D 606
RESLURRYING TANK
D 607
SPRAY DRYER FEED TANK
MOTHER LIQUORS STORAGE
P 612
SCRUBBING SOLUTION PUMP MANEB - ZINEB
P 609
MOTHER LIQUORS PUMP
P 610
RESLURRYING TANK PUMP
P 611
SPRAY DRYER FEED PUMP

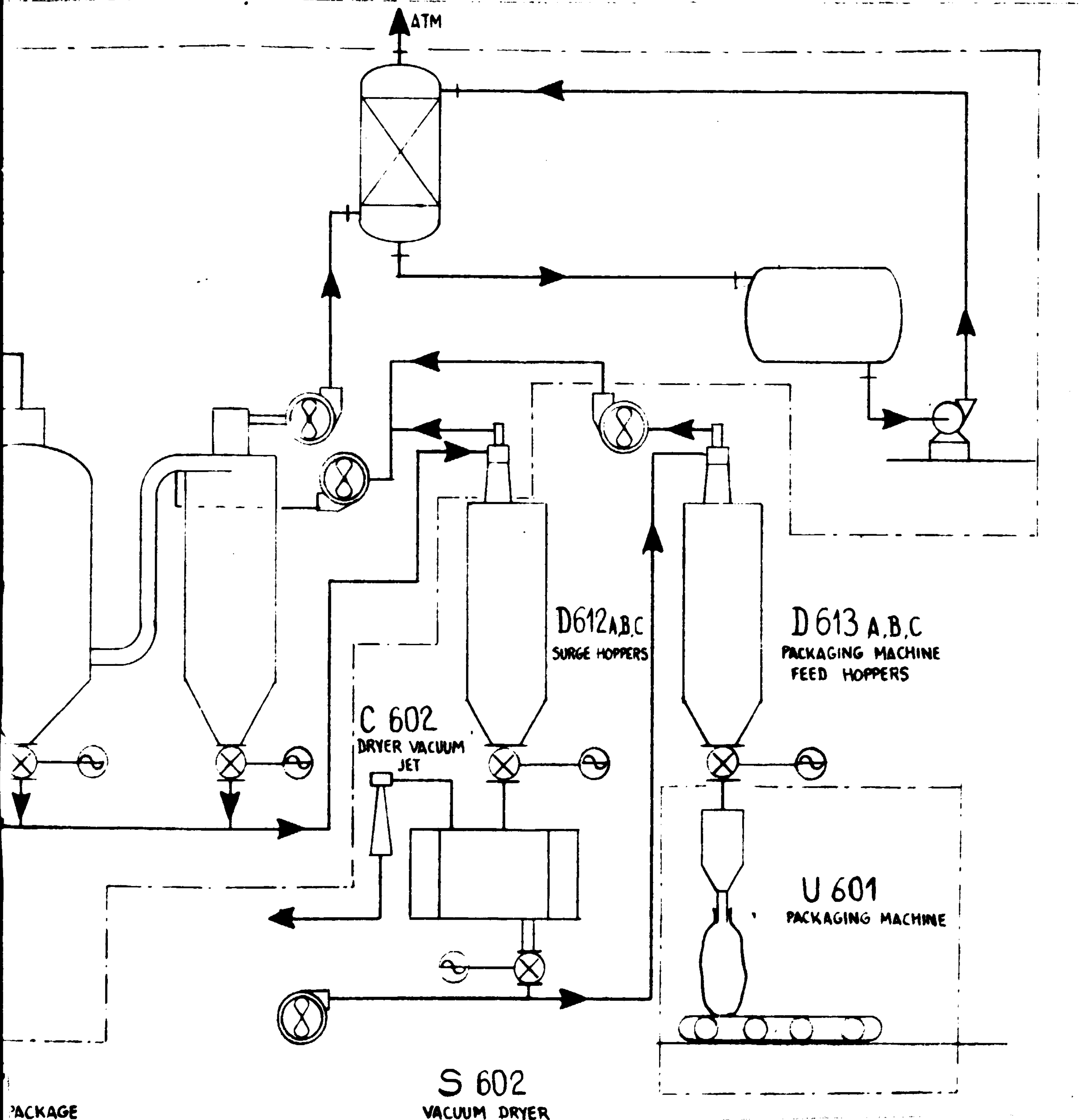
SECTION 3



SECTION 4

- CLIENT -
UNIDO

- UNITE -
MANEB / ZINEB
(BATCH PROCESS)



SECTION 5

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-CLIENT- UNIDO	SECTION 600
-UNITE- MANEB / ZINEB (BATCH PROCESS)	FIGURE 6002-PX-600

TABLE 2.62.1

ZINEB PRODUCTION SCHEDULE

Operation	Time.	Item n°
- Ethylene diamine is charged into nabam reactor	0.5 hr	R 601
- Water is added to ethylene diamine	0.5 hr	R 601
- Mixture is heated to 45°C	2.0 hrs	R 601
- Carbon disulfide is added to mixture until pH 9.3 (variation from 12.1 to 9.3)	1.0 hr	R 601
- Caustic solution and carbon disulfide are simultaneously added to mixture. pH is kept between 9.4 and 9.6 and temperature between 40 and 45°C.	5.0 hrs	R 601
- pH is adjusted to 10.8	0.5 hr	R 601
- Excess carbon disulfide is stripped by nitrogen	I.0 hr	R 601
- Suspension of Nabam is cooled to 25° C	2.5 hrs	R 601
- Cold suspension is transfered to dilution tanks. (the zinc or manganese salt solution is prepared during the nabam reaction in D603)	1.0 hr	R 601/D602 A or B
- Mother liquors from a preceding batch are charged into Maneb/Zineb reactor	1.0 hr	R 602
- pH of mixture is adjusted by a small amount of salt solution	1.0 hr	R 602
- Zn (or Mn) salt solution and nabam solution are added to agitated mixture simultaneously. pH is kept between 2.8 and 3.4 and temperature between 26.5 and 28.5°C.	2.0 hrs	R 602
- Mixture is kept under the same conditions for 2 more hours	2.0 hrs	R 602
- Zineb (or Maneb) crystals are recovered and water washed in a basket centrifuge. Wet cake is reslurried in reslurrying tank	9.0 hrs	R602-H601 D606
- Zineb (or Maneb) suspension is pumped to spray dryer feed tank	1.0 hr	D606/D607
- Product is pre-dried in spray dryer, dried is vaccum dryer and transfered to packaging machine	continuous operation	

Ethylene diamine is charged into an agitated carbon steel reactor fitted with a heating/cooling coil. Process water is added to the reactor in order to get a 40.5% aqueous solution. The aqueous solution is heated to 40-45°C and carbon disulfide is added with good agitation. pH of solution drops from an initial level of 12.1-13.0 to about 9.3. At that point, 50% caustic and carbon disulfide are added simultaneously, the relative rates of addition being adjusted to maintain the pH of the reaction mixture at about 9.3.

During the addition, the temperature of the reaction mixture is kept at 40-45°C by circulating chilled water through the cooling coil.

A small amount of sodium hydroxide is then added to raise the pH to a final level of about 10.8.

During the reaction, crystals of disodium ethylene bis-dithiocarbamate hexahydrate precipate.

Traces of unreacted carbon disulfide are stripped by nitrogen and suspension is cooled to 25°C to precipitate more crystals.

The overall yield of nabam (in solid and liquid phases) is essentially quantitative.

The nabam suspension is pumped to an agitated tank where the solids concentration is adjusted to 20% .

The Zinc chloride solution (or the manganese sulfate solution) is prepared in a rubber lined agitated vessel.

The Zineb (or Maneb) mother liquors from a preceding batch are charged into an agitated, rubber lined reactor.

Zinc chloride solution and hydrochloric acid are added to the reactor in order to adjust the pH of the mixture (pH 3 to 5).

The disodium ethylene bis-dithiocarbamate hexahydrate suspension and the zinc chloride solution are added practically simultaneously (zinc chloride solution is slightly ahead of EBDC suspension) in order to have the reactants in substantially stoichiometrically equivalent amounts.

During the precipitation, the pH is controlled between 2.5 and 5 by addition of an aqueous hydrochloric solution.

Throughout this operation the temperature is maintained at 26-30°C.

The white zinc ethylene bis-dithiocarbamate precipitate is allowed to remain in the reaction mass for an additional 0.5 to 2 hours under the same operating conditions.

The precipitate is recovered in a basket centrifuge and water washed until the filtrate contains less than 0.1% of sodium salt.

The wet cake is then reslurried in water; the solids content of the suspension is about 40%.

This suspension is transfered to the spray drying feed tank and pumped continuously to the spray dryer.

The air heater is gas or fuel fired and the hot air temperature is around 300°C. In order to minimize the risk of explosion in the spray dryer, the moisture content of the predried solids is kept at 10% or above.

The solids are pneumatically conveyed to surge hoppers installed above a vacuum drying system.

Finally, Zineb (or Maneb) crystals are vacuum dried batchwise to a water content of 0.2%.

The dry products are pneumatically conveyed to the packaging machine feed hoppers and transfered to an automatic bagging machine.

The battery limits capital costs for a 1000 metric tons per year Zineb (or Maneb) plant is estimated at 4,27 million dollars (US) based on construction at a Kuweit location (Shuaiba Area) in the third quarter 1979. The components of the capital cost are summarized in Table 2.62.2. Specifications of the individual pieces of equipment are shown in appendix 3.6.

TABLE 2.62.2

INSIDE BATTERY LIMITS CAPITAL COST

MANEB/ ZINEB

1000 metric tons/yr

KUWEIT LOCATION - Third quarter of 1979

	1000 US Dollars
- Purchased equipment	1 460
- Equipment handling	80
- Concrete and steel	110
- Piping	438
- Instrumentation	190
- Electrical	161
- Insulation,paint & Misc.	95
- Buildings	453
- Direct cost	2 987
- Engineering	299
- Field construction,overhead & profit	597
- Base plant cost	3 883
- Contingencies (including contractors fee of 3%)	387
Inside Battery Limits Capital Cos	4 270

See revised table in annexe 1

TABLE 2.62.3

MANEB/ZINEB PRODUCTION UNIT- SECTION 600
CAPITAL SUMMARY

BASIS		CAPITAL INVESTMENT	$ Million
-Location	: KUWEIT	Inside battery limits	4,27
-Capacity	: Third quarter 1979 1000 metric tons per yr	Outside battery limits	1,80
		Total fixed investment	6,07
		Working Capital*	1,04
-ON-Stream Time:	8,000 hours per yr		

PRODUCTION COST SUMMARY : ZINEB

RAW MATERIALS	Units per kg	Price ¢/unit	Annual cost, $M	Cents per kg
Carbon disulfide, kg	0,543	33,0	179,190	
Ethylene diamine, kg	0,212	246,0	521,520	
Zinc chloride, kg	0,469	92,0	431,480	
Chemicals and additives			95,120	
Total raw materials			1,227,310	122,73
UTILITES				
Steam, 150psig, metricton	0,00012	700,0	840	
Glycol (0°C), 10^6kcal	0,00047	3550,0	16,690	
Power, KWH	0,6550	1,0	6,550	
Process water, m3	0,0150	19,0	2,850	
Fuel, 10^6kcal	0,0017	800,0	13,600	
Total utilities			40,530	4,05
OPERATING COSTS				
Labor, 15 men @$16,000/yr	3 men per shift		240,000	
Supervision, 5 men @$22,000/yr	1 man per shift		110,000	
Maint., material &Labor	6% of ISBL		256,200	
Total operating cost			606,200	60,62
OVERHEAD EXPENSES				
Direct Overhead	40 %(labor&sup.)		140,000	
General plant overhead	65 % Operating costs		394,030	
Insurance, property taxes	1.5% total invest.		91,050	
Depreciation	10 % total invest.		607,000	
Total overhead expenses			1,232,080	123,21
TOTAL COST OF PRODUCTION			3,106,120	310,61
BY-PRODUCT CREDIT				
Total by-product credit				
NET COST OF PRODUCTION			3,106,120	310,61
Return on Investment	30% Total investment		1,821,000	
Interest on Working Capital	10% working capit.		104,000	
Sales Expenses	-		-	
TRANSFER PRICE	92% technical product		5,031,120	503,11

(*equivalent to four months production costs)

PAGE	AFFAIRE	NUMERO	REV
	6002		

 See revised table in annexe 1

TABLE 2.62.4

MANEB/ZINEB PRODUCTION UNIT- SECTION 600

CAPITAL SUMMARY

BASIS		CAPITAL INVESTMENT	$ Million
-Location	: KUWEIT	Inside battery limits	4,27
-Capacity	: Third quarter 1979	Outside battery limits	1,80
	1000 metric tons per yr	Total fixed investment	6,07
		Working Capital*	1,04

-ON-Stream Time: 8,000 hours per yr

PRODUCTION COST SUMMARY: MANEB

RAW MATERIALS	Units per kg	Price ¢/unit	Annuel cost,$M	Cents per kg
Carbon disulfide,kg	0,607	33,0	200,310	
Ethylene diamine,kg	0,239	246,0	587,940	
Manganese sulfate, kg	0,575	62,o	356,500	
Chemicals and additives			99,640	
Total raw materials			1,244,390	124,44
UTILITES				
Steam,150psig,metricton	0,00012	700,0	840	
Glycol (0°C), 10^6kcal	0,00053	3550,0	18,820	
Power, Kwh	0,7342	1,0	7,350	
Process water, m3	0,01656	19,0	3,150	
Fuel, 10^6 kcal	0,0017	800,0	13,600	
Total utilities			43,760	4,38
OPERATING COSTS				
Labor, 15 men @$16,000/yr 3 men per shift			240,000	
Supervision,5men @$22,000/yr1 man per shift			110,000	
Maint.,material &Labor 6% of ISBL			256,200	
Total operating cost			606,200	60,62
OVERHEAD EXPENSES				
Direct Overhead 40 %(labor&sup.)			140,000	
General plant overhead 65 % Operating costs			394,030	
Insurance, property taxes 1.5% total invest.			91,050	
Depreciation 10 % total invest.			607,000	
Total overhead expenses			1,232,080	123,21
TOTAL COST OF PRODUCTION			3,126,430	312,65
BY-PRODUCT CREDIT				
Total by-product credit				
NET COST OF PRODUCTION			3,126,430	312,65
Return on Investment 30% Total investment			1,821,000	
Interest on Working Capital 10% working capit.			104,000	
Sales Expenses			-	
TRANSFER PRICE 92% technical product			5,051,430	505,14

(*equivalent to four months production costs)

PAGE	AFFAIRE	NUMERO	REV
	6002		

The costs of production of technical Maneb and Zineb (92% pure product + 7-8% additives + 0-1% miscellaneous) from this facility are respectively estimated at 3.13 dollars/kg and 3.11 dollars/kg. Component costs are shown in Tables 2.62.3 and 2.62.4. The transfer prices, including a 30% pretax return on investment and 10% interest on working capital are:

Maneb : 5.05 $/kg
Zineb : 5.03 $/kg

These prices are based on carbon disulfide at 33 cents/kg, ethylene diamine at 246 cents/kg, Zinc chloride at 92 cents/kg and Manganese sulfate monohydrate at 62 cents/kg (price based on 100% $MnSO_4$).

The structure of the two costs of production is presented in Table 2.62.5.

The costs of production of Maneb and Zineb are fairly sensitive to capital cost, since a 20% increase of the capital cost would increase these costs of production of 22.3 cents per kg (i.e. 7.2%).

The costs of raw materials account for about 40% of the costs of production of Maneb and Zineb; however, the most significant reactant is ethylene diamine which accounts for about 16-19% of the costs of production.

TABLE 2.62.5

COSTS OF PRODUCTION BREAKDOWN

	MANEB	ZINEB
• Raw materials:		
– Carbon disulfide	6.4 %	5.8 %
– Ethylene diamine	18.8 %	16.8 %
– Manganese sulfate	11.4 %	
– Zinc chloride		13.9 %
– Miscellaneous	3.2 %	3.0 %
Total	39.8 %	39.5 %
• Utilities	1.4 %	1.3 %
• Operating costs	19.4 %	19.5 %
• Overhead expenses	39.4 %	39.7 %
Total cost of production	100.0 %	100.0 %

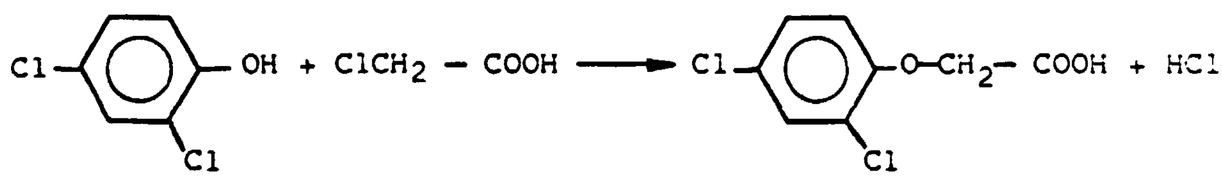
2.7 - 2,4 DICHLOROPHENOXYACETIC ACID, AMINE SALT

2.71 Background and Chemistry

One of the major aromatic-based herbicide is 2,4 dichlorophenoxy acetic acid (or 2,4 D). It is used in the control of broad-leaved annual weeds in grain fields and of herbaceous weeds in pasture lands. It is also used as a general herbicide.

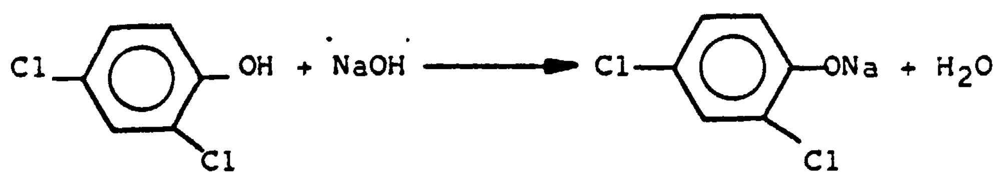
The most important derivatives of 2,4 D are the amine salts and alkyl esters.

Superficially, the overall reaction appears quite simple, i.e. monochloroacetic acid reacts with 2,4 dichlorophenol:



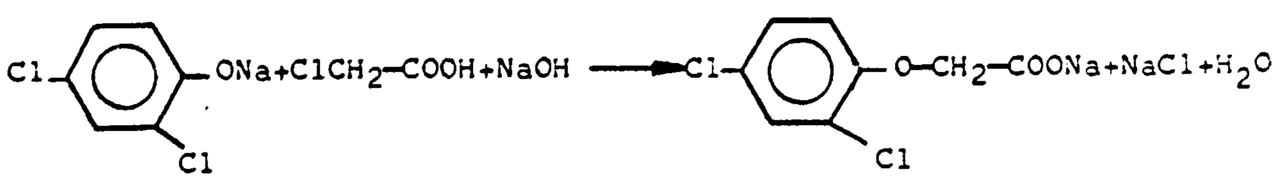
However, this operation has to be carried out in three steps:

i) dichlorophenate production

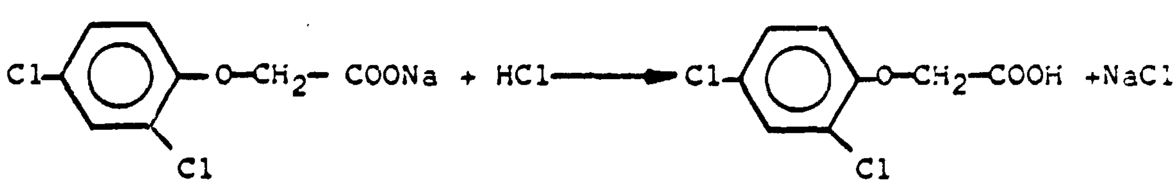


2,4 dichlorophenol 2,4 dichlorophenate

ii) Sodium salt of 2,4 D production

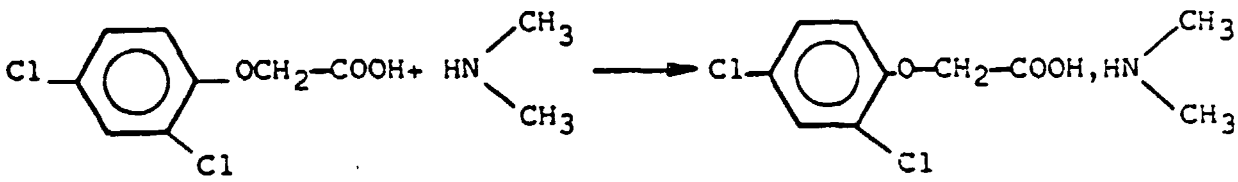


iii) 2,4 D recovery



2,4 D

2,4 D recovered as solid, is dryed and subsequently reacted with an amine to form the 2,4 D amine salt; various amines can be used, however, the only product presented in this chapter is the dimethylamine salt:

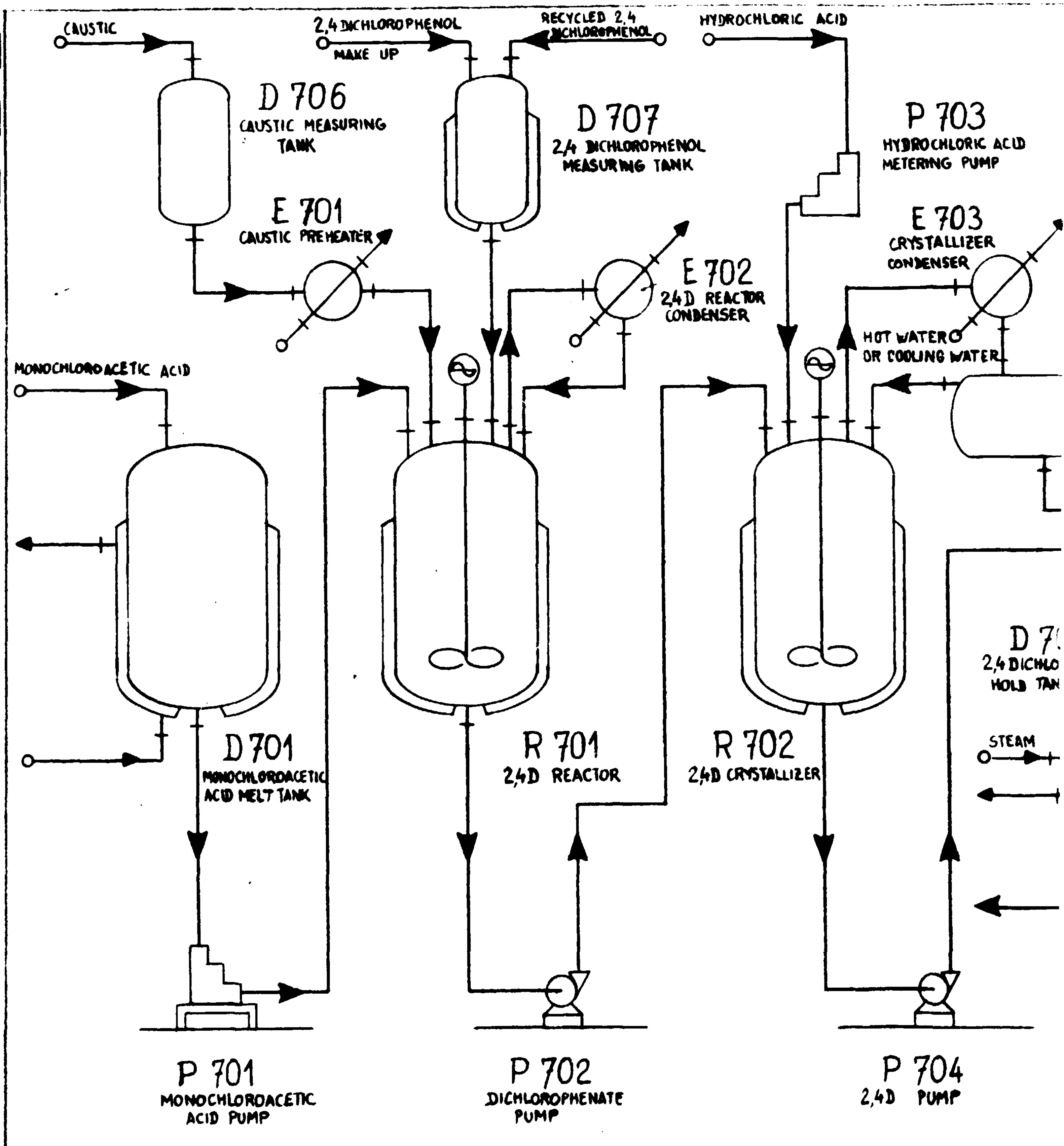


2,4 D dimethylamine 2,4 D dimethylamine salt

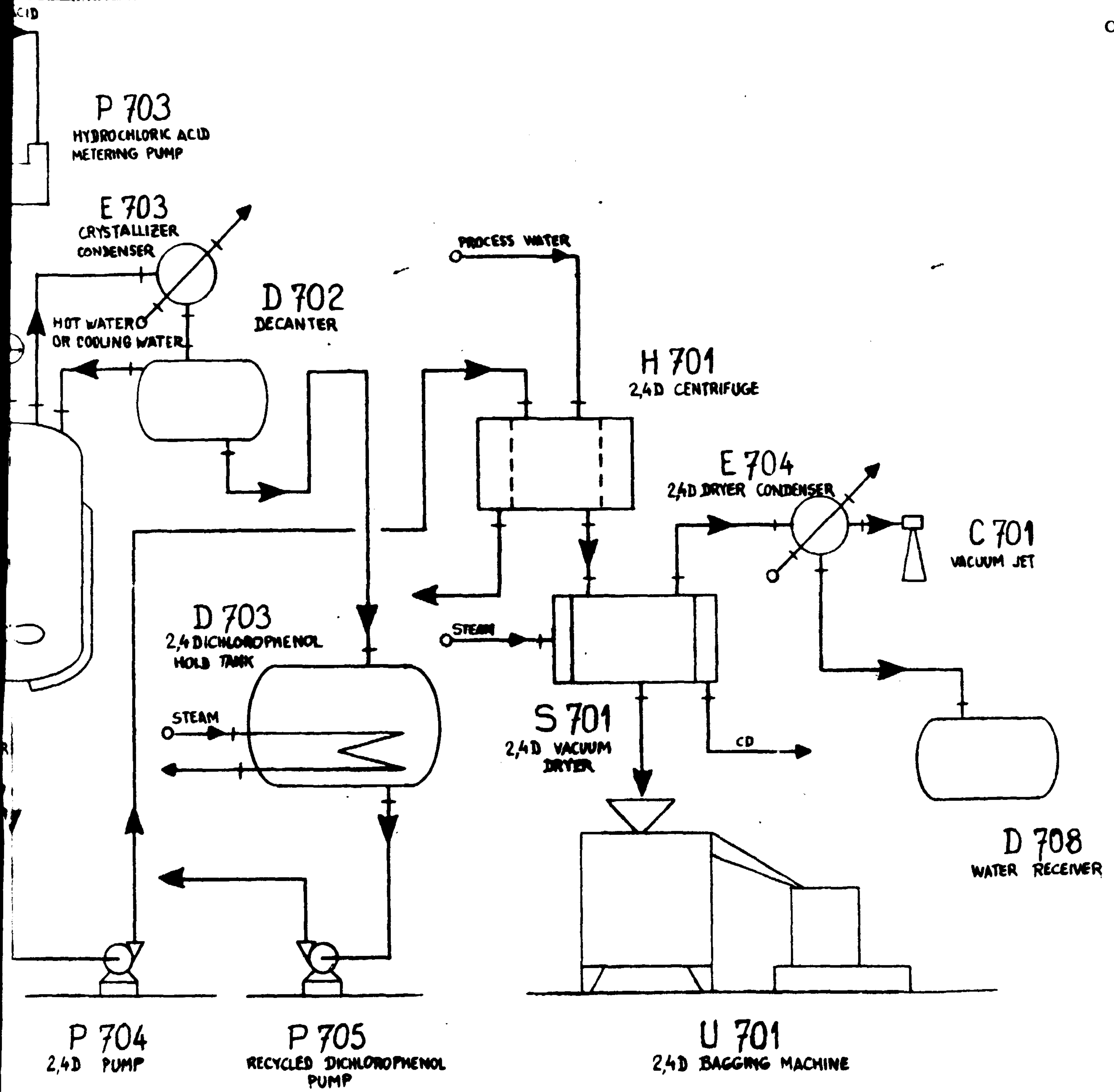
2.72 Process design and Economics

Figure 6002-PX-700 is a flow sheet for the batch production of 2,4 dichlorophenoxyacetic acid (2,4 D) by the reaction of monochloroacetic acid with 2,4 dichlorophenol.

The design is based on three shifts per day, 7 days a week, 8000 hours per year schedule. A complete 2,4 D batch can be made in 20 hours in accordance with the following production schedule:

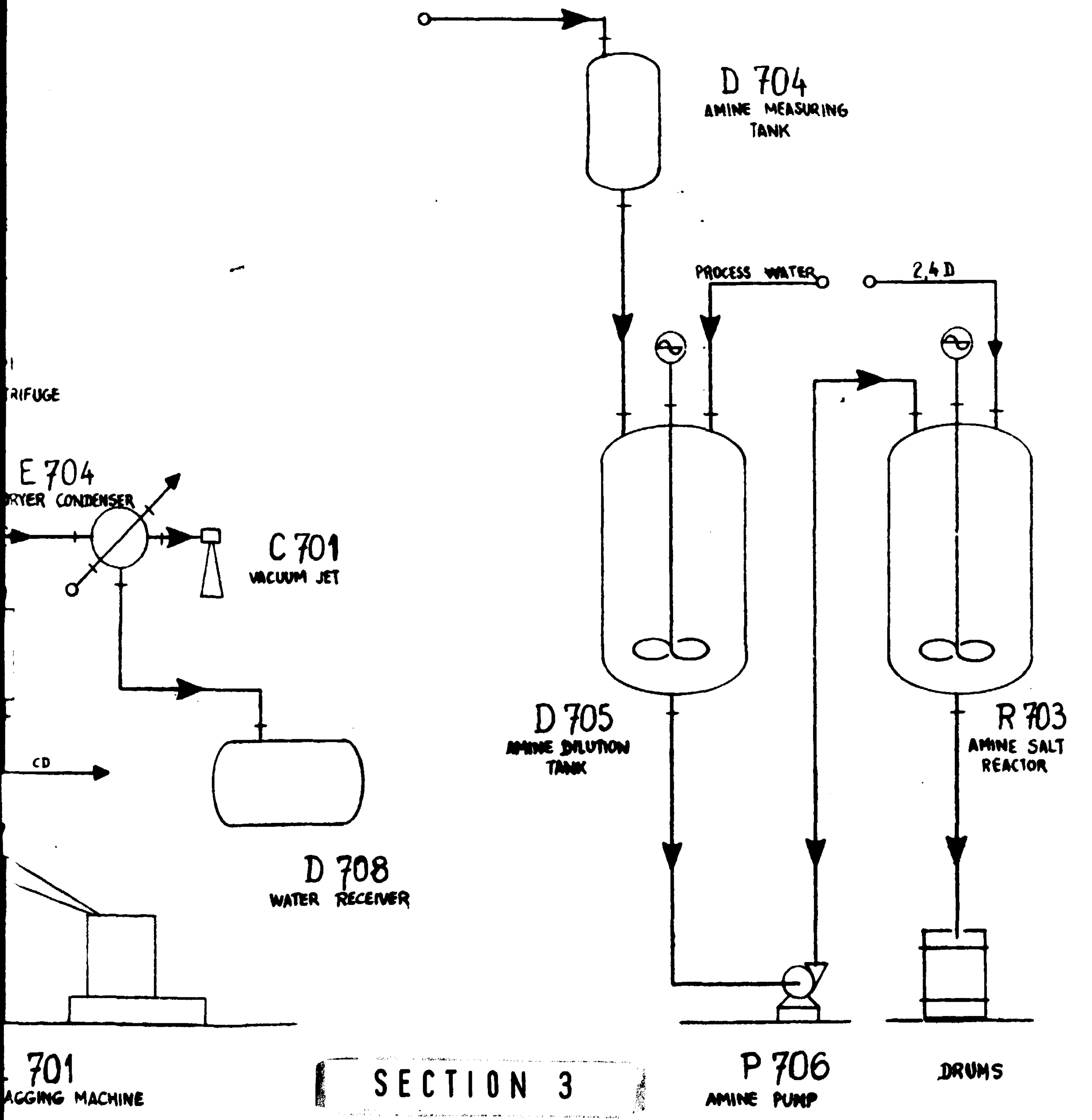

CAUSTIC
2,4 DICHLOROPHENOL
MAKE UP
RECYCLED 2,4 DICHLOROPHENOL
HYDROCHLORIC ACID
D 706
CAUSTIC MEASURING TANK
D 707
2,4 DICHLOROPHENOL MEASURING TANK
P 703
HYDROCHLORIC ACID METERING PUMP
E 701
CAUSTIC PREHEATER
E 702
2,4D REACTOR CONDENSER
E 703
CRYSTALLIZER CONDENSER
HOT WATER OR COOLING WATER
MONOCHLOROACETIC ACID
D 701
MONOCHLOROACETIC ACID MELT TANK
R 701
2,4D REACTOR
R 702
2,4D CRYSTALLIZER
STEAM
P 701
MONOCHLOROACETIC ACID PUMP
P 702
DICHLOROPHENATE PUMP
P 704
2,4D PUMP

SECTION 1



SECTION 2

-CLIENT-
UNIDO
-UNITE-
2,4D-AMINE S



Ce document contenant des informations confidentielles est la propriété de C.D.I et ne peut être reproduit ou [illegible]	CHIMIE DEVELOPPEMENT INTERNATIONAL 42 rue Legendre PARIS 17e Tel 766-29-10 -
-CLIENT- UNIDO	SECTION 700
-UNITE- 2,4 D-AMINE SALT	FIGURE 6002-PX-700

TABLE 2.72.1

2,4 DICHLOROPHENOXY ACETIC ACID PRODUCTION SCHEDULE

Operation	Time	Item n°
- Molten dichlorophenol is charged into reactor	0.5 hr	R 701
- Caustic solution is added to dichlorophenol	0.5 hr	R 701
- Dichlorophenolate production	1.0 hr	R 701
- Molten monochloroacetic is added to the dichlorophenolate at 60 90°C and atmospheric pressure	8.0 hrs	R 701
- Reaction mixture is transfered to crystallizer	0.5 hr	R701/R702
- Mixture is acidified to pH5	0.5 hr	R 702
- Mixture is heated to 100°C	2.0 hrs	R 702
- 2,4 dichlorophenol is steam distilled	3.0 hrs	R 702
- Crude product is cooled to 40°C	5.0 hrs	R 702
- pH is reduced to 1 and 2,4 D precipitates	2.0 hrs	R 702
- 2,4 D is filtered and washed in centrifuge	6.0 hrs	R702/H701

TABLE 2.72.2

2,4 D amine salt production schedule

Operation	Time	Item n°
- Dimethylamine solution is charged into dilution tank	0.5 hr	D 705
- Dimethylamine solution is diluted by process water	1.0 hr	D 705
- Amine solution is transfered to reactor	0.5 hr	D705/R703
- 2,4 D solids (wet or dry) are added to amine solution	1.0 hr	R 703
- Reactant are kept in contact for one hour	1.0 hr	R 703
- 2,4 D amine salt solution is transfered into drums	2.0 hrs	R 703

Amine salt production is completely independant from 2,4 D production and could actually be made from purchased 2,4 D.

Molten dichlorophenol and 50% caustic solution are charged into an agitated, jacketed stainless steel reactor. Monochloroacetic acid is then gradually added under agitation to the phenate solution. During the reaction the temperature is maintained between 60 and 80°C and the pH is kept above 7 by introduction of 50% caustic in the reaction mixture.

When the reaction is complete, the mixture is transfered to an agitated, jacketed glass lined reactor where excess dichlorophenol (50% excess with respect to monochloroacetic acid) is recovered.

The reaction mixture is acidified to pH 5 by treatment with hydrochloric acid; sodium dichlorophenate is then converted to dichlorophenol which is insoluble in the aqueous phase. The two phases are heated up and the dichlorophenol is removed by steam distillation. The dichlorophenol steam mixture is condensed overhead by hot water and the heterogeneous liquid mixture is allowed to decant. The dichlorophenol layer is recovered for reuse in the next batch.

The hot mixture left in the reactor is cooled to 40°C by circulating cooling water in the reactor jacket.

Hydrochloric acid is added to the cool agitated mixture and the 2,4 D acid precipitates from the solution as fine white crystals when the pH is about 1.

The slurry is then pumped to a bottom discharge basket centrifuge. The solids are washed with water until free of sodium chloride and discharged into an agitated vacuum dryer.

Various useful amine salts can be produced from 2,4 D acid, however, the description will only deal with one product: the dimethylamine salt.

A 40% dimethyl amine solution is charged into an agitated tank. The amine solution is then diluted to 14% by process water. The dilute amine solution is pumped to an agitated stainless steel reactor and the 2,4 D solids are added to the amine solution.

When all the crystals are dissolved, the reaction is complete, and if deemed necessary, various additives are added to the mixture. Finally, the resulting solution is analyzed and metered into drums. The inside battery limits capital costs for a 600 metric tons per year 2,4 dichlorophenoxyacetic acid plant is estimated at 1.65 million dollars (US) based on construction at a Kuweit location (Shuaiba Area) in the third quarter 1979. The oomponents of the capital cost are summarized in Table 2.72.3. Specifications of the individual pieces of equipment are shown in appendix 3.7.

The costs of production of 2,4 D acid and 2,4 D-DMA salt from this facility are estimated at 323.7 and 310.04 cents per kg respectively (Note: 2,4 D acid plant capacity: 600 t/year and 2,4 D-DMA salt capacity: 720 t/year).

The transfer prices, including a 30% pretax return on investment and a 10% interest on working capital are:

2,4 D acid : 476.03 cents per kg

2,4 D-DMA salt : 438.37 cents per kg

The structure of the cost of production of 2,4 D acid and 2,4 D-DMA salt are presented in Table 2.72.6.

TABLE 2.72.3

INSIDE BATTERY LIMITS CAPITAL COST

2,4 D AMINE SALTS

600 metric tons (2,4 D)/yr

KUWEIT LOCATION- Third quarter of 1979

	1000 US Dollars
- Purchased equipment	551
- Equipment handling	33
- Concrete and steel	47
- Piping	154
- Instrumentation	66
- Electrical	55
- Insulation, paint and misc.	45
- Buildings	198
- Direct cost	1149
- Engineering	115
- Field construction, overhead & profit	230
- Base plant cost	1494
- Contingencies (including contractors fee of 3%)	149
Inside battery limits capital cost	1643

See revised table in annexe 1

TABLE 2.72.4

2,4 DICHLOROPHENOXY ACETIC ACID PRODUCTION UNIT- SECTION 700

CAPITAL SUMMARY

BASIS

- Location : KUWEIT
- Capacity : Third quarter 1979 600 metric tons per yr
- ON-Stream Time: 8,000 hours per yr

CAPITAL INVESTMENT	$ Million
Inside battery limits	1.65
Outside battery limits	1.18
Total fixed investment	2.83
Working Capital*	0.65

PRODUCTION COST SUMMARY

RAW MATERIALS	Units per kg	Price ¢/unit	Annual cost,$M	Cents per kg
2,4 dichloropheno, kg	0.740	118.0	523,920	
Monochloroacetic acid,kg	0.430	90.0	232,200	
Sodium hydroxide (100%),kg	0.470	23.0	64,860	
Hydrochloric acid (100%),kg	0.280	24.0	40,320	
Total raw materials			861,300	143.55
UTILITES				
Steam,150psig,metricton	0.0084	700.0	35,280	
Cooling water, m3	0.3920	1.0	2,360	
Power, Kwh	0.1220	1.0	740	
Process water, m3	0.0015	19.0	180	
Total utilities			38,560	6.43
OPERATING COSTS				
Labor, 10 men @$16,000/yr 2 men per shift			160,000	
Supervision,5 men @$22,000/yr1 man per shift			110,000	
Maint.,material &Labor 6% of ISBL			99,000	
Total operating cost			369,000	61,50
OVERHEAD EXPENSES				
Direct Overhead 40 %(labor&sup.)			108,000	
General plant overhead 65 % Operating costs			239,850	
Insurance, property taxes 1.5% total invest.			42,450	
Depreciation 10 % total invest.			283,000	
Total overhead expenses			673,300	112.22
TOTAL COST OF PRODUCTION			1,942,160	323.70
BY-PRODUCT CREDIT				
Total by-product credit			1,942,160	323.70
NET COST OF PRODUCTION				
Return on Investment 30% Total investment			849,000	
Interest on Working Capital 10% working capit.			65,000	
Sales Expenses -			-	
TRANSFER PRICE (99% plus 2,4D acid)			2,856,160	476.03

(*equivalent to four months production costs)

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See revised table in annexe 1

TABLE 2.72.5

2,4 D DIMETHYLAMINE SALT PRODUCTION UNIT - SECTION 700

CAPITAL SUMMARY

BASIS		CAPITAL INVESTMENT	$ Million
Location	: KUWEIT	Inside battery limits	1.65
Capacity	: Third quarter 1979	Outside battery limits	1.18
	720 metric tons per yr	Total fixed investment	2.83
		Working Capital•	0.75
ON-Stream Time:	8,000 hours per yr		

PRODUCTION COST SUMMARY

RAW MATERIALS	Units per kg	Price ¢/unit	Annuel cost, $M	Cents per kg
2,4 dichlorophenol, kg	0.6167	118.0	523,950	
Monochloroacetic acid, kg	0.3584	90.0	232,240	
Dimethylamine, kg	0.1667	105.0	126,030	
Sodium hydroxide (100%), kg	0.3917	23.0	64,870	
Hydrochloric acid (100%), kg	0.2333	24.0	40.310	
Total raw materials			987,400	137.14
UTILITES				
Steam, 150psig, metricton	0.0070	700.0	35,280	
Cooling water, m3	0.3267	1.0	2,360	
Power, Kwh	0.1017	1.0	740	
Process water, m3	0.0013	19.0	180	
Total utilities			38,560	5,36
OPERATING COSTS				
Labor, 15 men @$16,000/yr	3 men per shift		240,000	
Supervision, 5 men @$22,000/yr	1 man per shift		110,000	
Maint., material &Labor	6% of ISBL		99,000	
Total operating cost			449,000	62,36
OVERHEAD EXPENSES				
Direct Overhead	40 % (labor&sup.)		140,000	
General plant overhead	65 % Operating costs		291,850	
Insurance, property taxes	1.5% total invest.		42,450	
Depreciation	10 % total invest.		283,000	
Total overhead expenses			757,300	105,18
TOTAL COST OF PRODUCTION			2,232,260	310.04
BY-PRODUCT CREDIT				
Total by-product credit				
NET COST OF PRODUCTION			2,232,260	310.04
Return on Investment	30% Total investment		849,000	
Interest on Working Capital	10% working capit.		75,000	
Sales Expenses	-			
TRANSFER PRICE (100% 2,4 D-DMA salt)			3,156,260	438.37

(•equivalent to four months production costs)

TABLE 2.72.6

COST OF PRODUCTION BREAKDOWN

	2,4 D acid	2,4 D-DMA salt
. Raw materials	44.3 %	44.3 %
. Utilities	2.0 %	1.7 %
. Operating costs	19.0 %	20.1 %
. Overhead expenses	34.7 %	33.9 %
Total cost of production	100.0 %	100.0 %

The costs of production of 2,4 D acid and 2,4 D-DMA salt are not very sensitive to capital cost, since a 20% increase of the capital cost would only increase the costs of production of 5.0 % (16.3 ¢ /kg) and 4.4 % (13.6 ¢ /kg).

The cost of raw materials and, more specifically, the cost of 2,4 dichlorophenol is the most significant factor of the cost of production.

It should be noted that 2,4 D esters can also be produced campaignwise in the R702- E703-D702 system.

2.8 - OFFSITE FACILITIES

2.81 Storage

The bulk storage of fluids and solids is mostly made of flat bottom tanks and transfer pumps. As specified in the design basis, the storage capacities are as follows:

- Raw materials : 15 days *
- Products : 30 days

The technical specifications of the individual pieces of equipment are presented in appendix 6.8.

As far as the solids are concerned, they are assumed to be received and/or shipped on 1000 kg pallets, stored in ground level warehouses and stocked in 2 levels.

The only exception is phosphorus pentasulfide which is received in tote bins and transfered to a bulk storage silo.

It should noted that the costs of the non standard shipping containers (steel cylinders for monomethyl and dimethyl-amines, P_2S_5 tote bins, ...) were not taken into account since they depend upon the suppliers policy. In other words, at a later stage of the project it will be necessary to discuss with the potential suppliers so as to determine the most suitable way of shipping and raw materials.

The cost of the various pieces of equipment and the cost of the warehouses was divided according to the quantities of products used in the various production units.

2.82 Waste disposal

2.82.1 Liquid effluents

The organic wastes are collected and transfered to the organic wastes storage tank prior to their incineration with much excess air in the incinerator.

* In revised economics annexed to the final report Annex 1, both raw materials and products storage capacities have been expanded to 3 months.

The aqueous wastes are drained in a specific sewer system connected to aqueous effluents holding pits. Moreover, the production facilities are diked and any runoff from malfuncion or any spill is collected in these holding pits.

From these underground holding pits, the aqueous wastes are pumped to neutralization-decantation tanks where they are treated with caustic and/or hydrochloric acid- when the neutralization is complete, the mixture is allowed to decant for about 16-24 hours. The organic layer is then pumped to the organic waste storage tank and the aqueous layer is pumped to battery limits. In this very simple neutralization operation, some toxic substances are changed to non toxic compounds, however other compounds (i.e. dichlorophenol) are left unchanged. It may therefore be necessary to add more sophisticated treatment systems such as a biologically active trickling filter, a biological treatment plant, an activated carbon adsorption column, etc...

In this preliminary study, the cost of the waste treatment unit only includes the cost of the neutralization-decantation system. This was made on purpose since the definition of the secondary treatment facilities would require extensive work not justified for a preliminary study. Moreover, they may not be required in certain areas.

The cost of the neutralization unit was split between sections 100-700 according to the quantity of effluents produced by every section (see Table 2.82.1)
For this plant, we recommand an activated carbon adsorphon unit. This type of unit can handle the organics dissolved in water resulting from the chemical operations described here. Moreover, such a unit is very flexible and could also handle other compounds, should other pesticide products be made in this plant at a later date.

Such units are standard and can be purchased from such componies as CECA in France.

TABLE 2.82.1

SUMMARY OF LIQUID WASTES (daily average)

Section	Water (kg/day)	Organics (kg/day)	Inorganics (kg/day)
S 100			
S 200	5205	581	757
S 300	5263	294	17
S 400	7056	1594	22
S 500	54317	3849	5146
S 600	68383	164	2116
S 700	17321	53	2287
	157545	6535	10345

2.82.2 Solid wastes

Approximately 1500 kg of solids wastes (filter cakes...) are produced every day. They are mostly coming from the dithiophosphoric acid unit (S100); they can be detoxified with NaOH and buried with lye in an approved landfill.

2.82.3 Gaseous effluents

The most important gaseous waste is H_2S co-produced with dithiophosphoric acid (about 1140 kg/day plus small amounts of toluene and methanol).

This compound is burned with a large excess of air in an incinerator and SO_2 produced is discharged to atmosphere. Besides, the incinerator is designed for handling H_2S and the toxic liquid wastes.

The other gaseous wastes are mainly air and/or CO_2 (neutralization with Na_2CO_3 or $NaHCO_3$) containing small amounts of solvents and traces of active ingredients. Most of them, are treated in caustic scrubber, prior to their discharge to atmosphere.

2.82.4 Utilities

The utilities are assumed to be purchased from a central producing unit of the industrial development area, i.e. the capital cost of the boilers, cooling towers, etc.. are not included in the outside battery limits capital cost.

The utility requirements of the whole plant are listed hereafter:

- STEAM : . 150 psig saturated steam
  - . steam requirements: 10 metric tons/hour
- "-20°C" GLYCOL SOLUTION:
  - . supply : -20°C; return : -10°C
  - . requirements: 2.85 x 10^6 kcal/hr
- "0°C" GLYCOL SOLUTION:
  - . supply: 0°C; return : +10°C
  - . requirements: 0.87 x 10^6 kcal/hr
- COOLING WATER:
  - . supply: 30°C; return: 40°C
  - . requirements: 580 m3/hr

  (the glycol units cooling requirements are not included in this figure)
- POWER :.220/380 Volts - 3 phases
  - .requirements: 500 Kwh/H
- PROCESS WATER:
  - . filtered and dionized "town" water
  - . requirements : 15 m3/hr
- INERT GAS:
  - . Nitrogen - 6 bar gage - dew point:-30°C
  - . requirements: 30 m3/hr @ 20°C -760 mmHg
- COMPRESSED AIR:
  - . 6 bar gage - dew point: -30°C
  - . requirements: 150 m3/hr @ 20°C- 760 mmHg

3- ORGANIZATION and MANPOWER

Irrespective of ownership structure, the management organisation must be clearly related to the objectives of the sponsors and the tasks to be performed, and should be flexible to meet the changing nature of the tasks as the project develops.

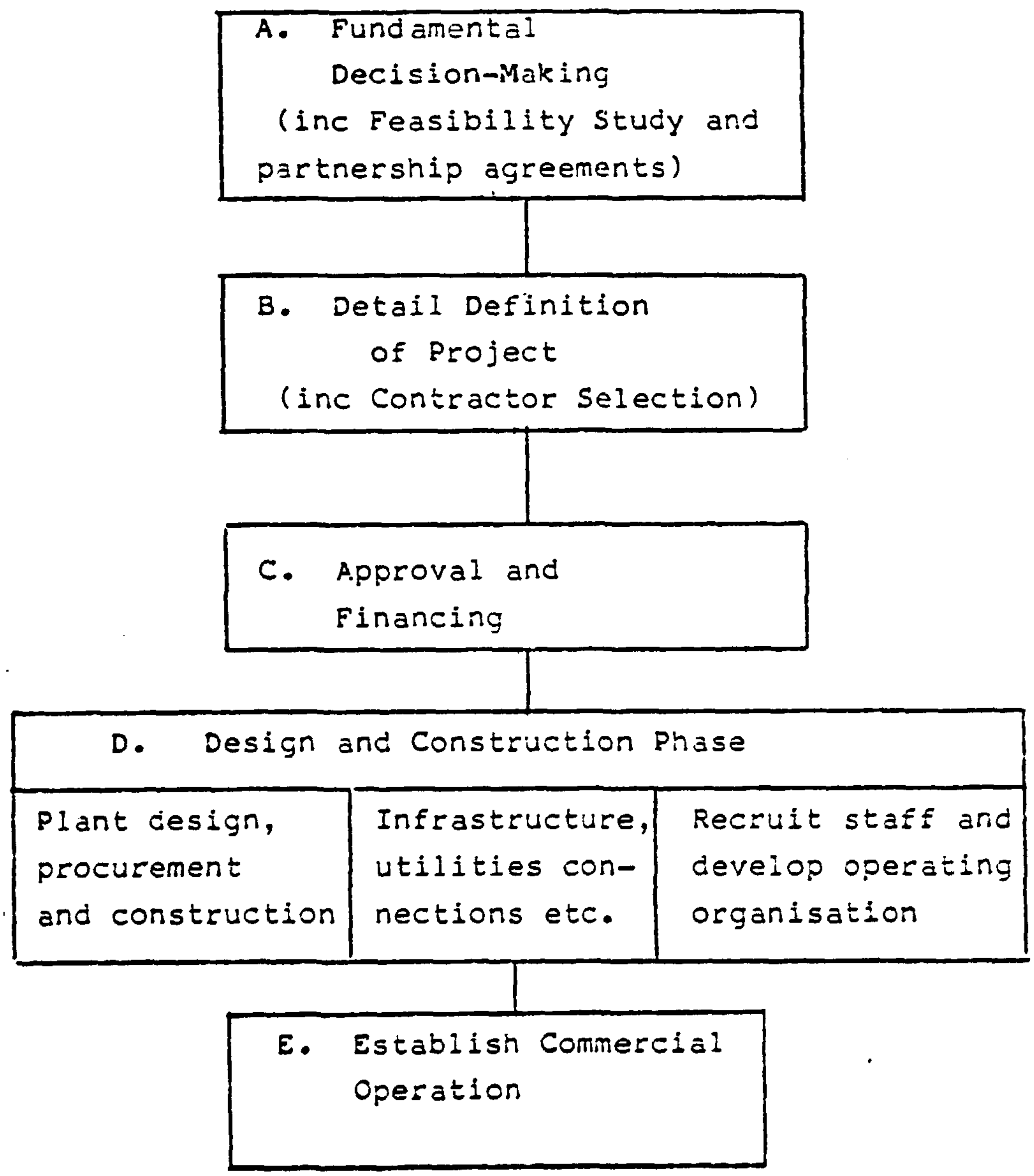
3.1 - PROJECT IMPLEMENTATION

The primary objective is seen as the establishment of a commercially successful venture producing basic pesticides and insecticides. Also, the project will provide useful employment and form a basis for future development.

A schedule of "project implementation" is given in Section 5 and figure 3.10.1 gives a simplified representation of the overall task. The appropriate organizational and manpower considerations are discussed below in relation to the main stages indicated by the figure.

FIGURE 3.10.1

MAIN ASPECTS OF PROJECT IMPLEMENTATION



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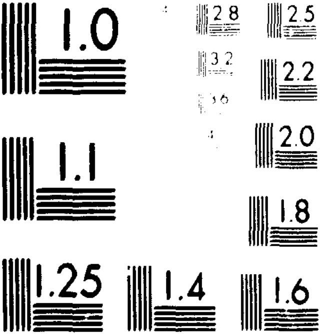

MICROCOPY RESOLUTION TEST CHART

A- Fundamental Decision-Making

Before seeki g contractor bids, certain fundamental decisions have to be made which will establish the whole pattern for the project, such a plant location, size, final product mix, partnership agreements and/or availabity of licensed know-how.

B- Detail Definition of Project

The main objective of this stage is to obtain and evaluate contractor bids for plant design supply and construction. However, there are numerous other activities which must proceed in parallel, such as negotiation of feedstock contracts and establishing details of financing. This is a task which requires skilful handling to obtain the best results. Oversights at this stage can have costly long-run effects. It is therefore recommended that a full-time Project Manager be appointed. The Project Manager should have experience in the bidding stage and in the execution of major projects. It is also essential that he be backed-up with appropriate expert support and advice, and be given authority to make the necessary decisions including commitment of expenditure within budget. Because of the number of aspects to be considered, it is recommended that a "steering committee" be appointed to assist the Project Manager, which can be attended by various specialists and responsible persons as necessary. Major decisions would obviously have to be ratified by the project sponsors themselves.

C- Approval and Financing

When plant bids have been obtained and evaluated, the project sponsors should be able to review the overall development of the project, finalise financing arrangements, and give the definitive go-ahead to the project. This stage is in a sense a continuation of the definition stage and the same structure of a steering committee plus Project Manager is recommended.

D. Design and Construction Phase

Activities during this phase cover not only the work of the plant contractor, but also questions of infrastructure development and the establishment of the operating organisation. Figure 3.10.2 shows the organisation that should be built up during this phase, and would be expected to set the basic pattern for the stage of commercial operation.

The various managers indicated by Figure 3.10.2 would have to be carefully selected and recruitment should start at an early stage, since each will have to recruit and train further staff ready for commercial operation. The Project Manager appointed earlier should continue with the project, reporting to the General Manager, until plant completion. Tasks of the individual managers in this phase are outlined below:

• General Manager

He must keep the objective of commercial viability in mind and give the overall direction needed. He will have to ensure that efforts to monitor the contractor do not result in delay to the work, and be ready to give a lead in overcoming obstacles as they arise. At the same time he will have to give a lead in developing the systems and procedures to ensure efficient coordination of company activities. Above all he must be responsible for selection of key staff and encouraging them to work as a team.

• Project Manager

He will have the primary responsibility to ensure that the plant is completed and is operational on schedule. This will require experienced judgement and adequate decision-making authority. It is therefore recommended that the Project Manager should also have the position of Deputy General Manager with authority to give instructions in the absence of the General Manager himself.

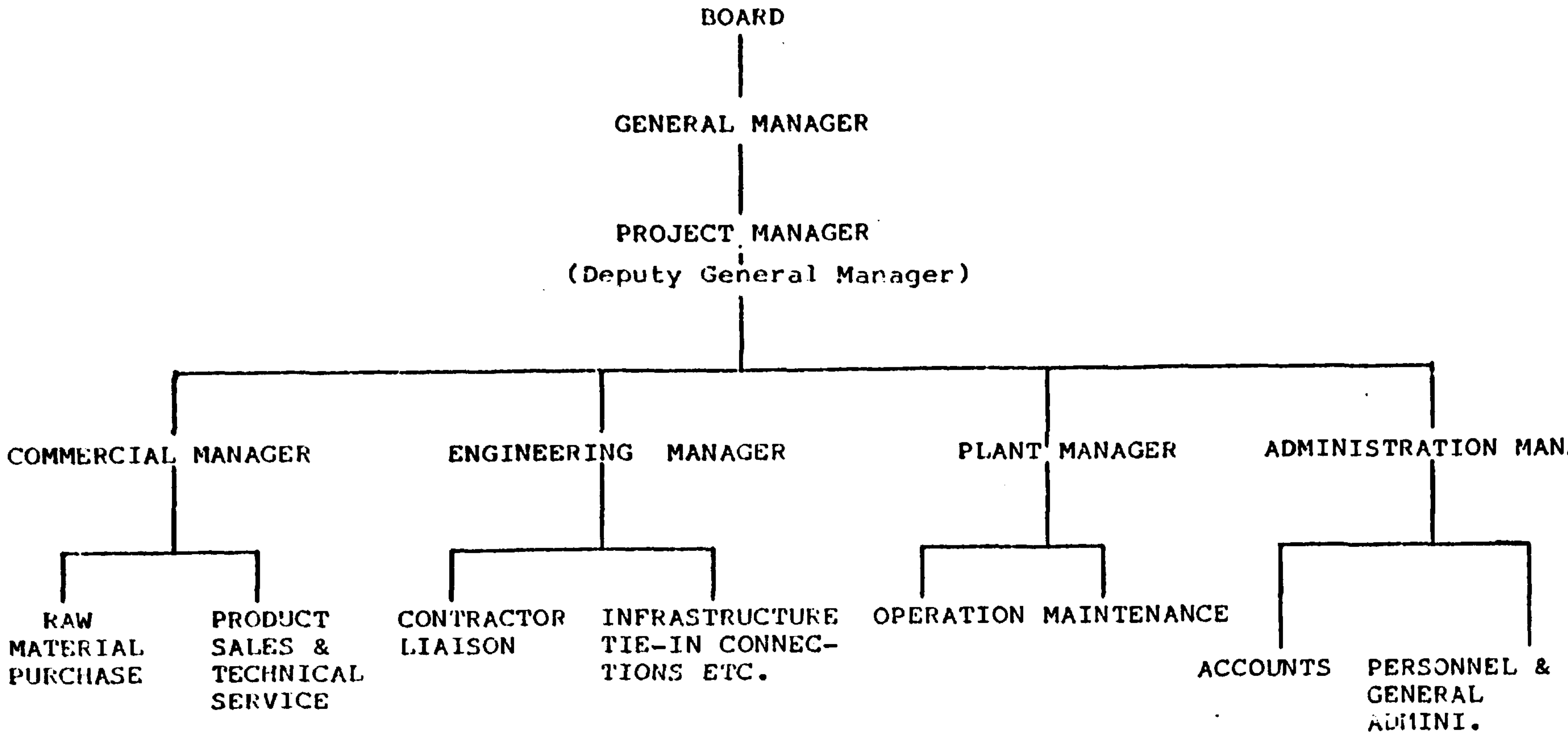

FIGURE 3.10.2

OUTLINE OPERATING ORGANISATION

• Commercial Manager

Feedstock purchase and the sale of bulk pesticides and insecticides need to be well planned in advance of plant operation and to be closely coodinated subsequently. It is therefore recommended that one experienced person be responsible for both aspects as Commercial Manager. Since the products selected have been used for a fairly long time and are mainly bought by established pesticide formulators, technical service back-up could be limited. Thus, the commercial department should be relatively small, i.e. manager, assistant for feedstock purchasing, assistant for product sales, assistant for technical service and clerical back-up.

• Engineering Manager

The Engineering Manager would assist the Project Manager in contractor supervision during this phase. However, equally important will be what can be described as "interface" activities, such as ensuring that all of the services and back-up within the owners' scope are provided to enable the contractor to work efficiently.

• Plant Manager

The Plant Manager should become responsible for plant operation and maintenance once it has been handed over by the contractor. Prior to that time, he will have the major task of organising the recruitment and training of plant staff.

• Administration Manager

Since the project sponsors will most likely be responsible for financing the project, it is not considered necessary to have a full-time high level financial officer, and responsibility for accounting could be combined with personnel and general administration.

• Establishing Commercial Operation

This is a critical time, when both the plant and the organisation must be brought into full operation. Clear definition of responsibilities between owner and contractor are necessary to minimize possibilities of conflict. Close cooperation is necessary together with patience in the face of the many minor snags which will have to be overcome.

During plant commissioning, a larger number of qualified staff is needed than that required for normal operation. This can be most readily accommodated by use of contractor's staff.

3.2-PERMANENT MANPOWER REQUIREMENTS

Actual manpower levels for operating plants can vary widely between different countries and companies. There are many reasons for this, including the level of staff turnover, number being trained, extent to which maintenance and service work is contracted out, etc. Table 3.10.3 represents Chem Systems' estimate of a reasonable level of staffing for an Arab Location.

Of the total staff level of 195, the largest proportion is of plant operation staff, due to the need to staff the plant 24 hours per day, seven days per week. A typical shift would comprise the following operating staff:

Supervisors : 5 to 7

Shift operators
product dispatch
helpers : 15

With a normal 40 hour-week, it would take 4.2 men to fill each shift post with no allowance for holidays, sickness, etc.... Therefore a figure of 5 has been used to arrive at the total of 75 operators.

Maintenance represents the next largest number of staff. It is assumed that on each shift there will be an instrument technician, an electrician and a pipefitter or mechanical fitter.

TABLE 3.10.3

ESTIMATED PERMANENT MANPOWER REQUIREMENT

• General Manager	1	
• Deputy general Manager	1	
• Clerical staff	2	
• Departments:		
• Commercial :		
Manager	1	
Assistants	3	
Clerical staff	4	
• Engineering:		
Manager	1	
Engineers	2	
Clerks and secretary	3	
• Plant Operation and Laboratory:		
Plant manager	1	
Shift supervisors	27	
Shift operators (product dispatch-helpers(	75	
Chief chemist	1	
Chemists	3	
Clerical staff	4	
• Plant Maintenance:		
Superintendent	1	(reporting to the
Shift crafstmen	15	plant manager)
Skilled-semi-skilled (day workers (	15	
Clerical staff	5	
• Administration and Accounting:		
Administration manager	1	
Personnel Director (	1	(reporting to the
Safety Director (	1	Administration
Medical Director (	1	Manager)
Chief Accountment (	1	
Accountants	10	
Clerical staff and others	15	
• Total staff	195	

4 - FINANCIAL ANALYSIS *

4.1 - INTRODUCTION

The cost of production of the individual products presented in chapter two are based on the performance data and capital cost estimates developed in the course of the design work.

Capital costs have been estimated from the individual equipment costs and adjusted for a Middle East location (based on Chem System's experience of detailed cost estimate analysis in various countries of the world).

As far as labour and utilities costs are concerned, they are typical figures used in Kuwait (Shuaiba Area- second/third quarter 1979). However, it should be noted that the fuel and steam costs are based upon crude oil at $ 15 per barrel with a 20% discount to encourage local industry. The cost of the various raw materials was taken at the current French or European level. The shipping cost was not taken into account since it is felt that for fairly large supply contracts, most manufacturers would adjust their landed prices to the current European prices. For the financial analysis presented hereunder, the same assumption is made, i.e. the landed prices of the active ingredients and/or the formulated products are the same as the current european prices.

4.2 - MALATHION

The costs of production and the transfer prices of the two malathion raw materials are presented in Table 4.20.1

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* After conversations with the Ministry of Commerce and Industry, financial figures have been slightly modified (see Annex 1) :

- utilities costs adjusted,
- interest rate on working capital reduced to 4 %,
- additional investment for general storage.

The three items introduce a very minor reduction of individual product costs between 0 and 1.0 %.

This slight change will note affect the hereafter conclusions.

Staffing in other departments is generally in line with the responsibilities described in 3.1.D above. The engineering staff allowed for would be adequate for planning special maintenance tasks, minor plant modifications and resolving technical problems as they arise.

With a more limited project scope (i.e. 2 products instead of 4), the direct operating labor and the personnel of the various departments would be reduced accordingly.

TABLE 4.20.1

MALATHION RAW MATERIALS

TRANSFER PRICES (US cents/kg)

	O,O Dimethyl-dithiophosphoric acid	Ethyl Maleate
• Raw materials	98.68	132.46
• Utilities	0.79	2.25
• Operating costs	11.29	19.67
• Overhead expenses	19.53	34.68
• Total cost of production	130.29	189.06
• Return on Investment	-	-
• Interest on working capital (10%)	4.35	6.27
• Transfer price	134.64	195.33

The malathion cost of production presented in Table 4.20.2 is based on raw materials transfer prices at zero return on investment (see Table 4.20.1). The resulting malathion transfer price is then the minimum acceptable sales price. When compared to the bulk malathion sales price in Europe, it appears that the netback is negative at effective annual capacity.

However, the difference between the European sales price of formulated malathion and the calculated minimum sales price is over 7 US dollars per kg.

TABLE 4.20.2

MALATHION

COST OF PRODUCTION & SALES PRICE (US cents/kg)

		Technical Malathion
• Raw materials:		
– O,O dimethyldithiophosphoric acid	67.37	
– Ethyl maleate	105.09	
– Solvents and Chemicals	1.00	
Total raw materials	173.46	173.46
• Utilities		1.64
• Operating costs		18.66
• Overhead expenses		31.91
• Cost of production		225.67
• Return on investment		–
• Interest on working capital (10%)		8.70
• Sales price (minimum for 97% product)		234.37
• Sales price (minimum-based on 100% product)		241.62
• European sales price (based on 100% Active Ingredient)(non formulated product -bulk)		179.00
• European sales price (based on 100% A.I) (formulated product-500 g/liter-10liter package)		988.00

Yet this difference is only reduced to 6.8 US dollars per kg if a 30% return on investment is added to the 0,0 dimethyl-dithiophosphoric acid, ethyl maleate and malathion transfer prices.

This very simple calculation shows that it would not be profitable to sell bulk malathion (non formulated) to local formulators. However, the construction of a simple formulation unit and the distribution of the formulated product to local distributors seems to be quite attractive.

4.3 - DIMETHOATE

The costs of production and the transfer prices of the two dimethoate raw materials are presented in Table 4.30.1

TABLE 4.30.1

DIMETHOATE RAW MATERIALS

TRANSFER PRICES (US cents/kg)

	O,O dimethyl-dithiophosphoric acid	N-methyl-chloroacetamide
. Raw materials	98.68	130.24
. Utilities	0.79	6.94
. Operating costs	11.29	14.57
. Overhead expenses	19.53	30.06
. Total cost of production	130.29	181.81
. Return on Investment	-	-
. Interest on working capital (10%)	4.35	6.06
. Transfer price	134.64	187.87

The dimethoate cost of production presented in Table 4.30.2 is based on raw materials transfer prices at zero return on investment (see Table 4.30.1). The resulting Dimethoate transfer price is then the minimum acceptable sales price.

When compared to the bulk Dimethoate sales price in Europe, it appears that the netback is negative at effective annual capacity.

However, the difference between the European sales price of formulated Dimethoate and the calculated minimum sales price is about 4.75 US dollars per kg.

TABLE 4.30.2

DIMETHOATE

COST OF PRODUCTIO. & SALES PRICE (US cents/kg)

		Technical Dimethoate
• Raw materials :		
– O,O dimethyldithiophosphoric acid	110.66	
– N-methylchloroacetamide	126.06	
– Solvents and Chemicals	21.78	
– Total raw materials	258.50	258.50
• Utilities		13.30
• Operating costs		23.07
• Overhead expenses		45.30
• Cost of production		340.1[illegible]
• Return on investment		–
• Interest on working capital (10%)		12.[illegible]
• Sales price (minimum for 90% product)		353.[illegible]
• Sales price (minimum for 100% product)		392.37
• European sales price (based on 100% A.I) (non formulated product-bulk)		305.00
• European sales price (based on 100% A.I) (formulated product-400 g/1-10 liter package)		868.00

Moreover, this difference still amounts to 3.5 US dollars per kg if a 30% return on investment is added to the O,O dimethyl-dithiophosphoric acid, N-methylchloroacetamide and Dimethoate transfer prices.

As for Malathion, this very simple calculation shows that it would be profitable to sell formulated Dimethoate to local distributors. It requires the construction of a simple formulation unit.

4.4 - MANEB-ZINEB

The costs of production and minimum sales prices (at zero percent rate of return) of Maneb/Zineb are presented in Table 4.40.1.

At the current sales prices of bulk or formulated products, the netbacks are negative at effective annual capacity.

Even if Maneb/Zineb were produced in a completely written off plant (i.e. depreciation=zero), the minimum sales prices would still be:

Maneb : 285 US cents/kg (100% A.I)
Zineb : 283 US cents/kg (100% A.I)

In any case, the only way to produce ethylene bis dithiocarbamate is to work in an "old plant" and to have access to low-price raw materials i.e. produce ethylene diamine; otherwise it is almost impossible to justify any investment in Maneb/Zineb production at the current price levels. On top of that, some Eastern European countries (Bulgaria for instance) are offering these products at incredibly low prices:

current Bulgarian Zineb price: 145 US cents/kg
(100% A.I technical product)

TABLE 4.40.1

MANEB / ZINEB

COST OF PRODUCTION & SALES PRICES (US cents/kg)

	MANEB	ZINEB
• Raw materials	124.44	122.73
• Utilities	4.38	4.05
• Operating costs	60.62	60.62
• Overhead expenses	123.21	123.21
• Cost of production	312.65	310.61
• Return on Investment	-	-
• Interest on working capital (10%)	10.40	10.40
• Sales price (minimum for 92% product)	323.05	321.01
• Sales price (minimum (based on 100% A.I)	351.14	348.92
• European sales price (based on 100% A.I- product sold in bulk)		217.00
• European sales price (based on 100% A.I formulated product 80%-20 or 25 kg package)	294-309	280

4.5 - 2,4 D -AMINE SALT

The costs of production and minimum sales prices (at zero percent rate of return) of 2,4 D acid/2,4 D- DMA salt are presented in Table 4.50.1.

At the current sales prices of bulk technical products, the netbacks are negative at effective annual capacity. The difference between the current sales price of the formulated 2,4 D-amine salt solution (in 10 liter package) and the calculated minimum sales price is very small : 7.4 to 15.5 US cents/kg acid equivalent. The expected return on investment of this production scheme (2,4 D from 2,4 dichlorophenol + amine salt production unit) is too small 1.5 to 3.3 percent of total inv.) to justify any investment.

However, it would be financially more interesting to buy 2,4 D acid on the merchant market and to mix it with an amine solution. This operation is technically very simple and could be carried out in any agitated batch reactor of the malathion or the dimethoate unit.

TABLE 4.50.1

2,4 D- 2,4 D, dimethylamine salt

COST OF PRODUCTION & SALES PRICES (US cents/kg)

	2,4 D acid	2,4 D DMA salt
• Raw materials	143.55	137.14
• Utilities	6.43	5.36
• Operating costs	61.50	62.36
• Overhead expenses	112.22	105.18
• Cost of production	323.70	310.04
• Return on Investment	-	-
• Interest on working capital (10%)	10.83	10.42
• Sales price(minimum based on 100% acid or salt)	334.53	320.46
• Sales price(minimum based on 100% acid)	334.53	384.55
• European sales price (based on 100% A.I 40% bulk technical product)	220.0	325.0
• European sales price (based on 100% A.I formulated product-600 g/l or 400 g/l 10 liter package)	-	392-400

5 - IMPLEMENTATION PLAN

5.1 - INTRODUCTION

The purpose of this section is to outline the steps which have to be taken to establish full commercial operation of the pesticides/insecticides plant and show the sequence of events.

Figure 5.10.1 is a basic activity network for the project. The emphasis is on the owners-side activities. Contractors normally develop detailed networks for design/procurement/construction etc to enable them to exercise detailed control and minimize time for contract execution. In practice however, owners-side activities are often more crucial to the overall schedule and failures on this side can completely upset the most careful contractor planning.

The network can be simplified into three main elements:

- i Definition of project basis
- ii Activities related to plant design and construction
- iii Activities related to corporate organisation and external relations.

Each of these main elements is discussed separately below.

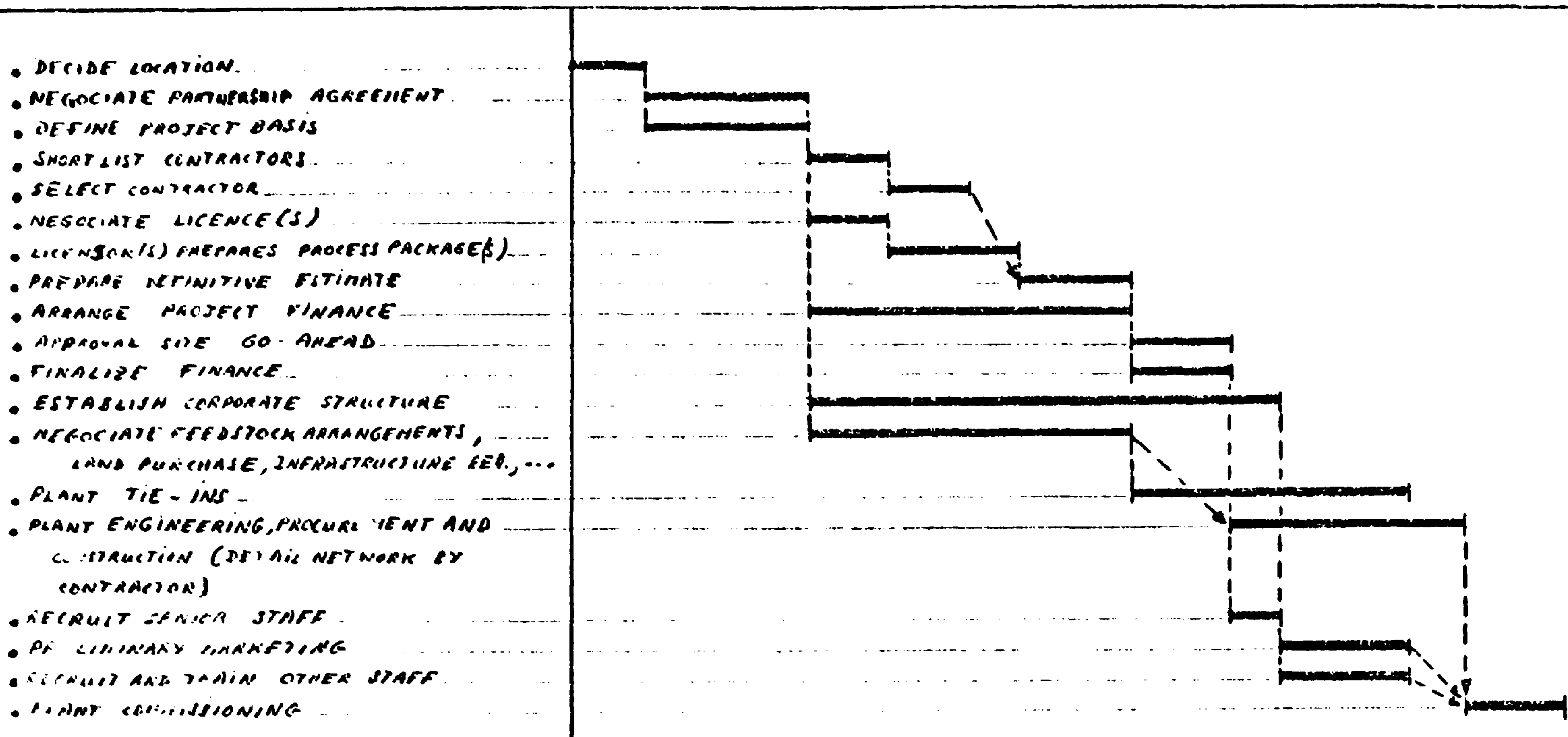
5.2 - DEFINITION OF PROJECT BASIS

This is shown as the first group of activities on Figure 5.10.1 and covers decisions on the following questions:

- Location
- Feedstock supply
- Plant capacity and duty specification
- Process selection
- Infrastructure and support service requirements
- Ownership and financial structure
- Management structure
- Basis for plant contracts
- Detailed program

FIGURE 5.10.1

MAJOR ACTIVITY NETWORK FOR PESTICIDES/INSECTICIDES PLANT



The length of time this activity will require clearly depends on the preliminary discussions which will be carried out between the Kuwait authorities and the industrial firms willing to transfer their know-how.

A minimum of six months could be taken into account however a 12 months period seems to be more realistic.

Ideally, the completion of this activity would be masked by the approval of a "Project Definition Document" by the parties concerned.

5.3 - PLANT DESIGN AND CONSTRUCTION

The final choice of process licences is assumed to be covered in the project definition stage. In practice, the choice will probably be between:

- i Acquire a licence for all products and intermediates
- ii Acquire a licence for some products and select a partner (or partners) having in house know-how
- iii Select a partner (or partners) having in house know-how for all products.

Whatever the choice, the agreement should include the provision of a basic design package which would be used as the basis for the detailed design by a contractor.

If the partner selected is unable to provide a basic design package, it is then necessary to have this work subcontracted to an engineering a consulting firm working in close cooperation with the industrial partner.

There are two main options in selection of a contractor:

a) Obtain competittive lump sum bids on the basis of the basic design package(s)

b) Select contractor on basis of general experience and capability, together with manhour rates, fees etc.

In the latter case, selection can proceed in parallel with preparation of the licensor's package, saving perhaps six months on schedule. In this case, option (b) is recommended with a "convertable" type contract to be awarded. After selection, the contractor would prepare a detailed estimate to present to the owner, who would have the option of converting the contract at that stage to lump sum, or to instruct the contractor to proceed on a cost plus fee basis. This approach has many advantages in addition to saving of time and can be very cost-effective since it greatly reduces bidding time and costs, and associated contractor mark-ups.

5.4 - ESTABLISHING CORPORATE ORGANIZATION AND EXTERNAL RELATIONS

The management organization required for this project is discussed in Section 3 of this report. Prior to full approval (or go-head for plant design and construction), a full time Project Manager is recommended, guided by a steering committee. Subsequently, the permanent management team should be recruited and this team will in turn organise the recruitement and training of the remaining staff.

Establishment of "external relations" covers matters such as feedstock supply, financing, marketing etc. Certain aspects of this have to be agreed at an early stage before full project go ahead, however many further aspects and details will have to be resolved at a later stage.

Based on the assumption made in drawing up the activity network in Figure 5.10.1, Table 5.40.1 shows the earliest timing for key events.

TABLE 5.40.1

EARLIEST TIMING OF KEY EVENTS

Event	Earliest Date
• Select Process Licence(s) and award contract for basic design package	May 1982
• Select Contractor (fee/convertable contract basis)	Sept 1982
• Completion of definitive Estimate	Jan 1983
• Go-ahead for detail design and construction	Mar 1983
• Mechanical completion	Mar 1985
• Completion of commissioning	Sept 1985

APPENDIX A

The technical specification of the pieces of equipment of the nine sections of the production facilities are presented hereafter.

1 - EQUIPMENT LIST - O,O DIMETHYLDITHIOPHOSPHORIC ACID

SECTION 100

DIMETHYL DITHIOPHOSPHORIC ACID PRODUCTION UNIT

ITEM N°	ITEM NAME
B 101	BUCKET ELEVATOR
C 101	VACUUM JET
D 101	P_2S_5 WEIGH HOPPER
D 102	TOLUENE METHANOL MEASURING TANK
D 103	P_2S_5 CONTAINER
D 104	DISTILLATE RECEIVER
D 105	DITHIOPHOSPHORIC ACID SURGE TANK
D 106	CAUSTIC SOLUTION SURGE TANK
D 107 A,B	SOLID WASTES CONTAINERS
E 101	REFLUX CONDENSER
E 102	METHANOL TOLUENE CONDENSER
H 101	PRECOAT FILTER
P 101	WASTE TRANSFER PUMP
P 102	CRUDE PRODUCT PUMP
P 103	FILTER FEED PUMP
P 104	DISTILLATE RECYCLE PUMP
P 105	PRECOAT -TOLUENE TRANSFER PUMP
P 106	DITHIOPHOSPHORIC ACID TRANSFER PUMP
P 107	CAUSTIC RECYCLE PUMP
R 101	P_2S_5 METHANOL REACTOR
R 102	METHANOL EVAPORATOR
R 103	PRECOAT MIXING TANK
T 101	METHANOL RECOVERY COLUMN

EQUIPMENT ITEM SYMBOL : B – CONVEYORS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
B 101	SERVICE : BUCKET ELEVATOR TYPE : Bucket elevator MATERIAL: Polyethylene or 316 SS buckets CAPACITY: 2 m3/hr (sp.gr.= 1.0) SIZE : length: 12 m driver: 1 HP -Explosion proof motor NOTES : includes feed hopper and rotary feeder	
	SERVICE : TYPE : MATERIAL: CAPACITY: SIZE : NOTES :	
	SERVICE : TYPE : MATERIAL: CAPACITY: SIZE : NOTES :	

EQUIPMENT ITEM SYMBOL : C – STEAM OR LIQUID JETS

TECHNICAL SPECIFICATIONS

ITEM. N°	ITEM NAME AND SPECIFICATION	
C 101	SERVICE : VACUUM JET TYPE : Liquid jet vacuum pump CAPACITY : 8 kg/hr of air @ 20°C SUCTION PRESSURE : 200 mmHg DISCHARGE PRESSURE: 760 mmHg PROPELLING FLUID :-steam : -liquid: 20% caustic solution MATERIAL : impervious graphite TEMPERATURE : <60°C NOTES :	
	SERVICE TYPE CAPACITY SUCTION PRESSURE DISCHARGE PRESSURE PROPELLING FLUID :-steam : -liquid: MATERIAL TEMPERATURE. NOTES	
	SERVICE : TYPE : CAPACITY : SUCTION PRESSURE : DISCHARGE PRESSURE: PROPELLING FLUID :-steam : -liquid: MATERIAL : TEMPERATURE : NOTES :	

EQUIPMENT ITEM SYMBOL : D – TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 101	SERVICE : P_2S_5 WEIGH HOPPER TYPE : Vertical hopper with conical bottom VOLUME : 2,3 m3 DIAMETER : 1400 mm HEIGHT : 2200 mm MATERIAL : 316 stainless steel PRESSURE : 0,5 bar g TEMPERATURE: 50°C NOTES : supplied with rotary feeder and drive	
D 102	SERVICE : TOLUENE-METHANOL MEASURING TANK TYPE : Vertical tank- dished head VOLUME : 3,5 m3 DIAMETER : 1300 mm HEIGHT : 2400 mm MATERIAL : 316 Stainless steel PRESSURE : atmospheric TEMPERATURE: 50°C NOTES :	
D 103	SERVICE : P_2S_5 CONTAINER TYPE : returnable tote bins with slide valve VOLUME : 1800 liters DIAMETER : as per manufacturer's standard HEIGHT : MATERIAL : Aluminium PRESSURE : + 0.1 bar g TEMPERATURE: 50°C NOTES : fitted with inert gas nozzle 4 containers	

EQUIPMENT ITEM SYMBOL : D – TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 104	SERVICE : DISTILLATE RECEIVER TYPE : Vertical- dished heads VOLUME : 1 m3 DIAMETER : 900 mm HEIGHT : 1500 mm MATERIAL : 316 ss PRESSURE : + 1,7 bar g + full vacuum TEMPERATURE: 110°C NOTES :	
D 105	SERVICE : DITHIOPHOSPHORIC ACID SURGE TANK TYPE : Vertical storage tank VOLUME : 4,5 m3 DIAMETER : 1,5 m HEIGHT : 2,6 m MATERIAL : 316 ss PRESSURE : – 5 g/cm2; + 25 g/cm2 TEMPERATURE: 60°C NOTES :	
D 106	SERVICE : CAUSTIC SOLUTION SURGE TANK TYPE : Horizontal – dished heads VOLUME : 2,5 m3 DIAMETER : 1200 mm ~~HEIGHT~~ : Lenght :2100 mm MATERIAL : Carbon steel PRESSURE : Atmosphéric TEMPERATURE: 60°C NOTES : Cooling coil: 2 m2	

EQUIPMENT ITEM SYMBOL : D – TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 107	SERVICE : SOLID WASTE CONTAINERS TYPE : open top with cover-light gage VOLUME : 0.5 m3 DIAMETER : HEIGHT : 800 x 800 x 800 mm MATERIAL . Carbon steel PRESSURE : Atmospheric TEMPERATURE: NOTES : portable container (with fork lift truck)	
	SERVICE : TYPE : VOLUME : DIAMETER : HEIGHT : MATERIAL : PRESSURE : TEMPERATURE: NOTES :	
	SERVICE : TYPE : VOLUME : DIAMETER : HEIGHT : MATERIAL : PRESSURE : TEMPERATURE: NOTES :	

EQUIPMENT ITEM SYMBOL : E – HEAT EXCHANGER

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
E 101	SERVICE : REFLUX CONDENSER HEAT TRANSFER AREA : 7 m2 TYPE : Graphite block exchanger PROCESS SIDE : H_2S+ toluene+ Methanol – material : graphite – pressure : 1,7 bar g – temperature: 140°C UTILITY SIDE : Cooling water – material : graphite+ carbon steel – pressure : 6 bar g – temperature: 70°C NOTES :	
E 102	SERVICE :ETHANOL–TOLUENE CONDENSER HEAT TRANSFER AREA : 10 m2 TYPE : graphite block exchanger PROCESS SIDE : methanol+toluene+traces H_2S – material : graphite – pressure : 1.7 bar gage+full vacuum – temperature: 140°C UTILITY SIDE : 44% ethylene glycol solution – material : graphite +carbon steel – pressure : 6 bar g – temperature: -20°C NOTES :	
	SERVICE : HEAT TRANSFER AREA : TYPE : PROCESS SIDE : – material : – pressure : – temperature: UTILITY SIDE : – material : – pressure : – temperature: NOTES :	

CE SCHEMA CONTENANT DES INFORMATIONS CONFIDENTIELLES EST LA PROPRIETE DE CDI ET NE PEUT ETRE REPRODUIT OU UTILISE SANS L AUTORISATION ECRITE DE CDI	PAGE	AFFAIRE		NUMERO		REV
		330	6002	ADS	E [illegible]	

EQUIPMENT ITEM SYMBOL : H - FILTERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
H 101	SERVICE : PRE COAT FILTER TYPE : Centrifugal discharge tray filter SOLIDS - weight : 321 kg volume : 350 liters FILTERING AREA : 5 m2 MATERIAL : 316 ss PRESSURE : 5 bar g TEMPERATURE : 90°C NOTES : Explosion proof motor	
	SERVICE : TYPE : SOLIDS - weight : - volume : FILTERING AREA : MATERIAL : PRESSURE : TEMPERATURE : NOTES :	
	SERVICE : TYPE : SOLIDS - weight : - volume : FILTERING AREA : MATERIAL : PRESSURE : TEMPERATURE : NOTES :	

EQUIPMENT ITEM SCHEDULE : P - PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS		
P 101	SERVICE	: WASTE TRANSFER PUMP	
	TYPE	: Centrifugal pump	
	FLOW RATE	: 5 m3/hr	
	DIFFERENTIAL PRESSURE	: 2.5 bars	
	MATERIAL	: impervious graphite	
	STUFFING BOX	: yes	
	MECHANICAL SEAL	:	
	DRIVER	: explosion proof motor	
	NOTES	:	
P 102	SERVICE	: CRUDE PRODUCT PUMP	
	TYPE	: Centrifugal pump	
	FLOW RATE	: 12 m3/hr	
	DIFFERENTIAL PRESSURE	: 2 bars	
	MATERIAL	: impervious graphite	
	STUFFING BOX	:	
	MECHANICAL SEAL	: yes-with toluene injection	
	DRIVER	: explosion proof motor	
	NOTES	: T= 85°C	
P 103	SERVICE	: FILTER FEED PUMP	
	TYPE	: Centrifugal pump	
	FLOW RATE	: 4 m3/hr	
	DIFFERENTIAL PRESSURE	: 3.5 bars	
	MATERIAL	: 316 SS	
	STUFFING BOX	:	
	MECHANICAL SEAL	: yes- with toluene injection	
	DRIVER	: Explosion proof water	
	NOTES	: T= 60°C	

	PAGE	AFFAIRE 330 6002 ADS NUMERO P1001	REV

EQUIPMENT ITEM SYMBOL : P – PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS	
P 104	SERVICE : DISTILLATE RECYCLE PUMP TYPE : Centrifugal pump FLOW RATE : 1.5 m3/hr DIFFERENTIAL PRESSURE: 1.5 bar g MATERIAL : 316 SS STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :	
P 105	SERVICE : PRECOAT-TOLUENE TRANSFER PUMP TYPE : Centrifugal pump FLOW RATE : 5 m3/hr DIFFERENTIAL PRESSURE: 2.0 bar g MATERIAL : 316 SS STUFFING BOX : yes MECHANICAL SEAL : DRIVER : Explosion proof motor NOTES : Open type impeller	
P 106	SERVICE : DITHIOPHOSPHORIC ACID TRANSFER PUMP TYPE : Centrifugal pump FLOW RATE : 12 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar g MATERIAL : 316 SS STUFFING BOX : MECHANICAL SEAL : Yes DRIVER : Explosion proof motor NOTES :	

EQUIPMENT ITEM SYMBOL : P - PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS	
P 107	SERVICE : CAUSTIC RECYCLE PUMP TYPE : Centrifugal pump FLOW RATE : 15 m3/hr DIFFERENTIAL PRESSURE: 5.5 bar eff MATERIAL : Carbon steel or cast iron STUFFING BOX : MECHANICAL SEAL : double DRIVER : explosion proof motor NOTES :	
	SERVICE : TYPE : FLOW RATE : DIFFERENTIAL PRESSURE: MATERIAL : STUFFING BOX : MECHANICAL SEAL : DRIVER : NOTES :	
	SERVICE : TYPE : FLOW RATE : DIFFERENTIAL PRESSURE: MATERIAL : STUFFING BOX : MECHANICAL SEAL : DRIVER : NOTES :	

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TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION		
R 101	SERVICE	:	P_2S_5- METHANOL REACTOR
	TYPE	:	Jacketed reactor
	NOMINAL CAPACITY	:	5000 liters
	MATERIAL	:	Glass lined carbon steel
	AGITATOR AND DRIVE	:	impeller- 7,5 kw
	PRESSURE	:	1,7 bar g
	TEMPERATURE	:	200°C
	HEATING/COOLING	:	10 bar steam- cooling water
	NOTE	:	explosion proof motor
R 102	SERVICE	:	METHANOL EVAPORATOR
	TYPE	:	Jacketed reactor
	NOMINAL CAPACITY	:	5000 liters
	MATERIAL	:	glass lined carbon steel
	AGITATOR AND DRIVE	:	impeller- 7,5 kw
	PRESSURE	:	1,7 barg + full vacuum
	TEMPERATURE	:	200°C
	HEATING/COOLING	:	10 bar steam- cooling water
	NOTES	:	explosion proof motor

EQUIPMENT ITEM SYMBOL : R - REACTOR

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
R 103	SERVICE : PRECOAT MIXING TANK TYPE : Agitated open tank with cover conical bottom NOMINAL CAPACITY : 1 m3 MATERIAL : 304 SS AGITATOR AND DRIVE: Turbine impeller- 1,5 kw PRESSURE : atmospheric TEMPERATURE : 50°C HEATING/COOLING : NOTE : Explosion proof motor	
	SERVICE : TYPE : NOMINAL CAPACITY : MATERIAL : AGITATOR AND DRIVE: PRESSURE : TEMPERATURE : HEATING/COOLING : NOTES :	

	PAGE	AFFAIRE	NUMERO	REV
	330	ADS 6002	R.001	

EQUIPMENT ITEM SYMBOL : T - COLUMNS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
T 101	SERVICE : METHANOL RECOVERY COLUMN TYPE : Packed tower DIAMETER: 400 mm TRAYS : Type : : Number : : Spacing : : Material : PACKING : Type : 1" pall rings : Height : 2400 mm : Material : 316 SS VESSEL : Material : 316 SS : Pressure : + 1.7 bar g and full vacuum : Temperature: 140°C NOTES :	
	SERVICE : TYPE : DIAMETER: TRAYS : type : : number : : spacing : : material : PACKING : type : : height : : material : VESSEL : material : : pressure : : temperature: NOTES :	

2 - EQUIPMENT LIST - ETHYL MALEATE

SECTION 200

ETHYL MALEATE PRODUCTION UNIT

ITEM N°	ITEM NAME
B 201	SCREW CONVEYOR
C 201	VACUUM JETS
C 202	SUCTION FAN
D 201	MALEIC ANHYDRIDE FEED HOPPER
D 202	ETHANOL FEED TANK
D 203	BAROMETRIC LEG SEAL POT
D 204	REFLUX DRUM
D 205	SOLVENT RECEIVER
D 206	PRODUCT RECEIVER
E 201	FALLING FILM EVAPORATOR
E 202	CONDENSER
P 201	SODIUM CARBONATE SOLUTION TRANSFER PUMP
P 202	CATALYST SOLUTION TRANSFER PUMP
P 203	REACTION MIXTURE RECIRCULATION PUMP
P 204	PRODUCT TRANSFER PUMP
R 201	SODIUM CARBONATE MIXING TANK
R 202	CATALYST MIXING TANK.
R 203	ESTERIFICATION REACTOR
T 201	DISTILLATION COLUMN

EQUIPMENT ITEM SYMBOL : B - CONVEYORS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
B 201	SERVICE : SCREW CONVEYOR TYPE : screw conveyor MATERIAL: carbon steel CAPACITY: 1000 kg /hr or 1700 l/hr SIZE : length 18 m Driver 1 HP- Explosion proof water NOTES : includes feed hopper	
	SERVICE : TYPE : MATERIAL: CAPACITY: SIZE : NOTES :	
	SERVICE : TYPE : MATERIAL: CAPACITY: SIZE : NOTES :	

CE SCHEMA CONTENANT DES INFORMATIONS CONFIDENTIELLES EST LA PROPRIETE DE CDI ET NE PEUT ETRE REPRODUIT OU UTILISE SANS L'AUTORISATION ECRITE DE CDI	PAGE 1/1	AFFAIRE 330 6002 ADS NUMERO B 200I	REV

EQUIPMENT ITEM SYMBOL : C - STEAM OR LIQUID JETS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
C 201	SERVICE : VACUUM JETS TYPE : multistage steam jets with surface condensers CAPACITY : 8 kg/hr of air SUCTION PRESSURE : 15 mmHg DISCHARGE PRESSURE: 760 mmHg PROPELLING FLUID :-steam : 150 psig saturated steam -liquid: MATERIAL : Cast Iron and carbon steel TEMPERATURE : NOTES : condensers: shell and tube	
	SERVICE TYPE CAPACITY SUCTION PRESSURE DISCHARGE PRESSURE PROPELLING FLUID :-steam : -liquid: MATERIAL TEMPERATURE. NOTES	
	SERVICE : TYPE : CAPACITY : SUCTION PRESSURE : DISCHARGE PRESSURE: PROPELLING FLUID :-steam : -liquid: MATERIAL : TEMPERATURE : NOTES :	

EQUIPMENT ITEM SYMBOL : C – FANS AND BLOWERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
C 202	SERVICE : SUCTION FAN TYPE : Centrifugal fan CAPACITY : 500 m3/hr of air at 760 mmHg 20°C DISCHARGE PRESSURE: + 80 mm water column TEMPERATURE 20°C MATERIAL : PVC or Aluminium DRIVER : Explosion proof motor NOTES :	
	SERVICE : TYPE : CAPACITY : DISCHARGE PRESSURE: TEMPERATURE : MATERIAL : DRIVER : NOTES :	
	SERVICE : TYPE : CAPACITY : DISCHARGE PRESSURE: TEMPERATURE : MATERIAL : DRIVER : NOTES :	

EQUIPMENT ITEM SYMBOL : D – TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D201	SERVICE : MALEIC ANHYDRIDE FEED HOPPER TYPE : Vertical hopper with conical bottom VOLUME : 3,6 m3 DIAMETER : 1400 mm HEIGHT : 3000 mm MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 50°C NOTES : supplied with rotary feeder and drive	
D202	SERVICE : ETHANOL FEED TANK TYPE : Vertical tank- dished heads VOLUME : 8 m3 DIAMETER : 1900 mm HEIGHT : 2600 mm MATERIAL : carbon steel PRESSURE : atmosphéric TEMPERATURE: 50°C NOTES :	
D203	SERVICE : BAROMETRIC LEG SEAL POT TYPE : Vertical tank-flat bottom- light gage VOLUME : 100 liters DIAMETER : 500 mm HEIGHT : 750 mm MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 60°C NOTES : removable cover included	

EQUIPMENT ITEM SYMBOL : D - TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 204	SERVICE : REFLUX DRUM TYPE : horizontal decanter-dished heads VOLUME : 1 m3 DIAMETER : 850 mm HEIGHT : 1600 mm MATERIAL : 304 SS PRESSURE : 1,7 bar g + full vacuum TEMPERATURE: 130°C NOTES :	
D 205	SERVICE : SOLVENT RECEIVER TYPE : Vertical tank- dished heads VOLUME : 5 m3 DIAMETER : 1500 mm HEIGHT : 2600 mm MATERIAL : carbon steel PRESSURE : 1,7 bar g + full vacuum TEMPERATURE: 130°C NOTES : cooling coil: 2 m2	
D 206	SERVICE : PRODUCT RECEIVER TYPE : Vertical tank- dished heads VOLUME : 3,5 m3 DIAMETER : 1300 mm HEIGHT : 2400 mm MATERIAL : 304 SS PRESSURE : 1,7 bar gage, full vacuum TEMPERATURE: 130°C NOTES : cooling coil: 2,5 m2	

EQUIPMENT ITEM SYMBOL : E - HEAT EXCHANGER

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
E 201	SERVICE : Falling film evaporator HEAT TRANSFER AREA : 20 m2 TYPE : tubular heat exchanger-falling film PROCESS SIDE : ethyl maleate +PTSA+ethylene dichloride - material : 316 L SS - pressure : 1,7 bar g+full vacuum - temperature: 200°C UTILITY SIDE : 150 psig saturated steam - material : carbon steel+316 L - pressure : 12 bar g - temperature: 200°C NOTES :	
	SERVICE : CONDENSER HEAT TRANSFER AREA : 35 m2 TYPE : shell and tube exchanger PROCESS SIDE : shell side -ethanol-ethylene dichloride-product - material : 304 SS - pressure : 1,7 bar g, full vacuum - temperature: 160°C UTILITY SIDE : Cooling water - material : 304 SS and carbon steel - pressure : 6 bar g - temperature: 70°C NOTES :	
	SERVICE : VENT CONDENSER HEAT TRANSFER AREA : 3 m2 TYPE : shell and tube exchanger PROCESS SIDE : tube side -ethanol-ethylene dichloride - material : 304 SS - pressure : 1,7 bar g, full vacuum - temperature: 160°C UTILITY SIDE : 44% glycol solution - material : 304 SS-carbon steel - pressure : 6 bar g - temperature: -20°C NOTES :	

EQUIPMENT ITEM SYMBOL : P – PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS	
P 201	SERVICE :SODIUM CARBONATE SOLUTION TRANSFER PUMP TYPE :Volumetric pump FLOW RATE :5 m3/hr DIFFERENTIAL PRESSURE:2.0 bar MATERIAL : cast Iron STUFFING BOX : MECHANICAL SEAL : with external fluid flushing DRIVER : explosion proof motor NOTES :	
P 202	SERVICE : CATALYST SOLUTION TRANSFER PUMP TYPE : Volumetric pump FLOW RATE : 1 m3/hr DIFFERENTIAL PRESSURE: 2.0 bar MATERIAL : 316 SS STUFFING BOX : MECHANICAL SEAL : Yes DRIVER : Explosion proof motor NOTES :	
P 203	SERVICE : REACTION MIXTURE RECIRCU- LATION PUMP TYPE : Centrifugal pump FLOW RATE : 40 m3/hr DIFFERENTIAL PRESSURE: MATERIAL : 316 SS or 316 L SS STUFFING BOX : MECHANICAL SEAL : double mechanical seal DRIVER : explosion proof motor NOTES : operates under vacuum	

EQUIPMENT ITEM SYMBOL : P - PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS		
P 204	SERVICE	:	PRODUCT TRANSFER PUMP
	TYPE	:	Volumetric pump
	FLOW RATE	:	6 m3/hr
	DIFFERENTIAL PRESSURE	:	3.0 bar
	MATERIAL	:	316 SS
	STUFFING BOX	:	
	MECHANICAL SEAL	:	yes
	DRIVER	:	explosion proof motor
	NOTES	:	reversible pump
	SERVICE	:	
	TYPE	:	
	FLOW RATE	:	
	DIFFERENTIAL PRESSURE	:	
	MATERIAL	:	
	STUFFING BOX	:	
	MECHANICAL SEAL	:	
	DRIVER	:	
	NOTES	:	
	SERVICE	:	
	TYPE	:	
	FLOW RATE	:	
	DIFFERENTIAL PRESSURE	:	
	MATERIAL	:	
	STUFFING BOX	:	
	MECHANICAL SEAL	:	
	DRIVER	:	
	NOTES	:	

EQUIPMENT ITEM SYMBOL : R - REACTOR

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
R 201	SERVICE : SODIUM CARBONATE MIXING TANK TYPE : Agitated open tank with cover conical bottom NOMINAL CAPACITY : 2,5 m3 MATERIAL : fiber reinforced polyester AGITATOR AND DRIVE: turbine impeller, 2.2 kw PRESSURE : Atmospheric TEMPERATURE : 50°C HEATING/COOLING : NOTE : Explosion proof motor	
R 202	SERVICE : CATALYST MIXING TANK TYPE : Agitated open tank with cover conical bottom NOMINAL CAPACITY : 200 l MATERIAL : 316L stainless steel AGITATOR AND DRIVE: turbine impeller - 0,75 KW PRESSURE : atmospheric TEMPERATURE : 50°C HEATING/COOLING : NOTES : Explosion proof motor	

CE SCHEMA CONTENANT DES INFORMATIONS CONFIDENTIELLES EST LA PROPRIETE DE CDI ET NE PEUT ETRE REPRODUIT OU UTILISE SANS L AUTORISATION ECRITE DE CDI	PAGE 1/	AFFAIRE 330 6002 NUMERO ADSR2001	REV

EQUIPMENT ITEM SYMBOL : R - REACTOR

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
R 203	SERVICE : ESTERIFICATION REACTOR TYPE : Jacketed reactor NOMINAL CAPACITY : 10000 liters MATERIAL : 316 L- stainless steel AGITATOR AND DRIVE: 7.5 HP- turbine impeller PRESSURE : Full vacuum + 1,7 bar g TEMPERATURE : 200°C HEATING/COOLING : 10 bar steam/cooling water NOTE : explosion proof motor	
	SERVICE : TYPE : NOMINAL CAPACITY : MATERIAL : AGITATOR AND DRIVE: PRESSURE : TEMPERATURE : HEATING/COOLING : NOTES :	

EQUIPMENT ITEM SYMBOL : T - COLUMNS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
T 201	SERVICE : DISTILLATION COLUMN TYPE : Packed tower DIAMETER: 800 mm TRAYS : Type : : Number : : Spacing : : Material : PACKING : Type : 2" pall rings : Height : 6000 mm : Material : 316 SS VESSEL : Material : 304 SS : Pressure : +1,7 bar gage +full vacuum : Temperature: 160°C NOTES :	
	SERVICE : TYPE : DIAMETER: TRAYS : type : : number : : spacing : : material : PACKING : type : : height : : material : VESSEL : material : : pressure : : temperature: NOTES :	

PAGE	AFFAIRE			NUMERO	REV
1/	330	6002	ADS	T200T	

3 - EQUIPMENT LIST - MALATHION

SECTION 300

MALATHION PRODUCTION UNIT

ITEM N°	ITEM NAME
C 301	REACTOR VACUUM PUMP
C 302	STRIPPER VACUUM PUMP
D 301	HOTWELL
D 302	HOTWELL
D 303	ETHYL MALEATE FEED TANK
D 304	DMTA-TOLUENE FEED TANK
D 305	RECOVERED TOLUENE TANK
D 306 A, B	RECOVERED REACTANTS TANK
D 307	HEAVY PHASE SURGE TANK
D 308	CRUDE MALATHION SURGE TANK
D 309	CRUDE MALATHION SURGE TANK
D 310 A,B	SOLID WASTES CONTAINERS
E 301	REACTOR CONDENSER
E 302	REACTOR VENT CONDENSER
E 303	EVAPORATOR CONDENSER
E 304	EVAPORATOR VENT CONDENSER
E 305	AGITATED FILM EVAPORATOR
E 306	STRIPPER CONDENSER
H 301	PRECOAT FILTER
P 301	EVAPORATOR FEED PUMP
P 302	RECOVERED REACTANTS PUMP
P 303	FILTER FEED PUMP
P 304	SODIUM CARBONATE SOLUTION PUMP
P 305	PRECOAT SUSPENSION TRANSFER PUMP

DESCRIPTION	REV	DATE	SIGN	VERIF.

CHIMIE DEVELOPPEMENT INTERNATIONAL
42 rue Legendre PARIS 17°

CLIENT: UNIDO

EQUIPMENT LIST

SECTION 300

PAGE | AFFAIRE | NUMERO | REV

ITEM N°	ITEM NAME
P 306	MALATHION TRANSFER PUMP
R 301	MALATHION REACTOR
R 302	MALATHION STRIPPER
R 303	SODIUM CARBONATE MIXING TANK
R 304	PRECOAT MIXING TANK

PAGE		AFFAIRE		NUMERO	REV
2/2	310	6002	SOM	003	0

EQUIPMENT ITEM SYMBOL : C - STEAM OR LIQUID JETS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
C 301	SERVICE : REACTOR VACUUM PUMP TYPE : multistage steam jets with surface oondensers CAPACITY : 10 kg/hr of air SUCTION PRESSURE : 10 mmHg DISCHARGE PRESSURE: 760 mmHg PROPELLING FLUID :-steam : 150 psig satured steam -liquid: MATERIAL : cast iron and carbon steel TEMPERATURE : NOTES : condensers:shell and tube	
C 302	SERVICE : STRIPPER VACUUM PUMP TYPE : multistage steam jets with surface condensers CAPACITY : 9 kg/hr of air SUCTION PRESSURE : 25 mmHg DISCHARGE PRESSURE : 760 mmHg PROPELLING FLUID :-steam : 150 psig saturated steam -liquid: MATERIAL : cast iron and carbon steel TEMPERATURE. NOTES : condensers:shell and tube	
	SERVICE : TYPE : CAPACITY : SUCTION PRESSURE : DISCHARGE PRESSURE: PROPELLING FLUID :-steam : -liquid: MATERIAL : TEMPERATURE : NOTES :	

EQUIPMENT ITEM SYMBOL : D - TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 301	SERVICE : HOT WELL TYPE :vertical tank-flat bottom-light gage VOLUME :100 liters DIAMETER :500 mm HEIGHT :750 mm MATERIAL :carbon steel PRESSURE :atmospheric TEMPERATURE: 60°C NOTES :removable cover included	
D 302	SERVICE : HOT WELL TYPE :Vertical tank-flat bottom-light gage VOLUME :100 liters DIAMETER :500 mm HEIGHT :750 mm MATERIAL :carbon steel PRESSURE :atmospheric TEMPERATURE: 60°C NOTES : removable cover included	
D 303	SERVICE : ETHYL MALEATE FEED TANK TYPE : Vertical tank -dished heads VOLUME : 2 m3 DIAMETER : 1100 mm HEIGHT : 1900 mm MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 50°C NOTES :	

EQUIPMENT ITEM SYMBOL : D - TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 304	SERVICE : DMTA - TOLUENE FEED TANK TYPE : Vertical tank- dished heads VOLUME : 2,5 m3 DIAMETER : 1200 mm HEIGHT : 2100 mm MATERIAL : 316 SS PRESSURE : - 5 g/cm2; + 25 g/cm2 TEMPERATURE: 50°C NOTES :	
D 305	SERVICE : RECOVERED TOLUENE TANK TYPE : Vertical tank-dished heads VOLUME : 1,2 m3 DIAMETER : 1000 mm HEIGHT : 1400 mm MATERIAL : carbon steel PRESSURE : full vacuum+ 1,7 barg TEMPERATURE: 120°C NOTES :	
D306 A,B	SERVICE : RECOVERED REACTANTS TANKS TYPE : Vertical tank-dished heads VOLUME : 1.0 m3 DIAMETER : 900 mm HEIGHT : 1500 mm MATERIAL : 316 SS PRESSURE : Full vacuum and 1,7 bar g TEMPERATURE: 120°C NOTES : 2 tanks in parallel	

EQUIPMENT ITEM SYMBOL : D - TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 307	SERVICE : HEAVY PHASE SURGE TANK TYPE : Vertical tank-dished heads VOLUME : 2.8 m3 DIAMETER : 1250 mm HEIGHT : 2100 mm MATERIAL : 304 SS PRESSURE : Full vacuum + 1.7 bar gage TEMPERATURE: 80°C NOTES :	
D 308	SERVICE : CRUDE MALATHION SURGE TANK TYPE : Vertical tank- dished heads VOLUME : 2.8 m3 DIAMETER : 1250 mm HEIGHT : 2100 mm MATERIAL : 316 SS PRESSURE : Full vacuum + 1,7 bar gage TEMPERATURE: 180°C NOTES : cooling coil 2m2	
D 309	SERVICE : CRUDE MALATHION SURGE TANK TYPE : Vertical tank-dished heads VOLUME : 3 m3 DIAMETER : 1300 mm HEIGHT : 2100 mm MATERIAL : 304 SS PRESSURE : atmospheric TEMPERATURE: 70°C NOTES :	

EQUIPMENT ITEM SYMBOL : D – TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D310 A,B	SERVICE : SOLID WASTES CONTAINERS TYPE : open top with cover-light gage VOLUME : 0,5 m3 DIAMETER : 800x800x800 mm HEIGHT : MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: NOTES : 2 portable containers (with fork light truck)	
	SERVICE : TYPE : VOLUME : DIAMETER : HEIGHT : MATERIAL : PRESSURE : TEMPERATURE: NOTES :	
	SERVICE : TYPE : VOLUME : DIAMETER : HEIGHT : MATERIAL : PRESSURE : TEMPERATURE: NOTES :	

EQUIPMENT ITEM SYMBOL : E – HEAT EXCHANGER

TECHNICAL SPECIFICATIONS.

ITEM N°	ITEM NAME AND SPECIFICATION	
E 301	SERVICE : REACTOR CONDENSER HEAT TRANSFER AREA : 6m2 TYPE : graphite block exchanger PROCESS SIDE :toluène +miscellaneous – material :organic compounds – pressure :graphite – temperature: 1,7 bar gage+full vacuum $<$120°C UTILITY SIDE :44% ethylene glycol solution – material :graphite,carbon steel – pressure :6 bar g – temperature: -20°C NOTES :	
E 302	SERVICE :REACTOR VENT CONDENSER HEAT TRANSFER AREA :1 m2 TYPE :graphite block exchanger PROCESS SIDE :toluene – material :graphite – pressure :1,7 bar gage+full vacuum – temperature: $<$120°C UTILITY SIDE :44% ethylene glycol solution – material :graphite+carbon steel – pressure :6 bar g – temperature: – 20°C NOTES :	
E 303	SERVICE : EVAPORATOR CONDENSER HEAT TRANSFER AREA : 4 m2 TYPE : graphite block exchanger PROCESS SIDE : DMTA+ ethylmaleate – material : graphite – pressure : 1,7 barg+ full vacuum – temperature: 180°C UTILITY SIDE : Cooling water – material : graphite+carbon steel – pressure : 6 barg – temperature: 70°C NOTES :	

EQUIPMENT ITEM SYMBOL : E - HEAT EXCHANGER

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
E 304	SERVICE : EVAPORATOR VENT CONDENSER HEAT TRANSFER AREA : 0.5 m2 TYPE : graphite block exchanger PROCESS SIDE : DMTA+ethyl maleate - material : graphite - pressure : 1,7 bar gage+full vacuum - temperature: 100°C UTILITY SIDE : 44% ethylene glycol solution - material : graphite +carbon steel - pressure : 6 barg - temperature: -20°C NOTES :	
E 305	SERVICE : AGITATED FILM EVAPORATOR HEAT TRANSFER AREA : 2.0 m2 TYPE : agitated thin film evaporator PROCESS SIDE : crude malathion - material : 316 SS - pressure : 1.7 bar g+full vacuum - temperature: 200°C UTILITY SIDE : 150 psig saturated + - material : 316 SS and/or carbon steel - pressure : 11 bar g - temperature: 200°C NOTES : explosion proof motor	
E 306	SERVICE : STRIPPER CONDENSER HEAT TRANSFER AREA : 8 m2 TYPE : shell and tube PROCESS SIDE : tube side- water+malathion - material : 304 SS - pressure : full vacuum +1,7 bar g - temperature: 80°C UTILITY SIDE : shell side(-5°C glycol) - material : 304 SS +carbon steel - pressure : 6 bar g - temperature: - 5°C + 40°C NOTES :	

EQUIPMENT ITEM SYMBOL : H - FILTERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
H 301	SERVICE : PRECOAT FILTER TYPE : centrifugal discharge tray filter SOLIDS - weight : } <50 liters volume : } FILTERING AREA : 2,5 m2 MATERIAL : 304 SS PRESSURE : 5 bar g TEMPERATURE : 70°C NOTES : Explosion proof motor	
	SERVICE : TYPE : SOLIDS - weight : - volume : FILTERING AREA : MATERIAL : PRESSURE : TEMPERATURE : NOTES :	
	SERVICE : TYPE : SOLIDS - weight : - volume : FILTERING AREA : MATERIAL : PRESSURE : TEMPERATURE : NOTES :	

EQUIPMENT ITEM SYMBOL : P - PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS		
P 301	SERVICE	: EVAPORATOR FEED PUMP	
	TYPE	: Centrifugal pump	
	FLOW RATE	: 3,5 m3/hr	
	DIFFERENTIAL PRESSURE	: 2.0 bar	
	MATERIAL	: graphite	
	STUFFING BOX	:	
	MECHANICAL SEAL	: double mechanical seal	
	DRIVER	: explosion proof motor	
	NOTES	:	
P 302	SERVICE	: RECOVERED REACTANTS PUMP	
	TYPE	: Volumetric pump	
	FLOW RATE	: 3.0 m3/hr	
	DIFFERENTIAL PRESSURE	: 2.5 bar	
	MATERIAL	: 316 SS	
	STUFFING BOX	:	
	MECHANICAL SEAL	: Yes	
	DRIVER	: explosion proof motor	
	NOTES	:	
P 303	SERVICE	: FILTER FEED PUMP	
	TYPE	: Volumetric pump	
	FLOW RATE	: 6 m3/hr	
	DIFFERENTIAL PRESSURE	: 3.5 bar	
	MATERIAL	: 316 SS	
	STUFFING BOX	: yes	
	MECHANICAL SEAL	:	
	DRIVER	: explosion proof motor	
	NOTES	:	

EQUIPMENT ITEM SYMBOL : P – PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS	
P 304	SERVICE : SODIUM CARBONATE SOLUTION PUMP TYPE : Volumetric pump FLOW RATE : 2.0 m3/hr DIFFERENTIAL PRESSURE: 2.0 bar MATERIAL : cast iron or carbon steel STUFFING BOX : MECHANICAL SEAL : with water injection DRIVER : explosion proof motor NOTES :	
P 305	SERVICE :PRECOAT SUSPENSION TRANSFER PUMP TYPE :Centrifugal pump FLOW RATE :2.5 m3/hr DIFFERENTIAL PRESSURE:2.0 bar MATERIAL :cast iron or carbon steel STUFFING BOX :yes MECHANICAL SEAL : DRIVER :explosion proof motor NOTES :open type impeller	
P 306	SERVICE :MALATHION TRANSFER PUMP TYPE :Volumetric pump FLOW RATE :2.5 m3/hr DIFFERENTIAL PRESSURE:2.0 bar MATERIAL :316 SS STUFFING BOX :Yes MECHANICAL SEAL :explosion proof motor DRIVER : NOTES :	

EQUIPMENT ITEM SYMBOL : R - REACTOR

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
R 301	SERVICE : MALATHION REACTOR TYPE : Jackted reactor NOMINAL CAPACITY : 6000 liters MATERIAL : glass lined carbon steel AGITATOR AND DRIVE: impeller 11 KW PRESSURE : 1.7 bar gage + full vacuum TEMPERATURE : 200°C HEATING/COOLING : 150 psig steam/cooling water NOTE : Explosion proof motor double mechanical seal	
R 302	SERVICE :MALATHION STRIPPER TYPE :Jacketed reactor NOMINAL CAPACITY :4000 liters MATERIAL :316 SS AGITATOR AND DRIVE: impeller 7,5 kw PRESSURE : 1.7 bar g + full vacuum TEMPERATURE :200°C HEATING/COOLING :150 psig steam/cooling water NOTES :explosion proof motor double mechanical seal	

PAGE	AFFAIRE			NUMERO	REV
1/	330	6002	ADS	R3001	

EQUIPMENT ITEM SYMBOL : R - REACTOR

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
R 303	SERVICE : SODIUM CARBONATE MIXING TANK TYPE :Agitated open tank with oover conical bottom NOMINAL CAPACITY :0.75 m3 MATERIAL :Fiber reinforced polyester AGITATOR AND DRIVE:turbine impeller-1.5 kw PRESSURE :atmospheric TEMPERATURE :50°C HEATING/COOLING : NOTE : Explosion proof motor	
R 304	SERVICE :PRECOAT MIXING TANK TYPE :agitated open tank with cover conical bottom NOMINAL CAPACITY :0.75 m3 MATERIAL :304 SS AGITATOR AND DRIVE:Turbine impeller-1,5 kw PRESSURE :atmospheric TEMPERATURE : 50°C HEATING/COOLING : NOTES : explosion proof motor	

4 - EQUIPMENT LIST - N-METHYLCHLOROACETAMIDE

SECTION 400

N-METHYLCHLOROACETAMIDE PRODUCTION UNIT

ITEM N°	ITEM NAME
B 401	SCREW CONVEYOR
C 401	VACUUM JETS
D 401	OVERHEAD DECANTER
D 402	DISTILLATE RECEIVER
D 403	DISTILLATE RECEIVER
D 404	SOLVENT SURGE TANK
D 405	PRODUCT SURGE TANK
D 406	METHYLAMINE FEED TANK
D 407	CAUSTIC DILUTION TANK
D 408	HOT WELL
D 409	CHLOROACETIC ACID HOPPER
E 401	REACTOR CONDENSER
E 402	VENT CONDENSER
P 401	SOLVENT FEED PUMP
P 402	CAUSTIC DILUTION PUMP
P 403	PRODUCT TRANSFER PUMP
P 404	SOLVENT RECYCLE PUMP
R 401	AGITATED BATCH REACTOR
T 401	DISTILLATION TOWER

EQUIPMENT ITEM SYMBOL : B - CONVEYORS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
B 401	SERVICE : SCREW CONVEYOR TYPE : screw conveyor MATERIAL: stainless steel - 304 CAPACITY: 5 m3/hr SIZE : lenght 25 m Driver: 1.5 HP- explosion proof motor NOTES : includes feed hopper	
	SERVICE : TYPE : MATERIAL: CAPACITY: SIZE : NOTES :	
	SERVICE : TYPE : MATERIAL: CAPACITY: SIZE : NOTES :	

CE SCHEMA CONTENANT DES INFORMATIONS CONFIDENTIELLES EST LA PROPRIETE DE CDI ET NE PEUT ETRE REPRODUIT OU UTILISE SANS L AUTORISATION ECRITE DE CDI	PAGE 1/	AFFAIRE 330 6002 ADS NUMERO B4001	REV 0

EQUIPMENT ITEM SYMBOL : C - STEAM OR LIQUID JETS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
C 401	SERVICE : VACUUM JETS TYPE : multistage steam jets with intercondensers CAPACITY : 20 kg/hr of air SUCTION PRESSURE : 15 mmHg DISCHARGE PRESSURE: 760 mmHg PROPELLING FLUID :-steam : 150 psig sat steam -liquid: MATERIAL : cast iron and carbon steel TEMPERATURE : NOTES : shell and tube condensers	
	SERVICE TYPE CAPACITY SUCTION PRESSURE DISCHARGE PRESSURE PROPELLING FLUID :-steam : -liquid: MATERIAL TEMPERATURE. NOTES	
	SERVICE : TYPE : CAPACITY : SUCTION PRESSURE : DISCHARGE PRESSURE: PROPELLING FLUID :-steam : -liquid: MATERIAL : TEMPERATURE : NOTES :	

EQUIPMENT ITEM SYMBOL : D - TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 401	SERVICE : OVERHEAD DECANTER TYPE : horizontal drum- dished heads VOLUME : 400 liters DIAMETER : 0,5 m HEIGHT : 2,0 m MATERIAL : 304 ss PRESSURE : 1,7 bar gage + full vacuum TEMPERATURE: 100°C NOTES :	
D 402	SERVICE : DISTILLATE RECEIVER TYPE : vertical drum- dished heads VOLUME : 12 m3 DIAMETER : 1.9 m HEIGHT : 4.0 m MATERIAL : carbon steel PRESSURE :1.7 bar gage +full vacuum TEMPERATURE: 100°C NOTES : cooling coil: 2 m2	
D 403	SERVICE : DISTILLATE RECEIVER TYPE : Vertical drum- dished heads VOLUME : 5.0 m3 DIAMETER : 1.5 m HEIGHT : 2.6 m MATERIAL : carbon steel PRESSURE : 1.7 bar gage + full vacuum TEMPERATURE: 100°C NOTES :	

EQUIPMENT ITEM SYMBOL : D - TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 404	SERVICE : SOLVENT SURGE TANK TYPE : Vertical tank- flat bottom- light gage VOLUME : 18 m3 DIAMETER : 2.0 m HEIGHT : 5.9 m MATERIAL : carbon steel PRESSURE : ± 50 cm water column TEMPERATURE: 60°C NOTES :	
D 405	SERVICE : PRODUCT SURGE TANK TYPE : Vertical- dished heads VOLUME : 8 m3 DIAMETER : 1.9 m HEIGHT : 2.6 m MATERIAL : 304 ss PRESSURE : atmospheric TEMPERATURE: 60°C NOTES :	
D 406	SERVICE : METHYLAMINE FEED TANK TYPE : Vertical dished heads VOLUME : 6.5 m3 DIAMETER : 1.7 m HEIGHT : 2.6 m MATERIAL : carbon steel PRESSURE : 6 bar g + full vacuum TEMPERATURE: 60°C NOTES : Cooling coil: 5 m2	

EQUIPMENT ITEM SYMBOL : D – TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 407	SERVICE : CAUSTIC DILUTION TANK TYPE : Vertical tank- flat bottom- light gage VOLUME : 4.5 m3 DIAMETER : 1.4 m HEIGHT : 3.0 m MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE : 60°C NOTES : Heat treated welds	
D 408	SERVICE : HOT WELL TYPE : Vertical tank- flat bottom- light gage VOLUME : 100 li s DIAMETER : 500 mm HEIGHT : 750 mm MATERIAL : carbon st el PRESSURE : atmospheri TEMPERATURE : 60°C NOTES : Removable cover included	
D 409	SERVICE : CHLOROACETIC ACID HOPPER TYPE : Vertical tank- conical bottom VOLUME : 9.5 m3 DIAMETER : 2 m HEIGHT : 4.5 m MATERIAL : 316 SS PRESSURE : atmospheric TEMPERATURE : 50°C NOTES : Rotary feeder and drive included (explosion proof motor)	

EQUIPMENT ITEM SYMBOL : E - HEAT EXCHANGER

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
E 401	SERVICE : REACTOR CONDENSER HEAT TRANSFER AREA : 150 m2 TYPE : shell and tube PROCESS SIDE : tube side - material : 304 SS - pressure : 1.7 bar g + full vacuum - temperature: 150°C UTILITY SIDE : Cooling water-glycol-shell side - material : 304 SS + carbon steel - pressure : 6 bar g - temperature: 70°C NOTES :	
E 402	SERVICE : VENT CONDENSER HEAT TRANSFER AREA : 10 m2 TYPE : shell and tube PROCESS SIDE : tube side - material : 304 SS - pressure : 1.7 bar g+ full vacuum - temperature: 100°C UTILITY SIDE : Cooling water-glycol-shell side - material : 304 ss +carbon steel - pressure : 6 bar g - temperature: 70°C NOTES :	
	SERVICE : HEAT TRANSFER AREA : TYPE : PROCESS SIDE : - material : - pressure : - temperature: UTILITY SIDE : - material : - pressure : - temperature: NOTES :	

EQUIPMENT ITEM SYMBOL : P - PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS		
P 401	SERVICE	:	SOLVENT FEED PUMP
	TYPE	:	Centrifugal pump
	FLOW RATE	:	30 m3/hr
	DIFFERENTIAL PRESSURE	:	2,5 bar
	MATERIAL	:	cast iron
	STUFFING BOX	:	
	MECHANICAL SEAL	:	yes
	DRIVER	:	explosion proof motor
	NOTES	:	
P 402	SERVICE	:	CAUSTIC DILUTION PUMP
	TYPE	:	Volumetric pump
	FLOW RATE	:	15 m3/hr
	DIFFERENTIAL PRESSURE	:	2.5 bar
	MATERIAL	:	cast iron or carbon steel
	STUFFING BOX	:	
	MECHANICAL SEAL	:	double
	DRIVER	:	explosion proof motor
	NOTES	:	variable speed drive- self priming
P 403	SERVICE	:	PRODUCT TRANSFER PUMP
	TYPE	:	volumetric pump
	FLOW RATE	:	30 m3/hr
	DIFFERENTIAL PRESSURE	:	3.5 bar
	MATERIAL	:	316 SS
	STUFFING BOX	:	
	MECHANICAL SEAL	:	yes
	DRIVER	:	explosion proof motor
	NOTES	:	variable speed drive

EQUIPMENT ITEM SYMBOL : P - PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS	
P 404	SERVICE : SOLVENT RECYCLE PUMP TYPE : centrifugal pump FLOW RATE : 20 m3/hr DIFFERENTIAL PRESSURE: 2.5 bar MATERIAL : cast iron STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :	
	SERVICE : TYPE : FLOW RATE : DIFFERENTIAL PRESSURE: MATERIAL : STUFFING BOX : MECHANICAL SEAL : DRIVER : NOTES :	
	SERVICE : TYPE : FLOW RATE : DIFFERENTIAL PRESSURE: MATERIAL : STUFFING BOX : MECHANICAL SEAL : DRIVER : NOTES :	

CE SCHEMA CONTENANT DES INFORMATIONS CONFIDENTIELLES EST LA PROPRIETE DE CDI ET NE PEUT ETRE REPRODUIT OU UTILISE SANS L AUTORISATION ECRITE DE CDI	PAGE	AFFAIRE	NUMERO	REV
	2/	330 6002	ADS P4001	0

EQUIPMENT ITEM SYMBOL : R – REACTOR

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
R 401	SERVICE : AGITATED BATCH REACTOR TYPE : Jacketed reactor with internal coil NOMINAL CAPACITY : 28m3 MATERIAL : 316 stainless steel AGITATOR AND DRIVE: 15 kw turbine PRESSURE : 1.7 bar gage + full vacuum TEMPERATURE : 200°C HEATING/COOLING : 150 psig steam/cooling water/ glycol NOTE : explosion proof motor- double mechanical seal coil area: 14 m2	
	SERVICE : TYPE : NOMINAL CAPACITY : MATERIAL : AGITATOR AND DRIVE: PRESSURE : TEMPERATURE : HEATING/COOLING : NOTES :	

CE SCHEMA CONTENANT DES INFORMATIONS CONFIDENTIELLES EST LA PROPRIETE DE CDI ET NE PEUT ETRE REPRODUIT OU UTILISE SANS L AUTORISATION ECRITE DE CDI	PAGE 1/	330	AFFAIRE 6002	ADS NUMERO R4001	REV 0

EQUIPMENT ITEM SYMBOL : T - COLUMNS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
T 401	SERVICE : DISTILLATION TOWER TYPE : packed tower DIAMETER: 1 m TRAYS : Type : : Number : : Spacing : : Material : PACKING : Type : pall rings- 2" : Height : 5 m : Material : 304 SS VESSEL : Material : 304 SS : Pressure : 1.7 bar gage+full vacuum : Temperature: 150°C NOTES :	
	SERVICE : TYPE : DIAMETER: TRAYS : type : : number : : spacing : : material : PACKING : type : : height : : material : VESSEL : material : : pressure : : temperature: NOTES :	

5 - EQUIPMENT LIST - DIMETHOATE

SECTION 500

DIMETHOATE PRODUCTION UNIT

ITEM N°	ITEM NAME
B 501	BUCKET ELEVATOR
C 501	VACUUM JETS
D 501	ACID SURGE TANK
D 502	LEAN TOLUENE TANK
D 503	ACID SOLUTION TANK
D 504	ACETAMIDE SURGE TANK
D 505	BICARBONATE HOPPER
D 506	WASTE WATER TANK
D 507	SOLVENT EVAPORATOR
D 508	SOLVENT RUN DOWN TANK
D 509	DIMETHOATE SURGE TANK
D 510	HOT WELL
D 511	REFLUX DRUM
D 512	RECOVERED CYCLOHEXANONE TANK
D 513	TOLUENE EVAPORATION DRUM
D 514	DISTILLED TOLUENE TANK
E 501	VENT CONDENSER
E 502	WIPED FILM EVAPORATOR
E 503	EVAPORATOR CONDENSER
E 504	EVAPORATOR VENT CONDENSER
E 505	COLUMN REBOILER
E 506	COLUMN CONDENSER
E 507	COLUMN VENT CONDENSER
E 508	EFFLUENT COOLER
E 509	TOLUENE CONDENSAL
H 501	METAL BELT FLAKER

ITEM N°	ITEM NAME
P 501	ACID SOLUTION FEED PUMP
P 502	ACID SOLUTION TRANSFER PUMP
P 503	LEAN TOLUENE PUMP
P 504	REACTOR FEED PUMP
P 505	RAW PRODUCT TRANSFER PUMP
P 506	WASTE WATER PUMP
P 507	EVAPORATOR PUMP
P 508	DICHLOROETHANE RECYCLE PUMP
P 509	FLAKER FEED PUMP
P 510	CYCLOHEXANONE TRANSFER PUMP
P 511	EFFLUENT TRANSFER PUMP
P 512	DISTILLED TOLUENE PUMP
R 501	ACID EXTRACTION TANK
R 502	DIMETHOATE REACTOR
T 501	DISTILLATION COLUMN
U 501	PACKAGING MACHINE

EQUIPMENT ITEM SYMBOL : B – CONVEYORS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
B 501	SERVICE : BUCKET ELEVATOR TYPE : bucket elevator MATERIAL: carbon steel (plastic buckets allowed) CAPACITY: 2000 kg/hr (d=1.0) SIZE : length : 15 m NOTES : explosion proof motor	
	SERVICE : TYPE : MATERIAL: CAPACITY: SIZE : NOTES :	
	SERVICE : TYPE : MATERIAL: CAPACITY: SIZE : NOTES :	

	PAGE 1/	AFFAIRE 330 6002 ADS NUMERO B 5001	REV 0

EQUIPMENT ITEM SYMBOL : C - STEAM OR LIQUID JETS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
C 501	SERVICE : VACUUM JETS TYPE : multistage steam jets with surface condensers CAPACITY : 25 kg/hr of air SUCTION PRESSURE : 25 mmHg DISCHARGE PRESSURE: 760 mmHg PROPELLING FLUID :-steam : 150 psig saturated steam -liquid: MATERIAL : cast iron and carbon steel TEMPERATURE : NOTES : condensers: shell and tube	
	SERVICE TYPE CAPACITY SUCTION PRESSURE DISCHARGE PRESSURE PROPELLING FLUID :-steam : -liquid: MATERIAL TEMPERATURE. NOTES	
	SERVICE : TYPE : CAPACITY : SUCTION PRESSURE : DISCHARGE PRESSURE: PROPELLING FLUID :-steam : -liquid: MATERIAL : TEMPERATURE : NOTES :	

EQUIPMENT ITEM SYMBOL : D - TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 501	SERVICE : ACID SURGE TANK TYPE : Vertical tank-dished heads VOLUME : 5 m3 DIAMETER : 1.5 M HEIGHT : 2.6 m MATERIAL : 316 SS PRESSURE : atmospheric TEMPERATURE: 60°C NOTES :	
D 502	SERVICE : LEAN TOLUENE TANK TYPE : Vertical tank-flat bottom- light gage VOLUME : 5 m3 DIAMETER : 1.5 m HEIGHT : 3.0 m MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 60°C NOTES :	
D 503	SERVICE : ACID SOLUTION TANK TYPE : Vertical tank-flat bottom- light gage VOLUME : 18 m3 DIAMETER : 2.4 m HEIGHT : 4.1 m MATERIAL : 316 SS PRESSURE : Atmospheric TEMPERATURE: 60°C NOTES :	

PAGE	AFFAIRE		NUMERO	REV
1/	330	6002	ADS D5001	0

EQUIPMENT ITEM SYMBOL : D – TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 504	SERVICE : ACETAMIDE SURGE TANK TYPE : Vertical tank-dished heads VOLUME : 5 m3 DIAMETER : 1.5 m HEIGHT : 2.6 m MATERIAL : 304 ss PRESSURE : atmospheric TEMPERATURE: 60°C NOTES :	
D 505	SERVICE : BICARBONATE HOPPER TYPE : Vertical tank-conical bottom VOLUME : 2.9 m3 DIAMETER : 1.4 m HEIGHT : 2.8 m MATERIAL : fiber reinforced polyester PRESSURE : atmospheric TEMPERATURE: 40°C NOTES : includes rotary feeder and drive (explosion proof motor)	
D 506	SERVICE : WASTE WATER TANK TYPE : Vertical tank-flat bottom- light gage VOLUME : 30 m3 DIAMETER : 2.7 m HEIGHT : 5.4 m MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 60°C NOTES :	

EQUIPMENT ITEM SYMBOL : D - TANKS AND HOPPERS		
TECHNICAL SPECIFICATIONS		
ITEM N°	ITEM NAME AND SPECIFICATION	
D 507	SERVICE : SOLVENT EVAPORATOR TYPE : vertical tank -dished heads VOLUME : 22 m3 DIAMETER : 2.5 m HEIGHT : 4.5 m MATERIAL : 304 SS PRESSURE : 1.7 bar gage + full vacuum TEMPERATURE: 200°C NOTES : heating coil: 6 m2	
D 508	SERVICE : SOLVENT RUN DOWN TANK TYPE : Vertical tank- dished heads VOLUME : 18 m3 DIAMETER : 2.3 m HEIGHT : 4.2 m MATERIAL : carbon steel PRESSURE : 1.7 bar gage + full vacuum TEMPERATURE: 60°C NOTES : cooling coil: 3 m2	
D 509	SERVICE : DIMETHOATE SURGE TANK TYPE : Vertical tank- dished heads VOLUME : 8 m3 DIAMETER : 1.9 m HEIGHT : 2.8 m MATERIAL : 304 SS PRESSURE : 1.7 bar gage + full vacuum TEMPERATURE: 150°C NOTES : Cooling coil : 4 m2 Heating jacket: 2 m2	

EQUIPMENT ITEM SYMBOL : D - TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 510	SERVICE : HOT WELL TYPE : Vertical tank--flat bottom-light gage VOLUME : 100 liters DIAMETER : 500 mm HEIGHT : 750 mm MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 60°C NOTES : removable cover included	
D 511	SERVICE : REFLUX DRUM TYPE : Vertical tank- dished heads VOLUME : 0.23 m3 DIAMETER : 0.6 m HEIGHT : 0.8 m MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 100°C NOTES :	
D 512	SERVICE : RECOVERED CYCLOHEXANONE TANK TYPE : Vertical tank- flat bottom VOLUME : 4 m3 DIAMETER : 1.4 m HEIGHT : 2.8 m MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 100°C NOTES :	

EQUIPMENT ITEM SYMBOL : D – TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 513	SERVICE : TOLUENE EVAPORATION DRUM TYPE : Vertical tank-dished heads VOLUME : 2.5 m3 DIAMETER : 1.2 m HEIGHT : 2.2 m MATERIAL : carbon steel PRESSURE : 1.7 bar g + full vacuum TEMPERATURE: 200°C NOTES : heating coil: 3 m2	
D 514	SERVICE : DISTILLED TOLUENE TANK TYPE : Vertical tank-flat bottom-light gage VOLUME : 2.5 m3 DIAMETER : 1.2 m HEIGHT : 2.1 m MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 80°C NOTES :	
	SERVICE : TYPE : VOLUME : DIAMETER : HEIGHT : MATERIAL : PRESSURE : TEMPERATURE: NOTES :	

EQUIPMENT ITEM SYMBOL : E - HEAT EXCHANGER

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
E 501	SERVICE : VENT CONDENSER HEAT TRANSFER AREA : 7.5 m2 TYPE : graphite block exchanger PROCESS SIDE : solvent vapors - material : graphite - pressure : atmospheric - temperature : 85°C UTILITY SIDE : cooling water - material : graphite-carbon steel - pressure : 6 bar g - temperature : 60°C NOTES :	
E 502	SERVICE : WIPED FILM EVAPORATOR HEAT TRANSFER AREA : 7.5 m2 TYPE : wiped film evaporator PROCESS SIDE : dimethoate +solvent - material : 304 SS - pressure : 1.7 bar gage + full vacuum - temperature : 200°C UTILITY SIDE : 150 psig steam - material : 304 SS + carbon steel - pressure : 11 bar g - temperature : 200°C NOTES : 15 HP explosion proof motor	
E 503	SERVICE : EVAPORATOR CONDENSER HEAT TRANSFER AREA : 35 m2 TYPE : graphite block exchanger PROCESS SIDE : dichloroethane - material : graphite - pressure : 1.7 bar gage+ full vacuum - temperature : 120°C UTILITY SIDE : glycol solution - material : graphite- carbon steel - pressure : 6 bar g - temperature : - 20°C NOTES :	

CE SCHEMA CONTENANT DES INFORMATIONS CONFIDENTIELLES EST LA PROPRIETE DE CDI ET NE PEUT ETRE REPRODUIT OU UTILISE SANS L AUTORISATION ECRITE DE CDI	PAGE 1/	AFFAIRE NUMERO 330 6002 ADS E5001	REV 0

EQUIPMENT ITEM SYMBOL : E - HEAT EXCHANGER

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
E 504	SERVICE :EVAPORATOR VENT CONDENSER HEAT TRANSFER AREA :4 m2 TYPE :graphite block exchanger PROCESS SIDE :dichloroethane - material :graphite - pressure :1.7 bar g+ full vacuum - temperature: ~2°C UTILITY SIDE :glycol solution - material : graphite-carbon steel - pressure :6 bar g - temperature:- 20°C NOTES :	
E 505	SERVICE :COLUMN REBOILER HEAT TRANSFER AREA :20 m2 TYPE :kettle reboiler PROCESS SIDE :waste water - material :316 SS - pressure :1.7 bar g+ full vacuum - temperature:200°C UTILITY SIDE :150 psig steam - material :carbon steel - pressure :11 bar g - temperature:200°C NOTES :vessel volume=15 m3 (DIA=2.0m- L=4.6 m)	
E 506	SERVICE :COLUMN CONDENSER HEAT TRANSFER AREA : 25 m2 TYPE :shell and tube PROCESS SIDE :cyclohexanone-water - material :carbon steel - pressure :1.7 bar g+full vacuum - temperature:130°C UTILITY SIDE :cooling water - material :carbon steel - pressure :6 bar G - temperature:60°C NOTES :	

EQUIPMENT ITEM SYMBOL : E - HEAT EXCHANGER		
TECHNICAL SPECIFICATIONS		
ITEM N°	ITEM NAME AND SPECIFICATION	
E 507	SERVICE : COLUMN VENT CONDENSER HEAT TRANSFER AREA : 3 m2 TYPE : shell and tube PROCESS SIDE : cyclohexanone + water - material : carbon steel - pressure : atmospheric - temperature: 100°C UTILITY SIDE : cooling water - material : carbon steel - pressure : 6 bar g - temperature: 60°C NOTES :	
E 508	SERVICE : EFFLUENT COOLER HEAT TRANSFER AREA : 50 M2 TYPE : plate heat exchanger PROCESS SIDE : waste water - material : 316 SS - pressure : 3 bar g - temperature: 100°C UTILITY SIDE : cooling water - material : carbon steel - pressure : 6 bar g - temperature: 60°C NOTES :	
E 509	SERVICE : TOLUENE CONDENSER HEAT TRANSFER AREA : 5 m2 TYPE : shell and tube PROCESS SIDE : toluene - material : carbon steel - pressure : 1.7 bar g+full vacuum - temperature: 150°C UTILITY SIDE : cooling water - material : carbon steel - pressure : 6 bar g - temperature: 60°C NOTES :	

EQUIPMENT ITEM SYMBOL - H- FLAKERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION
H 501	SERVICE : METAL BELT FLAKER
	TYPE : "SANDVIK" metal belt flaker
	BELT MATERIAL : 304 SS
	CAPACITY : 850 kg/hr
	EFFECTIVE AREA : 12 m2
	HEAT TRANSFER FLUID : glycol solution
	DRIVE : explosion proof motor
	NOTES : includes feed system, solids discharge hopper, rotary discharge valve, enclosure and drive.

EQUIPMENT ITEM SYMBOL : P – PUMPS

TECHNICAL SPECIFICATIONS

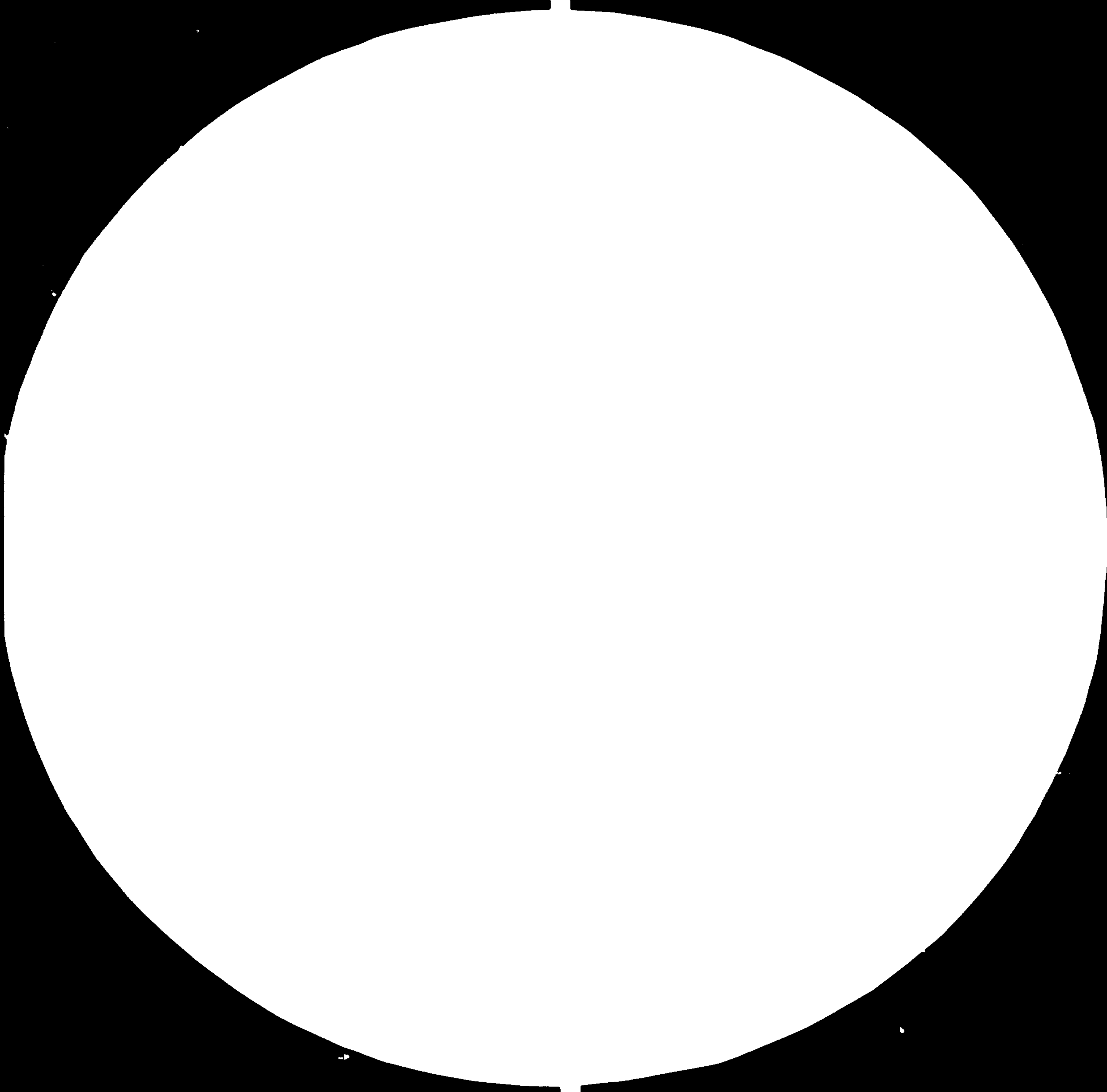
ITEM N°	ITEM NAME AND SPECIFICATIONS	
P 501	SERVICE : ACID SOLUTION FEED PUMP TYPE : centrifugal pump FLOW RATE : 10 m3/hr DIFFERENTIAL PRESSURE: 2 bar MATERIAL : graphite STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :	
P 502	SERVICE : ACID SOLUTION TRANSFER PUMP TYPE : Centrifugal pump FLOW RATE : 40 m3/hr DIFFERENTIAL PRESSURE: 2.0 bar MATERIAL : graphite STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :	
P 503	SERVICE : LEAN TOLUENE PUMP TYPE : centrifugal pump FLOW RATE : 8 m3 /hr DIFFERENTIAL PRESSURE: 2.0 bar MATERIAL : cast iron STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :	

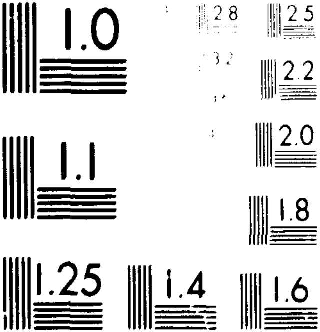
EQUIPMENT ITEM SYMBOL : P - PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS		
P 504	SERVICE	: REACTOR FEED PUMP	
	TYPE	: centrifugal pump	
	FLOW RATE	: 30 m3/hr	
	DIFFERENTIAL PRESSURE	: 2.0 bar	
	MATERIAL	: graphite	
	STUFFING BOX	:	
	MECHANICAL SEAL	: yes	
	DRIVER	: explosion proof motor	
	NOTES	:	
P 505	SERVICE	: RAW PRODUCT TRANSFER PUMP	
	TYPE	: centrifugal pump	
	FLOW RATE	: 50 m3/hr	
	DIFFERENTIAL PRESSURE	: 2.0 bar	
	MATERIAL	: graphite	
	STUFFING BOX	:	
	MECHANICAL SEAL	: yes	
	DRIVER	: explosion proof motor	
	NOTES	:	
P 506	SERVICE	: WASTE WATER PUMP	
	TYPE	: centrifugal pump	
	FLOW RATE	: 25 m3/hr	
	DIFFERENTIAL PRESSURE	: 2.0 bar	
	MATERIAL	: cast iron	
	STUFFING BOX	: yes	
	MECHANICAL SEAL	:	
	DRIVER	: explosion proof motor	
	NOTES	:	

PAGE	AFFAIRE	NUMERO	REV
2/	330 6002	ADS P5001	0

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EQUIPMENT ITEM SYMBOL : P - PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS	
P 507	SERVICE :EVAPORATOR PUMP TYPE :volumetric pump FLOW RATE :15 m3/hr DIFFERENTIAL PRESSURE:2 bar MATERIAL :316 SS STUFFING BOX : MECHANICAL SEAL :double DRIVER :explosion proof motor NOTES :reversible pump	
P 508	SERVICE :DICHLOROETHANE RECYCLE PUMP TYPE :centrifugal pump FLOW RATE :30 m3/hr DIFFERENTIAL PRESSURE:3.0 bar MATERIAL :cast iron or carbon steel STUFFING BOX : MECHANICAL SEAL :double DRIVER :explosion proof motor NOTES :	
P 509	SERVICE :FLAKER FEED PUMP TYPE :volumetric pump FLOW RATE :1 m3/hr DIFFERENTIAL PRESSURE:2.0 bar MATERIAL :316 SS STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :	

EQUIPMENT ITEM SYMBOL : P – PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS	
P 510	SERVICE : CYCLOHEXANONE TRANSFER PUMP TYPE : centrifugal pump FLOW RATE : 5 m3/hr DIFFERENTIAL PRESSURE: 2.5 bar MATERIAL : 316 SS STUFFING BOX : yes MECHANICAL SEAL : DRIVER : explosion proof motor NOTES :	
P 511	SERVICE : EFFLUENT TRANSFER PUMP TYPE : volumetric pump FLOW RATE : 35 m3/hr DIFFERENTIAL PRESSURE: 2.0 bar MATERIAL : 316 SS STUFFING BOX : yes MECHANICAL SEAL : DRIVER : explosion proof motor NOTES :	
P 512	SERVICE : DISTILLED TOLUENE PUMP TYPE : centrifugal pump FLOW RATE : 5 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL : cast iron STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :	

EQUIPMENT ITEM SYMBOL : R - REACTOR

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION		
R 501	SERVICE	:ACID EXTRACTION TANK	
	TYPE	: agitated vertical tank-conical bottom	
	NOMINAL CAPACITY	: 28 m3 (O.D.=3000 mm)	
	MATERIAL	: 316 SS	
	AGITATOR AND DRIVE	: turbine impeller	
	PRESSURE	: atmospheric	
	TEMPERATURE	: 60°C	
	HEATING/COOLING	:	
	NOTE	: explosion proof motor	
R 502	SERVICE	: DIMETHOATE REACTOR	
	TYPE	:agitated vertical tank-dished heads	
	NOMINAL CAPACITY	:40 m3	
	MATERIAL	:316 SS	
	AGITATOR AND DRIVE	:turbine impeller	
	PRESSURE	: atmospheric	
	TEMPERATURE	: 85°C	
	HEATING/COOLING	: 150 psig sat.steam/glycol	
	NOTES	: explosion proof motor	

PAGE	AFFAIRE			NUMERO	REV
1/	330	6002	ADS	R5001	0

EQUIPMENT ITEM SYMBOL : T - COLUMNS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
T 501	SERVICE : DISTILLATION COLUMN TYPE : packed tower DIAMETER: 750 mm TRAYS : Type : : Number : : Spacing : : Material : PACKING : Type : pall rings -2" : Height : 3 x 3 meters : Material : 304 SS VESSEL : Material : carbon steel : Pressure : 1.7 bar g + full vacuum : Temperature: 130°C NOTES :	
	SERVICE : TYPE : DIAMETER: TRAYS : type : : number : : spacing : : material : PACKING : type : : height : : material : VESSEL : material : : pressure : : temperature: NOTES :	

PAGE	AFFAIRE		NUMERO	REV
1/	330	6002	ADS T5001	0

EQUIPMENT ITEM SYMBOL : U- PACKAGE UNITS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION
U 501	SERVICE : PACKAGING MACHINE TYPE : automatic bagging and palletizing unit CAPACITY : 2 bags per minute NOTES : includes an automatic scale and roller (or band) conveyors

6 - EQUIPMENT LIST - MANEB-ZINEB

SECTION 600

MANEB -ZINEB PRODUCTION UNIT

ITEM N°	ITEM NAME
B 601	FORK LIFT TRUCK
C 601	LIQUID JET- NABAM REACTOR
C 602	DRYER VACUUM JET
D 601	CAUSTIC SOLUTION TANK-NABAM REACTOR
D 602 A,B	NABAM DILUTION TANKS
D 603	Zn/Mn SALTS SURGE TANK
D 604	MOTHER LIQUORS RECEIVER
D 605	CAUSTIC MEASURING TANK
D 606	RESLURRYING TANK
D 607	SPRAY DRYER FEED TANK
D 608	ETHYLENE DIAMINE MEASURING TANK
D 609	MANEB/ZINEB REACTOR-SCRUBBING SOLUTION TANK
D 610	CS_2 MEASURING TANK
D 611	ACID MEASURING TANK
D 612 A,B,C	SURGE HOPPERS
D 613 A,B,C	PACKAGING MACHINE FEED HOPPERS
E 601	NABAM REACTOR CONDENSER
E 602	MANEB/ZINEB REACTOR COOLER
E 603	NABAM COOLER
E 604	COOLER
H 601	MANEB/ZINEB CENTRIFUGE
K 601	SCALE

DESCRIPTION	REV	DATE	SIGN	VERIF.

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EQUIPMENT LIST

SECTION 600

PAGE	AFFAIRE			NUMERO	REV
1/2	310	6002	SOM	006	0

ITEM N°	ITEM NAME
P 601	CS_2 METERING PUMP
P 602	CAUSTIC SOLUTION METERING PUMP
P 603	NABAM PUMP
P 604	SCRUBBING SOLUTION PUMP-NABAM REACTOR
P 605	NABAM PUMP
P 606	SALT TANK PUMP
P 607	REACTOR PUMP
P 608	ACID METERING PUMP
P 609	MOTHER LIQUORS PUMP
P 610	RESLURRYING TANK PUMP
P 611	SPRAY DRYER FEED PUMP
P 612	SCRUBBING SOLUTION PUMP-MANEB/ZINEB
R 601	NABAM REACTOR
R 602	MANEB/ZINEB REACTOR
S 601	SPRAY DRYER PACKAGE
S 602	VACUUM DRYER
T 601	NABAM REACTOR SCRUBBER
T 602	MANEB/ZINEB REACTOR SCRUBBER
U 601	PACKAGING MACHINE

PAGE	AFFAIRE			NUMERO	REV
2/2	310	6002	SOM	006	

EQUIPMENT ITEM SYMBOL: B - HANDLING EQUIPMENT

	TECHNICAL SPECIFICATIONS	
ITEM N°	ITEM NAME AND SPECIFICATION	
B 601	SERVICE : FORK LIFT TRUCK NOMINAL CAPACITY: 3000 kg (Center of gravity of load at 0.8 m from rear end of fork) TRUCK POWERED BY: Internal combustion engine or batteries ENVIRONMENTAL CONDITIONS: hazardous area WHEELS TYPE: tires	

EQUIPMENT ITEM SYMBOL : C - STEAM OR LIQUID JETS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
C601	SERVICE :LIQUID JET-NABAM REACTOR TYPE :draft inducing venture scrubber CAPACITY : 350 m3/hr @ 20°C-760 mmHg SUCTION PRESSURE : minus 50 mm water column DISCHARGE PRESSURE: 760 mmHg PROPELLING FLUID :-steam : -liquid: water +carbon disulfide MATERIAL : cast iron or carbon steel TEMPERATURE : <45°C NOTES :	
C602	SERVICE DRYER VACUUM JET TYPE Steam jets in series CAPACITY 4 kg/hr of air SUCTION PRESSURE 10 mmHg abs DISCHARGE PRESSURE 760 mmHg PROPELLING FLUID :-steam : 150 psig sat.steam -liquid: MATERIAL cast iron or carbon steel TEMPERATURE. <45°C NOTES	
	SERVICE : TYPE : CAPACITY : SUCTION PRESSURE : DISCHARGE PRESSURE: PROPELLING FLUID :-steam : -liquid: MATERIAL : TEMPERATURE : NOTES :	

EQUIPMENT ITEM SYMBOL : D – TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D601	SERVICE : CAUSTIC SOLUTION TANK-NABAM REACTOR TYPE : Horizontal tank-dished heads VOLUME : 2 m3 DIAMETER : 1.[illegible] m HEIGHT : 2.2 m MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 100°C NOTES :	
D602 A,B	SERVICE : NABAM DILUTION TANKS-(2 tanks) TYPE : vertical tank-dished heads VOLUME : 10 m3 DIAMETER : 2400 mm HEIGHT : 2600 mm MATERIAL : rubber lined carbon steel PRESSURE : atmospheric TEMPERATURE: 70°C NOTES : agitator: pitched blades turbine power: 7,5 kw	
D603	SERVICE : Zn/Mn SALTS SURGE TANK TYPE : vertical tank-dished heads VOLUME : 8 m3 DIAMETER : 2200 mm HEIGHT : 2200 mm MATERIAL : rubber lined carbon steel PRESSURE : atmospheric TEMPERATURE: 50°C NOTES : Agitator: pitched blades turbine power: 5,5 kw	

PAGE	AFFAIRE		NUMERO	REV
1/5	330 6002	ADS	D600[illegible]	0

EQUIPMENT ITEM SYMBOL : D – TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D604	SERVICE : MOTHER LIQUORS RECEIVER TYPE : Horizontal tank-dished heads VOLUME : 5 m3 DIAMETER : 1500 mm HEIGHT : 2800 mm MATERIAL : rubber lined carbon steel PRESSURE : atmospheric TEMPERATURE: 50°C NOTES :	
D605	SERVICE : CAUSTIC MEASURING TANK TYPE : Vertical tank-dished heads VOLUME : 1 m3 DIAMETER : 900 mm HEIGHT : 1500 mm MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 50°C NOTES : Heat treated welds	
D606	SERVICE : RESLURRYING TANK TYPE : vertical tank-dished heads VOLUME : 15 m3 DIAMETER : 2500 mm HEIGHT : 2700 mm MATERIAL : rubber lined carbon steel or polyester PRESSURE : atmospheric TEMPERATURE: 50°C NOTES : agitator:pitched blades turbine power: 15 kw	

CE SCHEMA CONTENANT DES INFORMATIONS CONFIDENTIELLES EST LA PROPRIETE DE CDI ET NE PEUT ETRE REPRODUIT OU UTILISE SANS L AUTORISATION ECRITE DE CDI	PAGE 2/5	AFFAIRE 330 6002	NUMERO ADS D6001	REV 0

EQUIPMENT ITEM SYMBOL : D - TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D607	SERVICE : SPRAY DRYER FEED TANK TYPE : Vertical tank-dished heads VOLUME : 40 m3 DIAMETER : 3400 mm HEIGHT : 4400 mm MATERIAL : rubber lined carbon steel PRESSURE : atmospheric TEMPERATURE: 50°C NOTES : Agitator:pitched blades turbine power: 37 kw	
D608	SERVICE : ETHYLENE DIAMINE MEASURING TANK TYPE : vertical tank-dished heads VOLUME : 600 l DIAMETER : 750 mm HEIGHT : 1500 mm MATERIAL : rubber lined carbon steel PRESSURE : + 100 g/cm2 TEMPERATURE: 50°C NOTES :	
D609	SERVICE : MANEB/ZINEB REACTOR-SCRUBBING SOLUTION TANK TYPE : horizontal tank-dished heads VOLUME : 2 m3 DIAMETER : 1100 mm HEIGHT : 1900 mm MATERIAL : rubber lined carbon steel PRESSURE : atmospheric TEMPERATURE: 100°C NOTES : Heat treated welds	

EQUIPMENT ITEM SYMBOL : D - TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D610	SERVICE : CS_2 MEASURING TANK TYPE : vertical tank-dished heads VOLUME : 1.2 m3 DIAMETER : 1000 mm HEIGHT : 1400 mm MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE : 50°C NOTES :	
D611	SERVICE : ACID MEASURING TANK TYPE : vertical tank-dished heads VOLUME : 1 m3 DIAMETER : 900 mm HEIGHT : 1500 mm MATERIAL : rubber lined carbon steel PRESSURE : atmospheric TEMPERATURE : 50°C NOTES :	
D612 A,B,C	SERVICE : SURGE HOPPERS TYPE : Vertical tank-conical bottom VOLUME : 4 m3 DIAMETER : 1400 mm HEIGHT : 3700 mm MATERIAL : polyester PRESSURE : atmospheric TEMPERATURE : ambient NOTES : 3 tanks	

EQUIPMENT ITEM SYMBOL : D – TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 613 A,B,C	SERVICE : PACKAGING MACHINE FEED HOPPERS TYPE : Vertical tanks–conical bottom VOLUME : 4 m3 DIAMETER : 1400 mm HEIGHT : 3700 mm MATERIAL : polyester PRESSURE : atmospheric TEMPERATURE: ambient NOTES : 3 tanks	
	SERVICE : TYPE : VOLUME : DIAMETER : HEIGHT : MATERIAL : PRESSURE : TEMPERATURE: NOTES :	
	SERVICE : TYPE : VOLUME : DIAMETER : HEIGHT : MATERIAL : PRESSURE : TEMPERATURE: NOTES :	

	PAGE	AFFAIRE	NUMERO	REV
	5/5	330 6002	ADS D6001	0

EQUIPMENT ITEM SYMBOL : E - HEAT EXCHANGER

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
E 601	SERVICE : NABAM REACTOR CONDENSER HEAT TRANSFER AREA : 5 m2 TYPE : shell and tube PROCESS SIDE : tube side - material : carbon steel - pressure : 1.7 bar g+full vacuum - temperature: UTILITY SIDE : shell side-GLYCOL solution (0°C) - material : Carbon steel - pressure : 6 bar g - temperature: NOTES :	
E 602	SERVICE : MANEB/ZINEB REACTOR COOLER HEAT TRANSFER AREA : 30 m2 TYPE : graphite block exchanger PROCESS SIDE : tube side - material : graphite - pressure : 1.7 bar g - temperature: UTILITY SIDE : shell side-glycol solution (0°C) - material : graphite- carbon steel - pressure : 6 bar g - temperature: NOTES :	
E603	SERVICE : NABAM COOLER HEAT TRANSFER AREA : 20 m2 TYPE : shell and tube PROCESS SIDE : tube side - material : titonium - pressure : 4 bar g - temperature: UTILITY SIDE : shell side-glycol solution (0°C) - material : carbon steel - pressure : 6 barg - temperature: NOTES :	

EQUIPMENT ITEM SYMBOL : E – HEAT EXCHANGER

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
E604	SERVICE : COOLER HEAT TRANSFER AREA : 20 m2 TYPE : shell and tube PROCESS SIDE : tube side – material : titonium – pressure : 4 bar eff – temperature: UTILITY SIDE : shell side-glycol solution (0°C) – material : carbon steel – pressure : 6 bar g – temperature: NOTES :	
	SERVICE : HEAT TRANSFER AREA : TYPE : PROCESS SIDE : – material : – pressure : – temperature: UTILITY SIDE : – material : – pressure : – temperature: NOTES :	
	SERVICE : HEAT TRANSFER AREA : TYPE : PROCESS SIDE : – material : – pressure : – temperature: UTILITY SIDE : – material : – pressure : – temperature: NOTES :	

PAGE	AFFAIRE			NUMERO	REV
2/2	330	6002	ADS	E 6001	0

EQUIPMENT ITEM SYMBOL : H - CENTRIFUGE

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION
H601	SERVICE: MANEB/ZINEB CENTRIFUGE TYPE: Three column basket centrifuge with bottom discharge BASKET CAPACITY:400 liters BASKET DIAMETER; 1500 mm MATERIAL: rubber lined carbon steel or Uranus B6 DRIVER: Explosion proof motor

PAGE	AFFAIRE			NUMERO	REV
1/1	330	6002	AD3	H6001	0

EQUIPMENT ITEM SYMBOL : Y- SCALE

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION
K601	SERVICE : SCALE TYPE : Pendulum balanced scale SCALE RANGE: 0-300 kg SCALE DIVISION: 1 kg maximum INDICATOR TYPE: dial

PAGE	AFFAIRE			NUMERO	REV
1/1	330	6002	ADS	K6001	0

EQUIPMENT ITEM SYMBOL : P – PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS	
P601	SERVICE	: CS_2 METERING PUMP
	TYPE	: metering pump
	FLOW RATE	: 400 l/hr
	DIFFERENTIAL PRESSURE	: 3 bar
	MATERIAL	: 316 ss
	STUFFING BOX	:
	MECHANICAL SEAL	:
	DRIVER	: Explosion proof motor
	NOTES	:
P602	SERVICE	: CAUSTIC SOLUTION METERING PUMP
	TYPE	: metering pump
	FLOW RATE	: 400 l/hr
	DIFFERENTIAL PRESSURE	: 3 bars
	MATERIAL	: 316 ss
	STUFFING BOX	:
	MECHANICAL SEAL	:
	DRIVER	: Explosion proof motor
	NOTES	:
P603	SERVICE	: NABAM PUMP
	TYPE	: Centrifugal pump
	FLOW RATE	: 12 m3/hr
	DIFFERENTIAL PRESSURE	: 2 bars
	MATERIAL	: cast iron or carbon steel
	STUFFING BOX	:
	MECHANICAL SEAL	: double
	DRIVER	: explosion proof motor
	NOTES	:

EQUIPMENT ITEM SYMBOL : P – PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS	
P604	SERVICE : SCRUBBING SOLUTION PUMP NABAM REACTOR TYPE : centrifugal pump FLOW RATE : 10 m3/hr DIFFERENTIAL PRESSURE: 4 bar MATERIAL : cast iron STUFFING BOX : MECHANICAL SEAL : simple DRIVER : explosion proof motor NOTES :	
P605	SERVICE : NABAM PUMP TYPE : metering pump-(membrane) FLOW RATE : 6400 l/hr DIFFERENTIAL PRESSURE: 3 bar MATERIAL : Hastelloy C or PTFE STUFFING BOX : MECHANICAL SEAL : DRIVER : Explosion proof motor NOTES :	
P606	SERVICE : SALT TANK PUMP TYPE : metering pump (membrane) FLOW RATE : 4900 l/hr DIFFERENTIAL PRESSURE: 3 bar MATERIAL : Hastelloy G or PTFE STUFFING BOX : MECHANICAL SEAL : Explosion proof motor DRIVER : NOTES :	

EQUIPMENT ITEM SYMBOL : P - PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS	
P607	SERVICE : REACTOR PUMP TYPE : centrifugal pump FLOW RATE : 150 m3/hr DIFFERENTIAL PRESSURE: 2,5 bar MATERIAL : rubber lined carbon steel STUFFING BOX : yes with lantern MECHANICAL SEAL : DRIVER : explosion proof motor NOTES : acid proof metallic parts	
P608	SERVICE : ACID METERING PUMP TYPE : metering pump FLOW RATE : 150 l/hr DIFFERENTIAL PRESSURE: 3 bar MATERIAL : PTFE STUFFING BOX : MECHANICAL SEAL : DRIVER : Explosion proof motor NOTES :	
P609	SERVICE : MOTHER LIQUORS PUMP TYPE : centrifugal pump FLOW RATE : 10 m3/hr DIFFERENTIAL PRESSURE: 2,5 bar MATERIAL : rubber lined carbon steel STUFFING BOX : yes with lantern MECHANICAL SEAL : DRIVER : explosion proof motor NOTES : acid proof metallic parts	

EQUIPMENT ITEM SYMBOL : P - PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS	
P610	SERVICE : RESLURRYING TANK PUMP TYPE : centrifugal FLOW RATE : 30 m3/hr DIFFERENTIAL PRESSURE: 2,5 bar MATERIAL : rubber lined carbon steel STUFFING BOX : yes with lantern MECHANICAL SEAL : DRIVER : explosion proof motor NOTES :	
P611	SERVICE : SPRAY DRYER FEED PUMP TYPE : volumetric pump FLOW RATE : 1000 l/hr DIFFERENTIAL PRESSURE: 3 bar MATERIAL : 316 ss and rubber STUFFING BOX : yes MECHANICAL SEAL : DRIVER : explosion proof motor NOTES : moyno single rotor screw pump with elastomeric lining	
P612	SERVICE : SCRUBBING SOLUTION PUMP MANEB /ZINEB TYPE : centrifugal FLOW RATE : 2 m3/hr DIFFERENTIAL PRESSURE: 2 bar MATERIAL : cast iron or carbon steel STUFFING BOX : yes MECHANICAL SEAL : DRIVER : explosion proof motor NOTES :	

	PAGE 4/4	AFFAIRE 330 6002 NUMERO ADS P6001	REV 0

EQUIPMENT ITEM SYMBOL : R – REACTOR

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
R 601	SERVICE : NABAM REACTOR TYPE : agitated vertical tank with heating/cooling coil NOMINAL CAPACITY : 4 m3 MATERIAL : carbon steel AGITATOR AND DRIVE: turbine 7,5 kw PRESSURE : + 1,7 bar– full vacuum TEMPERATURE : 100°C HEATING/COOLING : steam– glycol (0°C) NOTE : explosion proof motor–coil area: 10 m2	
R602	SERVICE : MANEB/ZINEB REACTOR TYPE : agitated vertical tank NOMINAL CAPACITY : 30 m3 MATERIAL : rubber lined steel AGITATOR AND DRIVE: pitched blades turbine; 30 kw PRESSURE : + 1,7 bar TEMPERATURE : 100°C HEATING/COOLING : NOTES : explosion proof motor	

PAGE	AFFAIRE		NUMERO	REV
1/1	330 6002	ADS	R6001	0

EQUIPMENT ITEM SYMBOL : S - DRYERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION
S 601	SERVICE: SPRAY DRYER PACKAGE TYPE : hot air spray drying package CAPACITY: solids :160 kg/hr @ 20°C liquids:240 kg/hr WATER CONTENT OF DRY PRODUCT: 10% weight HOT AIR TEMPERATURE: 300°C PARTS IN CONTACT WITH PRODUCT: 304 ss FUEL AVAILABLE: fuel oil or fuel gas NOTES: package including • fuel fired air heater • atomizing chamber • dust collection equipment • tail gas scrubbing equipment • instrumentation and control • product conveying equipment
S 602	SERVICE: VACUUM DRYER TYPE : horizontal agitated batch vacuum dryer VOLUME : 5 m3 DRYING TEMPERATURE: <45°C DRIVER : explosion proof PARTS IN CONTACT WITH PRODUCT: 304 SS

EQUIPMENT ITEM SYMBOL : T - COLUMNS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
T 601	SERVICE : NABAM REACTOR SCRUBBER TYPE : Packed column DIAMETER: 400 mm TRAYS : Type : : Number : : Spacing : : Material : PACKING : Type : Raschig ring- 1" : Height : 2 m : Material : Carbon steel VESSEL : Material : Carbon steel : Pressure : + 1.7 bar g + full vacuum : Temperature: 100°C NOTES :	
T 602	SERVICE : MANEB/ZINEB REACTOR SCRUBBER TYPE : packed column DIAMETER: 200 mm TRAYS : type : : number : : spacing : : material : PACKING : type : Rasching rings- 1/2" : height : 1.6 m : material : ceramic or glass VESSEL : material : glass or polyester : pressure : 1 bar g : temperature: $<$ 100°C NOTES :	

PAGE	AFFAIRE		NUMERO	REV
1/1	330	6002	ADS T600	0

EQUIPMENT ITEM SYMBOL : U- PACKAGE UNITS

ITEM N°	TECHNICAL SPECIFICATIONS ITEM NAME AND SPECIFICATION	
U601	SERVICE: PACKAGING MACHINE TYPE : Automatic bagging and pelletizing unit CAPACITY: 2 bags per minute (maxi) NOTES : includes an automatic scale and roller (or band) conveyors. - material in contact with final product :304 SS - electrical equipment: explosion proof	

PAGE	AFFAIRE			NUMERO	REV
1/1	330	6002	ADS	U 600	0

7 - EQUIPMENT LIST - 2,4 D AMINE SALT

SECTION 700

2,4 D AMINE SALT PRODUCTION UNIT

ITEM N°	ITEM NAME
C 701	VACUUM JET
D 701	MONOCHLOROACETIC ACID MELT TANK
D 702	DECANTER
D 703	2,4 DICHLOROPHENOL HOLD TANK
D 704	AMINE MEASURING TANK
D 705	AMINE DILUTION TANK
D 706	CAUSTIC MEASURING TANK
D 707	2,4 DICHLOROPHENOL MEASURING TANK
D 708	WATER RECEIVER
E 701	CAUSTIC PRE HEATER
E 702	2,4 D REACTOR CONDENSER
E 703	CRYSTALLIZER CONDENSER
E 704	2,4 D DRYER CONDENSER
H 701	2,4 D CENTRIFUGE
P 701	MONOCHLOROACETIC ACID PUMP
P 702	DICHLOROPHENATE PUMP
P 703	HYDROCHLORIC ACID METERING PUMP
P 704	2,4 D PUMP
P 705	RECYCLED DICHLOROPHENOL PUMP
P 706	AMINE PUMP

DESCRIPTION	REV	DATE	SIGN	VERIF.

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EQUIPMENT LIST
SECTION 700

PAGE	AFFAIRE			NUMERO	REV
1/2	310	6002	SOM	700	C

ITEM N°	ITEM NAME
R 701	2,4 D REACTOR
R 702	2,4 D CRYSTALLIZER
R 703	AMINE SALT REACTOR
S 701	2,4 D VACUUM DRYER
U 701	2,4 D BAGGING MACHINE

PAGE	AFFAIRE		NUMERO	REV
2/2	310 6002	SCM	700	0

EQUIPMENT ITEM SYMBOL : C - STEAM OR LIQUID JETS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
C701	SERVICE : VACUUM JET TYPE : Steam jets in series CAPACITY : 4 kg/hr of air SUCTION PRESSURE : 15 mmHg DISCHARGE PRESSURE: 760 mmHg PROPELLING FLUID :-steam : 150 psig sat.steam -liquid: MATERIAL : cast iron or carbon steel TEMPERATURE : $< 60°C$ NOTES :	
	SERVICE TYPE CAPACITY SUCTION PRESSURE DISCHARGE PRESSURE PROPELLING FLUID :-steam : -liquid: MATERIAL TEMPERATURE. NOTES	
	SERVICE : TYPE : CAPACITY : SUCTION PRESSURE : DISCHARGE PRESSURE: PROPELLING FLUID :-steam : -liquid: MATERIAL : TEMPERATURE : NOTES :	

CE SCHEMA CONTENANT DES INFORMATIONS CONFIDENTIELLES EST LA PROPRIETE DE CDI ET NE PEUT ETRE REPRODUIT OU UTILISE SANS L AUTORISATION ECRITE DE CDI	PAGE 1/1	AFFAIRE 330 6002 NUMERO ADS C70[illegible]	REV 0

EQUIPMENT ITEM SYMBOL : D – TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 701	SERVICE : MONOCHLOROACETIC MELT TANK TYPE : Jacketed vertical tank-dished heads VOLUME : 1,2 m3 DIAMETER : 1,2 m HEIGHT : 1,4 m MATERIAL :glass lined carbon steel PRESSURE :1,7 bar g+ full vacuum TEMPERATURE:150°C NOTES :	
D 702	SERVICE : DECANTER TYPE : horizontal tank-dished heads VOLUME : 1 m3 DIAMETER : 0,9 m HEIGHT : 1,5 m MATERIAL :316 SS PRESSURE :1,7 barg+ full vacuum TEMPERATURE: 150°C NOTES :	
D 703	SERVICE : 2,4 DICHLOROPHENOL HOLD TANK TYPE : horizontal tank-dished heads VOLUME : 0,5 m3 DIAMETER : 0,65 m HEIGHT : 1,4 m MATERIAL : 316 SS PRESSURE : 1,7 bar g+ full vacuum TEMPERATURE: 150°C NOTES :heating coil= 2m2	

EQUIPMENT ITEM SYMBOL : D - TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 704	SERVICE : AMINE MEASURING TANK TYPE : Vertical tank-dished heads VOLUME : 0.25 m3 DIAMETER : 0.5 m HEIGHT : 1.2 m MATERIAL : 304 SS PRESSURE : 1.7 barg TEMPERATURE: 100°C NOTES :	
D 705	SERVICE : AMINE DILUTION TANK TYPE : agitated vertical tank-dished heads VOLUME : 0.8 m3 DIAMETER : 1.0 m HEIGHT : 1.2 m MATERIAL : 304 SS PRESSURE : 1.7 bar g TEMPERATURE: 100°C NOTES :	
D 706	SERVICE : CAUSTIC MEASURING TANK TYPE : vertical tank-dished heads VOLUME : 3.5 m3 DIAMETER : 1.6 m HEIGHT : 1.8 m MATERIAL : carbon steel PRESSURE : 1.7 bar g TEMPERATURE: 100°C NOTES :	

EQUIPMENT ITEM SYMBOL : D – TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 707	SERVICE : 2,4 DICHLOROPHENOL MEASURING TANK TYPE : jacketed, vertical tank-dished heads VOLUME : 1.5 m3 DIAMETER : 1.05 m HEIGHT : 1.60 m MATERIAL : 316 SS PRESSURE : 1.7 barg TEMPERATURE: 150°C NOTES :	
D 708	SERVICE : WATER RECEIVER TYPE : horizontal tank-dished heads VOLUME : 0.5 m3 DIAMETER : 0.65 m HEIGHT : 1.4 m MATERIAL : carbon steel PRESSURE : 1.7 barg+ full vacuum TEMPERATURE: 150°C NOTES :	
	SERVICE : TYPE : VOLUME : DIAMETER : HEIGHT : MATERIAL : PRESSURE : TEMPERATURE: NOTES :	

EQUIPMENT ITEM SYMBOL : E - HEAT EXCHANGER

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
E 701	SERVICE : CAUSTIC PREHEATER HEAT TRANSFER AREA : 6 m2 TYPE : shell and tube PROCESS SIDE : tube side - material : carbon steel - pressure : 1.7 bar g - temperature: UTILITY SIDE : shell side-150 psig steam - material : carbon steel - pressure : 10 barg - temperature: 200°C NOTES :	
E 702	SERVICE : 2,4 REACTOR CONDENSER HEAT TRANSFER AREA : 15 m2 TYPE : shell and tube PROCESS SIDE : tube side - material : 316 SS - pressure : 1.7 bar g+full vacuum - temperature: UTILITY SIDE : shell side - material : carbon steel - pressure : 6 bar g - temperature: NOTES :	
E 703	SERVICE : CRYSTALLIZER CONDENSER HEAT TRANSFER AREA : 8 m2 TYPE : shell and tube PROCESS SIDE : tube side - material : 316 SS - pressure : 1.7 bar g+full vacuum - temperature: UTILITY SIDE : shell side-hot water - material : carbon steel - pressure : 6 bar g - temperature: NOTES :	

EQUIPMENT ITEM SYMBOL : E – HEAT EXCHANGER

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
E 704	SERVICE : 2,4 DRYER CONDENSER HEAT TRANSFER AREA : 2 m2 TYPE : shell and tube PROCESS SIDE : shell side – material : carbon steel – pressure : 1.7 bar g+full vacuum – temperature : UTILITY SIDE : tube side-cooling water – material : carbon steel – pressure : 6 bar g – temperature : NOTES :	
	SERVICE : HEAT TRANSFER AREA : TYPE : PROCESS SIDE : – material : – pressure : – temperature : UTILITY SIDE : – material : – pressure : – temperature : NOTES :	
	SERVICE : HEAT TRANSFER AREA : TYPE : PROCESS SIDE : – material : – pressure : – temperature : UTILITY SIDE : – material : – pressure : – temperature : NOTES :	

CE SCHEMA CONTENANT DES INFORMATIONS CONFIDENTIELLES EST LA PROPRIETE DE CDI ET NE PEUT ETRE REPRODUIT OU UTILISE SANS L AUTORISATION ECRITE DE CDI	PAGE 2/2	AFFAIRE 330 6002 ADS	NUMERO E 700	REV 0

EQUIPMENT ITEM SYMBOL : H- CENTRIFUGE

ITEM N°	TECHNICAL SPECIFICATIONS ITEM NAME AND SPECIFICATION	
H701	SERVICE : 2,4 D CENTRIFUGE TYPE: Three column basket centrifuge with bottom discharge BASKET CAPACITY: 400 liters BASKET DIAMETER : 1500 mm MATERIAL : Uranus B6 DRIVER: Explosion proof motor	

PAGE	AFFAIRE		NUMERO		REV
1/1	330	6002	ADS	H7001	0

EQUIPMENT ITEM SYMBOL : P - PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS	
P 701	SERVICE	: MONOCHLOROACETIC ACID PUMP
	TYPE	: metering pump
	FLOW RATE	: 50 to 200 l/hr
	DIFFERENTIAL PRESSURE	: 1.5 bar
	MATERIAL	: 316 SS
	STUFFING BOX	:
	MECHANICAL SEAL	:
	DRIVER	: explosion proof motor
	NOTES	: jacketed pump-steam heated
P 702	SERVICE	: DICHLOROPHENATE PUMP
	TYPE	: centrifugal pump
	FLOW RATE	: 12 m3/hr
	DIFFERENTIAL PRESSURE	: 2.5 bar
	MATERIAL	: 316 SS
	STUFFING BOX	:
	MECHANICAL SEAL	: double
	DRIVER	: explosion proof motor
	NOTES	:
P 703	SERVICE	: HYDROCHLORIC ACID METERING PUMP
	TYPE	: membrane metering pump
	FLOW RATE	: 1000-3000 l/hr
	DIFFERENTIAL PRESSURE	: 1.5 bar
	MATERIAL	: PTFE
	STUFFING BOX	:
	MECHANICAL SEAL	:
	DRIVER	: explosion proof motor
	NOTES	:

EQUIPMENT ITEM SYMBOL : P - PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS	
P 704	SERVICE : 2,4 D PUMP TYPE : centrifugal pump FLOW RATE : 3 m^3/hr DIFFERENTIAL PRESSURE: 1.5 bar MATERIAL : rubber lined STUFFING BOX : MECHANICAL SEAL : double DRIVER : explosion proof motor NOTES :	
P 705	SERVICE : RECYCLED DICHLOROPHENOL PUMP TYPE : centrifugal pump FLOW RATE : 1 m3/hr DIFFERENTIAL PRESSURE: 2.0 bar MATERIAL : 316 SS STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES : jacketed pump-steam heated	
P 706	SERVICE : AMINE PUMP TYPE : centrifugal pump FLOW RATE : 3 m3/hr DIFFERENTIAL PRESSURE: 2.0 bar MATERIAL : 316 SS STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :	

PAGE	AFFAIRE			NUMERO	REV
2/2	330	6002	ADS	P 7001	0

EQUIPMENT ITEM SYMBOL : R - REACTOR		
TECHNICAL SPECIFICATIONS		
ITEM N°	ITEM NAME AND SPECIFICATION	
R701	SERVICE : 2,4 D REACTOR TYPE : agitated, jacketed batch reactor NOMINAL CAPACITY : 6 m3 MATERIAL : 316 SS AGITATOR AND DRIVE: Turbine - 7,5 KW PRESSURE : 6 barg+ full vacuum TEMPERATURE : 200°C HEATING/COOLING : steam /cooling water NOTE :-explosion proof motor -mechanical seal	
R702	SERVICE : 2,4 D CRYSTALLIZER TYPE : agitated, jacketed batch reactor NOMINAL CAPACITY : 6 m3 MATERIAL : glass lined carbon steel AGITATOR AND DRIVE: impeller- 7,5 KW PRESSURE : 6 bar g + full vacuum TEMPERATURE : 200°C HEATING/COOLING : steam/cooling water NOTES :-explosion proof motor -mechanical seal	

EQUIPMENT ITEM SYMBOL : R – REACTOR		
TECHNICAL SPECIFICATIONS		
ITEM N°	ITEM NAME AND SPECIFICATION	
R 703	SERVICE :AMINE SALT REACTOR TYPE : agitated batch reactor NOMINAL CAPACITY : 1.5 m3 MATERIAL : 316 SS AGITATOR AND DRIVE: turbine – 4 kw PRESSURE : 1.7 bar g TEMPERATURE : 150 °C HEATING/COOLING : NOTE : explosion proof motor	
	SERVICE : TYPE : NOMINAL CAPACITY : MATERIAL : AGITATOR AND DRIVE: PRESSURE : TEMPERATURE : HEATING/COOLING : NOTES :	

	PAGE 2/2	AFFAIRE NUMERO 330 6002 ADSR7001	REV 0

EQUIPMENT ITEM SYMBOL : S-DRYER

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION
S 701	SERVICE : 2,4 D VACUUM DRYER TYPE : horizontal agitated batch vacuum dryer VOLUME : 4 m3 DRYING TEMPERATURE: $\leqslant$ 60°C DRIVER : explosion proof motor PARTS IN CONTAC WITH PRODUCT: 304 SS

PAGE	AFFAIRE			NUMERO	REV
1/1	330	6002	ADS	S 700	0

EQUIPMENT ITEM SYMBOL : U- PACKAGE UNITS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION
U 701	SERVICE: 2,4 D BAGGING MACHINE TYPE : automatic bagging unit CAPACITY: 2 bags per minute (25 kg bags) NOTES :-includes an automatic scale and roller or band conveyors -material in contact with product:304 SS -electrical equipment, explosion proof

PAGE	AFFAIRE			NUMERO	REV
1/1	330	6002	ADS	U7001	C

8 - EQUIPMENT LIST - OFFSITE FACILITIES

SECTION 800

S T O R A G E

ITEM N°	ITEM NAME
D 801	DITHIOPHOSPHORIC ACID SOLUTION STORAGE
D 802	METHANOL STORAGE TANK
D 803	TOLUENE STORAGE TANK
D 804	ETHANOL STORAGE TANK
D 805	ETHYLENE DICHLORIDE STORAGE TANK
D 806	ETHYL MALEATE STORAGE TANK
D 807	CYCLOHEXANE STORAGE TANK
D 808 A,B	MOMETHYL AMINE STORAGE TANKS
D 809	ACETAMIDE SOLUTION STORAGE TANK
D 810	CYCLOHEXANONE STORAGE TANK
D 811	2,4 DICHLOROPHENOL STORAGE TANK
D 812	RECOVERED 2,4 DICHLOROPHENOL TANK
D 813	SULFURIC ACID STORAGE TANK
D 814	AMINE SOLUTION STORAGE TANK
D 815	HYDROCHLORIC ACID STORAGE TANK
D 816	ZINEB MOTHER LIQUORS STORAGE TANK
D 817	MANEB MOTHER LIQUORS STORAGE TANK
D 818	CARBON DISULFIDE STORAGE TANK
D 819	ETHYLENE DIAMINE STORAGE TANK
D 820	CAUSTIC SOLUTION STORAGE TANK
D 821	AMINE DILUTION TANK
P 801	DITHIOPHOSPHORIC ACID SOLUTION PUMP
P 802	METHANOL TRANSFER PUMP
P 803	TOLUENE TRANSFER PUMP
P 804	ETHANOL TRANSFER PUMP
P 805	ETHYLENE DICHLORIDE TRANSFER PUMP

DESCRIPTION	REV	DATE	SIGN	VERIF.

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EQUIPMENT LIST
SECTION 800

PAGE | AFFAIRE | NUMERO | REV

ITEM N°	ITEM NAME
P 806	ETHYL MALEATE TRANSFER PUMP
P 807	CYCLOHEXANE TRANSFER PUMP
P 808	ACETAMIDE SOLUTION PUMP
P 809	CYCLOHEXANONE TRANSFER PUMP
P 810	SOLVENT UNLOADING PUMP
P 811	HYDROCHLORIC ACID PUMP
P 812	MOTHER LIQUORS PUMP
P 813	2,4 DICHLOROPHENOL PUMP
P 814	SULFURIC ACID PUMP
P 815	CARBON DISULFIDE PUMP
P 816	ETHYLENE DIAMINE PUMP
P 817	CAUSTIC SOLUTION PUMP
P 818	AMINE SOLUTION PUMP
U 801	P_2S_5 STORAGE UNIT

	PAGE	AFFAIRE		NUMERO	REV
CE SCHEMA CONTENANT DES INFORMATIONS CONFIDENTIELLES EST LA PROPRIETE DE CDI ET NE PEUT ETRE REPRODUIT OU UTILISE SANS L AUTORISATION ECRITE DE CDI	2/2	310 6002	SOM	008	0

EQUIPMENT ITEM SYMBOL : D - TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 801	SERVICE : DITHIOPHOSPHORIC ACID SOLUTION STORAGE TYPE : vertical tank-flat bottom VOLUME : 30 m3 DIAMETER : 2.85 m HEIGHT : 5.70 m MATERIAL : 316 SS PRESSURE : atmospheric TEMPERATURE: 60°C NOTES :	
D 802	SERVICE : METHANOL STORAGE TANK TYPE : vertical tank-flat bottom VOLUME : 100 m3 DIAMETER : 4.0 m HEIGHT : 9.0 m MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 60°C NOTES :	
D 803	SERVICE : TOLUENE STORAGE TANK TYPE : vertical tank- flat bottom VOLUME : 15 m3 DIAMETER : 2.45 m HEIGHT : 3.0 m MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 60°C NOTES :	

EQUIPMENT ITEM SYMBOL : D – TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 804	SERVICE : ETHANOL STORAGE TANK TYPE : vertical tank-flat bottom VOLUME : 40 m3 DIAMETER : 2.9 m HEIGHT : 6.0 m MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 60°C NOTES :	
D 805	SERVICE : ETHYLENE DICHLORIDE STORAGE TANK TYPE : vertical tank-flat bottom VOLUME : 20 m3 DIAMETER : 2.35 m HEIGHT : 4.50 m MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 60°C NOTES :	
D 806	SERVICE : ETHYL MALEATE STORAGE TANK TYPE : vertical tank-flat bottom VOLUME : 15 m3 DIAMETER : 2.05 m HEIGHT : 4.5 m MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 60°C NOTES :	

EQUIPMENT ITEM SYMBOL : D – TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 807	SERVICE : CYCLOHEXANE STORAGE TANK TYPE : vertical tank- flat bottom VOLUME : 12 m3 DIAMETER : 1.8 m HEIGHT : 4.5 m MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 60°C NOTES :	
D 808 A,B	SERVICE :MONOMETHYL AMINE STORAGE TANKS TYPE : horizontal tanks-elliptical heads VOLUME : 20 m3 DIAMETER : 2.0 m HEIGHT : 6.5 m MATERIAL : carbon steel PRESSURE : 20 bar TEMPERATURE: 60°C NOTES : 2 tanks	
D 809	SERVICE :ACETAMIDE SOLUTION STORAGE TANK TYPE :vertical tank- flat bottom VOLUME : 40 m3 DIAMETER : 2.9 m HEIGHT : 6.0 m MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 60°C NOTES :	

EQUIPMENT ITEM SYMBOL : D - TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 810	SERVICE : CYCLOHEXANONE STORAGE TANK TYPE : vertical tank- flat bottom VOLUME : 4 m3 DIAMETER : 1.4 HEIGHT : 3.0 MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 60°C NOTES :	
D 811	SERVICE :2,4 DICHLOROPHENOL STORAGE TANK TYPE : vertical tank-flat bottom VOLUME : 15 m3 DIAMETER : 2.5 m HEIGHT : 3.2 m MATERIAL : 304 SS PRESSURE : atmospheric TEMPERATURE: 100°C NOTES : heating coil:10 m2-insulated tank	
D 812	SERVICE : RECOVERED 2,4 DICHLOROPHENOL TANK TYPE : vertical tank- flet bottom VOLUME : 7 m3 DIAMETER : 1.8 m HEIGHT : 2.8 m MATERIAL : 304 SS PRESSURE : atmospheric TEMPERATURE: 100°C NOTES :heating coil 5 m2-insulated tank	

EQUIPMENT ITEM SYMBOL : D - TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 813	SERVICE : SULFURIC ACID STORAGE TANK TYPE : vertical tank-flat bottom VOLUME : 3 m3 DIAMETER : 1.4 m HEIGHT : 2.0 m MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: ambient NOTES :	
D 814	SERVICE : AMINE SOLUTION STORAGE TANK TYPE : vertical tank-flat bottom VOLUME : 8 m3 DIAMETER : 2.0 m HEIGHT : 2.6 m MATERIAL : 304 SS PRESSURE : -5 g/cm2; + 25 g/cm2 TEMPERATURE: ambient NOTES : cooling coil= 2 m2	
D 815	SERVICE : HYDROCHLORIC ACID STORAGE TANK TYPE : vertical tank-flat bottom VOLUME : 50 m3 DIAMETER : 4.0 m HEIGHT : 4.0 m MATERIAL : FRP PRESSURE : atmospheric TEMPERATURE: ambient NOTES :	

EQUIPMENT ITEM SYMBOL : D - TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 816	SERVICE : ZINEB MOTHER LIQUORS STORAGE TANK TYPE : vertical tank-flat bottom VOLUME : 140 m3 DIAMETER : 4.5 m HEIGHT : 9.0 m MATERIAL :rubber lined carbon steel PRESSURE :atmospheric TEMPERATURE: ambient NOTES :	
D 817	SERVICE : MANEB MOTHER LIQUORS STORAGE TANK TYPE : vertical tank- flat bottom VOLUME : 140 m3 DIAMETER : 4.5 m HEIGHT : 9.0 m MATERIAL : rubber lined carbon steel PRESSURE : atmospheric TEMPERATURE: ambient NOTES :	
D 818	SERVICE :CARBON DISULFIDE STORAGE TANK TYPE :vertical tank-flat bottom VOLUME :25 m3 DIAMETER : 3.0 m HEIGHT : 3.5 m MATERIAL : aluminium PRESSURE :-5 g/cm2; + 25 g/cm2 TEMPERATURE: ambient NOTES :	

EQUIPMENT ITEM SYMBOL : D – TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 819	SERVICE : ETHYLENE DIAMINE STORAGE TANK TYPE : vertical tank- flat bottom VOLUME : 10 m3 DIAMETER : 2.0 m HEIGHT : 3.25 m MATERIAL : 304 SS PRESSURE : -5g/cm2 ; + 25 g/cm2 TEMPERATURE: ambient NOTES : cooling coil= 2 m2	
D 820	SERVICE : CAUSTIC SOLUTION STORAGE TANK TYPE : vertical tank-flat bottom VOLUME : 60 m3 DIAMETER : 4.5 m HEIGHT : 3.6 m MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 50°C NOTES : heating coil= 5 m2	
D 821	SERVICE : AMINE DILUTION TANK TYPE : vertical- dished heads VOLUME : 6 m3 DIAMETER : 1.6 m HEIGHT : 2.8 m MATERIAL : carbon steel PRESSURE : 6 bar g + full vacuum TEMPERATURE: 60°C NOTES : cooling ooil= 5 m2	

CE SCHEMA CONTENANT DES INFORMATIONS CONFIDENTIELLES EST LA PROPRIETE DE CDI ET NE PEUT ETRE REPRODUIT OU UTILISE SANS L AUTORISATION ECRITE DE CDI	PAGE 7/7	330	AFFAIRE 5002	ADS	NUMERO D 800	REV 0

EQUIPMENT ITEM SYMBOL : P – PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS
P 801	SERVICE : DITHIOPHOSPHORIC ACID SOLUTION PUMP TYPE : centrifugal FLOW RATE : 10 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL : graphite STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :
P 802	SERVICE : METHANOL TRANSFER PUMP TYPE : centrifugal FLOW RATE : 6 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL : cast iron or carbon steel STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :
P 803	SERVICE : TOLUENE TRANSFER PUMP TYPE : centrifugal pump FLOW RATE : 3 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL : cast iron or carbon steel STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :

EQUIPMENT ITEM SYMBOL : P - PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS
P 804	SERVICE :ETHANOL TRANSFER PUMP TYPE :centrifugal pump FLOW RATE :5 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar g MATERIAL :cast iron-or carbon steel STUFFING BOX : MECHANICAL SEAL :yes DRIVER : explosion proof motor NOTES :
P 805	SERVICE :ETHYLENE DICHLORIDE TRANSFER PUMP TYPE :centrifugal pump FLOW RATE :3 m3/hr DIFFERENTIAL PRESSURE: 4.0 bar MATERIAL : cast iron or carbon steel STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :
P 806	SERVICE :ETHYL MALEATE TRANSFER PUMP TYPE : centrifugal pump FLOW RATE : 5 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL : cast iron or carbon steel STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :

EQUIPMENT ITEM SYMBOL : P - PUMPS		
TECHNICAL SPECIFICATIONS		
ITEM N°	ITEM NAME AND SPECIFICATIONS	
P 807	SERVICE : CYCLOHEXANE TRANSFER PUMP TYPE : Volumétric pump FLOW RATE : 2 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL : cast iron or carbon steel STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :	
P 808	SERVICE : ACETAMIDE SOLUTION PUMP TYPE : centrifugal pump FLOW RATE : 15 m3/h DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL : cast iron or carbon steel STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :	
P 809	SERVICE : CYCLOHEXANONE TRANSFER PUMP TYPE : centrifugal pump FLOW RATE : 5 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL : cast iron or carbon steel STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :	

EQUIPMENT ITEM SYMBOL : P – PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS	
P 810	SERVICE : SOLVENT UNLOADING PUMP TYPE : centrifugal pump FLOW RATE : 30 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL : cast iron or carbon steel STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :	
P 811	SERVICE :HYDROCHLORIC ACID PUMP TYPE : centrifugal pump FLOW RATE : 10 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL : glass or PTFE STUFFING BOX : yes MECHANICAL SEAL : DRIVER :explosion proof motor NOTES :	
P 812	SERVICE :MOTHER LIQUORS PUMP TYPE : centrifugal pump FLOW RATE : 30 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL :rubber lined carbon steel STUFFING BOX : yes MECHANICAL SEAL : DRIVER : explosion proof motor NOTES :	

EQUIPMENT ITEM SYMBOL : P - PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS	
P 813	SERVICE : 2,4 DICHLOROPHENOL PUMP TYPE : centrifugal FLOW RATE : 3 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL : 316 SS STUFFING BOX : MECHANICAL SEAL : double DRIVER : explosion proof motor NOTES : jacketed pump--steam heated	
P 814	SERVICE : SULFURIC ACID PUMP. TYPE : volumetric FLOW RATE : 1 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL : cast iron or carbon steel STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :	
P 815	SERVICE : CARBON DISULFIDE PUMP TYPE : centrifugal FLOW RATE : 5 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL : 316 SS STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :	

EQUIPMENT ITEM SYMBOL : P - PUMPS	
TECHNICAL SPECIFICATIONS	
ITEM N°	ITEM NAME AND SPECIFICATIONS
P 816	SERVICE : ETHYLENE DIAMINE PUMP TYPE : volumetric pump FLOW RATE : 2 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL : 316 SS STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :
P 817	SERVICE :CAUSTIC SOLUTION PUMP TYPE : centrifugal pump FLOW RATE : 12 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL : cast iron-carbon steel STUFFING BOX : yes MECHANICAL SEAL : DRIVER : explosion proof motor NOTES :
P 818	SERVICE : AMINE SOLUTION PUMP TYPE : volumetric pump FLOW RATE : 2 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL : 316 SS STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :

EQUIPMENT ITEM SYMBOL : U- PACKAGES

ITEM N°	TECHNICAL SPECIFICATIONS ITEM NAME AND SPECIFICATION	
U 801	SERVICE : P_2S_5 STORAGE UNIT • one 100 m3 storage silo (material= aluminium) • one bucket elevator • includes : rotary valves, drives, piping and instrumentation • note: the entire system is under nitrogen blanket	

PAGE	AFFAIRE		NUMERO	REV
1/1	330 6002	ADS	U8C01	0

SECTION 900

WASTE TREATMENT UNIT

ITEM N°	ITEM NAME
D 901 A,B	AQUEOUS EFFLUENTS HOLDING PITS
D 902 A,B,C,D	NEUTRALIZATION-DECANTATION TANKS
D 903	ORGANIC WASTES STORAGE TANK
P 901 A,B	AQUEOUS EFFLUENTS TRANSFER PUMPS
P 902 A,B,C,D	EFFLUENT NEUTRALIZATION PUMPS
P 903	ORGANIC WASTES PUMP
U 901	H_2S INCINERATOR

DESCRIPTION	REV	DATE	SIGN	VERIF.

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EQUIPMENT LIST

SECTION 900

PAGE	AFFAIRE	NUMERO	REV

EQUIPMENT ITEM SYMBOL : D - TANKS AND HOPPERS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION	
D 901 A,B	SERVICE : AQUEOUS EFFLUENTS HOLDING PITS TYPE : underground concrete tank with acid proof brick lining VOLUME : 50 m3 DIAMETER : 5x4 m HEIGHT : 2.5 m MATERIAL : concrete + acid-proof bricks+ plastic liner PRESSURE : atmospheric TEMPERATURE: 60°C NOTES : 2 tanks	
D 902 A,B,C,D	SERVICE : NEUTRALIZATION-DECANTATION TANKS TYPE : vertical tanks-flat bottom VOLUME :100 m3 DIAMETER : 4 m HEIGHT : 7,5 m MATERIAL :carbon steel PRESSURE : atmospheric TEMPERATURE: 80°C NOTES : 4 tanks	
D 903	SERVICE :ORGANIC WASTES STORAGE TANK TYPE : vertical tank-flat bottom VOLUME :30 m3 DIAMETER : 3 m HEIGHT :4.5 m MATERIAL : carbon steel PRESSURE : atmospheric TEMPERATURE: 60°C NOTES :	

EQUIPMENT ITEM SYMBOL : P - PUMPS

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATIONS	
P 901 A,B	SERVICE : AQUEOUS EFFLUENTS TRANSFER PUMPS TYPE : centrifugal pumps FLOW RATE : 20 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL : TEFLON STUFFING BOX : MECHANICAL SEAL : double DRIVER : explosion proof motor NOTES : 2 pumps	
P 902 A B,C,D	SERVICE : EFFLUENT NEUTRALIZATION PUMPS TYPE : centrifugal pumps FLOW RATE : 100 m3/hr DIFFERENTIAL PRESSURE: 2.0 bar MATERIAL : TEFLON STUFFING BOX : MECHANICAL SEAL : double DRIVER : explosion proof motor NOTES : 4 pumps	
P 903	SERVICE : ORGANIC WASTES PUMP TYPE : centrifugal pump FLOW RATE : 15 m3/hr DIFFERENTIAL PRESSURE: 3.0 bar MATERIAL :cast iron or carbon steel STUFFING BOX : MECHANICAL SEAL : yes DRIVER : explosion proof motor NOTES :	

EQUIPMENT ITEM SYMBOL : U- PACKAGES

TECHNICAL SPECIFICATIONS

ITEM N°	ITEM NAME AND SPECIFICATION
U 901	SERVICE : H_2S INCINERATOR

CAPACITY: the following gas stream is completely oxidized in the incinerator H_2S: 165 kg/hr
toluène: 20 kg/hr
methanol: 41 kg/hr

- gas incineration package including blowers, stack, instruments and safety devices.
- note: the incinerator is also designed for burning liquid wastes.

PAGE	AFFAIRE			NUMERO	REV
1/1	330	6002	ADS	U9001	0

ANNEX I

REVISED COSTS OF PRODUCTION SHEETS

Following conversations held in Kuwait on March 21-22 with representatives of the Ministry of Commerce & Industry, Kuwait, the costs of production sheets has been modified on the basis of the following data :

Utility costs

Electricity	2 FILS per KWH (1000 FILS = $ 3.6)
Cooling Water	5 FILS per M3
Process Water	55 FILS per M3
Gas	260 FILS per 1000 cubic feet

Interest on working capital

Theinterest on working capital is equal to 4 %.

It has been assumed that steam is raised in a gas-fired-boiler which leads to a cost of 7 $/metric tonne.

Storage capacity increase

It has been asked to increase the storage capacities to 3 month. This implies an increase of the outside battery limits investment.

TABLE 2.12.3

O,O DIMETHYLDITHIOPHOSPHORIC ACID PRODUCTION UNIT- SECTION 100

CAPITAL SUMMARY

BASIS		CAPITAL INVESTMENT	$ Million
-Location	: KUWEIT	Inside battery limits	1.33
-Capacity	: Third quarter 1979	Outside battery limits	1.29
	3100 metric tons per yr	Total fixed investment	2.62
		Working Capital*	1.35
-ON-Stream Time:	8,000 hours per yr		

PRODUCTION COST SUMMARY

RAW MATERIALS	Units per kg	Price ¢/unit	Annual cost,$M	Cents per kg
Phosphorus Pentasulfide,kg	0.7960	108.24	2,671,000	
Methanol, kg	0.4911	21.00	320,000	
Solvents and chemicals			68,000	
Total raw materials			3,059,000	98.68
UTILITES				
Steam,150psig,metricton	0.00025	700.0	5,430	
Cooling water, m3	0.0252	1.88	1,470	
Glycol (-20°C),10^6kcal	0.00008	7100.0	17,610	
Power, KwH	0.0242	0.75	560	
Total utilities			25,070	0.81
OPERATING COSTS				
Labor, 10 men @$16,000/yr	2 men per shift		160,000	
Supervision,5men @$22,000/yr	1 man per shift		110,000	
Maint.,material &Labor	6% of ISBL		80,000	
Total operating cost			350,000	11.29
OVERHEAD EXPENSES				
Direct Overhead	40	%(labor&sup.)	108,000	
General plant overhead	65	% Operating costs	227,000	
Insurance, property taxes	1.5%	total invest.	39,300	
Depreciation	10	% total invest.	262,000	
Total overhead expenses			636,300	20.52
TOTAL COST OF PRODUCTION			4,070,370	131.30
BY-PRODUCT CREDIT				
Total by-product credit				
NET COST OF PRODUCTION			4,070,370	131.30
Return on Investment	30%	Total investment	705,000	
Interest on Working Capital	4 %	working capit.	54,000	
Sales Expenses	-		-	
TRANSFER PRICE			4,820,370	155.78

(*equivalent to four months production costs)

PAGE	AFFAIRE	NUMERO	REV
	6002	100	1

TABLE 2.22.3

ETHYL MALEATE PRODUCTION UNIT- SECTION 200

CAPITAL SUMMARY

BASIS		CAPITAL INVESTMENT	$ Million
-Location	: KUWEIT	Inside battery limits	1.24
-Capacity	: Third quarter 1979	Outside battery limits	0.44
	1100 metric tons per yr	Total fixed investment	1.68
		Working Capital*	0.69
-ON-Stream Time:	8,000 hours per yr		

PRODUCTION COST SUMMARY

	Units per kg	Price ¢/unit	Annual cost,$M	Cents per kg
RAW MATERIALS				
Ethanol,kg	0.6905	74.6	566,700	
Maleic anhydride	0.6312	118.0	819,300	
Catalyst,solvents and chemicals			71,000	
Total raw materials			1,457,000	132.46
UTILITES				
Steam,150psig,metricton	0.0029	700.0	22,400	
Cooling water, m3	0.1340	1.88	2,770	
Power, KwH	0.0523	0.75	430	
Process water, m3	0.0013	20.68	300	
Total utilities			25,900	2.35
OPERATING COSTS				
Labor, 7,5 men @$16,000/yr	1,5 men per shift		120,000	
Supervision,1 man @ $22,000/yr	1 man overall		22,000	
Maint.,material &Labor	6% of ISBL		74,400	
Total operating cost			216,400	19.67
OVERHEAD EXPENSES				
Direct Overhead	40 %(labor&sup.)		56,800	
General plant overhead	65 % Operating costs		140,700	
Insurance, property taxes	1.5% total invest.		25,200	
Depreciation	10 % total invest.		168,000	
Total overhead expenses			390,700	35.50
TOTAL COST OF PRODUCTION			2,089,800	189.98
BY-PRODUCT CREDIT				
Total by-product credit				
NET COST OF PRODUCTION			2,089,800	189.98
Return on Investment	30% Total investment		480,000	
Interest on Working Capital	4 % working capit.		27,600	
Sales Expenses	-		-	
TRANSFER PRICE			2,597,400	236.11

(*equivalent to four months production costs)

PAGE	AFFAIRE	NUMERO	REV
	6002		1

TABLE 2.32.3

MALATHION PRODUCTION UNIT-SECTION 300

CAPITAL SUMMARY

BASIS		CAPITAL INVESTMENT	$ Million
-Location	: KUWEIT	Inside battery limits	1.72
-Capacity	: Third quarter 1979 2000 metric tons per yr	Outside battery limits	1.02
		Total fixed investment	2.74
		Working Capital*	1.74
-ON-Stream Time:	8,000 hours per yr		

PRODUCTION COST SUMMARY

RAW MATERIALS	Units per kg	Price ¢/unit	Annuel cost,$M	Cents per kg
Dimethyldithiophosphoric acid , kg	0.5004	157.38	1,575,100	
Ethyl maleate, kg	0.5380	238.97	2,571,400	
Solvents and Chemicals			20,000	
Total raw materials			4,166,500	208.32
UTILITES				
Steam,150psig,metricton	0.0012	700.0	16,800	
Cooling water, m3	0.0429	1.88	1,610	
Glycol(-20°C),10^6kcal	0.0001	7100.0	14,200	
Power, KwH	0.0346	0.75	520	
Process water, m3	0.0004	20.68	170	
Total utilities			33,300	1.66
OPERATING COSTS				
Labor, 10 men @$16,000/yr	2 men per shift		160,000	
Supervision,5 men @ $22,000/yr	1 man per shift		110,000	
Maint.,material &Labor	6% of ISBL		103,200	
Total operating cost			373,200	18.66
OVERHEAD EXPENSES				
Direct Overhead	40 %(labor&sup.)		108,000	
General plant overhead	65 % Operating costs		242,600	
Insurance, property taxes	1.5% total invest.		41,100	
Depreciation	10 % total invest.		274,000	
Total overhead expenses			665,700	33.29
TOTAL COST OF PRODUCTION			5,238,700	261.93
BY-PRODUCT CREDIT				
Total by-product credit				
NET COST OF PRODUCTION			5,238,700	261.93
Return on Investment	30% Total investment		750,000	
Interest on Working Capital	4 % working capit.		69,600	
Sales Expenses	-		-	
TRANSFER PRICE	97% Technical product		6,058,300	302.92

(*equivalent to four months production costs)

PAGE	AFFAIRE	NUMERO	REV
	6002		1

TABLE 1-5 2.42.3

N- METHYLCHLOROACETAMIDE PRODUCTION UNIT- SECTION 400

CAPITAL SUMMARY

BASIS		CAPITAL INVESTMENT	$ Million
-Location	: KUWEIT	Inside battery limits	1.76
-Capacity	: Third quarter 1979	Outside battery limits	1.00
	1700 metric tons per yr	Total fixed investment	2.76
		Working Capital•	1.03

-ON-Stream Time: 8,000 hours per yr

PRODUCTION COST SUMMARY

RAW MATERIALS	Units per kg	Price ¢/unit	Annuel cost, $M	Cents per kg
Monochloroacetic acid, kg	1.0124	90.0	1,549,000	
Monomethylamine; kg	0.364	80.0	495,100	
Catalyst, solvents and chemicals			169,900	
Total raw materials			2,214,000	130.24
UTILITES				
Steam, 150psig, metricton	0.0035	700.0	41,700	
Cooling water, m3	0.1339	1.88	4,280	
Glycol(-20°C), 10^6 kcal	0.0006	7100.0	72,500	
Power, kwh	0.0620	0.75	790	
Process water, m3	0.0010	20.68	350	
Total utilities			119,620	7.04
OPERATING COSTS				
Labor, 7,5 men @$16,000/yr 1,5men per shift			120,000	
Supervision, 1man @$22,000/yr 1 man			22,000	
Maint., material &Labor 6% of ISBL			105,600	
Total operating cost			247,600	14.57
OVERHEAD EXPENSES				
Direct Overhead	40 %(labor&sup.)		56,800	
General plant overhead	65 % Operating costs		161,000	
Insurance, property taxes	1.5% total invest.		41,400	
Depreciation	10 % total invest.		276,00	
Total overhead expenses			535,200	31.48
TOTAL COST OF PRODUCTION			3,116,420	183.33
BY-PRODUCT CREDIT				
Total by-product credit				
NET COST OF PRODUCTION			3,116,420	183.33
Return on Investment	30% Total investment		765,000	
Interest on Working Capital	4 % working capit.		41,200	
Sales Expenses	-		-	
TRANSFER PRICE			3,922,620	230.74

(•equivalent to four months production costs)

TABLE 2.52.3

DIMETHOATE PRODUCTION UNIT- SECTION 500

CAPITAL SUMMARY

BASIS		CAPITAL INVESTMENT	$ Million
-Location	: KUWEIT	Inside battery limits	3.78
-Capacity	: Third quarter 1979 2500 metric tons per yr	Outside battery limits	1.96
		Total fixed investment	5.74
		Working Capital*	3.24
-ON-Stream Time:	8,000 hours per yr		

PRODUCTION COST SUMMARY

RAW MATERIALS	Units per kg	Price ¢/unit	Annual cost, $M	Cents per kg
O,O dimethyldithiophosphoric acid, kg	0.8219	157.38	3,233,800	
N-methylchloroacetamide, kg	0.6710	232.86	3,906,300	
Solvents and chemicals			544,400	
Total raw materials			7,684,500	307.38
UTILITES				
Steam, 150psig, metricton	0.0072	700.0	126,000	
Cooling water, m3	0.1965	1.88	9,240	
Glycol(-20°C), 10^6 kcal	0.0011	7100.0	195.300	
Power, kwh	0.1148	0.75	2,150	
Process water, m3	0.0066	20.68	3,410	
Total utilities			336,100	13.44
OPERATING COSTS				
Labor, 15 men @$16,000/yr 3 men per shift			240,000	
Supervision, 5 men @ $22,000/yr 1 man per shift			110,000	
Maint., material &Labor 6% of ISBL			226,800	23.07
Total operating cost			576,800	
OVERHEAD EXPENSES				
Direct Overhead 40 %(labor&sup.)			140,000	
General plant overhead 65 % Operating costs			375,000	
Insurance, property taxes 1.5% total invest.			86,100	
Depreciation 10 % total invest.			574,000	
Total overhead expenses			1,175,100	47.00
TOTAL COST OF PRODUCTION			9,772,500	390.89
BY-PRODUCT CREDIT				
Total by-product credit				
NET COST OF PRODUCTION			9,772,500	390.89
Return on Investment 30% Total investment			1,611,000	
Interest on Working Capital 4 % working capit.			129,600	
Sales Expenses -			-	
TRANSFER PRICE 90% technical product			11,513,100	460.52

(*equivalent to four months production costs)

CE SCHEMA CONTENANT DES INFORMATIONS CONFIDENTIELLES EST LA PROPRIETE DE CDI ET NE PEUT ETRE REPRODUIT OU UTILISE SANS L AUTORISATION ECRITE DE CDI	PAGE	AFFAIRE 6002 NUMERO	REV 1

TABLE 2.62.3

MANEB/ZINEB PRODUCTION UNIT- SECTION 600

CAPITAL SUMMARY

BASIS		CAPITAL INVESTMENT	$ Million
-Location	: KUWEIT	Inside battery limits	4.27
-Capacity	: Third quarter 1979 1000 metric tons per yr	Outside battery limits	2.17
		Total fixed investment	6.44
		Working Capital*	1.04
-ON-Stream Time:	8,000 hours per yr		

PRODUCTION COST SUMMARY : ZINEB

RAW MATERIALS		Units per kg	Price ¢/unit	Annual cost,$M	Cents per kg
Carbon disulfide,kg		0.543	33.0	179,190	
Ethylene diamine,kg		0.212	246.0	521,520	
Zinc chloride, kg		0.469	92.0	431,480	
Chemicals and additives				95,120	
Total raw materials				1,227,310	122.73
UTILITES					
Steam,150psig,metricton		0.00012	700.0	840	
Glycol (0°C),10^6kcal		0.00047	3550.0	16,690	
Power,KWH		0.5550	0.75	4,910	
Process water, m3		0.0150	20.68	3,100	
Fuel, 10^6kcal		0.0017	390.0	6,630	
Total utilities				32,170	3.22
OPERATING COSTS					
Labor, 15 men @$16,000/yr	3 men per shift			240,000	
Supervision 5 men @$22,000/yr	1 man per shift			110,000	
Maint.,material &Labor	6% of ISBL			256,200	
Total operating cost				606,200	60.62
OVERHEAD EXPENSES					
Direct Overhead	40 %(labor&sup.)			140,000	
General plant overhead	65 % Operating costs			394,030	
Insurance, property taxes	1.5% total invest.			96,600	
Depreciation	10 % total invest.			644,000	
Total overhead expenses				1,274,630	127.46
TOTAL COST OF PRODUCTION				3,140,310	314.03
BY-PRODUCT CREDIT					
Total by-product credit					
NET COST OF PRODUCTION				3,140,310	314.03
Return on Investment	30% Total investment			1,821,000	
Interest on Working Capital	4 %working capit.			41,600	
Sales Expenses	-			-	
TRANSFER PRICE	92% technical product			5,002,910	500.29

(*equivalent to four months production costs)

PAGE	AFFAIRE	NUMERO	REV
	6002		1

TABLE 2.62.4

MANEB/ZINEB PRODUCTION UNIT- SECTION 600

CAPITAL SUMMARY

BASIS		CAPITAL INVESTMENT	$ Million
-Location	: KUWEIT	Inside battery limits	4.27
	Third quarter 1979	Outside battery limits	2.17
-Capacity	: 1000 metric tons per yr	Total fixed investment	6.44
		Working Capital*	1.04
-ON-Stream Time:	8,000 hours per yr		

PRODUCTION COST SUMMARY: MANEB

RAW MATERIALS	Units per kg	Price ¢/unit	Annuel cost,$M	Cents per kg
Carbon disulfide,kg	0.607	33.0	200,310	
Ethylene diamine,kg	0.239	246.0	587,940	
Manganese sulfate, kg	0.575	62.o	356,500	
Chemicals and additives			99,640	
Total raw materials			1,244,390	124.44
UTILITES				
Steam,150psig,metricton	0.00012	700.0	840	
Glycol (0°C), 10^6 kcal	0.00053	3550.0	18,820	
Power, Kwh	C.7342	0.75	5,510	
Process water, m3	0.01656	20.68	3,420	
Fuel, 10^6 kcal	0.0017	390.0	6,630	
Total utilities			35,220	3.52
OPERATING COSTS				
Labor, 15 men @$16,000/yr	3 men per shift		240,000	
Supervision,5men @$22,000/yr	1 man per shift		110,000	
Maint.,material &Labor	6% of ISBL		256,200	
Total operating cost			606,200	60.62
OVERHEAD EXPENSES				
Direct Overhead	40 %(labor&sup.)		140,000	
General plant overhead	65 % Operating costs		394,030	
Insurance, property taxes	1.5% total invest.		96,600	
Depreciation	10 % total invest.		644,000	
Total overhead expenses			1,274,630	127.46
TOTAL COST OF PRODUCTION			3,160,440	316.04
BY-PRODUCT CREDIT				
Total by-product credit				
NET COST OF PRODUCTION			3,160,440	316.04
Return on Investment	30% Total investment		1,821,000	
Interest on Working Capital	4 % working capit.		41,600	
Sales Expenses	-		-	
TRANSFER PRICE	92% technical product		5,023,040	502.30

(*equivalent to four months production costs)

CE SCHEMA CONTENANT DES INFORMATIONS CONFIDENTIELLES EST LA PROPRIETE DE CDI ET NE PEUT ETRE REPRODUIT NI UTILISE SANS L AUTORISATION ECRITE DE CDI	PAGE	AFFAIRE 6002 NUMERO	REV 1

TABLE 2.72.4

2,4 DICHLOROPHENOXY ACETIC ACID PRODUCTION UNIT- SECTION 700

CAPITAL SUMMARY

BASIS		CAPITAL INVESTMENT	$ Million
-Location :	KUWEIT	Inside battery limits	1.65
-Capacity :	Third quarter 1979	Outside battery limits	1.56
	600 metric tons per yr	Total fixed investment	3.21
		Working Capital•	0.65

-ON-Stream Time: 8,000 hours per yr

PRODUCTION COST SUMMARY

RAW MATERIALS	Units per kg	Price ¢/unit	Annuel cost, $M	Cents per kg
2,4 dichloropheno, kg	0.740	118.0	523,920	
Monochloroacetic acid, kg	0.430	90.0	232,200	
Sodium hydroxide (100%), kg	0.470	23.0	64,860	
Hydrochloric acid (100%), kg	0.280	24.0	40,320	
Total raw materials			861,300	143.55
UTILITES				
Steam, 150psig, metricton	0.0084	700.0	35,280	
Cooling water, m3	0.3920	1.88	4,420	
Power, Kwh	0.1220	0.75	550	
Process water, m3	0.0015	20.68	180	
Total utilities			40,430	6.74
OPERATING COSTS				
Labor, 10 men @$16,000/yr	2 men per shift		160,000	
Supervision, 5 men @$22,000/yr	1 man per shift		110,000	
Maint., material &Labor	6% of ISBL		99,000	
Total operating cost			369,000	61,50
OVERHEAD EXPENSES				
Direct Overhead	40 %(labor&sup.)		108,000	
General plant overhead	65 % Operating costs		239,850	
Insurance, property taxes	1.5% total invest.		48,150	
Depreciation	10 % total invest.		321,000	
Total overhead expenses			717,000	119.50
TOTAL COST OF PRODUCTION			1,987,730	331.29
BY-PRODUCT CREDIT				
Total by-product credit				
NET COST OF PRODUCTION			1,987,730	331.29
Return on Investment	30% Total investment		849,000	
Interest on Working Capital	4% working capit.		26,000	
Sales Expenses	-		-	
TRANSFER PRICE (99% plus 2,4D acid)			2,862,730	477.12

(•equivalent to four months production costs)

PAGE	AFFAIRE	NUMERO	REV
	6002	700	1

TABLE 2.72.5

2,4 D DIMETHYLAMINE SALT PRODUCTION UNIT - SECTION 700

CAPITAL SUMMARY

BASIS		CAPITAL INVESTMENT	$ Million
-Location	: KUWEIT	Inside battery limits	1.65
-Capacity	: Third quarter 1979	Outside battery limits	1.56
	720 metric tons per yr	Total fixed investment	3.21
		Working Capital*	0.75
-ON-Stream Time:	8,000 hours per yr		

PRODUCTION COST SUMMARY

RAW MATERIALS	Units per kg	Price ¢/unit	Annual cost,$M	Cents per kg
2,4 dichlorophenol,kg	0.6167	118.0	523,950	
Monochloroacetic acid,kg	0.3584	90.0	232,240	
Dimethylamine,kg	0.1667	105.0	126,030	
Sodium hydroxide (100%),kg	0.3917	23.0	64,870	
Hydrochloric acid (100%),kg	0.2333	24.0	40.310	
Total raw materials			987,400	137.14
UTILITES				
Steam,150psig,metricton	0.0070	700.0	35,280	
Cooling water, m3	0.3267	1.88	4,420	
Power, Kwh	0.1017	0.75	550	
Process water, m3	0.0013	20.68	190	
Total utilities			40,440	5.62
OPERATING COSTS				
Labor, 15 men @$16,000/.r 3 men per shift			240,000	
Supervision,5 men @$22,000/yr1 man per shift			110,000	
Maint.,material &Labor 6% of ISBL			99,000	
Total operating cost			449,000	62.36
OVERHEAD EXPENSES				
Direct Overhead 40 %(labor&sup.)			140,000	
General plant overhead 65 % Operating costs			291,850	
Insurance, property taxes 1.5% total invest.			48,150	
Depreciation 10 % total invest.			321,000	
Total overhead expenses			801,000	111.25
TOTAL COST OF PRODUCTION			2,277,840	316.37
BY-PRODUCT CREDIT				
Total by-product credit				
NET COST OF PRODUCTION			2,277,840	316.37
Return on Investment 30% Total investment			849.000	
Interest on Working Capital 4% working capit.			30,000	
Sales Expenses -				
TRANSFER PRICE (100% 2,4 D-DMA salt)			9,156,840	438.45

(*equivalent to four months production costs)

CE SCHEMA CONTENANT DES INFORMATIONS CONFIDENTIELLES EST LA PROPRIETE DE CDI ET NE PEUT ETRE REPRODUIT OU UTILISE SANS L AUTORISATION ECRITE DE CDI	PAGE	AFFAIRE	NUMERO	REV
		6002	700	1

ANNEX 2

SAFETY

In such a plant, safety involves hazards generally associated with chemical operations, plus some specific problems.

1 - SPECIFIC PROCESS HAZARDS

One process step requires specific precautions to be incorporated in the plant design and lay-out. It is the reaction between methanol and P_2S_5 to give dimethylthiophosphoric acid, which is the first step for the various organophosphorous insecticides.

This reaction is exothermic and can easily get out of hand, and even become explosive.

Two features have been incorporated in plant design to prevent accidents and/or minimize their consequences.

a- Interlock systems

P_2S_5 is added progressively in the cooled reactor containing methanol and solvent. Temperature rise is controlled by the rate at which P_2S_5 is introduced.

The mixture temperature is measured and registered. An automatic shut-off (solenoid valve on P_2S_5 feed) is actuated when :

- the temperature reaches a pre-set limit,
- the rate of temperature rise (obtained by differentiating the temperature versus time curve) tends to go above a pre-set limit.

In this manner, a dangerous acceleration of the reaction can be immediately detected and stopped, which is more effective than a simple high temperature cut-off which can be already late when it starts acting.

b- Enclosures

Reactor R-101 is installed within a reinforced concrete cubicle in order to contain the detrimental effects of an explosion to other buildings. One side of the cubicle is open with a dyke in front of the opening, in order to stop any flying debris in case of explosion.

Instrumentation is such that no personnel is authorized within the cubicle while the reaction is in progress, and all useful indications are legible on a control panel located outside the cubicle. All operating parameters can also be controlled by means of automatic control loops or remotely operated hand control stations located on that panel.

2 - GENERAL CHEMICAL PLANT HAZARDS

Most of materials handled in a chemical plant are flamable and some are toxic.

If accidental liquid spillage occurs, it is indispensible that it remains contained so that it does not spread or gets into the sewage system.

For this reason, each process area and bulk storage areas are dyked. The dykes containing storage tanks are of such volume that they can contain the whole volume of the largest tank included there. All liquids are collected in a pit from which they can be pumped to reclaiming or disposal facilities.

Fire-fighting facilities, including hydrants strategically located in front of buildings and bulk storage area, plus mobile extinguishers, are provided. Water is supplied to hydrants by a special network, completely independant from other water distribution systems, and independantly pressurized.

Buildings can be ventilated by wall fans able to exhaust the whole volume of the building in a few minutes. Moreover suction points going to abatement devices are located near potential leak points (shaft seals, etc.).

3 - PERSONNEL PROTECTION

Personnel working within process buildings is provided with protection clothing including helmets, gloves, boots, goggles plus coveralls and/or gas masks in more critical areas.

Safety showers, with eye-washing devices, are provided on each floor. Fire blankets are located near exits.

Central medical facilities are located in the office-laboratories building where first medical care can be given to injured personnel.

ANNEX 3

PACKAGING

The profitability analysis has shown that profitability on insecticide production could be obtained if formulated product solution was prepared and packaged for sale in cans.

The quantities of malathion and dimethoate solutions imply therefore a sizable filling operation, in the order of 10 million liters per year.

Unlike chemical operations, such filling operations are usually carried out only 5 days a week, 8 hours per day.

Assuming 10 liters cans (classical for such products), a capability of 600 cans per hour is needed. This requires a mechanized operation.

We have therefore considered for that operation a special machinery for which the total investment (with installation) is $ 50 000.

It is composed of a feed table on which empty cans are accumulated by hand. From there, everything is done automatically :

- empty cans conveyed one by one under the liquid feed head,
- filling with 2 nozzles to prevent froth. Volume can be preset at any desired value,
- clothing cans,
- printing a lot number under them,
- labeling cans (70 mm x 70 mm labels possible),
- conveying full cans to final conditionning.

For containers of that size, the easiest is to put them in pallets-cartons at the end of the filling chain (hand operation). These pallet-cartons are easily handled by a fork-truck, and stacked.

Let us note that the filling machine which has been selected is capable of handling cans of other volumes if the market would make it advisable. The height of the filling head is adjustable, and also the dosage volume and the filling speed.

It is advisable to run such a machinery by campaigns of at least one week on one given product, say malathion.

The filling head and feed tank are then cleaned thoroughly by circulating the dilution solvent (toluene), before starting on another product.