POLLUTION ABATEMENT IN PAPER INDUSTRY

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ABSTRACT

Twenty highly polluting industries have been notified by the Central Government as falling within the purview of industrial licensing. One of these is paper, pulp and newsprint. Environment(Protection)Act 1986 with comprehensive measures to protect the environment has been brought into force as tribute to the memory of the late Prime Minister Indira Gandhi, who pioneered the movement for environmental protection in the country. Paper industry is capital intensive. Return on the investment is very low. There are constraints in implementing full treatment system like equipment, technology, non-availability of power and water etc. In this paper pollutants in air, water and solid base of paper industry are discussed. pollution abatement measures are also suggested. Particular stress is given for liquid effluent pollution and abatement measures for the same are discussed.

Secondary treatment is not practicable within reasonable cost as volume of water used in high and BOD concentration is low. Clause 17 of Water(Prevention & Control of Pollution)Act, 1974 describes clearly the functions of the State Board. Sub-clause 'J' clearly mentions that one of the functions of the State Board is to evolve efficient methods of disposal of sewage and trade effluents on land as are necessary on account of the predominant conditions of scant stream flows that do not provide for major part of the year the minimum degree of dilution.

This paper conclusively proves that pulp and paper mill effluent can be successfully employed continuously on land for irrigation within reasonable cost and simultaneously abating pollution totally. Practical trials for several years conducted by M/S Amlai Paper Mills, J.K.Paper Mills and Seshasayee Paper Mills are cited. Pollution abatement measures in M/S Seshasayee Paper & Boards Ltd., Tamil Nadu are discussed detail.

INTRODUCTION

Pollution is an unavoidable evil of industrialisation. Every industry directly or indirectly, in one form or the other, pollutes the environment. To think of an absolute pollution-free industrialisation atleast on the basis of up to date technology is a fool's paradise.

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POLLUTION ABATEMENT VERSUS CAPITAL REQUIREMENTS

Pollution control is a developing technology. It needs capital with practically no return on investment. No one can think of closing down the industry to control or avoid pollution nor can the industry be allowed to indiscriminately play with the nation's health & the life of aquatic fauna. On the other hand, just because the environmental conditions are to be maintained, the impact on financial resources cannot be ignored. Both the health and economy of the nation are equally important and by supporting one, the other cannot be overlooked.

RECYCLING WASTE PRODUCTS WILL REDUCE POLLUTION ABATEMENT COSTS

Environmental protection may not always prove a cost escalation phenomenon from the long-term point of view. Quite often, the measures towards environmental protection may yield good result and even add to the revenues of an industrial undertaking, especially when valuable materials are retrived from wastes. These retrieved materials can well be recycled into use.

CONSTRAINTS

Age of Industrial Units

Old industrial units, however, suffer from several structural disadvantage and are not, therefore, always able to put into effect even some of the required measures. They are mostly based on technologies which when developed were not much concerned with environmental protection. Dovetailing modern equipment with the presently installed machineries invariably poses practical difficulties. Space limitations, too are a major constraint on putting up pollution control equipment in lar ge number of such units, even if they co-operate fully in going in for these equipments. This is particularly the case with the units in the metropolitan cities.

DIFFERENTIAL TREATMENT FOR OLD UNITS

The old units, with technology which did not take into account environmental protection, obviously, need to be treated on a different footing. The environmental protection norms in their case cannot be fixed as stringently as in the case of the modern projects the equipments for which invariably take into account the need for environmental protection. The pollution load from various industries is indicated in Annexure - I.

IS EQUIPMENT/TECHNOLOGY AVAILABLE FOR POLLUTION ABATEMENT?

Even in the case of new units, environmental norms ought to take into consideration the equipment manufacturing technology currently available in the country. Self-reliance in equipment supplies is one of the corner-stones of our industrial policy; imports are allowed either when the technology involved is not available within the country or it is high-tech. Mismatch between environmental protection norms and the available equipment supplies, apparently, needs to be obviated.

POWER, WATER CONSTRAINTS

Then, the kinds of power and water supplies available from public utilities often make it difficult to set up sophisticated environmental protection equipment. Owing to frequent power breakdown, load shedding, low voltage, etc not only do the pollution control measures fail quite often, but also the levels of pollution go up due to the various processes involved. Water supplied to industries, sometimes, does not conform to the tolerence limits laid down, making it impossible for industrial units to control pollution at their levels.

The progressive deterioration in the quality of coal supplied has aggravated the problem.

Proper supportive measures from governmental agencies, including municipalities, for the adoption of pollution control measures quickly are often found wanting. Stringent standards, therefore, cannot be met by industrial units owing to factors beyond their control.

POLLUTION ABATEMENT IN PULP AND PAPER INDUSTRY

Pollutants discharged by the Paper Industry can be divided into 4 categories.

1. Air Pollutants
2. Solid wastes
3. Liquid effluent
4. Pollution caused by noise.

AIRPOLLUTION

These gaseous pollutants in pulp and paper mills are discharged through -

1. Digester relief and blow
2. Brown stock washers
3. Washer - bleach liquor preparation plant
4. Multi-effect evaporators for black liquor
5. Direct contact evaporators like cascades, cyclones etc.
6. Chemical recovery furnace.
7. Smelt dissolving and slaking tanks
8. Lime kilns
9. Boiler flue gasses.

Air pollutants from 1) Talcum/China clay dissolving system, 2) Chipper House and 3) Lime, Salt Cake, Coal and other similar materials handling systems also contribute substantially to air pollution. However, they have only localised effect and are easily controllable by dust collecting equipment.

Air pollutants from the paper mill are composed of the components.-

1. Chemical particulates and
2. Gases.

Chemical particulates are mainly emitted from recovery furnaces, smelt dissolving tanks, and lime kilns. Particulates emitted out of the recovery furnace and the smelt dissolving tank are mostly of Sodium sulphate and Sodium carbonate, while from the lime kilns various calcium salts are emitted out.

Particulate emission is controllable to a considerable extent by improving the performance of recovery furnace and using venturi scrubbers, electrostatic precipitators and other effective dust collecting devices in the particulate emission passages.

Gases emitted are variable mixture of hydrogen sulphide, methyl mercaptants, dimethyl sulphide and dimethyl disulphide. Sulphur dioxide is also present in these gases in small proportions. Areas where density of population is low, air pollution is normally not considered as a serious hazard because their nuisance value is limited to the neighbourhood of the mills. In our country, though most of the pulp and paper mills are located far away from the urban areas, yet, due to high labour compliment and consequent concentration of rural population, it will be immature to say that the air pollution by the paper mills will be allowed to continue for long.

Air pollution control will need high capital investment and operating costs, and unless the ill effects of air pollution on the health of the community are established there will hardly be any sense for such investment.

SOLID WASTES

About 4-6 per cent of the wood/bamboo processed ends up as dust, rejects and grit. Solid wastes in a pulp and paper mill are discharged practically through every process.

While the raw material is extracted from the forests, a large portion, i.e., leaves, scantlings, bark in case of woods are thrown out as waste. The waste, though degradable by nature create serious fire hazards in the forests.

While chipping, about 2 % to 3 % of total raw material is discarded in the form of fine dust and under size chips. This waste is either burnt, discharged through the liquid effluent or thrown out in barren lands.

Lime sludge from causticizers and hypochlorite preparation plant is a major solid waste. In most of the countries, the lime sludge is reburnt to produce lime for recycling in the process. In India, sludge reburning has still not become successful and hence the same is either discharged through the water effluent or used as landfil.

Sludge from water treatment or effluent treatment plants contain both organic and inorganic solids. Recovery of these wastes in solid form is practically absent in India, and most of these are allowed to flow with the liquid effluent or used as landfil.

Coal ash which accounts for nearly 30 to 32 % of the total coal burnt adds to the solid waste disposal problem. Most of it is used as landfil yet, at many a place, coal ash from paper mills has become a serious concern for the community.

In short, solid waste disposal is slowly becoming a headache for the paper mills. The pressure on land in our country is already high and unless long term but time-bound plans are made to:

1. Reburn lime sludge
2. Separate and reuse maximum fibrous waste and
3. Use coal ash for building material (Making bricks and cement).

the mills will face serious problem of solid waste disposal within a few years.

LIQUID EFFLUENT

Liquid effluent is regarded as the biggest nuisance for environment from Paper industry. Paper mill liquid effluent is a complex liquid flowing out of the mill in enormous quantities. On an average, about 3,50,000 litres of water is used for making one tonne of paper. This quantity represents the requirement of nearly 4,000 persons per day. Or, in other words, a 100 t/d capacity paper mill will consume as much water as will be required by a city of 4,00,000 population. Nearly 90 % of the total water used goes out as mill effluent.

Pollution load of liquid effluent consists of:

a) Suspended solids like bamboo/wood dust, fibres, pigments, ink particles, dirt, lime sludge and similar solids.

b) Dissolved organic and inorganic compounds like lignin compounds, hemicellulose, sugar, salts, acid and alkali compounds.

c) Colour bodies like dyes and primary lignin compounds.

d) Micro-organism.

SOURCES AND CHARACTER OF THE EFFLUENTS

As Sulphate Process is the predominant among the processes used in India, the sources and character of the effluent from a mill using this process are detailed below:

1. Bamboo Wash

In order to remove dirt, sand etc from the bamboo before cooking it, the bamboo is washed. The washing operation is also helpful in mills where wet-chipping is followed. The bamboo wash water and the Chipper House waste primarily contain grit, some organic matter & some suspended solids. Usually water recovered from the paper machines is used for this operation.

2. Digester House

The waste waters from this section (in mills recovering chemicals) are primarily the spillovers and floor-washes. In very small mills where chemical recovery is not practised even the black liquor is discharged along with the floor washes etc. The quantity of the effluent discharged from the various operations and their chemical characteristics

are given in Tables I and II respectively. The Digester House wastes are high in colour, pH, total solids, BOD and COD.

TABLE - I

VOLUMES OF INDIVIDUAL WASTES DISCHARGED FROM A MODERN SULPHATE MILL PRODUCING 200 TONS OF BLEACHED PRINTING AND WRITING PAPER PER DAY.

NAME OF DIFFERENT EFFLUENTS	VOLUME MILLION GALLONS/DAY
1. Chipper house	2.42
2. Pulp Mill, Digester and Chemical recovery house	1.10
3. Chlorination	3.16
4. Caustic Extraction	2.43
5. Paper Machine	1.90
6. Lime Mud	0.402
7. Combined	11.02

TABLE - II

CHEMICAL CHARACTERISTICS OF DIFFERENT WASTE WATERS FROM A MODERN SULPHATE MILL

(All - values except pH are expressed as mg/1).

WASTE WATER FROM	pH	COLOUR	ALKALINITY ($CaCO_3$)	TOTAL SOLIDS	SUSPENDED SOLIDS	CHEMICAL OXYGEN DEMAND (COD)	BIO-CHEMICAL OXYGEN DEMAND (BOD)	REMARKS
1. Chipper House	7.0	Muddy	-	891	529	450	49	
2. Pulp Mill, Digester & Recovery Houses	11.1	Dark Brown	1143	2756	944	1220	469	High in pH dark brown in colour with BOD COD and suspended solids.
3. Chlorination	2.2	Pale yellow	434	2609	147	701	177	Acidic, low suspended solids and BOD
4. Caustic Extraction	9.2	Dark Brown	368	1328	110	905	121	Dark brown colour high pH and low BOD.
5. Paper Machine	7.6	White	150	1170	778	745	131	High suspended solids and low BOD
6. Recausticization (Lime Sludge)	12.4	Light green	57000	76140	72921	563	-	-
7. Combined sections	9.0	-	-	3285	1732	758	176	-

3. Pulp Washing Operations:

The waste from these operations known is brown stock wash waters are also known to be high in pH, BOD, COD and suspended solids and dark brown in colour.

4. Bleaching Operations

After bleaching with chlorine some mills extract the colour with mild alkali. The chlorination wastes and the caustic extraction wastes are somewhat different in their character. Chlorination wastes are low pH and high in total solids. The caustic extract is high in pH but not as high in total solids.

5. Paper Machine Water

The waste from the paper machines are usually around neutral pH, high in total solids, suspended solids and COD. In the modern mills, the suspended solids are removed from these wastes by the use of save-alls, returning the pulp to the pulp section and the water for re-use in other operations such as bamboo washing etc.

6. Chemical Recovery House

Caustic soda and Sodium sulphide are recovered from the smelt by causticisation with slaked lime. These wastes are high in pH and suspended solids the high pH being due some free lime and the suspended solids due primarilly to the precipitated Calcium Carbonate. The suspended solids in this waste are around 73,000 mg/l (about 7 %).The combined wastes from all the above sections have a pH of 9.0 very high total and suspended solids, high COD and moderate BOD and looks dark brown in colour.

It can be seen from the above that the pulp and paper mills discharge large columes of waste water that are coloured, high in pH and COD and modarate in BOD and enormous quantities of suspended solids (mostly inorganic and some organic).

POLLUTION EFFECTS

The pollutional effects of the industrial wastes with special reference to paper and pulp industry are discussed below:

1. pH

The pH of a medium has very serious influence on the biological life. It is well known that most of the aquatic organisms have an optimum pH in the range 6 to 9. When the pH of the medium goes beyond these limits, the aquatic organisms have an optimum pH in the range 6 to 9. When the pH of the medium goes beyond these limits, the aquatic organisms are upset.

2. Suspended Solids:

The suspended solids can be inorganic or organic. Inorganic suspended solids are heavier and are more likely to create the silting problem of the river. Organic suspended solids are usually lighter but have the property of decomposing under the influence of micro-organisms and also increase the turbidity of the water. When such suspended solids are deposited at the bed of a river, they decompose and create anaerobic conditions in the river, and quite often float up and create unsightly conditions. The suspended solids deposited on the river bed eliminate the spawning grounds for fish and also choke the gills and thus lead to the death of the fish. Further; they deplete the dissolved oxygen of the stream, which is essential for the normal activity of the aquatic fauna. The oxygen demand properties of these suspended solids are discussed in the next item.

3. Bio-Chemical Oxygen Demand (BOD)

Every living creature requries oxygen for oxidizing food for deriving energy. While the higher group of living organisms take in gaseous oxygen, the lower organisms have the capacity of using oxygen dissolved in the water. Some micro-organisms are capable of utilizing oxygen available in inorganic and organic compounds, when there is no dissolved oxygen in the medium, River waters invariably contain some bacteria which proliferate on most types of organic materials, they use oxygen firstly in the form of dissolved oxygen (D.O.). This can give rise to depletion of oxygen in the stream & would create an unsatisfactory environment, for all aquatic life. Most of the fresh water fish are not known to thrive below a dissolved oxygen is reduced to zero, anaerobic conditions set in with the liberation of hydrogen sulphide and methane which are highly toxic to fish. Hence the dissolved oxygen of a stream is of primary importance. Both dissolved and suspended organic solids would exert an oxygen demand in the stream. The oxygen demand due to

dissolved solids is faster than that of the suspended solids.

The paper and pulp mill wastes contain dissolved organic substances and suspended organic matter such as the fibre. These do demand oxygen from the receiving stream and when dilution is not adequate, can create anaerobic and foul conditions.

4. Toxic Chemicals

Many chemicals both inorganic and organic are known to be toxic to aquatic biological life. In the paper and pulp mill waste such toxic chemicals are restricted to be sulphides and Mercaptans, apart from the alkalies. These mercaptans are also odour producing compounds. Thev are toxic to fish even in small concentration.

5. Refractory Chemicals

Certain organic substances can be readily decomposed in the aquatic environment by the soil and water bacteria. However, certain organic compounds are known to resist biological degradation in the environment normally found in a river. These chemicals will be accumulating in the rivers - in the case of pulp mill waste, lignin and certain pictins which are known to be resistant for biological degradation. Origin, especially, which is found in large quantities in pulp mill waste and which is not readily biodegradable will last in the stream for many miles. Although lignin is not toxic in the form it comes out of the pulp mill waste, it is the main contributor to the brown colour of waste.

6. Odour

Some odour producing compound may be hazardous for human beings and cattle. However, all odorous compounds can be considered aesthetic pollutants, as living in such environment is considered unpleasant. Certain inorganic and organic sulphides are discharged in the pulp mill waste. The mercaptans especially are known to be highly odorous. The inorganic sulphides have a great immediate oxygen demand on the stream.

7. Colour

Although colour may not have direct significance on the health of the human beings, it has a very serious influence on his aesthetic sense. It is quite natural for public to restrain from using a coloured water even if it passes all the other tests that are normally applied for potable water. On the other hand, they may be

drived to use other sources of water which are not coloured but not necessarily potable leading to public health dangers. The pulp mill wastes are usually brown in colour, the colour primarily being the result of the dissolution of lignin in the alkaline materials used in the process. Refractory nature of lignin is already discussed above. The removal of colour due to lignin has been found to be a tough problem.

8. Temperature

Temperature has a serious influence on the activities of the flora and fauna of a river. Most of the microorganisms have optimum temperature at 30°C. It is well known that the activity of microorganisms is hastened by increase in temperature, a 10°C rise in temperature is known to double the reaction rate. Any increase in temperature of the river water can hasten the bio-chemical and micro-biological activity in the stream resulting in further depletion of dissolved oxygen which is inimical to the biological life. In addition, it is known that the oxygen has an inverse solubility meaning that the solubility at higher temperature is lower than at lower temperature. Hence, the effect of discharging waste at higher temperature than that of the river water is bad for the normal life of biological organisms in the stream. Some of the pulp mill wastes are known to be discharged at higher temperatures. These primarily come from the pulp washing section and chemical recovery section of the industry. The condensates from the evaporation of black liquor can be particularly high in temperature.

Water pollution control measures in pulp and paper industry aim at:

1. Conservation of water by recycling process waters.
2. Separation of suspended solids by settling and filtration and disposing them suitably.
3. Reduction in BOD loans by oxidation ponds or aerated lagoons, and addition of nutrients like nitrogen and phosphorous for aerobic reactions.
4. Colour removal by activated carbon, lime precipitation, reverse osmosis or amine treatment.
5. Adopting advanced technology during pulping and bleaching processes.

Conservation of Water

Water is used practically at all stages in a pulp and paper mill. Majority of transport, cleaning, cooling and sheet formation operations are carried out with water. Huge quantities of water are required for low consistency operations. Progressively increasing demand of superior quality papers require large amounts of water. Hence, if the water consumption is to be kept at a reasonable level, a systematic recycling and reuse of process waters only will provide a workable solution.

Every industry has its own way of using water for its process, and it has its own problems of recycling and treating the wastes to supplement fresh water. Even though the paper mills more or less follow the same process throughout the world, the fresh water consumption, process water recirculation systems hardly tally in toto. As such, it is difficult to make any thumb-rule for reuse and recycling of process waters. However, some common guidelines can be drawn, which adjusted according to individual mills working conditions, will considerably bring down the fresh water consumption. For example the drains from pulp and paper mills can be broadly divided into High solid low BOD stream and Low solid high BOD stream. High solid stream has to be passed through a clarifier and the clarified back water can be reused in certain places after necessary correction for pH. This need not pass through aerated lagoons at all. The low solid streams has to pass through primary clarifier aerated basins and secondary clarifier. This will reduce the cost of treatment also considerably. Also the quantity of effluent to be treated will be less. However this has to be carefully planned while building pulp and paper mills itself.

While in most of the other industries very little available by-products or energy can be reclaimed by recycling and reusing the process water, in a paper industry it can give manifold advantages. Apart from the basic advantage of reduction in fresh water consumption and consequent discharge of the effluent, the two other major advantages that can be expected by recycling and re-using process water are:

1. Substantial recovery of fibres giving better yield from the raw material
2. Saving in capital required for treatment of effluent.

This does not mean that the reuse of process water will pose no problem in the process. Building up of micro-biological or non-micro-biological or combination of both deposits can cause.

substantial loss. However, with proper deposit control and planned flushing system, many of these problems can be solved.

BOD 5 Reduction

BOD 5 load in paper mill effluent is due to dissolved organics especially the lignins. Except lignins, the other organics like hemicellulose and sugars are readily biodegradable and hence, due to the action of micro-organism present in the effluent, get consumed. BOD 5 load, as high as 1400 ppm in the effluent has been reported by some mills in India. The average is however around 500 ppm. BOD 5 reduction is achieved by biological treatment of the clarified effluent. This is usually referred as the secondary treatment. BOD 5 reduction systems are,

a) Natural stabilising lagoons
b) Mechanically aerated stabilising lagoons
3. Trickling filters, and
d) Activated sludge treatment.

BOD 5 treatment by natural stabilising lagoons is possible only where enough land is available and climatic conditions are suitable for photo-synthetic activity throughout the year.

Mechanically aerated, stabilising lagoons require much less area than required by natural stabilising lagoons. This is because the mechanical aerators accelerates the oxygen intake of the effluent thereby bringing down the BOD 5 load faster.

Trickling filters, where high rate of BOD 5 reduction is not required and the availability of land is also poor, are quite successful. In trickling filters, the effluent is allowed to pass through synthetic or rock media where the biological growth attached to the media consumes the waste organics.

Activated sludge system of BOD 5 removal is efficient, economical and effective. In this system, nutriants like nitrogen and phosphorous are added to the effluent before biological treatment. This is necessary for the existence of balance biological organism to react with the organic waste of the effluent. In conventional activated sludge process, the clarified effluent, after dosing with the required nutrients is aerated by mechanical means to absorb atmospheric oxygen. Within a retention period of about four to six hours nearly

85 % BOD 5 load is removed. To still improve the working efficiency, contact stabilisation modifications can be applied to the activated sludge system. In this system, the nutrient dosed effluent from the oxidation pond is fed to a clarifier. The settled biological organism are drawn out through the primary treatment clarifier. Upto 90 % BOD 5 reduction is possible with this system within a total detention time of 2 to 3 hours in oxidation pond and 2 to 3 hours in secondary clarifier.

Removal of colours and micro-organism

Colours to certain extent are removed in the primary and secondary treatment of the effluent, but from the aesthetic point of view, that is not enough Quite a few process, to remove the colours and micro-organism, have been tried, but none of them has come to stay because of economic considerations.

Massive lime treatment, reve se osmosis and absorption by activated carbon are the most talked systems. However, none of these systems fit into the economic structure of the industry.In fact if the effluent after primary and secondary treatment is used for irrigation purposes, removal of colours and micro-organism will not be necessary.

Internal Control Measures

Black liquor spills recovery will greatly reduce pollution load and adds to the value of recovered chemicals. A number of processes, e.g., ferrite process, are now available for chemical recovery from black liquor of SPM but for economic reasons the mill should have 20000 TPA capacity.

New technologies in pulping viz., chemo-mechanical (CM), Chemo-thermo-mechanical (CTM), thermo-chemo-mechanical processes provide high pulp yields which conserve raw materials and reduce pollution Similarly, multi-state belt washing results in lesser dilution and also leads to improved washing of brown stock.

Irrigatioin

Irrigation & land disposal of pulp mill waste were tried with a dual purpose for colour removal and waste disposal with considerable success. The soil used for this purpose should have colour removal capacity & should be

permeable enough to accept the waste water at a satisfactory rate. Large area of land will be required for this method of treatment.

From the literature cited above, lagooning under an aerobic conditions seems to be an economical and effect method of reducing the polutional load in pulp and paper industry. The nutrient requirement under anaerobic conditions are much less than under aerobic conditions. Anaerobic lagooning requires less capital and maintenance costs.

Anaerobic Lagoon Treatment

In order to reduce the high cost of nutrient supplementation and of operation, anaerobic digestion and lagooning have been tried on the above wastes and the results of pilot plant study are reported in Table III. Lagoon has been operated at detention periods ranging from 25 to 10 days. It has been observed that during the lagooning operation pH of the waste could be brought down from above 10 to about 8 and the BOD of the waste could be reduced by 65 to 75 per cent. At detention time of 10 days, BOD reduction was 67 per cent and effluent BOD was 90 ppm. COD reduction were however, in range of 15-25 %. Hence it can be seen that after properly seeding, the lagoon could remove about 2/3 of the BOD in 10 days time. Where land is available, the lagooning may be an inexpensive method of treatment of these wastes. The nutrients were supplemented in proportion of BOD:N:P = 100:e:0.5. As in general the paper mills are located in the country-side where land is not very expensive, it may be profitable to use anaerobic lagooning with detention periods of 10 days and above. The lagoon performance would be better at places with higher temperature and lower with lower temperature. In both cases of biological treatment, the colour of the waste is not perceptibly removed as the colour producing compound lignin is not readily degraded.

Land Treatment

Disposal of the pulp mill waste by land treatment was studied on a laboratory scale. It is well known that land treatment of organic wastes will reduce the BOD of the wastes provided the soil does not get "Sewage-sick". In this study land treatment has been tried to remove colour and incidentally some BOD, Results of these experiments are shown in Table IV.

TABLE - III

ANAEROBIC LAGOON PILOT PLANT PERFORMANCE DATA FOR TREATING PULP MILL WASTES

Detention time in days	pH		BOD mg/l		Percentage BOD reduction	COD mg/l		Percentage COD Reduction
	Influent	Effluent	Influent	Effluent		Influent	Effluent	
25	9.9	8.0	185	51	66	800	630	21
20	10.4	7.8	310	90	71	800	-	-
15	10.8	8.0	223	53	76	815	715	15
10	10.44	8.3	275	91	67	873	662	24

TABLE - IV

CHARACTERISTICS AND EFFICIENCY OF SOILS IN REMOVING COLOUR FROM PULP MILL EFFLUENTS

Classified Name	Soil used		
	A_1	A_2	K
	Sand	Sandy loam	Sandy loam
Bulk density, gm/cc	1.48	1.45	1.26
Specific gravity	2.43	2.31	2.24
Rate of percolation cm/day	18	8	15
Organic Content(Pereent)		6.8	0.5
Cation exchange capacity meq/100 gm	11.9	12.8	20.5
Percentage reduction in colour*	28	29	49

A_1 and A_2 are two different soils obtained from the surrounding areas of a Sulphate Mill.

K is a soil obtained from Kanpur.

*The waste x had a colour of 1500 units/litre on Platinum Cobalt Scale.

It can be seen from Table IV that the colour removal depends upon the type of soil, especially its cation exchange capacity. Soil K which had a high cation exchange capacity (20 meg/10C g) removed colour to 49 % whereas soil A1 and A2 with relatively lower cation exchange capacity (12 meg/100 g). The feasibility of land treatment for colour removal depends firstly on its cation exchange capacity and its rate of percolation. It appears that a very dense soil will permit only low rates of percolation. On the other hand, sandy solids will not be able to remove colour efficiently. A via-media may be an optimum for the requirements of land treatment of the pulp mill wastes. Wherever such soil are available they could be used for the removal of colour. Here again land treatment might be most useful for an effluent from annaerobic lagoon. This may serve to reduce the colour as well as BOD. Preliminary while using the pulp mill effluents, Acidic effluents obtained from certain sections of the pulp and paper manufacture have been found to be deliterious for raising crops.

Storage Lagoons

The last alternative for handling these wastes is to separate the pulp mill wastes which are coloured and to store them in storage lagoons for the entire period of the low flow and discharge during times of floods. The land requirement in this system would be considerable and may be possible only in very limited cases.

Aerated lagoons

Aerated lagoon should be very useful method of treatment before or after an aerobic lagooning. This should help in bringing the BOD closer to the limits laid by the ISI for industrial effluents to be discharged into inland surface waters.

FINANCIAL HEALTH OF PAPER INDUSTRY:

Paper industry is passing through a very critical phase in India. There is demand recession and most of the paper mills carry a huge stock of inventory. There is tight liquidity situation in almost all the paper mills due to this.

Most of the medium and larger paper mills require to be modernised and renovated. Huge capital cost is needed for this. A few big paper mills and many small paper mills are closed due to sickness. Many others are in the process of getting closed due to poor financial health prevailing in the industry.

Paper industry is a highly capital intensive industry. Still they are very conscious about the pollution problems caused by their effluent. Many paper mills have taken effective steps in this regard.

The large paper mills have Soda Recovery Plants for the recovery of the cooking chemicals but the small mills do not have the same.

Very few paper mills have installed complete effluent treatment plant consisting of Primary and Secondary Treatment. While some others have made a beginning with the primary treatment plants only.

PAPER MILLS CANNOT AFFORD SECONDARY (AEROBIC) TREATMENT

The pollution abatement measures to be followed by all the paper mills involves a huge capital and recurring cost. For a 100 tonne integrated pulp and paper mill with a good recovery plant, a capital of Rs. 150 to 200 lakhs may be needed for installation of Primary and Secondary Treatment plants. A recurring cost of about Rs. 100 per tonne is needed for an effective treatment. About 20 acres of land is also required. The running cost for various industries for discharge of effluents into inland surface water and also for discharge on land for irrigation are indicated in Annexure II.

SECONDARY(AEROBIC)TREATMENT METHOD IS NO SOLUTION TO POLLUTION PROBLEM IN OUR COUNTRY

Activated sludge process consumes huge power. Almost all the States in our country are power starved and power interruptions virtually paralyse production. Even if paper mills install Secondary Treatment system they will remain inoperative for want of reliable power.

WHY UTILISATION FOR AGRICULTURE IS SUPERIOR TO OTHER METHODS OF TREATMENT?

In recent years, NEERI has been collecting scientific information on the effect of continued use of pulp and paper mill wastes for growing a variety of crops. This institute has brought out a booklet on 'Agricultural utilisation of Paper Mill effluents'.

Besides its use for agriculture, land application also provides removal of trace organics some of which are removed in conventional treatment systems.

COLOUR REMOVAL INVOLVES HUGE COST WHICH THE PAPER MILLS CAN ILL AFFORD

It is impossible to remove the colour except at a high cost. As on date there is no economically acceptable technology available for total colour removal from pulp and paper mill effluents. Until such time feasible methods are developed the limits on COD and colour should not be insisted upon as long as other specifications in regard to BOD, suspended solids etc are met with. The impact of colour could be minimised if such effluents are put into agricultural use.

M/S J K Paper Mills, Orissa, Pudamjee Paper Mill in Maharashtra and Orient Paper Mills in Amalai have successfully utilised their effluents for agriculture and the Karnataka State Pollution Control Board supports this view.

UTILISATION OF MILL WASTE TO AGRICULTURE IS MOST IDEAL FOR OUR COUNTRY

If scientific data are collected in a systematic way, land for disposal of industrial wastes for agriculture will help in reducing the cost of waste treatment and will be in the present line of thinking of total recycling of waste-water. This will be more suited to a country like India and other developing countries where resources for complete treatment of the waste are limited.

Several industrial wastes after primary treatment can be put on land for disposal and utilization for agriculture provided they satisfy the irrigational water quality standards and sufficient land is available in the vicinity of the industry. Even if some of the parameters exceed the tolerence limits, these can be

amended by suitable pretreatment and adopting special farm irrigation practices. Under these circumstances, land treatment and disposal of industrial wastes become handy and economical.

In India although raw and partially treated sewage is being used in agriculture over 80 years, the application of industrial wastes for agriculture is only of recent origin.

HIGHER BOD - ADVANTAGEOUS TO CROPS

The BOD in the paper mill effluent is contributed by break down products of cellulose which are advantageous to plant growth. The effluent is most harmless as the inputs to the industry is vegetation having cellulose and inorganic chemical like Sodium Hydroxide. No lethal or toxic chemicals are used. Organic matter promotes a granular structure which permits a soil to hold more of both water and air. In other words, organic matter increases tremendously the amount of active surface in each square inch of soil. All chemical and physical activities take place on the surface of each soil particle.

This change brought about by more organic matter added to the soil means

i) a more extensive plant root system;
ii) more water entering the soil faster;
iii) less water flowing from the land and thus less erosin;
iv) a greater aeration;
v) less blowing of soil due to more moist surface;
vi) a greater amount of water stored in the soil for use of plants;
vii) less soil baking and less crust formation.

Industrial waste water has been tried by several workers for irrigation. Kraft Pulp Mill waste water has been utilised for a number of grasses. No adverse effect has been observed on the yield of crops like cotton, corn and grasses etc by using waste water from pulp and paper mill.

The analysis of composite samples of the untreated effluent, of course let out after exhaustive internal controls indicates to contain elements which are helpful to sugarcane growth if not high nutrients and it falls well within the tolerance limits prescribed by ISI standard No. 3307/1977 for effluents suitable for irrigation.

The conclusions arrived along with their discussions whereever necessary, based on experiments on four sets of full crop each covering a period of three years and consisting of plant Ist and 2nd rate on crops using untreated effluent from an integrated pulp and paper mill adopting alkaline process of pulping for irrigation are given below:

a) The effluent from a pulp and paper mill with good internal controls containing moderate contaminants but appreciable quantity of soluble organics and elements like Calcium, Magnesium and Potassium etc, necessary for the plant growth and falling well within the limits of ISI Standard for effluents suitable for irrigation, can be advantageously used for irrigation of sugar cane.

b) The irrigation with effluent is superior than with fresh water in respect of yield of sugarcane for plant Ist ratoon crops could be taken to be higher by a minimum of 18/20 % in comparison to fresh water irrigations. This is possibly

   i) Presence of soluable organic matter
   ii) Calcium along with organic matter
   iii) Organic matter constantly subjected to huminification and mineralization, by a chain of reactions, help the plant growth.
   iv) The increase in pH due to effluent irrigation on the acidic soil as sugarcane grows and yields well at pH 5.5 - 7.5, neutral pH preferred.

NOISE POLLUTION IN PULP AND PAPER INDUSTRY

The major contribution to the noise pollution is from the Chipper Ho use, Vacuum Pumps and Compressors used in various sections of the mill and the paper machine drives. Due to the adverse effects on the persons working in these areas, it is necessary to keep noise to the lowest possible level. If this cannot be achieved without affecting the process, necessary safety appliances can be provided to them.

Normally, the chipper house in the mill works almost round the clock. Due to the inherent nature of chipping operation high level

of noise is generated in this section. It may not be feasible or practical to reduce the sound to the lowest level as the area is open and handling of the raw material does not permit other methods to be utilised. The safest method is to provide the persons in this area with ear plugs so that noise generated does not have its adverse effects on their ear drums.

To reduce the noise pollution in the vacuum pumps it is necessary to install Mufflers (Silencers) for these vacuum pumps. The noise can be reduced to a considerable level using these appliances

In the paper machine drive, the innovation for reducing the noise level has been in the direction of changing the material of construction which has the additional advantage of self lubrication. Wherever possible, the paper machine drive gears should be made of Polypick or Nylon material which serves this purpose.

CONCLUSION

Twenty highly polluting industries have been notified by the Central Government as falling within the purview of industrial licensing. One of these is paper, pulp and newsprint. Specific clearance is necessary from the Department of Environment as a precondition for setting up an industrial unit for manufacture of pulp, paper or newsprint. Installation of equipment for prevention and control of pollution is insisted upon in such units before the commencement of production.

In respect of water and air the two major subjects of environmental concern specific legislations currently in force are - The Water (Prevention and Control of Pollution) Act, 1974 and The Air (Prevention and Control of Pollution) Act, 1981.

Environment (Protection)Act, 1986 with comprehensive measures to protect the environment has been brought into force as tribute to the memory of late Prime Minister Indira Gandhi, who poineered the movement for environmental protection in the country.

Paper industry is capital intensive. Return on the investments is already low. The extra cost of pollution control measures will either result in higher cost of the product or still lower return on the investments. It is true that simple economic consideration cannot be allowed to play with the nation's health

but there is also no justice in forcing the industry to install expensive purification plants without looking into their overall economy. Importance of capital is no less than a clean environment for a developing society and, as such, the modus operandi should be so set that all the money for pollution abatement programmes is wisely spent. It will be unwise to support one at the cost of the other.

Industries have certain obligation towards the society and it is a part of their responsibility to see that their wastes do not create hazards and annoyance to the community. Similarly, the regulatory bodies should also see that their ligislation or the norms fixed do not cripple the industry. Industries will have to part with a portion of their profits and the regulatory bodies will have to adjust their purification standards to a reasonable limit.

ANNEXURE - I

POLLUTION LOAD OF VARIOUS INDUSTRIES

S.No.	Industry	Volume of waste water per unit of product or raw material used.	Average BOD of waste water(mg/1)	BOD load per unit of product
1.	Starch	500-1000 gal/ton of Starch	800-1000	7.5 lb/ton starch
2.	Brewery and Distillery complex	0.42 mg For (i)Beer, 40000 1/day,(ii)Alcohol,15000 1/day & (iii)Fruit juices, 15 tons/day,	2040	3650 lb BOD load
3.	Instant Coffee	8000 gal/ton of Instant Coffee	1500	120 lb/ton of Instant Coffee.
4.	Dairy and Milk Bottling	2.2 gal/gal of milk processed in a product oriented Dairy	1750	120 lb/1000 gal of Milk processed.
5.	Fertilizer	Urea Plant 650 gal/ton of Urea	Major Pollutant is Ammonia	--
6.	Pulp & Paper	80000 gal/ton of Paper	165(Suspended solids 660 mg/1).	135 lb/ton of paper & 530 lb SS/ton of paper)
7.	Tannery	7550 gal/ton of Raw Hides.	5000	37 lb/100 lb of Raw Hides.

ANNEXURE -II

S.No.	Industry	CAPITAL COST: For discha-ge into inland surface wa er(IS:2490-1963)	Running cost	For discharge to. land for irriga-tion	Running cost yearly
1.	Starch	Rs.2000/- per ton of Starch	Rs. 300-500/ tonne of Starch	--	Rs.160-800/ tonne of Starch
2.	Brewery and Distillery complex	Rs.760,000 to Rs.815,000 for 15,000 1 of Alcohol/day 40000 1 of Beer/day, and 15 ton/day of canned food.	Rs. 8.30/litre capacity of alcohol	Rs.620,000	Rs.5-18/litre capacity of Alcohol
3.	Instant Coffee	Rs.20,000/-per ton of Instant Coffee	Rs.4-5/Kg of Instant Coffee	Rs.10,000/-per ton of Instant coffee	Rs.2.5-3 Kg of Instant Coffee.
4.	Dairy & Milk Bottling	Rs.3700/-per 1000 1 of Milk processed	Rs.2000-9000/ 1000 litres milk capacity.	Rs.1000/-per 1000 1 of Milk processed	Rs.200-800/ 1000 litre milk capacity
5.	Fertilizer	Rs.26000/-per ton of urea production	Rs.600-800/ tonne of urea	--	
6.	Pulp & Paper	Rs.70000/per ton of Paper	Rs.10000-13000 tonne capacity of paper.	Rs.46000/per ton of Paper	Rs.600-1000 tonne capacity of paper
7.	Tannery	Rs.40/-per Kg of raw hide	Rs.1.5-6.0 Kg capacity of hide	Rs.20/-perKg of raw hide	Rs.1.2-3.5 Kg capacity of hide
8.	Textiles	Rs.7-10/metre length of cloth.	Rs.5-6/metre length of cloth	Rs.4-5/metre length of cloth	Rs.2.5-3.5/ metre length of cloth.

NOTE: The costs mentioned above are for the cheapest amongst the various possible alternatives.

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