Pollution Control in Pulp & Paper Mills

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During my recent visit abroad, someone reflected serious consequences of Industrialization in U.S.A., and how the atmosphere and water are so polluted that many plants are facing closures on account of their inability to plug pollution. He was anxious to know how we in India combat this situation. I informed him that with the tight controls we have on new undertakings, licensing procedures, etc. we are ensuring that the plants do not come up in the first place and if they do come up, many of them do not run because they may not get enough raw materials or some such thing. Obviously, such a situation cannot last forever and hence we have to face the fact that with increasing pace of Industrialization, we will have to anticipate and attack the problem of pollution as a preventive measure rather than as a cure, taking advantage of the learning curve of the West. It is a fact that any Process Industry which uses water in large measure will in effect sluice large amounts of the same after doing some vital work Amongst all Industries, the Pulp & Paper Industry is by far the most water-intensive Industry and consequently is a major offender in the arena of water pollution.

Any projection of industrial growth will surely indicate a parallel and supportive growth of the Paper Industry. Unless we develop a process to produce pulp without the use of water, the river waters are going to be increasingly polluted. Hence, positive action must be taken to remedy the situation.

Pollution abatement or control is a social abligation for all concerned Otherwise, we will have only paper mills and no one to buy the paper.

VOLUME OF WASTE WATERS PRODUCED :

There are some waste waters which are easy to treat whereas there are other types of waste waters which are difficult to treat and dispose. The waste waters from pulp and paper mills fall into the second category. The volume of waste waters also varies from one paper mill to another as they employ different raw materials and processes for their pulp mills.

Table I gives the volume of waste waters produced per ton of pulp and paper produced. The figures are in U.S. gallons and are generally for the mills in U.S.A. The corresponding figures for Indian mills are not available, but they are generally known to be close to these figures and within the ranges indicated.

CHARACTERISTICS OF THE WASTE WATERS :

In an integrated pulp and paper mill. there are two distinct streams of waste waters, one from the pulp section and the other from paper section.

The analysis of the waste waters from the pulp mill sections vary from mill to mill. Hence, typical analysis of waste waters from these sections are not given. The pulp section produces waste waters which are alkaline, highly coloured, contain high concentration of suspended solids and have high B.O.D. The bleach section waste waters are acidic in nature and low in B.O.D. and have excess chlorine.

The waste waters from paper making section contain fibres, sizers, dyes and loading materials. These waste waters are known as "white water".

POLLUTIONAL EFFECTS OF WASTE WATERS

As stated above, the waste waters are of objectionable nature. The main constituents are the suspended matter and dissolved organic matter.

The suspended matter, when discharged into receiving waters, form deposits in the bottom. These deposits are unsight-

TABLE ... I

VOLUME OF WASTE WATERS PRODUCED FROM THE MANUFACTURE OF PULP & PAPER PRODUCT

Process		U.S. gallons per ton produced
Pulp Manufacture		
Kraft & Soda pulp	...	15,000 — 35,000
Sulphite pulp	...	40,000 — 60,000
Semichemical pulp	...	30,000 — 40,000
Groundwood pulp	...	4,000 — 10,000
Deinked pulp	...	20,000 — 35,000
Pulp Bleaching		
Kraft & Soda Pulp	...	15,000 — 60,000
Sulphite pulp	...	30,000 — 50,000
Neutral Sulphite pulp	...	40,000 — 60,000
Paper Manufacture		
White paper	...	20,000 — 40,000
Tissues	...	8,000 — 35,000
Kraft papers	...	2,000 — 10,000
Paper boards	...	2,000 — 15,000
Speciality papers	...	20,000 — 100,000

Reference : Industrial Waste Water Control by C.F. Gurnham.

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ly and adversely affect the aquatic life. Further, they can also exert an appreciable demand on the dissolved oxygen contained in water.

The discharge of highly dispersed solids, such as fibre, debris, filter and coating material, causes obstruction to the path of sunlight. By limiting the sunlight penetration, the self purification process of a stream is retarded.

Dissolved solids have a variety of effects on the receiving waters. Some of the solids (wood sugars) are responsible for depleting the dissolved oxygen and hence stimulate the growth of slime organisms causing a biological imbalance in the receiving waters. Lignins and Tannins cause discolouration. Mercaptans in high concentrations are toxic to aquatic life. In view of the above characteristics of the waste waters, it is necessary to treat them before they can be considered fit for discharge.

TREATMENT OF WASTE WATERS :

Technologically, it is possible to design plants, at least in most cases, to treat such effluents so that the treated effluent is rendered harmless. The question is of degree of purity needed, which would undoubtedly depend on several local factors. A universal standard may be unreasonable. For instance, we did see a plant in Japan where the mills were pumping water from a nearby river and mixing the same with the mill effluent so that the outlet from the drains entering the same river had adequate dilution. This way they could produce an effluent of an acceptable quality. We were given to understand that this mill is currently discussing with the water authorities the possibility of their sharing the savings in the cost of pumping the dilution water as it does not make any difference to the river.

It is possible to tackle and solve the problem of the disposal of pulp and paper mill waste waters. A great deal of work has been done in many of the western countries particularly in U.S.A. and U.K. Several methods have been evolved and a number of full scale treatment plants have been installed In India also considerable interest has been shown and some work has been done.

Before designing a treatment plant, it is necessary to make a detailed study of the waste waters of a particular mill. Since the characteristics of the waste waters differ from mill to mill and in one mill, it is necessary to ascertain accurate data regarding the quantity and quality of the waste waters to be treated.

From this study, it may be possible that with care in the use of water, the toal volume of waste waters producer can be reduced. This, in turn, will bring down the cost of the treatment plant. Further, it may be economical to separate a stream which is high in pollution and low in volume. Based on the detailed study of the waste waters, the next step would be to ascerain the quality of final effluent desired and use a treatment method to obtain the quality. Table II gives the approximate analysis of the waste waters from Pulp & Paper mills.

The analysis of the waste waters depends on the raw materials used and whether a mill has a recovery system and the efficiency of such a system. For the pulp and bleach sections, without a recovery system, the BOD and the suspended solids are very high. But, with a recovery system, these concentrations are very much reduced.

Similarly, for the paper mill section, the waste waters contain considerable amount of fibres. Most of the mills have arrangements, such as "Saveralls", for removal of these fibres. After the Saveralls, the waste waters are sent out into the drain, but they can be reused. Most of the Pulp & Paper mills are located near a river to ensure an uninterrupted supply of raw water and the waste waters are discharged back into the river. A number of ISI Standards have been formed for waste waters to be discharged into municipal drains, rivers etc. The relevant ISI tolerance limits are shown in Table III. Most of the mills have a common drain to take away all the waste waters. In case it is possible to have separate drains, then the paper mill waste waters can be segregated as these waste waters normally do not require any treatment after the Saveralls. In most of the mills ,separate drains do not exist hence all the waste waters have to be treated, even though, this means unnecessary increase in the hydraulic capacity of the treatment units.

Various methods of treatment of these waste waters are available. The first step — Primary Treatment — which is normally employed, is to remove the settleable suspended solids. It is assumed that the waste waters from the paper mill section, known as "white water", which are high in suspended solids have been passed through "Saveralls".

To expedite the removal of suspended solids, it is found that a coagulant is helpful. Hence a Clariflocculator type of unit is desirable. This is a combination unit having provision for flocculation and clarification in one tank. Necessary doses of suitable coagulant should be added to the waste waters ahead of the Clariflocculator.

For the Secondary Treatment i.e. for the removal of BOD, a number of methods are available. Figure-I, shows the different manner in which the waste waters can be treated. For illustration purposes, the paper mill waste waters have been shown as separate. In case separate drains do not exist at the Mills, all the waste waters will report to one common drain. Also, it has

TABLE II

ANALYSIS OF PULP & PAPER MILL EFFLUENTS

pH	...	...	...	8.4 — 9.4
Alkalinity in mg/l	...	...	...	74 — 830
Suspended solids mg/l	...	...	...	640 — 1376
Total solids mg/l	...	...	...	2560 — 3000
BOD 5-days @ 20°C mg/l	...	...	...	170 — 500

Reference : Indian Journal of Public Health — Volume-II — No .3 — July 1958.

FIGURE - 1

TREATMENT OF PULP & PAPER MILL WASTE WATERS

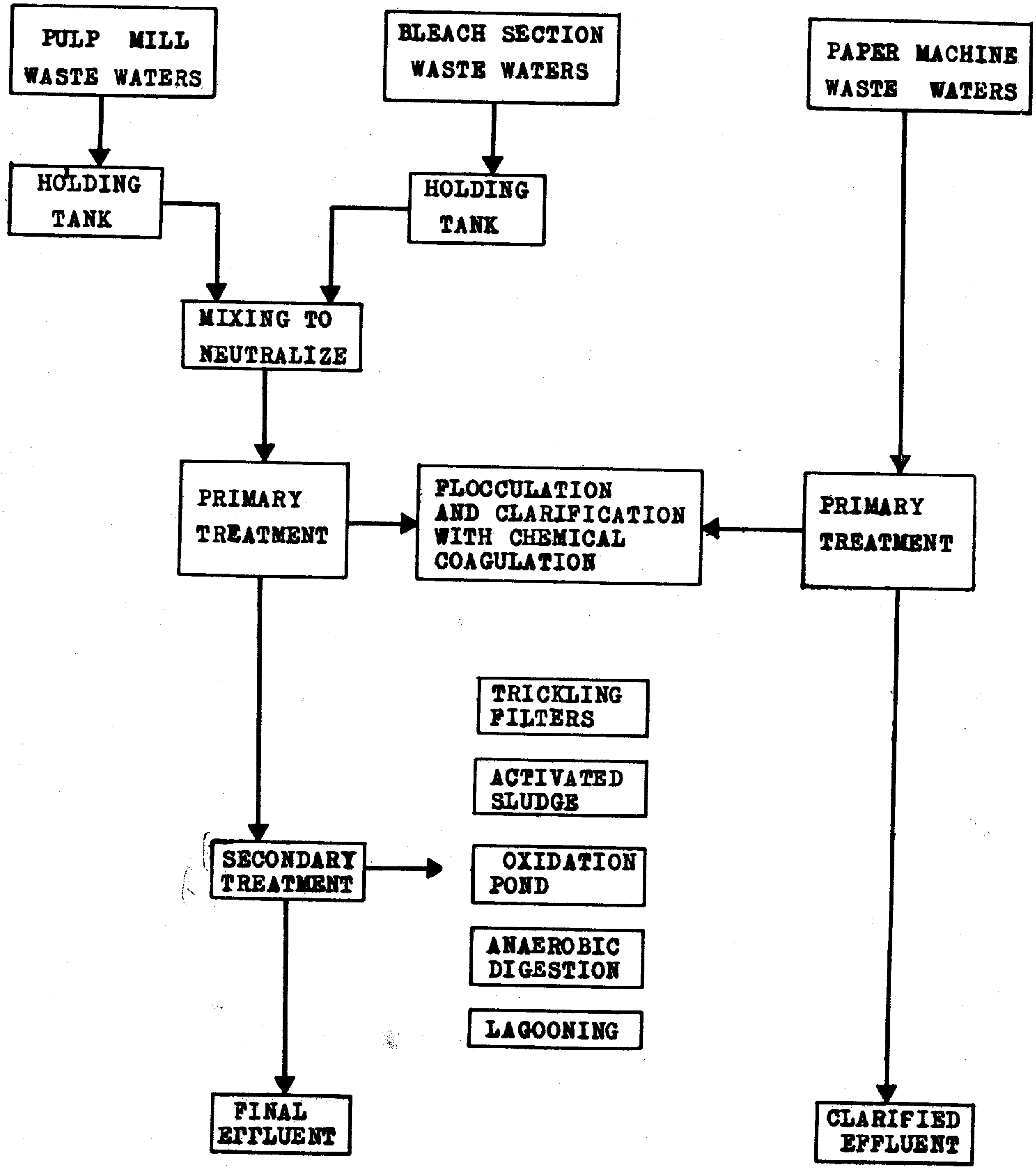


TABLE — III

S. No. (1)	Characteristics (2)	Tolerance Limit (See 0.5) (3)
i)	Total suspended solids mg/l max.	100
ii)	Particle size of total suspended solids	Shall pass 850-micron IS Sieve (See IS : 460-1962 specs. for Test Sieves (revised)
iii)	pH	8.5 ton 9.0.
iv)	Temperature	Shall not exceed 40°C in any section of the stream within 15-metres downstream from the effluent outlet.
v)	Biochemical oxygen demand for 5-days at 20°C. mg/l max.	30
vi)	Oils & grease mg/l max.	10
vii)	Phenolic compounds mg/l max.	1.0
viii)	Cyanides (as CN) mg/l max.	0.2
ix)	Sulphides (as S), mg/l max.	2.0
x)	Radioactive materials :	
	(a) Alpha emitters, uc/ml, max.	10^{-9}
	(b) Beta emitters, uc/ml, max.	10^{-8}
xi)	Insecticides	Nil
xii)	Total residual chlorine mg/l max.	1
xiii)	Fluorides (as F), mg/l max.	2.0
xiv)	Arsenic (as AS), mg/l max.	Not to exceed 1.0 mg/l individually or collectively.
xv)	Barium (as Ba), mg/l max.	
xvi)	Cadmium (as Cd) mg/l max.	
xvii)	Chromium (as Cr), mg/l,max.	
xviii)	Copper (as Cu), mg/l max.	
xix)	Lead (as Pb) mg/l max.	
xx)	Mercury (as Hg) mg/l max.	
xxi)	Nickel (as Ni) mg/l max.	
xxii)	Selenium (as Se), mg/l max.	
xxiii)	Silver (as Ag) mg/l max.	
xxiv)	Zinc (as Zn) mg/l max.	

been reported that the mixing of all the waste waters helps in improving the settling characteristics of the suspended solids.

The type of Secondary Treatment to be adopted depends on a number of factors, such as degree of treatment required, availability of space, etc. etc. Aerated lagoons and Oxidation Ponds are used where sufficient space is available. The conventional methods used are the Trickling Filters and the Activated Sludge Process. Of these two, the latter has been found to be more suitable as it gives a better final effluent and requires lesser area than the former. The estimated cost figures given in the following pages are based on the Activated Sludge Process.

An interesting arrangement we could notice in Australia is the availability of Industrial sewers managed by the Public Works Department. It is recognised that, in an Industrial belt, there will be many process industries, each discharging an effluent, of varying pH and analysis, and, consequently, mixing of such effluents in a sewer may yield a harmless neutral effluent which requires no special treatment prior to disposal.

Further, the saving in the cost of treatment by individual plants could be recovered by the Public Works Authority which could pay for this facility. In such a case, a master plan of the Industrial belt has to be made to ensure the blend of effluents is compatible.

ADDITION OF NUTRIENTS :

For the biological reaction to take place, it is necessary to have adequate quantities of Nitrogen and Phosphorus in proportion to the organic matter present in the waste waters. The ratios normally required are 20:1 for Nitrogen to Carbon. It is found that the pulp and paper mill waste waters are deficient both in Nitrogen and Phosphorus. Hence, depending on the organic matter (Carbon) present, adequate quantities of Nitrogen and Phosphorus are required to be added. Compounds normally used are Diammonium Phosphate, Phosphoric Acid, Ammonium Hydroxide. The choice of the chemicals depends on its availability and cost.

DISPOSAL OF SLUDGE :

Disposal of sludge from the waste water treatment plant is also a problem. It has been found that the sludge has poor settling quality. Large areas are required if the sludge is to be disposed off in lagoons or drying beds. Further, the filterability of this sludge is also low.

One of the methods is to mix the sludge discharged from the Clarifier with waste lime mud, and the resultant mixture could be filtered and the cake carted away.

One of the mills in Japan seems to make an interesting project out of the waste disposal system. In this Mill, the chlorination stage effluent is allowed to pass through a holding tank filled with iron filings with the result, the acid reacts with the iron producing Ferric chloride. The overflow from the holding tank thereafter joins the stream of the alkaline effluent, when the Ferric Hydroxide gets precipitated, giving good flows, aiding settling. In addition, milk of lime is added to give a body to the sludge.

The sludge is filtered in Rotary Vacuum Precoat Drum Filters or alternatively centrifuged and resulting cake is burnt in a rotary oil fired cocurrent kiln. The kiln gases, together with

SO_2 resulting from the 'Sulfur' present in the oil are scrubbed with a weak alkaline water as a result of which, the SO_2 is recovered as Na_2SO_3 and the clean gases leave the scrubber stack. The scrubber solution is fed back to the Digestor.

The overflow from the primary clarifier is further clarified and then pumped to a lagoon where the white water (after a Saveall) is mixed with the stream and the resulting effluent after aeration flows into a river. Being a large mill, the effluent treatment facility looked like a complex by itself.

ESTIMATED COST OF A TREATMENT PLANT :

The cost of providing a treatment plant has been estimated for different flows. In Figure—II. three lines are shown and the costs for different waste water flows have been plotted.

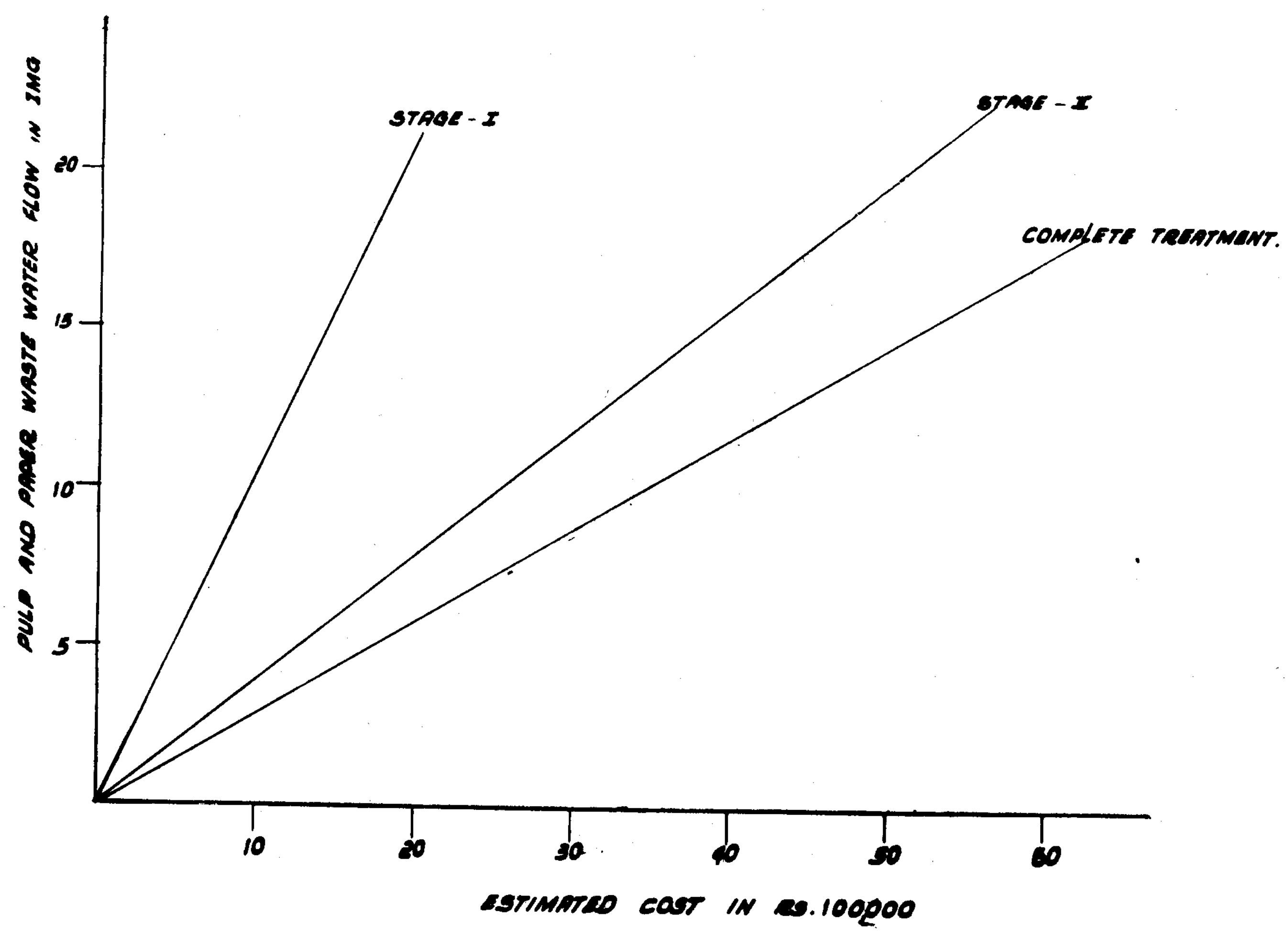
The line 'Stage I' shows the cost of providing only the Primary Treatment, i.e. chemical addition with flocculation and clarification. Line 'Stage II' indicates the cost of providing the Secondary Treatment i.e. Activated Sludge Process consisting of Aeration Tanks and Secondary. Clarifier together with Nutrient addition equipment. The cost of providing a complete treatment (i.e. addition of A & B) is shown by Line 'Complete Treatment'. The final effluent from the complete treatment plant is expected to satisfy the relevant ISI permissible limits.

The cost figures shown are estimated figures and will vary depending upon the degree of treatment required, availability of raw materials, labour, site conditions, etc. Hence these figures can be used merely as a guide and should be suitably adjusted depending on local conditions. Further, these figures do not include the cost for the disposal of sludge. This again depends on the facilities available at a particlar mill.

CONCLUSIONS

1. Before recommending a treatment plant, it is necessary to study the total waste water problem of a particular mill.
2. Any economy by good housekeeping, in reducing the volume of waste waters to be treated, should be implemented.
3. The paper mill waste waters after treatment should be added as dilution water to the treated pulp and bleach section waste waters.

FIGURE II



4. The treatment plant should be installed in two stages, Primary Treatment and Secondary Treatment. Primary Treatment is for removal of suspended solids and should be preferably a Clariflocculator type unit.

5. By doing so, it may be found that Secondary Treatment may not be necessary. In case it is necessary, then the most suitable Secondary Treatment method can be adopted depending on the quality of the effluent from Primary Treatment. Thus the total expenditure can be reduced and spread over a number of years.

6. For Secondary Treatment, Activated Sludge Process has been found to be more suitable.

7. The treatment given should be sufficient to satisfy the relevant permissible limits for discharge of the waste waters.

8. The treatment plant should be such that the expenses are kept to the minimum. Hence only the required degree of treatment should be given.

9. The sludge from the treatment plant can be filtered with the aid of lime mud slurry. Tests should be done to ascertain the filtration rate of this mixture.

10. Estimated costs have been worked out for the Primary, Secondary, and Complete Treatment Plants. The cost figure should be suitably adjusted depending on the local conditions, etc.

The type of equipment involved for the waste water treatment plant are not significantly different from the equipment used for Water and Municipal Waste Treatment Plants. The plants can be readily designed indigenously and no imports are needed. What we need is the conviction of our responsibilities to the society at large and willingness to accept the burden of cost of treatment to have safe and healthy environment.

Let us stop poisoning our rivers from today, or tomorrow they will poison us.

Presented by Mr. K. P. Mohandas Rao at the IPPTA Annual Meeting held at New Delhi on Nov. 8 & 9, 1971.