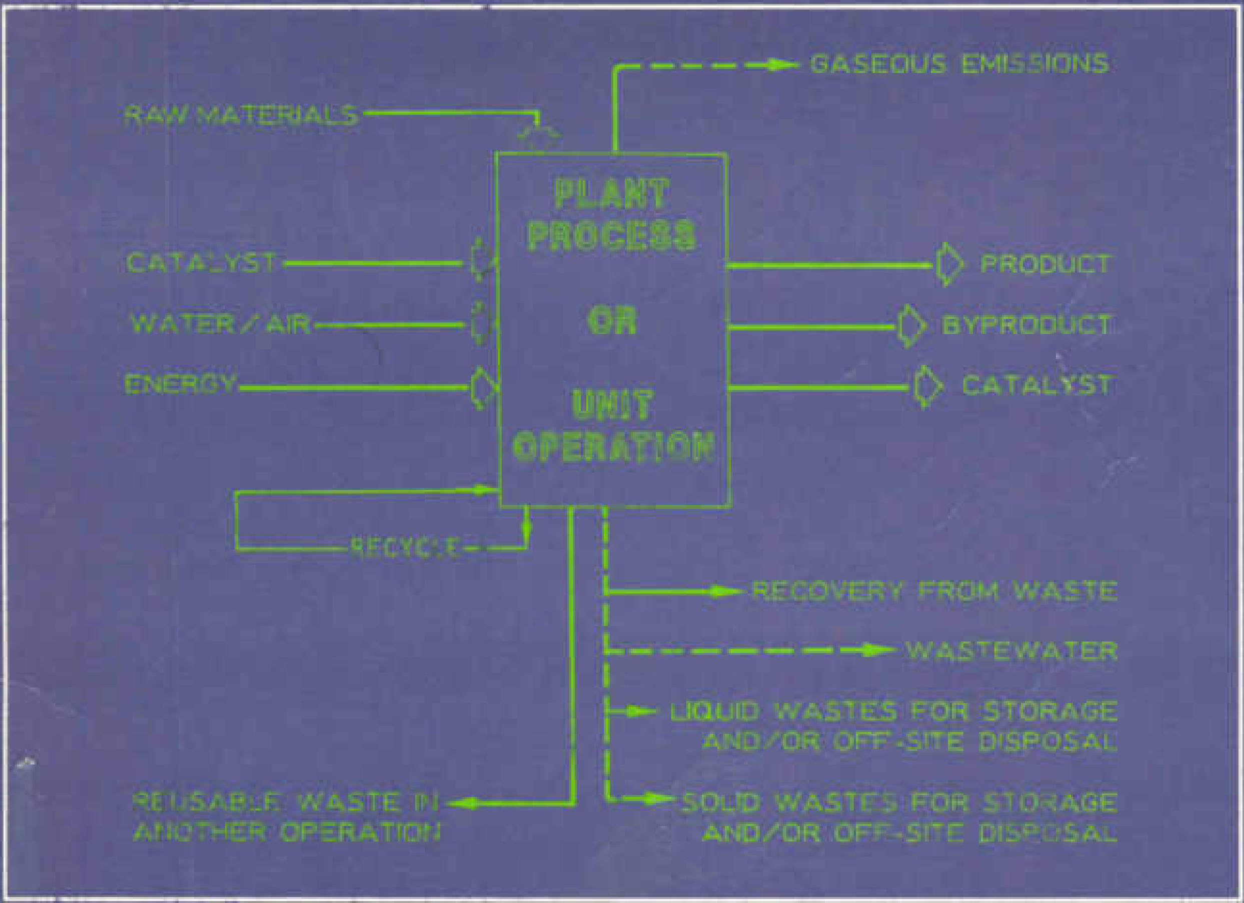
PROBES/50/1993-94

GUIDELINES

FOR

ENVIRONMENTAL AUDIT



CENTRAL POLLUTION CONTROL BOARD

DELHI

OCTOBER, 1993

PROBES/50/1993-94

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FOR

ENVIRONMENTAL AUDIT

CENTRAL POLLUTION CONTROL BOARD
PARIVESH BHAWAN, EAST ARJUN NAGAR
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FOREWORD

Environmental Audit is an exercise of self-assessment to minimise the generation of wastes and pollution potential.

A gazette notification on environmental audit has been issued by the Ministry of Environment and Forests on March 13, 1992 (amended vide notification GSR 386 (E) dated April 22, 1993). This notification applies to every person carrying on an industry, operation or process requiring consent to operate under Section 25 of the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974) or under section 21 of the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981), or both, or authorisation under the Hazardous Waste (Management and Handling) Rules, 1989, issued under the Environment (Protection) Act, 1986 (29 of 1986). The notification requires that an Environmental Statement for the financial year ending the 31st March be submitted to the concerned State Pollution Control Board, on or before the 30th September of the same year.

To assist the industry in carrying out environmental audit, the Central Pollution Control Board has conducted some case studies. This publication deals with the pesticide industry.

I hope, the guidelines and the case studies will be useful to all concerned with the methodologies for environmental audit.

The cooperation extended by Pesticide Association of India and the pesticide industries is gratefully acknowledged.

(DILIP BISWAS)
Chairman

October 29, 1993

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1.0 INTRODUCTION

Industrial pollution in our country is on increase and is creating a high risk environment. Various legislations viz. the Water (Prevention & Control of Pollution) Act, 1974, the Air (Prevention & Control of Pollution) Act, 1981 and the Environment (Protection) Act, 1986 have come into force and organisations created to combat pollution. Gone are the days when industrialisation meant profit-making and environment was grossly neglected. It is being realised that industry and environment should go hand-in-hand so as to achieve sustainable development. Also over the years awareness has brought in realisation to consider environmental protection a bare necessity. Yet, the investments for such a protection are still considered a liability by many a industrialists mainly due to lack of up-to-date scientific practices of environmental management. Consideration of environmental factors at par with production helps in minimising material losses and also in reduction of liabilities in the long run.

The growing environmental pollution and the complexity of this problem with increasing risks from the regulatory controls needs an effective management tool so as to prevent pollution and to make pollution control programmes cost-effective and feasible.

'Environmental audit' is a technique being introduced for integrating the interest of the industry and the environment so that these could be mutually supportive. This technique is basically a part of industry's internal procedures in meeting their responsibilities towards better environment. Also the policy statement for abatement of pollution by the Government of India provides for submission of environmental statement by all concerned industries, which would subsequently evolve into an environmental audit. A notification under the Environment (Protection) Rules, 1986 has been issued on April 22, 1993, requiring industries to submit an environmental statement for the financial year ending on March 31 in Form V to the concerned State Pollution Control Boards on or before September 30 every year beginning 1993 (Annexure I). The Department of Company Affairs also agreed to include this requirement as a part of the Director's Annual Report. The submission of an environmental statement is applicable to the following:

i) Those who require consent under the Water (Prevention & Control of Pollution) Act, 1974;

ii) Those who require consent under the Air (Prevention & Control of Pollution) Act, 1981; and

iii) Those who require authorisation under Hazardous wastes (Management & Handling) Rules, 1989.

The present document outlines the guidelines for environmental audit with particular reference to pesticides industry.

2.0 PHILOSOPHY OF ENVIRONMENTAL AUDIT

2.1 Definition

Environmental auditing is a management tool comprising a systematic, documented, periodic and objective evaluation of how well the management systems are performing with the aim of :

i) waste prevention and reduction;

ii) assessing compliance with regulatory requirements;

iii) facilitating control of environmental practices by a Company's management; and

iv) placing environmental information in the public domain.

In the industries, especially the chemical industries, raw materials are used in excess of the stoichiometric requirements because of the limitations on practically achievable operational efficiencies and the raw materials' purity.These excess usages of raw materials, unless recovered, find their way to environment causing pollution. Wastes from an industry include non-product discharges in gaseous, liquid and solid phases. End-of-the-pipe waste treatment techniques, wherein all the wastes are carried to a common facility for treatment,is proving to be ineffective and uneconomical due to the complexity of problems associated with waste generation, their quantity and characteristics. The waste generation may vary hourly, daily and seasonally, especially in case of the multiplicity of manufacturing product in the same premises. The wastewater characteristics also widely vary from stream to stream discharged from various unit operations of a particular product. In this growing complexity of problems, the concept of waste prevention and reduction can workout to be more effective.

It is important to find out whether an industry is complying with environmental standards and other regulatory requirements. It is also very essential to periodically monitor this aspect, determine the gaps and workout action plans for implementation with in a reasonable time frame keeping in view the financial and other considerations of a Company. In cases of gaps for compliance with the regulatory requirements, the regulatory bodies could be apprised of these action plans and time obtained for implementation. Thus the regulatory risk could be overcome and effective steps taken for pollution control.

Many a times, the top management of a Company or an industry may not be aware of the factual situation of their industry from environmental angle. Such unknown facts form hidden liabilities more often than not expose an industry to regulatory risks. The management should be able to periodically review the environmental practices of the Company to formulate/modify the Company's environmental policy accordingly.

It is also imperative that the management of a Company should have a clear picture of 'attitudes' and 'technical capabilities' of their organisational set-up for protecting environment, pollution control status, and their bounden social obligation related to environment so as to decide on the future mode of actions. Public are to be made aware of the environmental information of the Company, especially to those who are shareholders, so as to build-in among them confidence.

Environmental auditing can be viewed as a 'management tool' internally, and 'liaison' externally with the public and regulatory bodies.

2.2 Benefits of Environmental Audit

Environmental auditing has far reaching benefits to the industry, to the society and the nation at large. The benefits of environmental audit are:

i) determines how well the process systems and pollution control systems are performing, and identifies the operations of poor performance;

ii) identifies potential cost savings which can be accrued through reduction in raw material consumption by way of waste minimisation, and adoption of recycle/recovery/ reduction in pollution load ;

iii) increases awareness of environmental requirements, policies and responsibilities;

iv) helps in understanding the technical capabilities and attitude of the environmental organisation in a Company;

v) provides up-to-date environmental data base for use in plant modification, emergencies etc.;

vi) unravels surprises and hidden liabilities due to which regulatory risk and exposure to litigation can be reduced;

vii) ensures independent verification, identifies matters needing attention,and provides timely warning to management on potential future problems; and

viii) helps to safeguard environment, and assists in complying with local, regional and national laws and regulations, with the Company's policy and with the environmental standards.

2.3 Objectives

The environmental audit helps in pollution control, improved production, safety and health and conservation of natural resources and hence its overall objective can be stated as achieving of sustainable development. However for conducting environmental audit, objectives are to be defined clearly, or else the audit procedure will be subject to varying interpretations which may yield and contribute to differences in approach thereby influencing the end results. The objectives of environmental audit in an industry are :

i) to determine the mass balance of various materials used and the performance of various process equipment so as to identify usage of materials in excess than required, to review the conversion efficiencies of process equipment and accordingly fix up norms for equipment/operation performance and minimisation of the wastes.

ii) (a) to identify the areas of water usage and wastewater generation and determine the characteristics of wastewater;

(b) to determine the emissions, their sources, quantities and characteristics; and

(c) to determine the solid wastes and hazardous wastes generated, their sources, quantities and characteristics.

iii) to identify the possibilities of waste minimisation, and recovery and recycling of wastes;

iv) to determine the performance of the existing waste treatment/ control systems so as to modify or install additional or alternative control equipment accordingly;

v) to determine the impact on the surrounding environment (groundwater, stream, residential area, agricultural area, sensitive zone, etc.) due to the disposal of wastewater, emissions and solid wastes from the industry and accordingly identify suitable preventive measures, if necessary;

vi) to verify compliance with the standards and conditions prescribed by the regulatory bodies under the Water Act, the Air Act and the Environmental (Protection) Act; and

vii) to check the effectiveness of (a) organisational set-up of the industry for decision-making and environmental management with special reference to their 'technical' view point, 'attitudinal' view point and training, and (b) environmental policy of the Company.

3.0 AUDIT PROCEDURE

The audit procedure includes broadly the following :

i) Pre-audit activities;

ii) Activities at the site; and

iii) Post-audit activities.

The details of these activities and the entire audit procedure are depicted in Fig. 3.1. This procedure is discussed in detail below.

3.1 Pre-audit Activities

3.1.1 Preliminary information

Pre-audit activities include various preparatory works. Having chosen the industry to be audited, preliminary information on the industry are to be obtained through a questionnaire. The information include location of the industry with surrounding landuses, climatic conditions, products manufactured, raw materials used, details on water utilisation, wastewater generation and disposal, gaseous emissions, solid waste/hazardous waste, and organisational set-up and policies of the Company for environmental management. A typical questionnaire is given in Annexure II.

The preliminary information received on the industry should be reviewed to identify main areas of concern. Thereafter it is required to prepare and organise audit team and resources, and allocate specific tasks to team members. Resources such as the sampling and monitoring equipment and laboratory facilities for analysis should be checked if available at site or else arrangements should be made for their availability through external sources such as private/government laboratories, loan from other industries etc. The visit programme should then be intimated to the industry mentioning that the environmental audit should not be considered as a raid. The prior intimation to the industry helps them convince the senior management and staff at various levels of the purpose of audit and the cooperation they have to extend to the audit team. The staff should not feel that the audit would lead to surfacing problems and hence they would be subject to criticism by the management. They should be made clear about the purpose and objectives of the audit and how beneficial it would be for the industry. This would also increase employees' awareness towards waste reduction and promote input and support for the audit.

3.1.2 Audit team

Audit team should be carefully selected to cover various aspects of the audit. The team should include employees from production, quality control/laboratory, R&D, pollution control operations, technical staff for

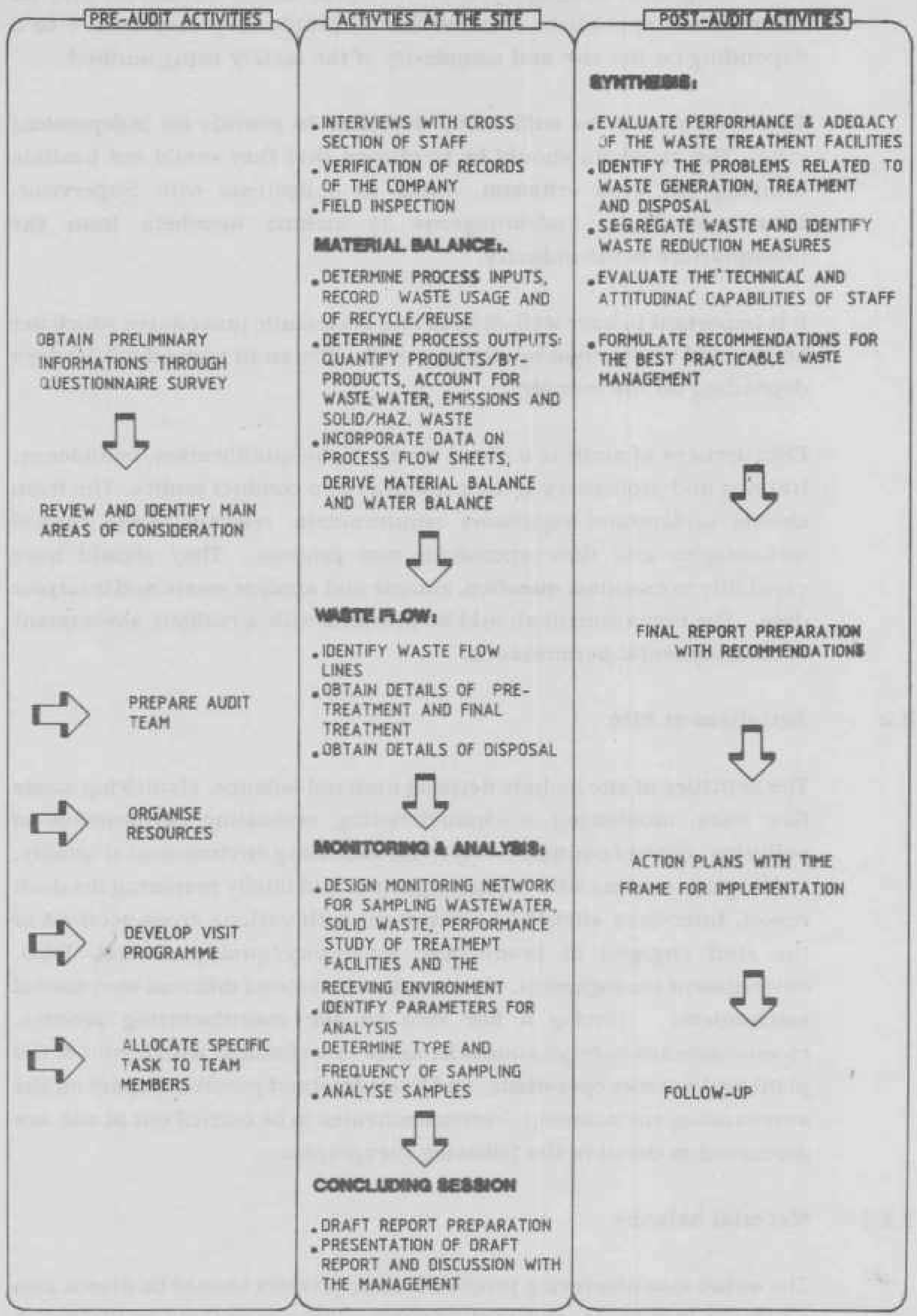


FIG. 3.1 ENVIRONMENT AUDIT PROCEDURE

monitoring and analysis of waste samples and environment and an environment specialist. The number of people may vary from 4 to 8 depending on the size and complexity of the facility being audited.

The team should be sufficiently detached to provide an independent view. The members should be so chosen that they would not hesitate bringing out even criticism, owing to obligations with Supervisor. Sometimes it is advantageous to include members from the headquarters of the industry.

It is important to have well-defined and systematic procedures which are known and understood by all concerned. The audit may take 3-10 days depending on the industry.

Effectiveness of audit is a direct result of the qualification, confidence, training and proficiency of the personnel who conduct audits. The team should understand regulatory requirements, relevant waste control technologies and their operations and process. They should have capability to examine, question, sample and analyse waste and interpret data. The management should be provided with a realistic assessment of environmental performance.

3.2 Activities at Site

The activities at site include deriving material balance, identifying waste flow lines, monitoring of characteristics, evaluating performance of pollution control equipment/system, assessing environmental quality, holding discussions with the management and finally preparing the draft report. Interviews should be carried out with various cross-sections of the staff engaged in production, laboratory/quality control, R&D, environment management, etc. so as to understand different operational mechanisms. Having a fair idea on the manufacturing process, reconnaissance surveys should be made to be familiar with layout of the plant and process operations, and to understand possible impact on the surrounding environment. Various activities to be carried out at site are discussed in detail in the following paragraphs.

3.2.1 Material balance

The entire manufacturing process of each product should be drawn into a process flow sheet representing various unit operations as blocks. A unit operation is a process where materials are input, a function occurs and materials are output mostly in a different form, state or composition. A typical process flow diagram of monocrotophos, an organophorphorous pesticide is given in Fig. 3.2. This process includes the unit operations of dehydration, adduct formation, chlorination of adduct, dissociation, concentration, toxification, preconcentration and purification. A typical unit operation with inputs of raw materials, catalyst, water/air, power and recycled material and outputs of products and by-products, wastewater, emissions, solid waste and reusable waste in another operation is schematically shown in Fig. 3.3.

The quantities of inputs and outputs at each unit operation should be worked out for the entire process and data incorporated in the process flow sheet. Discussions with the staff, perusal of the records of the Company and the reconnaissance survey will help in arriving at these flow sheets. From these flow sheets, data sheets incorporating the raw material requirement, water consumption, wastewater and solid waste generation, and gaseous emissions should be worked out for each product manufactured. A typical data sheet is shown in Table 3.1.

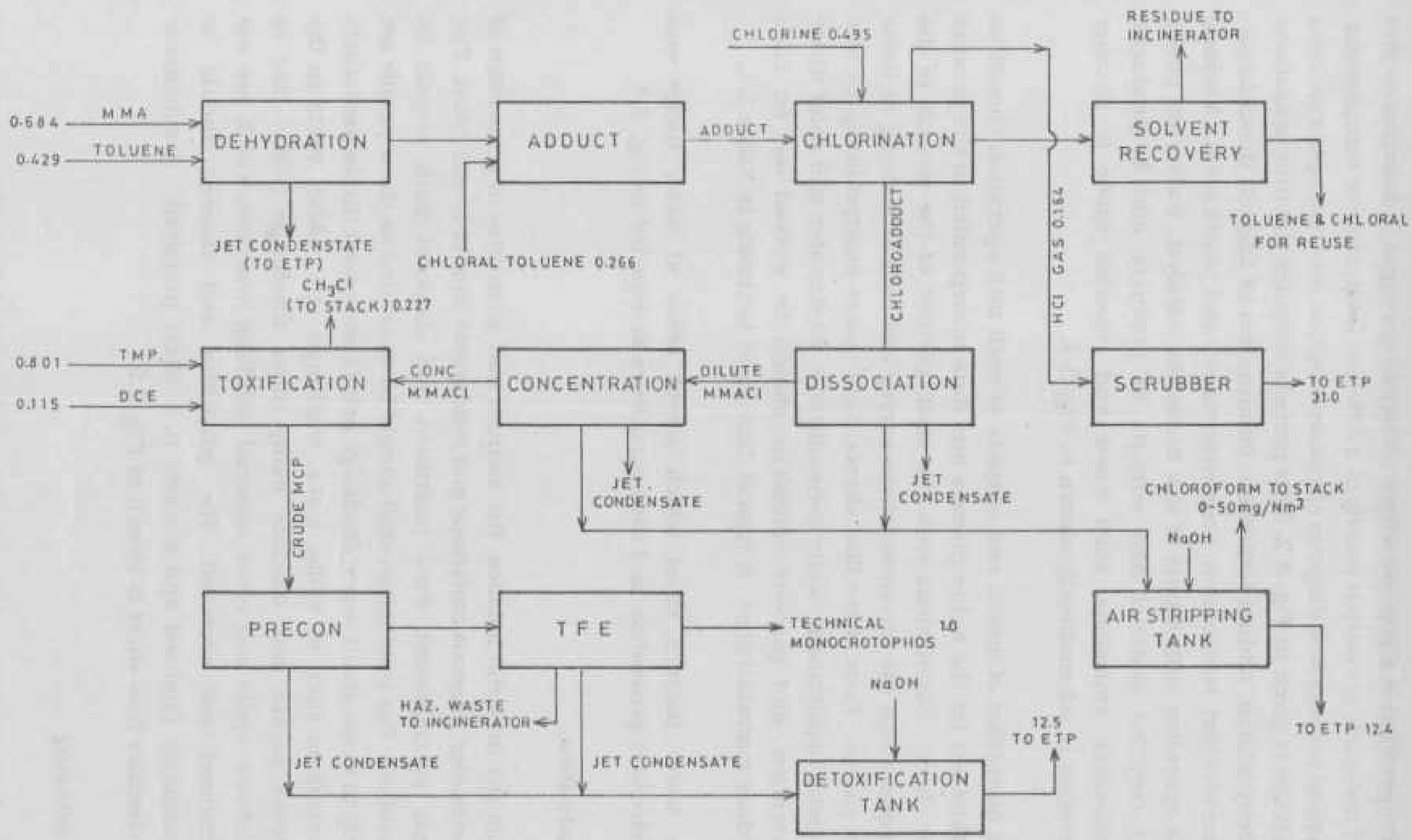
The water balance sheet which shows areas of water usage and wastewater generation and their quantities is depicted in Fig. 3.4.

3.2.2 Waste flow

From the material balance, the sources and quantities of generation of wastewater, gaseous emissions and solid waste should be identified. The waste pretreatment, final treatment and disposal path should be identified. The production staff should be consulted as these people are likely to know about waste discharge points and about unplanned waste generations such as spills, leaks, washings, etc. Also, visits to the process plants may disclose many other discharge points due to overflows, spills and other material handling practices which are not accounted and recorded. The quantities and sources should be accordingly finalised and a waste flow sheet prepared. A schematic wastewater flow sheet is shown in Fig. 3.5.

3.2.3 Monitoring

The characteristics of the wastes as generated from the sources are important to understand its use for recycle, recovery or treatment. Also,



M M A — MONOMETHYL ACETOACETAMIDE

T M P — TYIMETHYL PHOPHITE

D E C — DICHLOROETHANE

(ALL QUANTITIES ARE IN TONNES)

FIG. 3.2 PROCESS FLOW SHEET OF MONOCROTOPHOS

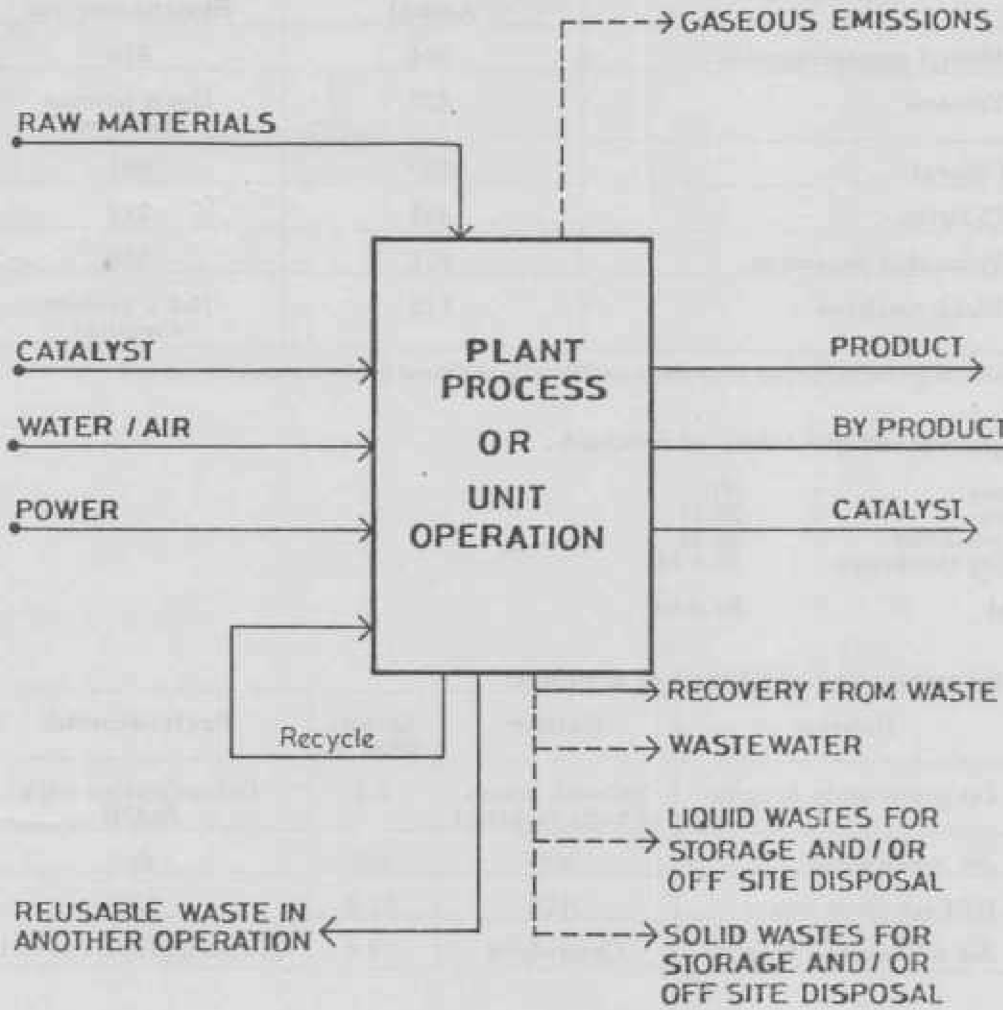


FIG. 3.3 A TYPICAL UNIT OPERATION

TABLE 3.1: DATA SHEET ON INPUTS AND OUTPUTS FOR THE MANUFACTURE OF MONOCROTOPHOS

Raw material requirement per tonne of product :

S.No.	Raw Material	Quantity, kg	
		Actual	Stoichiometric
1.	Methyl acetoacetamide	684	516
2.	Toluene	429	Not a process chemical
3.	Chloral	266*	661
4.	Chlorine	495	319
5.	Trimethyl phosphite	801	556
6.	Dichloroethane	115	Not a process chemical

* The value indicated is the loss to be made up Chloral is recovered by distillation and recycled.

Water requirement per tonne of product :

Process	:	Nil
Steam	:	25 kl
HCl scrubber	:	31 kl
Cooling (makeup)	:	25.4 kl
Total	:	**81.4 kl**

Wastewater generated per tonne of product:

S.No.	Source	Nature	Quantity, kl	Pretreatment
1.	Jet condensate & spills	Solvent, traces of toxic material	9.5	Detoxification with NaOH
2.	Jet condensate	- do -	3.0	- do -
3.	HCI scrubber liquor	HCI	31.0	Nil
4.	Jet condensate & spills	Chloroform	12.4	Air stripping at pH 11

Emissions:

S.No.	Source	Nature	Quantity kg/t	Gas flow, Nm^3/hr	Control equip.	Chimney ht., m
1.	Chlorination	HCI gas	164	2200	Water scrubber	36 m
2.	Toxification	CH3CI	227	17760	Nil	
3.	Air stripping	Chloroform	0-50 mg/m^3	441	Nil	

Solid waste/hazardous waste:

S.No.	Source	Nature	Quantity kg	Pretreatment	Method of disposal
1.	Residue from chloral and toluene recovery	Halogenated hydrocarbon	232	Nil	Incineration
2.	Product purification	Degraded solvents			

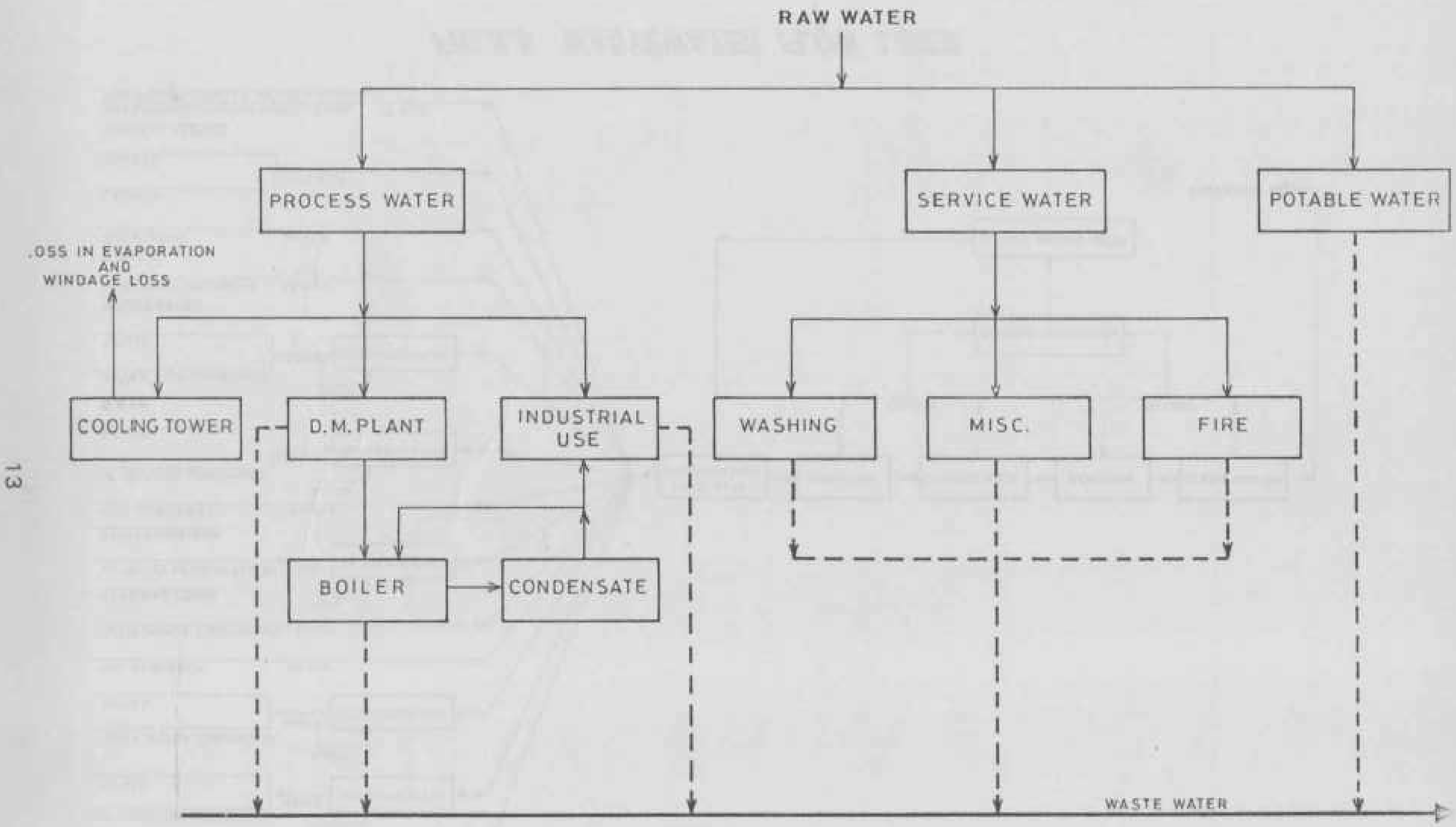


FIG. 3.4 MASS BALANCE OF WATER CONSUMPTION AND EFFLUENT GENERATION IN INDUSTRIES

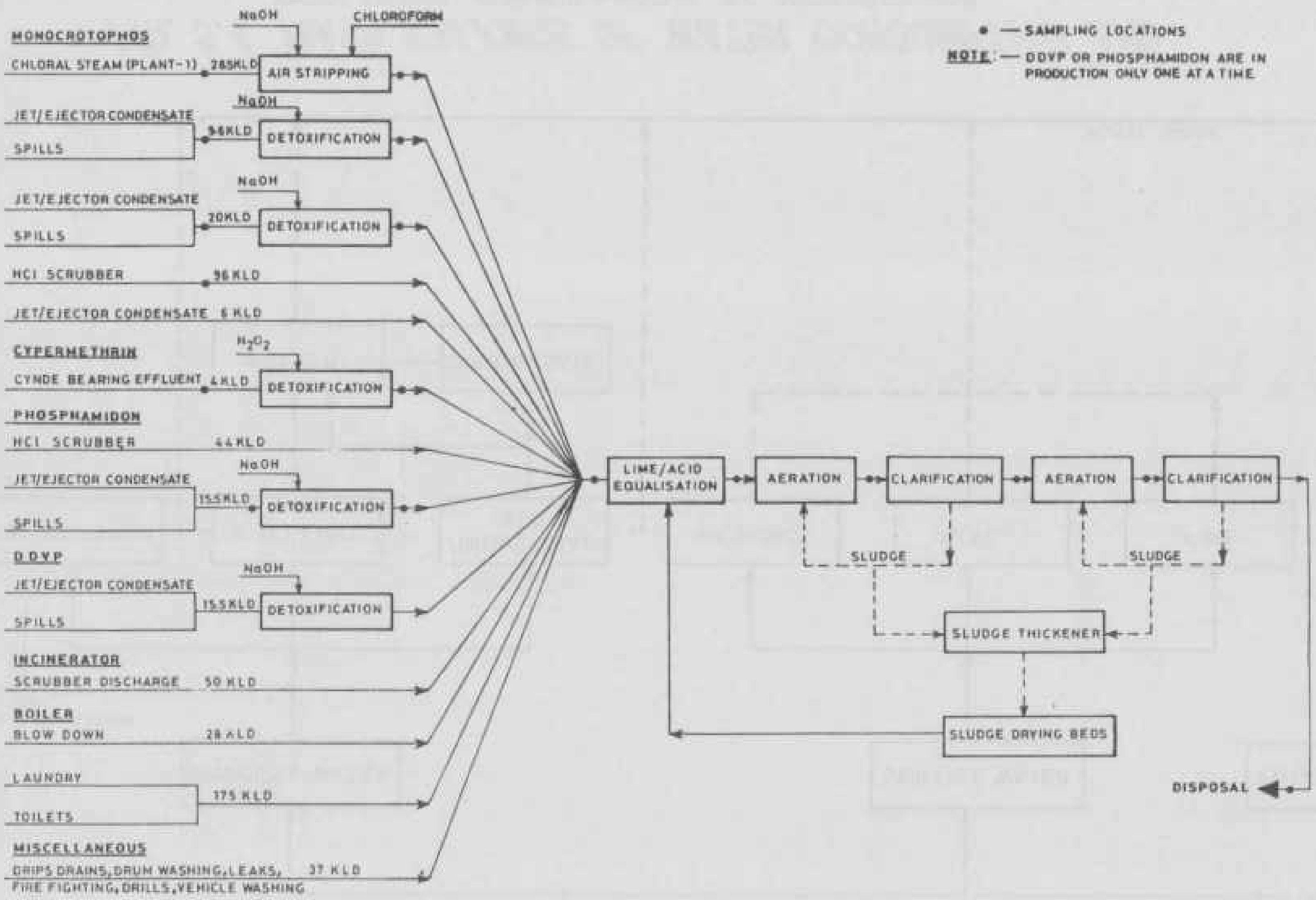


FIG.3.5 WASTEWATER FLOW LINES

the performance of the treatment facilities are to be monitored so as to check their efficiencies and to modify or install additional equipment/ facility, if necessary. The surrounding environment - groundwater, stream, soil, surrounding land uses - residential, agricultural etc., and ambient air quality should be monitored to determine the impact due to the industry. With the above objectives, sampling points should be identified and monitoring network established. Parameters to be analysed should be determined from the material balances of the wastes generated.

The frequency of sampling should be fixed so as to cover hourly and daily variation in characteristics. It should also cover atleast one full cycle of operations. More than one such sets of data can result in more realistic results. Samples collected should be of 'grab' type where characteristics do not vary significantly and of 'composite' type where characteristics fluctuate. 'Grab' sampling means collection of sample in one pick while composite sampling requires collection of sample continuously or at predetermined frequency (1-hr, 2-hr, etc) and compositing it in proportion to the flow rate observed at each sampling time. The method of analysis of samples should be done as per standard procedure and by trained analysts.

3.2.4 Field observations

The entire plant should be inspected thoroughly. The aspects of site layout, material handling and storage, drainage system, safety aspects, lapses/negligence in operations and attitude of operators in process and waste treatment facilities, handling of scrap and wastes, usage of sign boards, instruction, colour codes etc. should be observed.

The 'attitude' and 'technical capability' of various staff including senior management should be observed as is very critical in achieving the goal of safer environment. The training requirements can be assessed based on these observations.

3.2.5 Draft report

After completing the above-mentioned activities including determining material balance, identifying waste flow, monitoring and analysis of various samples and field observations, a draft report should be prepared with findings and possible recommendations.

The draft report should be presented before the senior management and various points should be thoroughly discussed. The Management should put forward their views. The participation of the Management and their acceptance of various observations and recommendations makes the task of implementation meaningful.

3.3 Post Audit Activities

3.3.1 Synthesis of data

The requirement of various raw materials according to the mass balance of chemical equation involved in the manufacture of a product is called stoichiometric requirement. A comparison of these requirements with the actually used in the industry gives an indication of excess usage of various raw materials. These excesses may be presumed to be finding their way to air, water and soil thus causing pollution. Hence, it is important to reduce these excesses. The unit operation should be checked up to find out the cause of excess usage of the materials and accordingly modifications made. Norms should then be fixed for performance of each of the unit operations, for wastes generated from each of these unit operations. The production and environment staff are simply to adhere to the norms. The Environment Manager thus can have a control over production as well as wastes generation too.

3.3.2 Evaluation of waste treatment facilities

Performance of various pretreatment and final treatment facilities should be evaluated based on the analysis reports. If the treated wastewater, gaseous emissions and solid waste do not conform to the standards prescribed by the Pollution Control Board, reasons for the same should be diagnosed.

From the individual streams of wastewater, recyclable and recoverable materials should be identified and provisions made for the same. All the 'avoidable' wastes should be completely controlled and only the 'unavoidable' allowed for discharge. The wastewater should be segregated based on the characteristics, such as inorganic, organic, acidic, alkaline, easily biodegradable, not easily biodegradable and toxic streams; and pretreatment units viz. oil separator, neutralisation, detoxification etc. should be provided, wherever required , at the source so as to minimise cost of final treatment.

The wastewater of similar nature should be combined and common treatment facilities provided. This would be efficient and economical. Many a times, it is observed that inorganic wastes and non-biodegradable wastes are treated in biological treatment plants which on the contrary render biological treatment ineffective. Toxic wastes should be detoxified before treating in biological treatment plant. Highly toxic wastes may be isolated and incinerated. The rate of wastewater flow and polluted loads to the effluent treatment plant (ETP) should be properly regulated to keep off shock loads to micro-organisms. The designed criteria and the actual operating conditions of various treatment units should be compared and norms fixed for the operation of these units.

Similarly, the problems related to gaseous emission and solid waste generation may be identified. Recommendations for the best practicable waste management systems should be formulated. The guidelines for environmentally safe layout are given in Annexure III and guidelines for reduction of raw materials losses, and wastewater and gaseous emissions are given in Annexure IV.

The Environment Division of the industry should have an environment specialist to look into matters related to pollution control and evolve norms for resource conservation/waste minimisation vis-a-vis process control. Besides, he should also evolve norms for optimal utilisation of resources and performance of various pollution control systems. The members of this division and the operators of the treatment facilities should be well-trained.

To oversee the implementation of the measures for pollution control and the overall management of environment, there should be a Peer Group comprising members from production, quality control/laboratory, R&D and waste treatment divisions, the top management, and an environment specialist.

3.3.2 Final report

Various aspects discussed above should be compiled and a final report prepared alongwith recommendations. The final report may,if necessary, be sent to the top management for comments so as to make further modifications.

3.3.3 Action plans

The recommendations include measures for best practicable environmental management. If the annual burden, i.e. the annualised capital cost of the pollution control measures and their operating cost, for the implementation of all the recommendations, is high and the investment not feasible for the industry, then these recommendations, should be implemented in phases. Priorities should be fixed and action plans with time-frame should be formulated.

3.3.4 Follow-up actions

Follow-up actions should be taken to check the progress of implementation of recommendations. The Environment Division of the industry should meet the other Divisional heads periodically to review the progress.

CASE STUDIES

4.0 CASE STUDIES

4.1 Organo-chlorine Pesticides Industry (Company 'A')

The industry is located in the Northern part of the country, and is involved in the manufacture of dichloro diphenyl trichloroethane (DDT), an organochlorine pesticide. It is a large scale industry and is in operation for about 40 years. The industry was commenced when there was not so much consciousness about pollution control. Over the years, residential development blossomed around the factory and a situation has arisen wherein the industry has to immediately review its activities thoroughly and effectively manage the wastes generated for its existence.

Environmental auditing was conducted by a team of scientists/ engineers from the Central Pollution Control Board (Central Board), Delhi. This was the first pesticides industry to be audited by the team. The procedure followed and the results obtained are explained below.

4.1.1. Pre-audit activities

4.1.1.1. Preliminary information

A questionnaire was sent to the industry and preliminary information obtained on products manufactured, raw materials and water used, wastewater, gaseous emissions, and solid wastes generated, waste disposal points and details on surrounding land uses. Details in brief based on the information received are given below.

The industry is involved in the manufacture of technical grade DDT and its formulations. The raw materials used for technical grade DDT are benzene, alcohol, chlorine and oleum (20%), and those used for formulations are : technical grade DDT, china clay and soap stone. The manufacture of DDT involves broadly the following three steps :

Step I	:	Manufacture of monochlorobenzene (MCB)
Step II	:	Manufacture of chloral
Step III	:	Manufacture of DDT

Step I has the unit operations of drying of benzene, chlorination of benzene, neutralisation and washing of chlorobenzene, enrichment of chlorobenzene and distillation of monochlorobenzene (MCB).

Step II has the unit operations of chlorination of alcohol, distillation of chloral alcoholide in the presence of oleum, and absorption of hydrogen chloride.

Step III includes the unit operations of condensation reaction between MCB and chloral using oleum as a condensing agent, separation of aqueous and organic phases, recovery of MCB from organic phase, and solidification of DDT.

The flow sheet of various operations as provided by the industry is shown in Fig. 4.1. The total water consumption is 460 kld of which 270 kld is for process, 30 kld for sanitary, 10 kld for services, 125 kld for boiler and 25 kld is for cooling water make-up.

The wastewater generated is 290 kld of which 250 kld is from process, 30 kld from sanitary and 10 kld from boiler blow down. Steam is borrowed from a neighbouring industry and hence boilers are not in regular use. The wastewater is characterised by parameters like, pH, SS, COD, BOD, O&G, sulphates, chlorides and DDT. Solid waste generated is 18 t/month (70% water) from effluent treatment plant (ETP) and is disposed off into a municipal dumping yard.

The gaseous emissions include combustion emissions from usage of furnace oil at the boilers whenever required and process emissions of benzene, chlorine, HCl and dust of DDT. The industry reported its problems to bring down COD within permissible limit of 250 mg/l and disposal of sludge from ETP.

4.1.1.2 Audit team

An audit team of seven members was constituted. The team included a Senior Environmental Engineer, two specialists on pesticides industry-one scientist and the other an engineer, two members for water sampling, and two members for emissions sampling. The members with relevant experience were chosen based on the nature of work assessed from the preliminary information. The members had expertise in their own fields. The two specialists were aware of environmental problems associated with a pesticides industry and various waste management options. From the factory side, an overall coordinator and representatives from production, environment management and laboratory were identified to assist the audit team. The members were allocated with specific tasks.

4.1.1.3. Resources

The laboratory of the Central Board at Delhi was chosen for analysis of samples. This laboratory has the facility to analyse various parameters identified, including DDT. The instruments required for sampling were high volume sampler and handy sampler for ambient air quality and stack monitoring kit for emissions from stacks. These were made available by the above laboratory.

4.1.1.4 Visit programme

The industry being a single product plant having no complications as in multi-product plants, a visit programme for 3 days was prepared. The programme was communicated to the industry well in advance, and also informed to confirm back that various operations would be normal and that there would be no shut downs or partial operations during the auditing period. After receiving confirmation, the visit programme was communicated to the members and the laboratory.

4.1.2. Activities at the site

On reaching the site, a meeting with the management of the industry was held. The purpose of audit was explained to them. The coordinator of the industry introduced various representatives who would assist the audit team. The manufacturing processes and various activities that take place at the site were explained to the audit team. The team then made a reconnaissance survey of the industry so as to be acquainted with location of various activities and operations. The team then went ahead with other activities at the site which are a part of the audit.

4.1.2.1. Material balance

The chemical reactions involved in the process are given below :

$$\underset{(78.1)}{C_6H_6} + \underset{(70.9)}{Cl_2} \longrightarrow \underset{(112.5)}{C_6H_5Cl} + \underset{(36.5)}{HCl}$$

$$\underset{(92.1)}{2\ C_2H_5OH} + \underset{(283.6)}{4Cl_2} \longrightarrow \underset{(193.5)}{CCl_3CH(OH)\ OC_2H_5} + \underset{(182.2)}{5\ HCl}$$

$$\underset{(193.5)}{CCl_3CH(OH)OC_2H_5} \xrightarrow{oleum} \underset{(147.5)}{C\ Cl_3CHO} + \underset{(126)}{C_2H_5O\ SO_3\ H}$$

$$\underset{(147.5)}{CCl_3CHO} + \underset{(225)}{2\ C_6H_5Cl} \xrightarrow{H_2SO_4.SO_3} \underset{(354.5)\ DDT}{(C_6H_5Cl)_2\ CHCCl_3} + \underset{(18)}{H_2O}$$

The process flow chart incorporating various unit operations alongwith inputs of raw material and water and outputs of products, by-products, wastewater, gaseous emission, solid waste and intermediates is shown in Fig. 4.1. The quantities of inputs and outputs at each unit operation could not be worked as the industry had no ready data. As it is a long procedure and time consuming, the industry was explained how to carryout the work, and was asked to complete the work later. The mass balance of chlorine and oleum derived from the overall usage is given below.

The requirements of raw materials per tonne of products are given in Table 4.1 below :

TABLE 4.1: RAW MATERIAL REQUIREMENT- STOICHIOMETRIC VS. ACTUAL

Raw material	Stoichiometric requirement (kg.)	Actual requirement* (kg.)	% Extra consumption
Benzene	440.7	780.7	77.1
Chlorine	1200.2	1773.24	47.7
Ethanol	259.9	409.00	57.4
Oleum (20%)	-	1580.58	-

*(*Based on the average of four years)*

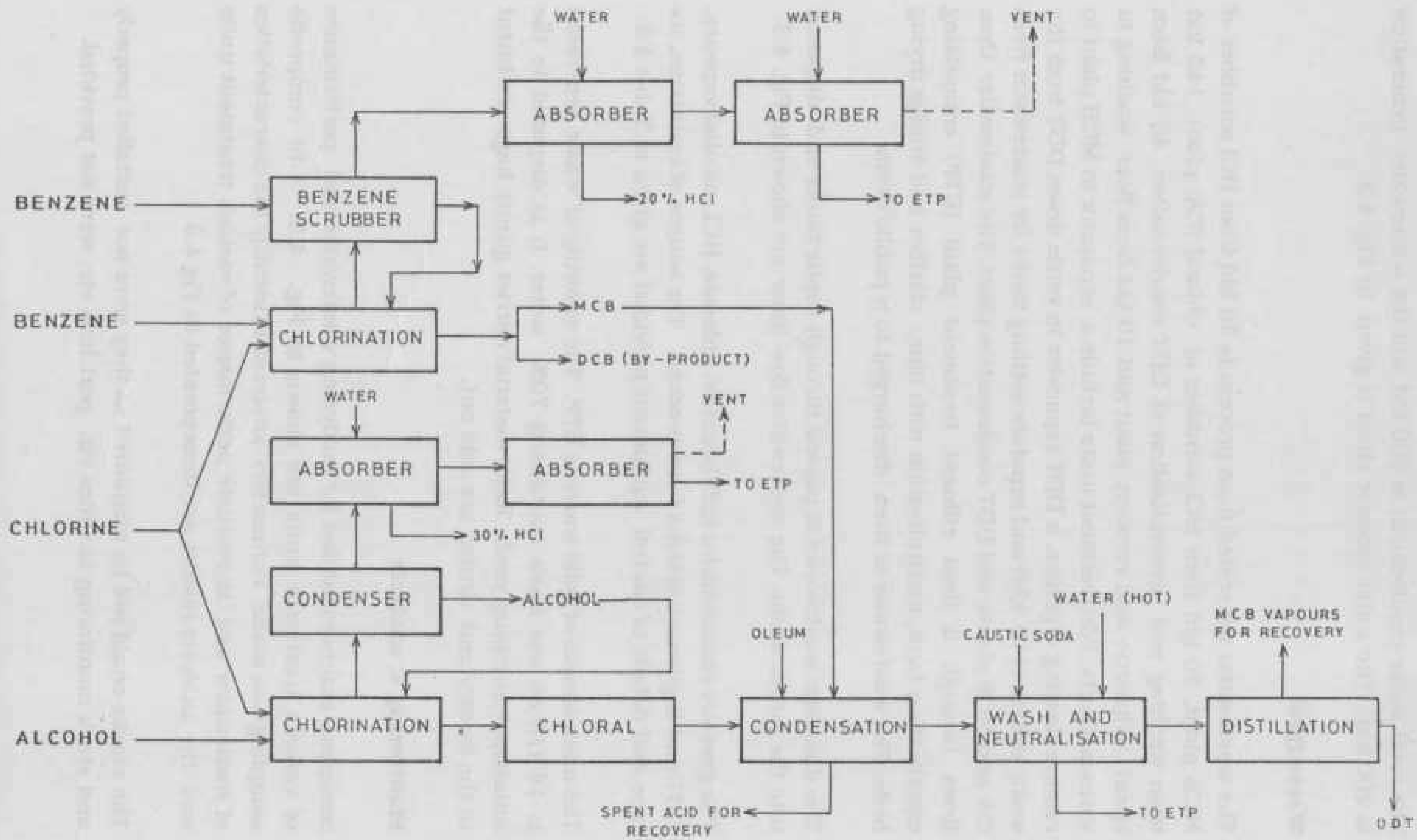


FIG. 4.1 SOURCES OF WASTEWATER AND EMISSIONS

The total water requirement is 460 kld and the wastewater generation is 290 kld. The water balance sheet is given in Fig. 4.2.

4.1.2.2 Waste flow

The wastewater generated from process is 30 kld from HCl scrubber of MCB plant, 30 kld from HCl scrubber of chloral (CA) plant, 140 kld from washing and neutralisation of DDT condensation, 40 kld from spent sulphuric acid recovery plant and 10 kld from floor washing in various plants. Pretreatment units include a separator in MCB plant to remove floating organics, a DDT separator to settle down DDT from the wash stream (140 kld) and separate settling tanks for wastewater from CA and MCB plants and DDT condensation plant. The wastewater then flows through a final effluent treatment plant (ETP) comprising equalisation tank, neutralisation with lime, clarifier and sludge drying beds. The wastewater is then discharged to a public drain.

The domestic wastewater is passed through septic tanks and disposed into the public drain. The wastewater flow lines are shown in Fig. 4.3.

The gaseous emissions include benzene, chlorine, HCl, alcohol vapours, DDT and fugitive emissions from process. The source of emissions, its type and details of control equipment provided are given in Table 4.2.

The main source of solid waste is ETP. The quantity of waste generated is 18 t/d on wet basis containing 70% water. It is disposed to the municipal dumping yard. Raw material carrier gunny bags are burnt in the factory and drums are sold out.

4.1.2.3. Monitoring & analysis

Sampling points identified for analysing wastewater and performance of various treatment units are shown in Fig. 4.3. 4-hr composite sampling was made. Parameters analysed to identify the characteristics of wastewater and to evaluate performance of various treatment units and the analysis results are incorporated in Fig 4.3.

The stacks could not be monitored as they were not installed properly and stack monitoring facilities viz. port hole etc. were not provided.

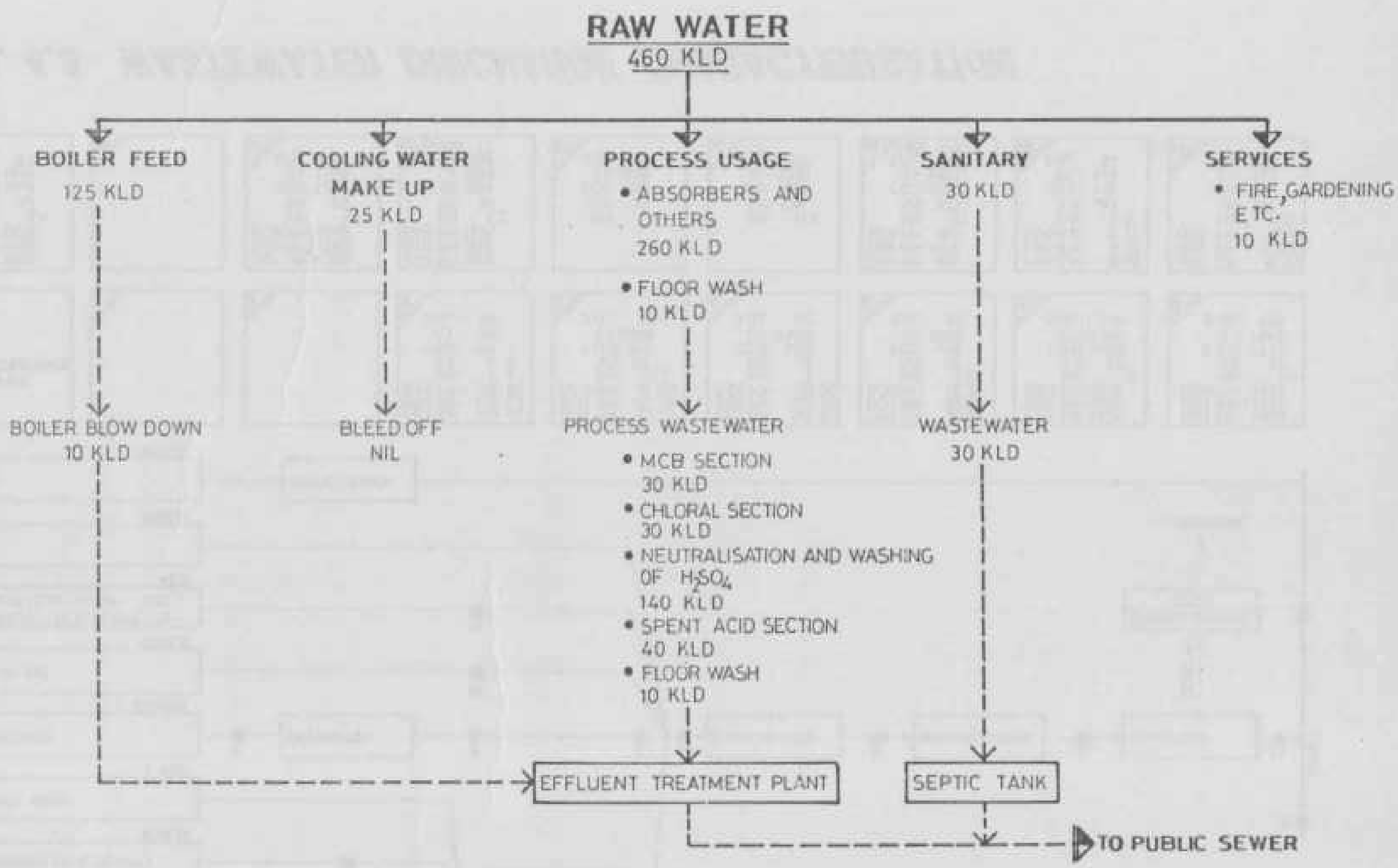


FIG. 4.2 WATER BALANCE

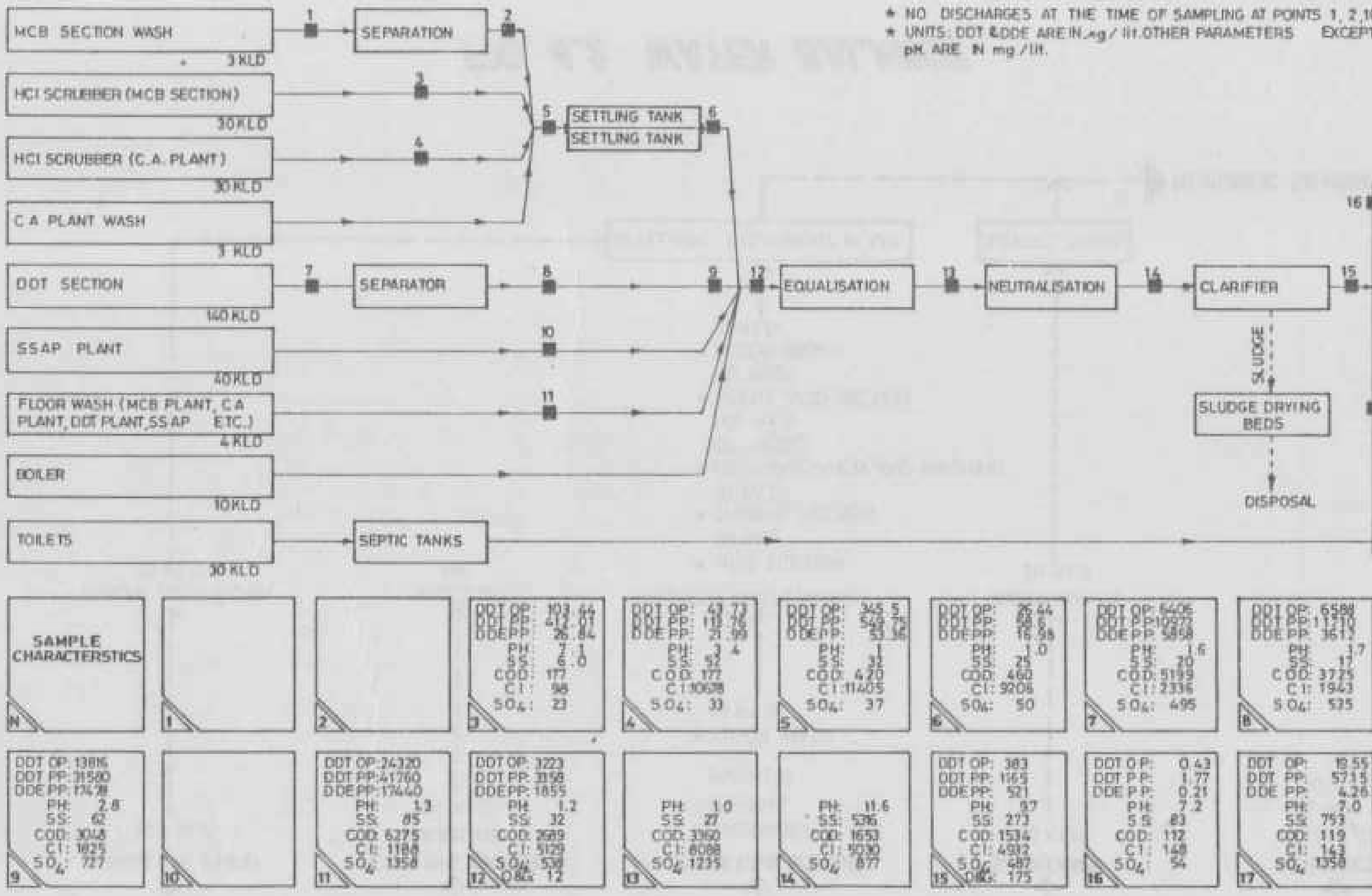


FIG. 4.3 WASTEWATER DISCHARGE CHARACTERISATION

TABLE 4.2: PROCESS EMISSIONS - TYPE, SOURCE AND CONTROL EQUIPMENT

Source of emission	Type of emission	Control Equipment Provided		Remarks
MCB Section Chlorinator	• Benzene vapours	i)	Benzene scrubber	No provisions in the chimney for monitoring. Emissions to be monitored and suitable chimney height to be provided
	• Chlorine gas	ii)	Water absorber to scrub HCl & produce 20% acid as by-product	- do -
	• HCl gas	iii)	Tail gas absorber where HCl gas is further scrubbed with water	- do -
CA House Chlorinator	• Alcohol vapours	i)	Alcohol vapours removed in a condenser using cooling water and brine	- do -
	• Chlorine gas	ii)	Water scrubber to absorb HCl gas and produce 30-35% acid as by-product	- do -
	• HCl gas	iii)	Tail gas absorber where HCl gas is further scrubbed with water	- do -
Grinding Section	• Dust of DDT and inerts	Dust extraction system with hoods, ducts, cyclone separator and a chimney of 55 m height		- do -

The ambient air quality was monitored at seven locations within the factory premises including the process areas using high volume samplers and handy samplers. The results are given in Table 4.3.

The public drain where the treated wastewater is discharged was monitored at upstream and downstream of the disposal point. Also, the groundwater in the factory premises was monitored. The results are given in Table 4.4.

The solid waste was analysed for DDT and DDE (dichloro diphenyl ethylene) - a breakdown product of DDT. The analysis of this waste showed DDE (PP') of 15474 $\mu g/g$, but DDT could not be traced.

4.1.2.4 Field observations

- In the manufacturing process certain side reactions take place. During the chlorination of benzene, dichlorobenzene (DCB) is also formed alongwith MCB which is recovered and sold as a by-product to the deodurant products manufacturers. During the condensation process of chloral and MCB to form DDT, a small amount of chlorobenzene sulphonic acid is also formed. These side reactions lead to wastage of materials. H2SO4 is used as a catalyst and for absorbing water. It is the major pollutant in the wastewater as the spent sulphuric acid is not recovered entirely. Certain process modifications are deemed necessary.

- The wastewater collection and drainage system is poor. No separate storm water drainage system has been provided. The process wastewater drains are subject to entry of stormwater due to which handling of wastewater during rains becomes very difficult.

- The manual dosing of lime in the neutralisation tank of ETP is inefficient. The operators though are able to test pH, adjusting of lime dosage is not well known.

- The sludge drying beds of ETP are choked. The solid waste is not properly collected. Scrap was found lying scattered in the plant. There is no earmarked area for solid waste.

TABLE 4.3: AMBIENT AIR QUALITY

S.No.	Location	Sampling Period	Total Sampling Time (minutes)	Analysis Results ($\mu g/m^3$)		
				SO_2	Cl_2	SPM
1.	Near chloral plant	11.55 AM - 03.55 PM	240	61.8	8.0	306
2.	Near DGM building at the height of 9 m.	12.10.PM - 14.10 PM	240	43.5	2.7	276
3.	Near GM building at the height of 4 m.	-1.10.PM - 05.10 PM	240	46.3	3.6	232
4.	Near Mono-chloro benzene (MCB) unit	11.40 AM - 01.40 PM	120	-	12.5	-
5.	- do -	01.45 PM - 03.45 PM	120	-	ND	-
6.	Near duct tower	11.40 AM - 01.40 PM	120	-	16.1	-
7.	- do -	01.45 PM - 03.45 PM	120	-	3.6	-

(ND - Not detectable)

TABLE 4.4: GROUNDWATER ANALYSIS

i)	pH	:	6.3
ii)	Chlorides (mg/l)	:	2101
iii)	Sulphate (mg/l)	:	573
iv)	Total Hardness (mg/l)	:	3480
v)	Conductivity (μmhos/cm)	:	7380
vi)	Phosphate (P) (mg/l)	:	Not traceable
vii)	Nitrate(N) (mg/l)	:	0.46
viii)	Alkalinity (mg/l)	:	463
ix)	DO (mg/l)	:	Not traceable
x)	DDT PP' (μg/l)	:	14569
xi)	DDT OP' (μg/l	:	3627
xii)	DDE PP' (μg/l)	:	2829

- Chemical spills, overflows and leaks from pipes in the process areas were observed almost everywhere. Final product of DDT, due to a crack in the DDT casting pans, was finding its way to wastewater drain.

- The HCl gases are scrubbed with water and discharged to ETP. This wastewater and that from washing in condensation reaction of DDT is contributing to acidity due to which huge quantities of lime has to be used for treatment. The source of DDT in the effluent is from washing in condensation section of DDT (140 kld).

- Huge quantities of HCl fume were observed while loading HCl tanker. Also emissions were observed from the HCl storage tanks.

- House-keeping is poor. Proper colour codes, sign boards and instructions are not incorporated. The industry has no clearcut buffer zone or green belt with the surroundings. Industry is surrounded by residential areas. Land availability is limited at the site. Site layout is poor.

- Industry has of late taken steps to improve waste management. However, the industry's staff are of the opinion that since it is a very old factory it is very difficult to make modifications needed for the best practicable waste management. Industry has a separate R&D wing to carry out research for improvement. The staff are not aware of the latest environmental management techniques and waste management options.

4.1.2.5. Draft report

No draft report was prepared at the site as the audit guidelines were yet to be evolved as this industry was the first industry to be audited. However, detailed discussions were carried out with the management about the observations and possible recommendations. The management agreed with the viewpoints of the audit team and welcomed a detailed report with recommendations for implementation.

- The comparison of the stoichiometric and actual requirements based on average figures of four consecutive years shows that there is excess usages of chemicals like benzene - 77%, chlorine - 48%, and ethanol - 57%. About 258 kg/d of HCl (100%) and 3.7

t/d of H_2SO_4 (100%) are finding their way to environment. The excess usage of materials besides contributing to loss of economy are causing pollution. The excess usages may be attributed to inefficient process technology, poor process performance, poor house-keeping, lack of inplant control measures and poor material handling.

- The wastewater generated is about 40 kld per tonne of product manufactured. It contains sulphuric acid, hydrochloric acid, soluble organics in the form of benzene, alcohol, MCB, DCB and DDT. The effluent is highly acidic and toxic in nature. The major contributor to water pollution is soda and hot water wash in DDT condensation section. From DDT cast pans, due to leaks, an amount of 6.6 kg/d of DDT is being contributed to ETP. HCl in the effluent is contributed from HCl scrubbers and H_2SO_4 is contributed from soda and hot water wash and H_2SO_4 recovery plant.

The solid waste generated is hazardous in nature due to the presence of DDE and hence cannot be disposed to municipal dumping yard. Also, an authorisation from the pollution control agency is to be obtained for the disposal of this waste. The open burning of used raw material bags is not permissible as it causes air pollution and may generate toxic fumes.

The scrubbers provided for HCl emissions appear to be insufficient. Additional caustic soda scrubbers are to be provided. The fugitive emissions due to material handling, from storage tanks and from loading and unloading of tanks are to be controlled.

The wastewater treatment system provided is insufficient. The DDT separator is not serving any purpose mainly due to insufficient detention time provided for DDT to settle down. The manual dosing of lime in neutralisation tank of ETP is inefficient. The clarifier is under-designed. The treated wastewater is not conforming to the prescribed standards.

- DDT concentration in the wastewater can be reduced by 50% by controlling leak from the DDT cast pans and collecting overflows or spills occuring while sampling under DDT condensation vessel.

- DDT separator is to be modified to achieve proper detention time for settling. Alum coagulation aided settling may enhance rate of DDT.

- The groundwater in the factory premises is highly polluted. It has a DDT of about 20,000 $\mu g/l$ and also high concentration of conductivity and chlorides. The process wastewater and leachate from sludge dumping might have caused this pollution of groundwater.

- Industry has air pollution problem due to HCl fumes from process, HCl storage tanks and loading of HCl road tankers. Fugitive emissions were observed at various process sections. On-line gases pose air pollution problem during power failures since stand-by D.G. set is not available.

- House-keeping is poor. Spills, leaks and fumes are generated from various processes. Drainage system and collection of scrap and waste are poor.

4.1.3.2. Final report

A final report incorporating various observations and recommendations was prepared. The important recommendations include the following:

- Review of process technology adopted and performance of process equipment is deemed necessary to take up modifications accordingly. Fixing up of norms for performance of process operation and wastes generated imminent such that the loss of materials and hence the wastages are minimised. The possibilities of replacing oleum with a suitable alternative may be explored.

- The proposed scheme for waste treatment is shown in Fig. 4.4.

- The top level of process drains are to be kept atleast 15 cm above ground level so that the rain water does not enter these drains. Storm water drainage is to be kept separate and polluted storm water carrying spills during the initial hours of rainfall to be collected and treated. Flooring in the process areas shall be

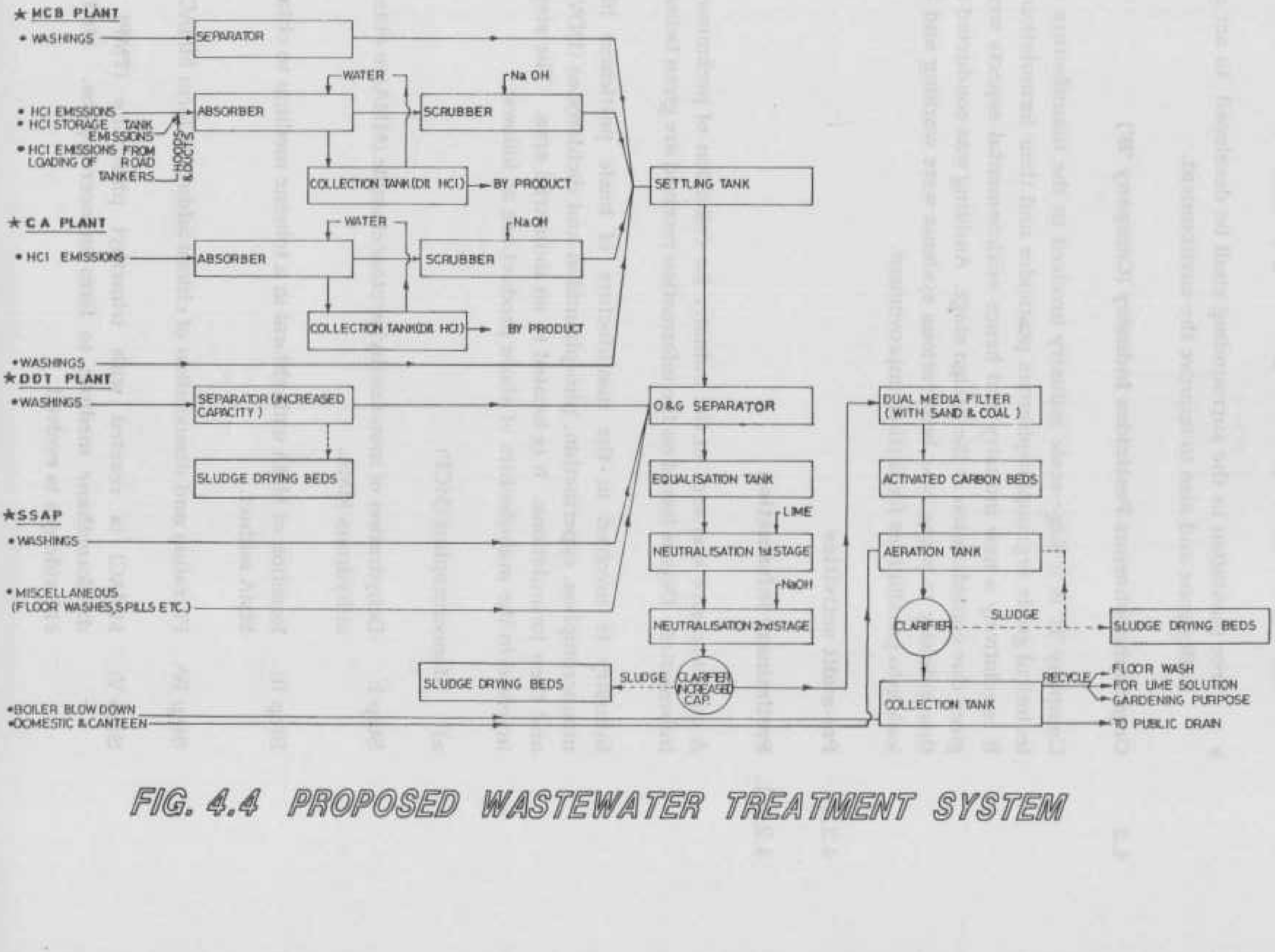


FIG. 4.4 PROPOSED WASTEWATER TREATMENT SYSTEM

made properly. Treated wastewater to be recycled for floor wash, making lime solution and for gardening purposes.

- Tree plantation in the surrounding shall be developed to act as buffer zone and also to improve the environment.

4.2 Organophosphorous Pesticides Industry (Company 'B')

Company 'B' is a large-scale industry involved in the manufacture of technical grade organophosphorous pesticides and their formulations. It is relatively a new industry and hence environmental aspects were given due consideration at the design stage. Auditing was conducted in this industry to probe how best various systems were working and to look into possibilities for further improvement.

4.2.1. Pre-audit activities

4.2.1.1. Preliminary information

A questionnaire was sent to the industry for collection of preliminary information. Details based on the information received are given below:

Industry is involved in the manufacture of basic pesticides like monocrotophos, cypermethin, phosphamidon and dichlorouos (DDVP) and their formulations. It is located in an industrial area. The steps involved in the manufacture of above product are as follows:

a) Monocrotophos (MCP)

Step I: Dehydration of monomethyl acetoacetamide (MMA) to obtain anhydrous MMA.

Step II: Reaction of MMA with chloral in a toluene medium to obtain MMA adduct.

Step IV: Filtration and dissociation of chloro adduct to form MMACl.

Step V: MMACl is reacted with trimethyl phosphite (TMP) in dichloroethane medium to form monocrotophos. Methyl chloride gas is evolved.

b) Cypermethrin (CYPER)

The first step involves condensation of 2-dimethyl - 3 (2-2 dichlorovinyl) - cyclopropane - 1, carboxyl chloride (DVO), meta phenoxy benzaldehyde (MPB) and sodium cyanide in xylene media in the presence of a catalyst. The above mixture is washed to remove ionic impurities. The washed product is dried and purified by distillation. Solvent is recovered and recycled. The product is cooled and filtered to obtain cypermethrin.

c) Dichlorovos (DDVP)

Chloral and TMP are reacted to produce crude DDVP which is further distilled to obtain required purity.

d) Phosphamidon (PMN)

Step I: Diethyl acetoacetamide is reacted with chlorine to produce diethyl dichloro-acetoacetamide (DDA).

Step II: DDA is reacted with TMP in presence of chlorobenzene to crude amide phosphamidon.

Step III: Crude phosphamidon is vacuum distilled to preconcentrate and is further flashed in a thin film evaporator to produce phosphamidon of required purity.

The water requirement is 1160 kld of which 140 kld is for boiler, 220 kld for cooling water, 160 kld for process [92 kld for monocrotophos, 60 kld for phosphamidon/DDVP and 8 kld for cypermethin], 200 kld for sanitary and 440 kld for services (fire, gardening etc). The wastewater generation is 500 kld of which 140 kld is from boiler blow down, 200 kld from sanitary and 160 kld from process (MCP : 92 kld, PMN/DDVP: 60 kld, CYPER : 8 kld). The wastewater characterised by parameters like pH, BOD, COD, TSS, cyanides, residual chlorine, pesticides and toxicity. The wastewater treatment includes pretreatment of process wastewater for detoxification followed by combined treatment of domestic and process wastewater in a two-stage biological treatment plant.

The process emissions include, HCl, CH3Cl, chloroform, HCN, P2O5 and SPM. Gaseous emissions also arise from combustion of furnace oil at boilers.

The solid waste generated is about 5.0 t/yr. It contains oils, pesticides, toxic residues, discarded containers etc.

4.2.1.2. Audit team

The audit team had seven members, same as in Case Study 4.1.

4.2.1.3. Resources

The industry has a full-fledged laboratory to analyse various expected parameters, including BOD, Pesticides and Toxicity. The laboratory also has stack monitoring kit and high volume samplers. The laboratory of the Central Pollution Control Board at Delhi was chosen as a stand-by.

4.2.1.4. Visit programme

A programme for a visit to the industry was prepared for six days. The programme was communicated to the industry well in advance and got confirmation of the normal working during those six days.

4.2.2. Activities at the site

A meeting with the Management of the industry and the representatives from the industry who would assist the team was held and a reconnaissance survey of the industry, was done. The team then went ahead with performing various other activities as detailed below.

4.2.2.1 Material balance

The chamical reactions involved in the manufacturing process are as follows:

a) **Monocrotophos:**

```
                  H                                          H
                  |                       toluene            |
i)   CH3 - CO- C-CO-NHCH3 + CCl3 CHO ---------->CH3-CO-C-CO-NHCH3
                  |                                          |
                  H                                       HOHCCl3
          (MMA)            (Chloral)              (MMA Adduct)

ii) MMA Adduct  +  Cl2  -------> CH3-CO-C-CO-NHCH3 + HCl
                                        |
                                     HOHCCl3
                                  (Chloro adduct)
```

```
                                      Cl
                                      |
iii)Chloro adduct  -------> CH3-CO-C-CO-NHCH3 +  Chloral
                                      |
                                      H
                                   (MMACl)
```

```
              OCH3                    O   H
               |                      |   |
iv) MMACl + OCH3-P-OCH3   ----> OCH3-P-O-C=C-CO-NHCH3 + CH3Cl
                                      |   |
                                      OCH3CH3
            (TMP)               (Monocrotophos)
```

b) **Cypermethrin:**

```
                                                           Catalyst
Acid Chloride + m-Phenoxybenzaldehyde + NaCN           ------->
                     NaCl     +    Cypermethrin
```

c) **DDVP:**

```
                                            O
                                            |
CCl3CHO + (CH3O) 3P --->(CH3O) 2P-O-CH = CCl2 + CH3Cl
(Chloral)   (TMP)              (DDVP)
```

d) **Phosphamidon:**

```
   O     O                          O  O
          C2H5                      Cl  C2H5
          |                         |   |
CH3-C-CH2-C-N  + Cl2  ------->CH3-C-C-C-N  +  2HCl
          |                         |   |
          C2H5                      Cl  C2H5

 (DEA)                            ( Diethyl
                            Dichloroacetoacetamide)
                                    (DDA)
```

```
                                                        O
                                              O   CH3    C2H5
                    Chlorobenzene             |    |      |
DDA + (CH3O) P     --------------> (CH3O)2-P-O-C=C-C-N   + CH3Cl
                                                   |      |
                                                   Cl   C2H5
  (TMP)                                          (Phosphamidon)
```

The process flow charts for the above products incorporating various unit operations alongwith various inputs and outputs of products, by-products, wastewater, gaseous emissions, and solid waste are given in Fig. 3.2, 4.5, 4.6, and 4.7. The requirement of raw materials per tonne of each product and the details of wastes generated alongwith pretreatment details are given in Tables 3.1, 4.5, 4.6 and 4.7. The total water requirement is 1081 kld and 570 kld is the wastewater generation. The water balance is shown in Fig. 4.8.

4.2.2.2. Waste flow

The sources of the wastewater are identified and their quantities determined. The wastewater from monocrotophos is 160 kld, kld from cypermethrin, 60 kld from phosphamidon and 16 kld from DDVP. The

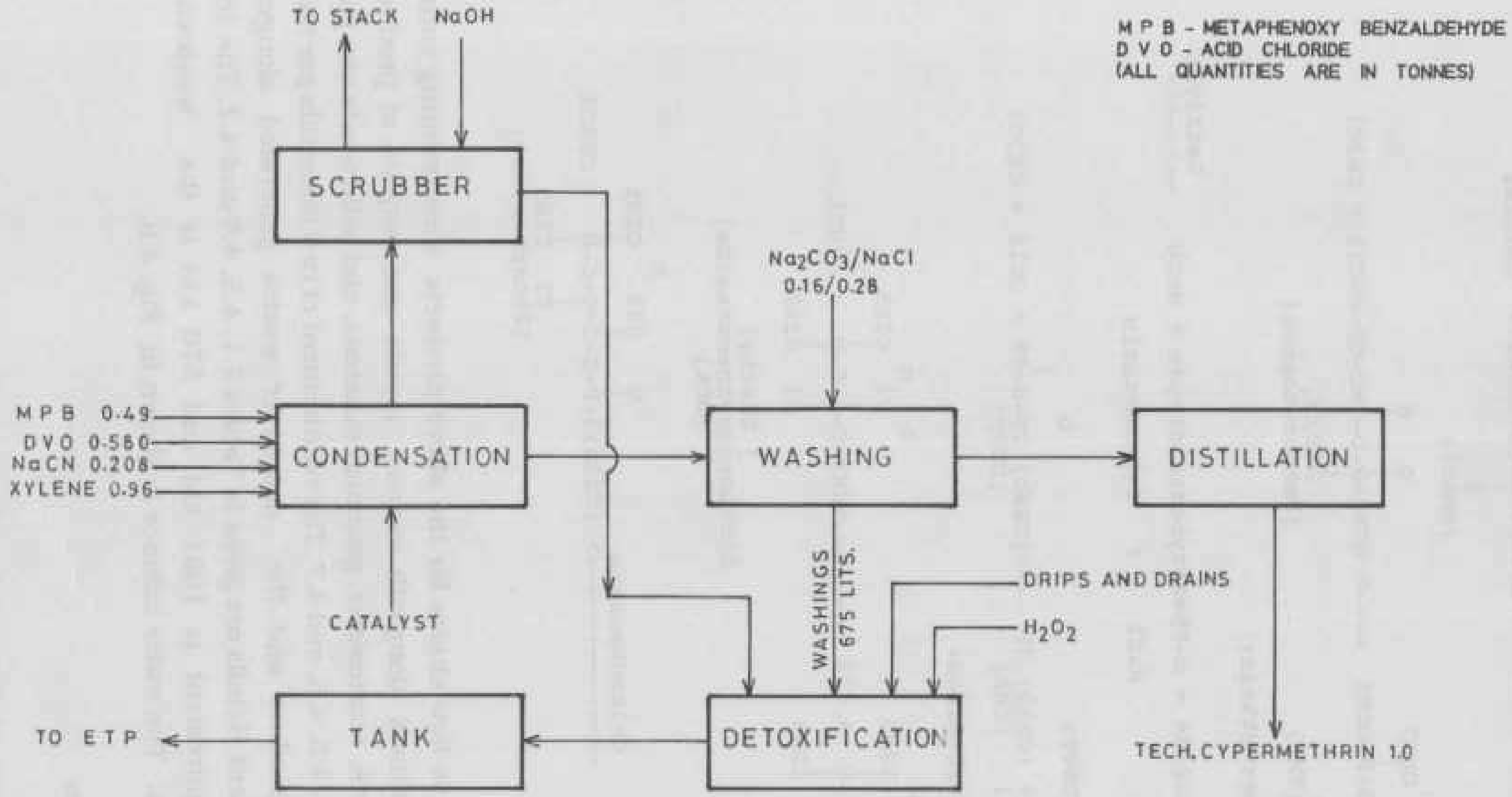


FIG. 4.5 PROCESS FLOW DIAGRAM OF CYPERMETHRIN

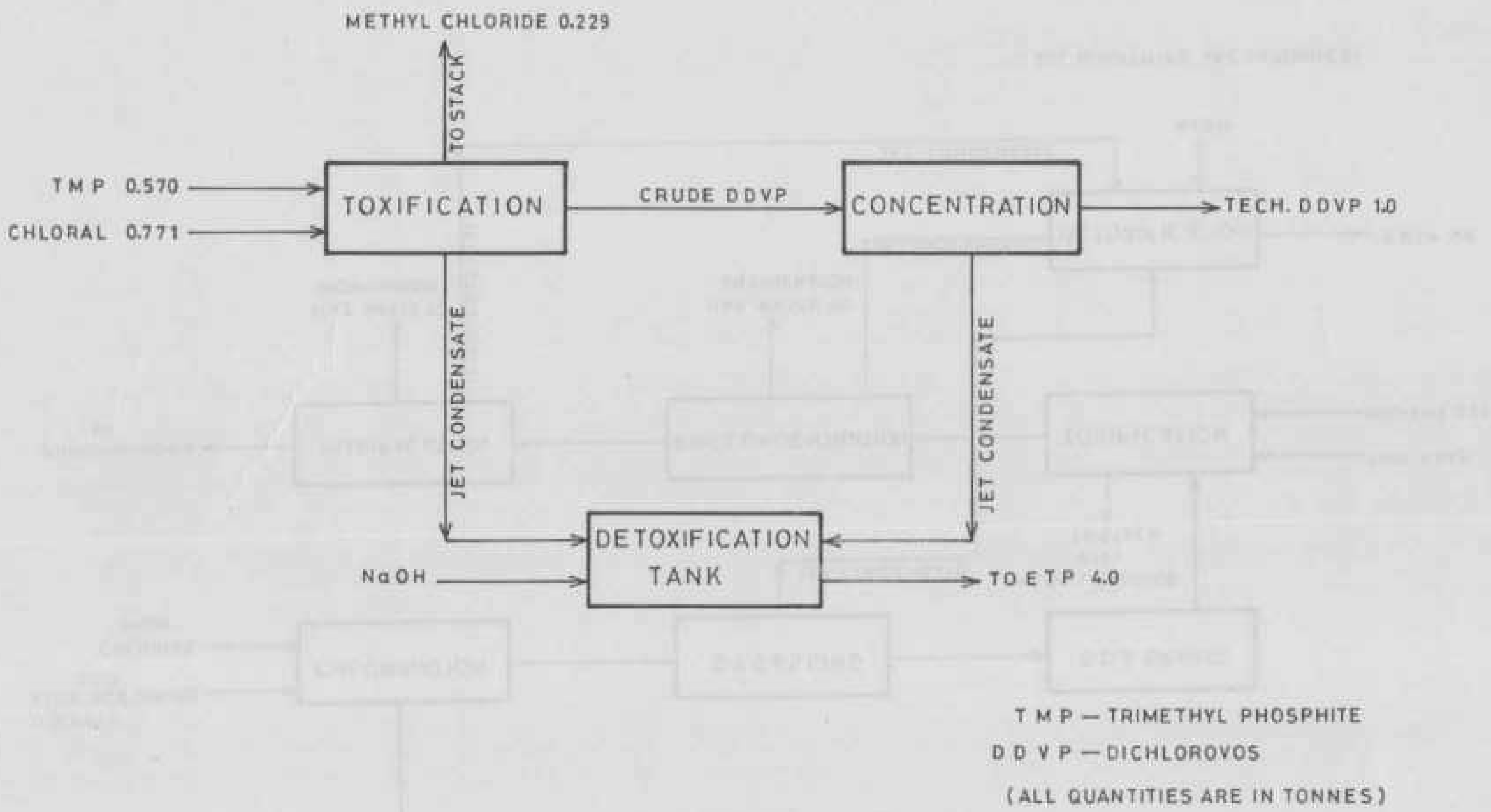


FIG. 4.6 PROCESS FLOW DIAGRAM OF DDVP

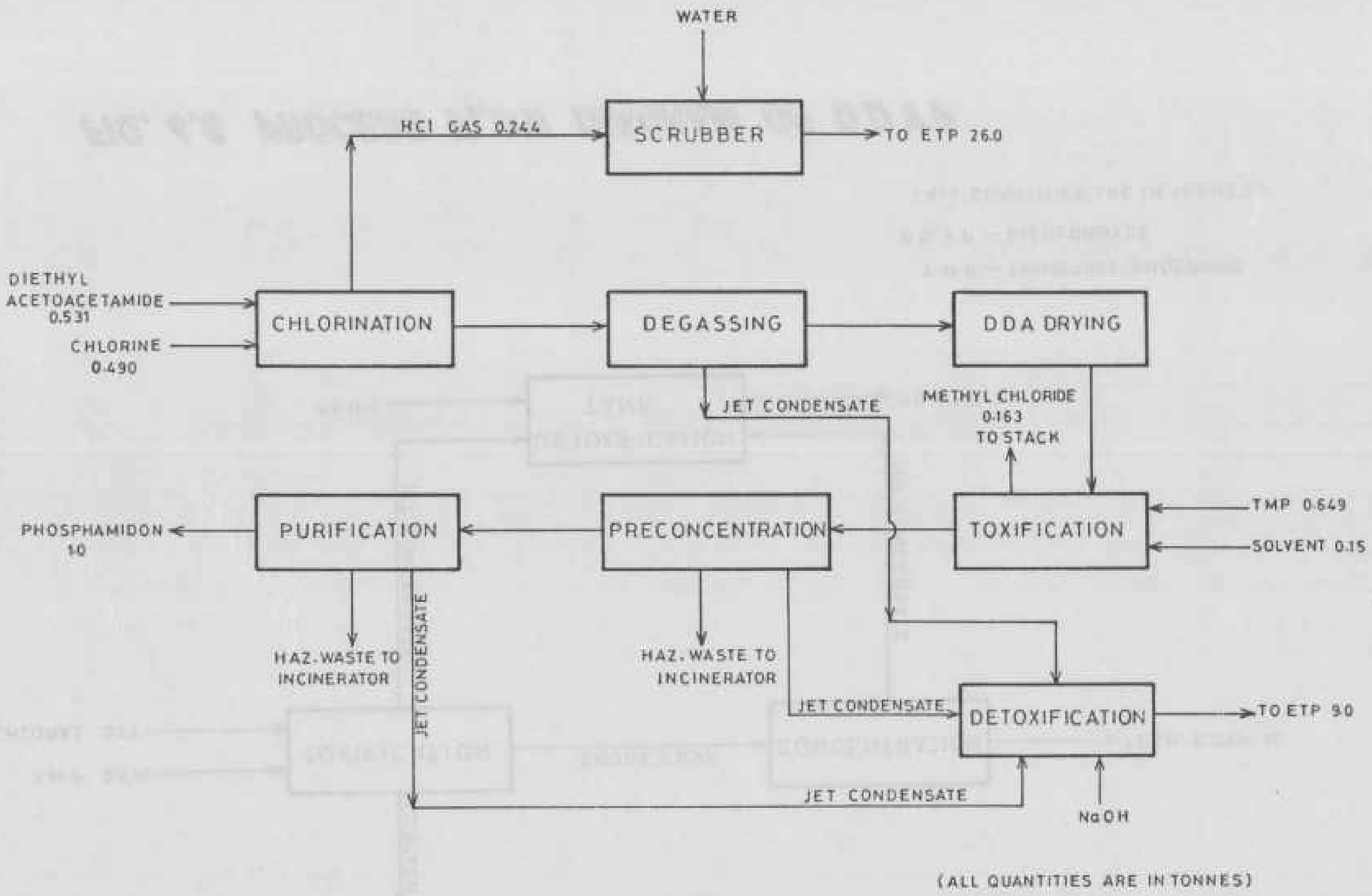


FIG. 4.7 PROCESS FLOW DIAGRAM OF PHOSPHAMIDON

TABLE 4.5: DATA SHEET ON INPUTS AND OUTPUTS FOR THE MANUFACTURE OF CYPERMETHRIN

Raw material per tonne of product:

S.No.	Raw material	Quantity, kg	
		Actual	Stoichiometric
1.	Acid Chloride (DVO)	580	547
2.	Metaphenoxy benzaldehide	490	476
3.	Sodium cyanide	208	118
4.	O-xylene	960.5	Not process chemicals used for washing
5.	Na2CO3	161.5	
6.	NaCl	280	

Water requirement per tonne of product:

Steam	:	Nil (no jet-ejectors)
Cooling	:	Nil
Process	:	Washing with Na2CO3/NaCl : 675 l Making solution of NaCN : 250 l

Wastewater generated per tonne of product

S.No.	Source	Nature	Quantity, kg	Pretreatment
1.	Washing with Na2CO3/NaCl	NaCN, Cypermethrin Na2CO3, NaCl	675	Detoxification using H2O2 after maintaining pH 9-10 using acetic acid
2.	Caustic Scrubber for HCN emission	Scrubber liquor	Varying quantity	-do-
3.	Drips and drains	-	-do-	-do-

Emissions:

S.No.	Source	Nature	Quantity	Gas flow Nm^3/hr	Control equip.	Chimney ht., m.
1	Condensation	HCN	-	900	Caustic scrubber	15

Solid waste/hazardous waste: Nil

TABLE 4.6: DATA SHEET ON INPUTS AND OUTPUTS FOR THE MANUFACTURE OF DICHLOROVOS

Raw material requirement per tonne of product :

S.No.	Raw Material	Quantity, kg	
		Actual	Stoichiometric
1.	Chloral	771	668
2.	Trimethyl phosphite	570	561

Water requirement per tonne of product :

Steam	:	4.0
Cooling	:	5.0
Process	:	Nil
Total	**:**	**9.0 kl**

Wastewater generated per tonne of product:

S.No.	Source	Nature	Quant -ity, kl	Pretreatment
1.	Jet condensate & spills	Solvent traces of toxic material	4.0	Detoxification with NaOH at pH 10-10.5

Emission:

S.No.	Source	Nature	Quantity kg/t	Gas flow, Nm^3/hr	Control equip.	Chimney ht., m
1.	Toxification	CH3CI	229	17760	Nil	39

Hazardous waste/Solid waste: Nil

TABLE 4.7: DATA SHEET ON INPUTS AND OUTPUTS FOR THE MANUFACTURE OF PHOSPHAMIDON

Raw material requirement per tonne of product:

S.No.	Raw material	Quantity, kg	
		Actual	Stoichiometric
1.	Diethyl Acetoacetamide	531	524
2.	Chlorine	490	474
3.	Trimethyl phosphite	649	414
4.	Solvent	150	Not a process chemical

Water requirement per tonne of product :

HCl Scrubber	:	26.0 kl
Steam	:	9.0 kl
Cooling (make up)	:	21.0 kl
Process	:	Nil
Total	**:**	**56.0 kl**

Wastewater generated per tonne of product:

S.No.	Source	Nature	Quantity, kl	Pretreatment
1.	HCl scubber	HCl	26	Nil
2.	Jet condensate spills	Solvent traces toxic materials	9	Detoxification

Emission:

S.No.	Source	Nature	Quantity kg/t	Gas flow Nm^3/hr	Control equip.	Chimney ht., m
1.	Chlorination	HCl	244	3500	Water scrubber	39
2.	Toxification	CH3CI	168	17760	Nil	-do-

Hazardous waste:

S.No.	Nature	Nature	Quantity, kg	Pretreat -ment	Method of disposal
1.	Preconcentration	Degraded HC	216	Nil	Incineration
2.	Product purification				

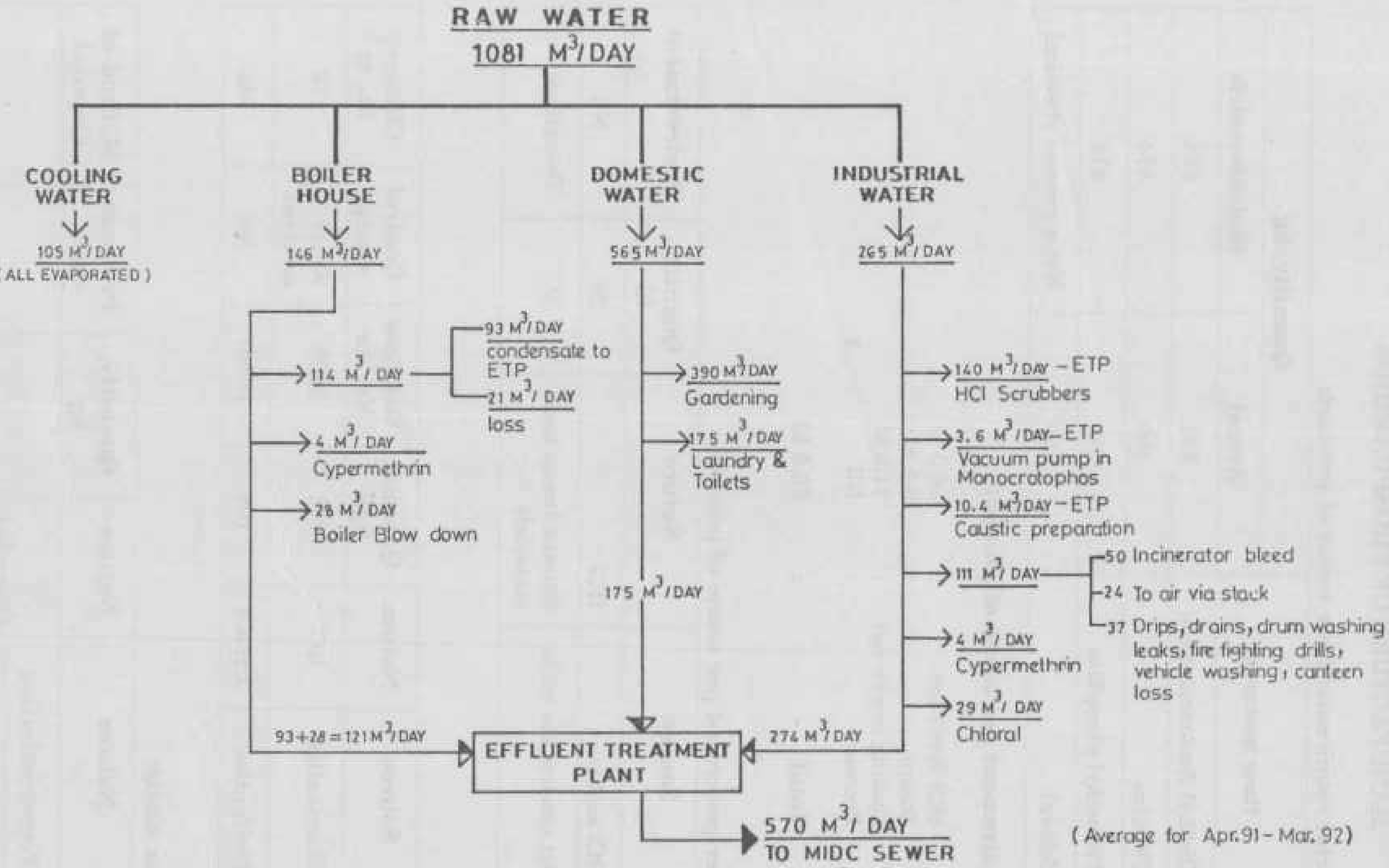


FIG. 4.8 RAW WATER CONSUMPTION – WATER BALANCE

other wastewater are 50 kld from incinerator, 28 kld from boiler blow down, 175 kld from laundry and toilets and 37 kld from drips, drain, drum washings etc. The toxic streams are detoxified by raising pH to 10-12 using caustic soda, and sufficiently detaining the wastewater under agitation. The wastewater from various sources is then collected and further treated in effluent treatment plant (ETP). The wastewater flow lines are given in Fig. 3.5.

The process emissions include HCl, CH_3Cl, chloroform, CH_3Cl, HCN, P_2O_5, SPM, SO_2 and NO_x. The details of the sources of emissions, gas flow rate, control equipment provided and height of the chimney are given in Table 4.8. About 5.0 t of solid waste is generated per annum. The details of its type, quantity and disposal are given in Table 4.9.

4.2.2.3. Monitoring and analysis

The sampling points identified to determine the characteristics of wastewater and performance of wastewater treatment system are shown in Fig. 3.5. The stacks could not be monitored due to time constraint. Two ambient air quality stations are operated by the industry at the site. The available data with the industry was collected. The process samples were analysed for pH, SS, COD, BOD, TDS, chlorides, TOC, sulphates and COD. The samples from ETP were analysed for pH, COD, TOC, TSS, pesticides (MCP, CYPER, DDVP, PMN) and flow rate, and DO, MLSS, and MLVSS in case of aeration tanks.

Process samples were of grab type but the ETP samples were collected hourly for eight hours and composited. The samples were collected on two consecutive days.

4.2.2.4. Field observations

- Not all the products are manufactured throughout the year, monocrotophos is manufactured throughout the year but cypermethrin is manufactured for nine months, phosphamidon for eight months and dichlorovos for two months. Monocrotophos and cypermethrin have separate process route but phosphamidon and DDVP have only one process route due to which only one of these products is manufactured at a time. Monocrotophos is

TABLE 4.8: DETAILS OF EMISSIONS

S.No.	Source	Nature	Quantity of product kg/t	Gas flow, Nm^3/hr	Control equip-ment	Chimney ht,m
	A. MONOCROTOPHOS					
1.	Chlorination	HCI	164	2,200	Water scrubber	36
2.	Toxification	CH3CI	227	17,760	Nil	41
3.	Air stripping chloral effluent	Chloro-form	0-50 mg/Nm^3	441	Nil	20
	B. DDVP					
4.	Toxification	CH3CI	229	17,760	Nil	39
	C. CYPERMETHRIN					
5.	Condensation	HCN	Traces	900	Caustic scrubber	15
	D. PHOSPHAMIDON					
6.	Chlorination	HCI	244	3,500	Water scribber	39
7.	Toxification	CH3CI	168	17,760	Nil	39
	E. INCINERATOR					
8.	Liquid waste incinerator	P2O5 HCI	0-35 mg/Nm^3	695	Caustic scrubber	30
9.	Solid waste inc: ierator	SPM	*	*	Nil	30
	F. BOILER					
10.	Boilers 4 nos. Steam gen. capacity 3456 kg/hr per boilder	SO_2,NO_X SPM	SPM-85-720 mg/Nm^3 SO2-10-140-mg/Nm^3 NO_x-0.5-2 mg/Nm^3	3,800	Nil	30
	G. DIESEL GENERATOR					
	Capacity 365 KVA	*	*	*	*	10 above RL

** information not available*

TABLE 4.9 DETAILS OF HAZARDOUS WASTE

S.No.	Type of waste	Quantity kg/yr	Method of disposal
1.	Cyanide waste from used cyanide containers	0.05-0.1	Empty container along with plastic bags is filled with H2O2, detoxified and then burried with alkali
2.	Organic residues	165 kl/yr	Incineration
3.	Oil drips as drains	200-300	Collected using saw dust, and incinerated
4.	Sludge from ETP	3600	Land filling in factory premises
5.	Waste containing pesticides	195 kl (10.5-3% of pesticides)	Incineration
6.	Off-specification and discarded products	-	Incineration
7.	Discarded containers & container liners of hazardous & toxic waste	1200	Metalic drums are detoxified by heating at high temperature and then crushed and sent as scrap

manufactured at 1.7 t per batch and batch time is 8.00 hrs., whereas phosphamidon is manufactured at 1.95 t per batch and the batch time is 16 hrs, cypermethrin manufactured at is 1 t/batch and batch time is 2 days, and DDVP is produced at 3.45 t/batch and batch time is 16 hrs.

- These variations in daily production lead to variation in characteristics of wastewater received at ETP. Detoxification systems are provided at the process wastewaters to reduce shock loads due to toxicity on the ETP.

- The wastewater from various sources is collected through a well-designed drainage system. Stormwater drains are kept separate.

- The treated wastewater is disposed to a pubic sewer which finally joins a river. The river has back waters normally except during rains.

- The location where the industry is existing has not been declared as air pollution control area under the Air Act, 1981 and hence this Act is not applicable. Industry need not obtain consent for emissions from the State Pollution Control Board.

- Industry has good house-keeping practices. Safety and quality control are given highest priority. Floor washing is totally avoided. In case of spills, saw dust is used to wipe it out. Overflows, spills and leaks are kept to the minimum. Manual transfer of chemicals is avoided. Site is well laid out considering compatibility and safety while locating various activities.

- The site is surrounded by hills and valleys.

- The staff are qualified, process performance norms are well understood. However, the operators at the ETP are not fully aware of 'dont's'.

- Land is available in plenty for any addition, if necessary.

4.2.2.5. **Draft report**

A draft report was prepared and handed over to the management. The management was not in favour of recovering a contaminated by-product and reusing or recycling waste that can contaminate product, but welcomed suggestions for the improvement of environment and assured immediate implementation.

4.2.3 **Post-audit activities**

4.2.3.1 **Synthetis**

i) A comparison of stoichiometric and actual requirement of various chemicals shows that their excess usages are 32-55% in case of monocrotophos. Sodium cyanide use is very high to the order of 76% in excess in case of cypermethrin, and trimethyl phosphite used is about 56% excess in case of phosphamidon. The material usage is not much in excess in case of dichlorovos. These excess usages of materials may be presumed to be finding their ways to environment thereby causing pollution. The cause of these excesses may be attributed to inefficient process performance and raw materials impurities.

ii) The water consumption per tonne of product is highest with 81.4 kld in case of monocrotophos, 50 kld in case of phosphamidon, 9 kld in case of DDVP and 1 kld in case of cypermethrin. The wastewater generation from process is 56 kld per tonne of monocrotophos, about 1 kld per tonne of cypermethrin, 4 kld per tonne of DDVP and 35 kld per tonne of phosphamidon. The total wastewater generation is 540 kld of which 48% is from process, 31% is from laundry & toilets and 21% from boiler blowdown and steam condensate.

The process wastewater is biodegradable but toxic. The treated wastewater is conforming to the prescribed standards except for COD which is slightly exceeding the limit of 250 mg/l. The wastewater flow rate in the final outlet is seen to be widely varying. The operators are not aware of how the flow should be regulated in the ETP.

iii) The treated effluent is disposed to a public drain which ultimately joins a river.

iv) About 3 t/d of methyl chloride emission, which is highly toxic is let into the atmosphere, thereby adding to the risk of environmental hazard.

v) The ambient air quality record maintained by the industry does not include all the air pollutants emitted.

2.3.2. Final report

A final report incorporating various observations and recommendations was prepared. The important recommendations included the following:

- The excess usage of raw materials especially in case of monocrotophos, sodium cyanide in case of cypermethrin and trimethyl phosphite in case of phosphamidon are to be reduced. Performance studies of various process equipment are to be carried out and norms fixed up for each operation such that maximum utilisation of materials takes place and only the unavoidable wastes are generated.

- The de-aerator overflow of the steam condensate has been found to be well within limits except for pH. This stream may be isolated, neutralised and reused for floor wash or used for gardening or irrigation purposes in the factory premises at the rate of 35 kld/hectare/day.

- The treated wastewater from ETP should be subjected to tertiary treatment by activated carbon, ozonation etc. so as to reduce COD and pesticides, and recycled for developing green belt in the factory premises.

- Methyl chloride emission should be recovered as a by-product through a liquifation plant or incinerated.

- Rate of flow to aeration tanks in the ETP should be kept constant to avoid shock loads.

- Ambient air quality monitoring in the factory premises should include the parameters of HCl, CH_3Cl, HCN and Cl_2 in addition to SPM, CO, NO_x and SO_2.

- A manual for operation of the waste treatment facilities is to be prepared for use mainly by the operators.

- An organisational set up for environmental management is to be made including people from production, R&D, quality control/laboratory, management, safety, waste treatment facilities and an environmental specialist. The operators of the waste treatment facilities are to be well-trained.

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7. Minimal National Standards - Pesticides Manufacturing and Formulation Industry, Central Pollution Control Board, Delhi, COINDS/15/1985-86.

8. Revised Minimal National Standards for Pesticide Manufacturing and Formulation Industry, Part I, Central Pollution Control Board, Delhi, COINDS/30/1988-89.

RESOURCE SECTION

5.1 MINAS FOR PESTICIDES INDUSTRY

Compulsory parameters	Limiting concentration
Temperature	Shall not exceed 5°C above the receiving water temperature
pH	6.5 to 8.5
Oils and grease	10 mg/l
Bio-chemical Oxygen Demand	30 mg/l
Total suspended solids	100 mg/l
Bio-assay test	90% survival after 96 hrs.with fish at 100% effluent

Optional Parameters		Limiting concentration (in $\mu g/l$)
a)	**Specific pesticides**	
-	Benzene hexachloride	10
-	Carbaryl	10
-	DDT	10
-	Endosulfan	10
-	Dimethoate	450
-	Fenitrothion	10
-	Malathion	10
-	Phorate	10
-	Methylparathion	10
-	Phenthoate	10
-	Pyrethrums	10
-	Copper oxychloride	9,600
-	Copper sulphate	50
-	Ziram	1,000
-	Sulphur	30
-	2, 4D	300

-	Paraquat	23,000
-	Propanil	7,300
-	Nitrofen	780
-	Phosalone	80
b)	**Heavy Metals**	
-	Copper	1.0
-	Manganese	1.0
-	Zinc	1.0
-	Nickel	1.0
-	Mercury	0.01
-	Tin	0.1
c)	**Organics**	
-	Phenol and Phenolic compounds as C6H5OH	1.0
d)	**Inorganics**	
-	Arsenic as As	0.2
-	Cyanide as CN	0.2
-	Nitrate as NO3	50
-	Phosphate as P	5

Notes:

1. Limits should be complied at the end of the treatment plant before any dilution.
2. Bio-assay test should be carried out with available species of fish in receiving water.
3. State Boards may prescribe total dissolved solids (TDS), sulphate and chloride depending on the uses of recipient water body. Industries are advised to analyse pesticides in wastewater by advanced analytical method such as GLC.
4. State Board may prescribe COD limit correlated with BOD limit.
5. Pesticides are known to have metabolites and isomers. If they are found in significant concentration, standards may be prescribed for these in optional list, by State Board.

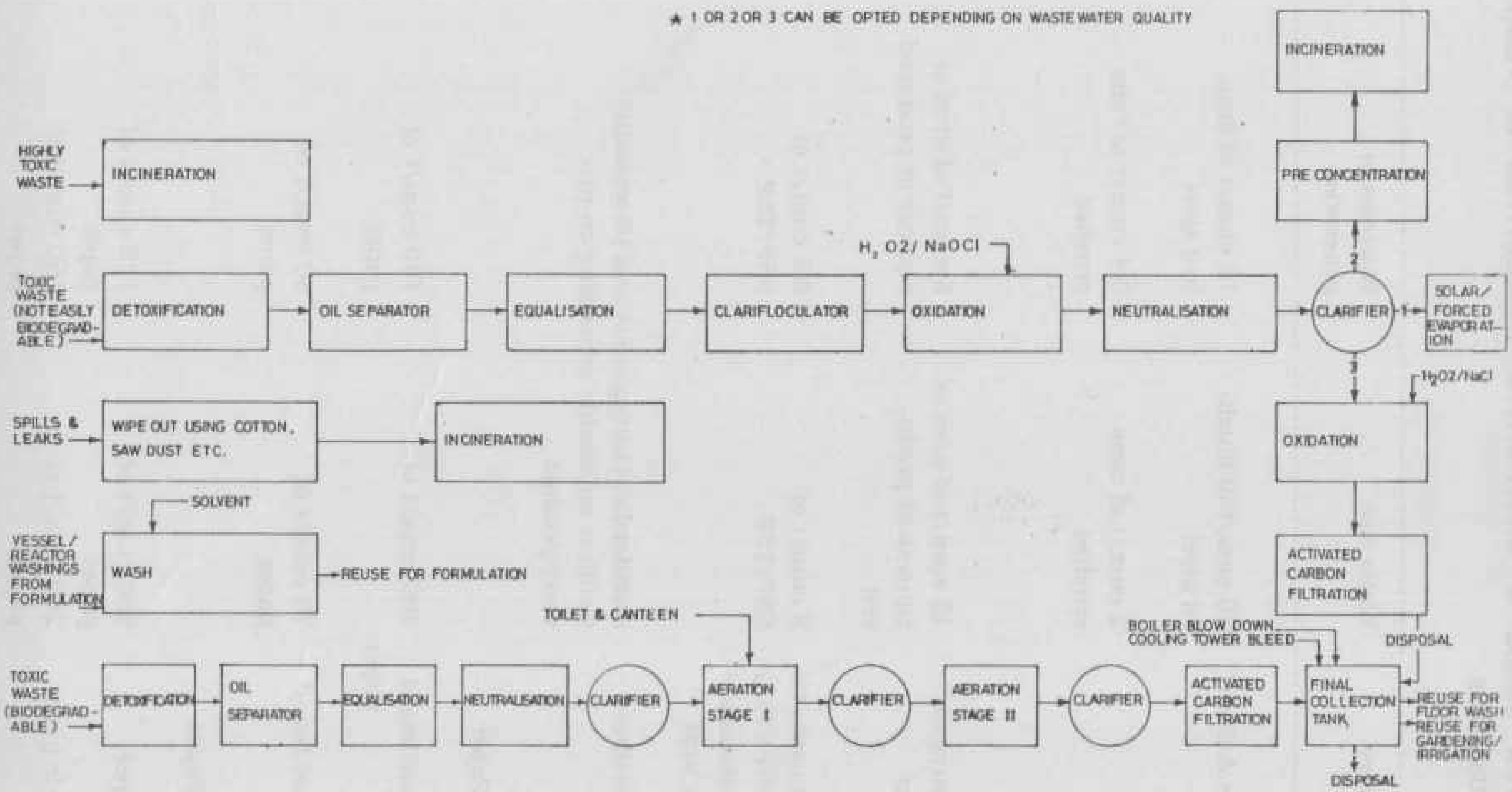
5.2 SEPARATION TECHNOLOGIES FOR REMOVAL OF ORGANIC AND PESTICIDAL CHEMICALS FROM WASTEWATER

The following unit operations have been grouped under the Separation Technology for removal of organic and pesticidal chemicals from waste-water:

1. Absorption
2. Adsorption including bubble adsorption
3. Centrifugation
4. Clathration
5. Coagulation
6. Coalescence
7. Condensation
8. Cyclonic Action
9. Desorption
10. Dialysis
11. Diffusion Process
12. Electro-phoresis
13. Evaporation
14. Extraction
15. Filtration
16. Flash Expansion
17. Floatation
18. Foam Fractionation
19. Gravity Settling
20. Impringement
21. Membrane Permeation
22. Precipitation
23. Reverse Osmosis
24. Scrubbing
25. Stripping
26. Ultra-filtration

5.3 DESTRUCTION & DETOXIFICATION TECHNOLOGIES FOR TOXIC WASTES

1. Chlorine dioxide oxidation
2. Dye sensitized photo-oxidation
3. Electro-chemical oxidation
4. Flameless catalytic oxidation
   (Low temperature vapour oxidation)
5. High energy radiation
6. Hydrogen peroxide oxidation
7. Incineration/combustion process
8. Micro-biological and other metabolic systems
9. Ozonation and other ultrasonic energy
10. Photo-decomposition - ultraviolet radiation
11. Potassium permanganate oxidation
12. Pyrolysis
13. Reductive dechlorination
14. Ultraviolet ray assisted ozonation
15. Wet catalytic oxidation



TREATMENT OPTIONS FOR WASTEWATER FROM PESTICIDES INDUSTRY

5.5 WATER USAGE & WASTEWATER GENERATION IN VARIOUS INDUSTRIES

Name of Industry	Water use	Wastewater generation
Integrated Iron & Steel	20 cum/t of finished steel	16 cum/t of finished steel
Sugar	2 cum/t of cane crushed	0.4 cum/t of cane crushed
Fertiliser		
Straight nitrogenous fetiliser	15 cum/t of urea or equivalent produced	5 cum/t of urea or equivalent produced
Straight phosphatic fertiliser (SSP&TSP) excluding manufacture of any acid	2 cum/t of SSP/TSP	0.5 cum/t of SSP/TSP
Complex fertiliser	Standards of nitrogenous and phosphatic fertiliser applicable depending on primary product	
Small Pulp & Paper		
Agro-residue based	200 cum/t of paper	150 cum/t of paper
Waste paper based	75 cum/t of paper	50 cum/t of paper
Large Pulp & Paper		
Pulp & Paper	250 cum/t of paper	175 cum/t of paper
Rayon grade pulp	200 cum/t of paper	150 cum/t of paper

Fermentation		
Maltry	8.5 cum/t of grain processed	3.5 cum/t of grain processed
Brewery	1 cum/kl of beer produced	0.25cum/kl of beer produced
Distillery	15 cum/kl of alcohol produced	12 cum/kl of alcohol produced
Caustic Soda		
Mercury cell process	5 cum/t of caustic soda produced(excluding cooling water) & 5 cum/t of caustic soda produced for cooling water	4 cum/t of caustic soda (Mercury bearing) 10% blow down permitted for cooling tower.
Membrane cell process	5 cum/t of caustic soda including cooling water	1 cum/t of caustic soda excluding cooling tower blow down
Textile		
Manmade fibre		
i) Nylon & polyester	170 cum/t of fibre produced	120 cum/t of fibre produced
ii) Viscose rayon	Limits specified in rayon grade Pulp & paper applicable	
Tanneries	30 cum/t of raw hide	28 cum/t of raw hide
Natural rubber	6 cum/t of rubber	4 cum/t of rubber
Starch, glucose & related products	10 cum/t of maize crushed	8 cum/t of maize crushed

5.6 EMISSION STANDARDS FOR SOME SPECIFIC POLLUTANTS

The emission standards for some of the specific pollutants are yet not laid down by the Central Board. These pollutants generally pertain to chemical process industries and are emitted not through the conventional stacks or chimneys but mostly from the reaction vessels, scrubber outlets and other such equipment. The emission of these pollutants gives rise to environmental pollution and nuisance, especially in the vicinity of the industrial plant. It is, therefore, necessary to determine and lay down the emission limits for these pollutants.

In the absence of adequate literature source which could be helpful in specifying the emission limits for these pollutants, the Threshold Limit Value (TLV) has been taken as the basis to determine the emission limits. The following formula has been adopted for this purpose :

$$\text{Emission limit} = \frac{TLV}{3 \times 10} \times (100 \text{ to } 150)$$

$$= 3.33\ TLV \text{ to } 5.0\ TLV$$

The constants appearing in the above formula are explained as under :

* The constant 3 is included to reduce the allowable concentration to take care of 24 hours exposure. This is to extrapolate the 8-hour span used in TLV over the span of 24 hours.

* The constant 10 is included to reduce the concentration in the ambient air to impart additional safety. This is in line with the "application factor" commonly used in fixing water quality criteria.

* The constant 100 to 150 represent the minimum dilution available in open atmosphere.

ANNEXURE I

MINISTRY OF ENVIRONMENT & FORESTS

NOTIFICATION

New Delhi, the 22nd April, 1993

G.S.R. 386(E)-In exercise of the powers conferred by sections 6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby makes the following rules further to amend the Environment (Protection) Rules, 1986, namely -

1. (1) These rules may be called the 'Environment (Protection) Amendment Rules, 1993.

   (2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Environment (Protection) Rules, 1986 -

   (a) In Rule 14 -

   (i) for the words "audit report" wherever they occur, the word "statement" shall be substituted :

   (ii) for the figures, letters and words "15th day of May" the words "thirtieth day of September," shall be substituted.

   (b) In Appendix 'A' for FORM-V, the following shall be substituted, namely :-

"FORM -V"

(See rule 14)

Environmental Statement for the financial year ending the 31st March............

PART - A

(i) Name and address of the owner/occupier of the industry operation or process.

(ii) Industry category Primary - (STC Code) Secondary - (SIC Code)

(iii) Production capacity - Units -

(iv) Year of establishment

(v) Date of the last environmental statement submitted.

PART - B

Water and Raw Material Consumption

(1) Water consumption m^3/d
Process
Cooling
Domestic

Nature of Products	Process Water Consumption per unit of product output	
	During the previous financial year	During the current financial year
1) 2) 3)		

(2) Raw material consumption

*Nature of Raw material	Process Water Consumption per unit of product output	
	During the previous financial year	During the current financial year

* Industry may use codes if dislosing details of raw material would violate contractual obligations, otherwise all industries have to name the raw materials used.

PART - C

Pollution discharged to environment/unit of output

(Parameter as specified in the consent issued)

Pollutants	Quantity of pollutants discharged (mass/day)	Concentration of pollutants in discharges (mass/volume)	Percentage of variation from prescribed standards with reasons
(a) Water			
(b) Air			

PART - D

HAZARDOUS WASTES

(as specified under Hazardous Wastes/Management and Handling Rules, 1989)

Hazardous Wastes	Total Quantity (kg)	
	During the previous financial year	During the current financial year
(a) From process		
(b) From pollution control facilities		

PART - E

SOLID WASTE

	Total Quantity	
	During the previous financial year	During the current financial year
(a) From process		
(b) From pollution control facility		
(c)(1) Quantity recycled or reutilised within the unit		
(2) Sold		
(3) Disposed		

PART - F

Please specify the characterisations (in terms of composition and quantum) of hazardous as well as solid wastes and indicate disposal practice adopted for both these categories of wastes.

PART - G

Impact of the pollution abatement measures taken on conservation of natural resources and on the cost of production.

PART - H

Additional measures/investment proposed for environmental protection including abatement of pollution, prevention of pollution.

PART - I

Any other particulars for improving the quality of the environment

(F. No. Q-15015/1/90/CPA)
Mukul Sanwal, Joint Secretary

QUESTIONNAIRE FOR ENVIRONMENTAL AUDIT

PART I

1. Name of the industry & location :
   (Enclose a map showing surrounding landuses upto 500 m)

2. Date of commencement of production:

3. Type of industry:

   (i) LARGE/ MEDIUM/ SMALL
   (based on capital investment)
   (Small: < Rs 50 lacs: Medium:Rs 50 lacs - Rs 5 crore: Large: > Rs 50 crore)

   (ii) MANUFACTURING/FORMULATING/MFG.&FORMULATING

4. Products manufactured:

Name of the product	Installed capacity. (t/a)	Avg.production (t/a)	No.of days of prod.per year	Remarks

Do you have separate process lines for each product ? Yes/No

If no, state which produts are manufactured in the same process line?

5. Raw materials used, productwise (kg/t of product) :

6(a) Details of manufacturing process alongwith process flow chart showing various unit operations and material balances. Indicate point sources of emission and fugitive emission
(Enclose separately)

(b) Give details of the State-of-art technology for the products manufactured:

c) Do you have plans for expansion? Yes/No

If yes, give details.

(d) Do you have plans for the modernisation of process technology ? If yes, provide details. Yes/No

PART II

7. Water requirement:

(a) Industrial (product wise):

Name of the product	Process operation where water used	Quantity used, kl	
		Per day	Per t of Product

(b) Domestic : kld:
(c) Others : kld;
(d) **Total** : kld
(Also incorporate all the above figures in PROCESS FLOW CHARTS)

8) Wastewater generated:

(a) Industrial:

S.No.	Operation where waste generated	Quantity, kl	
		Per day	Per t of Product

(b) Domestic : kld

(c) Boiler : kld

(d) Cooling tower : kld

(e) Others(specify) : kld

f) **Total** : kld
(Also incorporate the above figures in process flow chart)

9(a) Characteristics of wastewater, stream-wise:

Product	Source of wastewater generation	Characteristics

b) Characteristics of combined wastewater:

Parameter	Before treatment	After treatment	Standards prescribed

10. Effluent treament system provided:

Describe the treatment system provided to individual streams and combined effluent. Enclose drawings of the effluent tretment system showing the sizes of the individual units. Also provide analysis reports showing the performance of the individual treatment units. (Enclose separately).

11. Treated effluent disposal:

(a) DOMESTIC:
(b) INDUSTRIAL:

(specify the place of disposal and mode of discharge using sprinklers,marine outfall, etc.)

12. Storm water drainage system:

- Is it separate from industrial/domestic drainage system ?
- Describe the method of storm water collection,tratment and final disposal.

13(a) Solid waste:

Source	Composition	Quantity	Mode of Collection	Mode of Disposal

(b) Hazardous waste:

Source	Composition	Quantity	Method of collection	Method of disposal

PART III

14. Details of emission generated :

(a) Process emission (product wise):

S.No.	Source *	Type of pollutant	Source Strength (mg/Nm^3)	Std prescribed	Gas flow Nm^3 /hr	Control Equipment **	Conc. in Stack/ Vent (mg/Nm^3) ***	Stack Height (m) above GL rool level

* Indicate the operation in the reactor, incinerator, flare, furnace,etc

** Attach drawings of air pollution control systems alongwith design data

*** Based on actual monitoring

b) Emissions from combustion of fuel viz. coal, fire wood, furnace oil, etc.

Fuel used		Purpose	Type of control equipment provided	Gas flow in Stack mg/Nm^3	Conc. of SPM/ SO_2 in Stack/ Vent mg/Nm^3	Chimney Height (m) above GL/Rool Level
Type	Qty. (kg/hr, day)					

c) Information regarding principal air contaminants (Fugitive emissions):

Activity	Air contaminant	Typical toxic concentration (Range)	Possible sources of emission
eg. Polyvinyl chloride	Vinyl chloride	20 mg/cum	Leaks in pressurised system

d) Are emission monitoring provisions made in the stacks/vents ? Yes/No

10. Ambient air quality in the factory premises:

Parameter	Concerntration (Annual) $\mu g/m^3$ (Based on actual monitoring)		
	Minimum	Maximum	Average
SPM SO_2 CO NOX Acid mist HC VOC (non-methane) Others, specify			

PART IV

16. Details of inplant pollution control measures:

17. Details of waste (wastewater, gaseous emissions, solid waste) minimisation techniques used and recycling/reuse of waste adopted:

18. Whether the standards and other conditions laid down by the State Pollution Control Board under the Water Act, Air Act, and Environmental(Protection) Act are complied with ?

	Has valid consent/ authorisation	Complying with stds. and other conditions
The Water Act, 1974 :	Yes/No	Yes/No
The Air Act, 1981 :	Yes/No	Yes/No
The E(P)Act, 1986 :	Yes/No	Yes/No

If no, specify reasons thereof.
(Also enclose copies of consent orders)

19. Details of monitoring facilities available with the industry for emissions, wastewater, solid waste and the receiving environment:

Parameters	Instrument Used	Analytical Technique

20. Details of organisational set up for environmental management :

S.No.	Name of the person	Designation	Qualification	Duties

21. Cost of pollution control :

(a) Annual sales turnover of the industry : Rs.....
(b) Fixed cost of pollution control system (PCS) : Rs.....
(Mention details of components included)
(c) Operating cost of PCS : Rs.....
(d) Annual burden of PCS (Annualised capital cost of PCS + Operating cost) : Rs......

22. Are there any public complaints against pollution from your industry ? Yes/No

If yes, give details.

23. Details of green belt/plantation:

24. Problems faced by the industry in pollution control :

25. Name of the contact person with designation and telephone No:

Signature:..

Name:..

Designation:..

Date :
Place:

ENVIRONMENTALLY SAFE LAYOUT CODE FOR MANUFACTURING UNITS

1. An environmentally safe layout plan takes care of material loss, cost of collection, disposal, recycle and treatment which are parts of the process itself, and consequently of the layout arrangement.

2. This layout code postulates that environment protection is a factor for designing any equipment, reaction vessel, material transfer arrangement, storage tank, and service support to operate the production system.

3. All places of storage of solid and liquid materials are to be diked without drains. Any spillage is to be wiped out and cannot be washed out.

4. Each vessel should have its own catchpit to collect spills.

5. Each pump must be mounted on its own catchpit; a suction line of the pump should be connected to empty the pit, periodically or regularly or continuously.

6. As losses of materials take place during charging of the reaction vessels, discharging of produce and dripping of outlet valves, and as materials may be either solid or solid slurry or liquid, care needs to be exercised to prevent the losses, if necessary by changing the charging/discharging and transfer devices.

7. In order to collect spills from a particular vessel before the spilled materials get a chance of contamination with spills from another nearby vessel, the two vessels must be installed at sufficient distance so that inter-contamination cannot take place. The extra distance, 'non-contaminating distance' is to be provided for recycle of materials.

8. Flange joints should be avoided wherever avoidable.

9. Corrosion-prone areas and construction materials liable to atmospheric and process induced corrosion should be given special attention for finding better replacement material and stricter preventive maintenance frequency.

10. Exhaust ducts and fan outlets are sources of pollution, if the thrown out air is contaminated with pollutants. These may be treated before vented. Any vapour line should be connected with either a recovery system or an absorption system.

11. The engineering code for the operation of pressurised systems and the established practice for preventive maintenance are consistent with the protection of the environment. These system are fitted with pressure release valves, and in many cases with rupturable discs. The present practice is to allow the released materials to the atmosphere. To be environmentally, safe, these lines ought to be connected to recovery/ adsorption/ absorption arrangements. The rupturing of safety discs is accompanied with sudden release of high pressure; the design of the recovery arrangement of the released materials should be befitting the sudden emerging conditions of high temperatures/ pressure/ volumes.

12. New units will build floors with expanded metals, slotted angles, steel grills, steel grates, prefabricated industrial floor gratings, and the like which will make floor washing redundant.

13. If the plant layout demands that vessels should be installed in upper floors, arrangements should be simultaneously made to spill avoidance/collection. Vulnerable points of leakage should be taken special care of. This is necessary not only for pollution control but also for the safety of plant personnel working in lower floors.

14. Storage tanks of raw materials for supply to the production vessels, should be installed on a separate structure located just outside the main plant building, with arrangement for holding spills and overflow. Level alarms should be installed where possible; where the same is not feasible because of the nature of the liquid, two overflow pipes at two different levels of the tank should be fitted.

15. Plant management should evolve its own code for washing equipment, where a particular equipment is used for the manufacture of different products. Dry scraping of equipment surface followed by moping with wet cloth should be carried out before hosing operation. This will reduce the quantity of contaminants and wastewater volume.

16. All channels be fitted with wastewater measuring devices, half barrier for the separation floating immiscible liquid and in-built separation/sedimentation basins for withholding settleable particulate matters. This provision may be treated as compulsory for wastewater channels in the immediate vicinity of wastewater generating units.

17. All water usages that do not come in contact with chemicals, should have no opportunity to mix with process water. Uncontaminated water should have separate outlets from the plant and if recycle is not possible, should be drained out through separate channels, without any change of getting contaminated.

18. This proposed layout code recognises the solid waste generated in the process of manufacture must find a place within the factory premises. It will be stored on land/ lagoon which will be lined with compatible geo-textile materials.

19. The detoxification operation is to be carried out outside the main production plant, and provision has to be kept for the same.

20. Storm water drains should be segregated from process water drains. The former may be used for the removal of cooling water and non-process water.

(Source: 'Minimal National Standards-Pesticides manufacturing and formulation industry', COINDS/15/1985-86, Central Pollution Control Board, Delhi)

ANNEXURE IV

GUIDELINES TO MINIMISE MATERIAL LOSSES AND WASTES

A) HOW TO REDUCE RAW MATERIAL LOSSES ?

- Keep only an appropriate inventory of raw materials to ensure minimum material handling losses, evaporation losses etc.
- Adopt mechanical handling of materials with proper monitoring facilities so as to dose only the predetermined quantities as per norms prescribed.
- Plant layout should be properly made so as to minimise transfer distance of materials between storage and process or between unit operations.
- There is a risk of cross-contamination due to usage of same storage tanks for different materials depending on the batch product. Separate storages are to be provided.
- Separate process lines for separate products or separate equipment for each unit operation can minimise losses due to residues left out in the equipment which are usually washed out.
- Storage tanks should be provided with proper dip arrangements for exhausts/vents and insulation provided so as to reduce evaporation losses.
- Enclosed and covered material storage areas keep them secured and reduces losses due to carry over by wind and rain.
- Enclosures should be made to collect spills and overflows of materials at the material transfer and sampling points. These, if collected properly, can be recycled.
- Regular maintenance should be taken to check flange leaks, breaks/cracks, pump failures etc.
- Raw material purity should be ensured. Viscous raw materials lead to losses due to residues in drums. Raw materials should be easy to handle. Good house-keeping practices should be followed.
- Norms for performance of various process operations fixed so that the material usages are minimised and hence the material losses.

B. HOW TO REDUCE WATER USAGE AND WASTEWATER GENERATION?

- Quantities required for each operation should be determined and water usage regulated strictly. Reduced water usage reduces wastewater. Good house-keeping practices reduces water usage.

- Spills of materials should be restricted to enclosures constructed for this purpose. The floor washings can then be minimised and at times totally avoided.

- Wastewater may be stored and reused. The storage costs may be lower than waste treatment and disposal costs.

- Storm water drains should be kept separate and provisions should be made to collect only the rainfall of first few hours which carries contaminants. This can be subsequently treated and disposed.

- The scrubbing of gaseous emissions with a suitable chemical can yield an useful by-product. The discharges thus can be avoided by recycle or recovery of useful by-products.

- The wastewater is usually treated upto secondary treatment level to conform to the required standards. By providing tertiary treatment by dual media filtration, chlorination, activated carbon filtration etc. wastewater can be reused for floor wash, gardening, toilets etc.

C. HOW TO REDUCE EMISSIONS ?

- The process operations where emissions arise, should be provided with control equipment. Condensers can collect certain emissions which can be entirely reused.

- The transfer of materials should be done through closed operations.

- The areas where fugitive emissions arise and can be avoided should be enclosed and the air exhausted through induced draft and passed through control equipment before venting off. The enclosed area should be provided with atleast three air replacements per minute.

- Evaporation losses from storage tanks should be checked by proper insulation and putting the vents in suitable dip columns.

- Loading and unloading of materials from tankers leads to huge quantities of emissions. The material-transfers should be done through pipes/holes keeping the outlet of the tanker and the inlet of receiving tank covered. While loading the tanker, if the tanker inlet cannot be covered, a hood can be provided over the inlet and emissions collected through a ducting system and further controlled.