Effluent Treatment at Orient Paper Mills, Amlai (A case study)

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SUMMARY

Orient Paper Mills, Amlai produces about 200 tons of paper by sulphate process using bamboo about (70%) and tropical hardwoods about (30%). About 14 million gallons of fresh water is consumed in the different stages of pulp and paper making and discharges about 11—12 million gallons of wastewater per day. After a planned research of 8 –10 years the mill has developed an effluent treatment system which is scientifically possible and economically feasible.

INTRODUCTION

Effluent treatment system at Amlai is a combination of clariflocculator, an-aerobic and aerobic lagoons. In a tropical country like India where abundant sun energy is available throughout the year, aerobic and an-aerobic lagoons are the most suitable methods for treating the effluents. After this treatment grade II effluent confirm I.S. 2490–1974, part–I (limits for the discharge of industrial effluents into inland surface water), whereas parameters for treated grade III effluent is slightly higher than I.S.I. limits. Efforts are still continued to further improve the quality of wastewater. Mill has started reusing part of the grade II effluent in the process and research is going on for recycling more quantity of waste water within the process.

THE PROBLEM OF POLLUTION

Production of wastes is an inevitable consequence of majority of industrial processes. Conversion of natural raw materials into sophisticated consumer goods through the help of present day technology would not be possible without some wastes being produced.

The problem of waste is as new as the present technology itself, which is not very old considering the known history of civilised man. It is in this light that the demarcation of levels at which the industrial wastes becoming an environmental hazard or pollutants is still a matter of much discussion and investigation. In last thirty or forty years standards of pollution factors have been fixed in several countries. These standards have, however, been updated in several instances when more experience and changing needs made it imperative. Even today the efforts of research and development wings are concentrated not so much towards meeting the standards but more so towards going beyond the standards in their ultimate search for a pollution free technology.

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PROBLEM OF POLLUTION IN PAPER INDUSTRY

Paper industry probably consumes the largest volume of water per unit of consumer goods produced. The entire process right from the washing of fibrous raw-material to the drying of sheet of paper, depends on water in some form. And since the end product is free from water, all the water consumed in pulp and paper making reappears as wastewater. 40,000 to 100,000 gallons of water are required to produce one ton of paper under todays typical technology. Mills established during past five or six years under new technology have reduced this requirement to 25,000 to 30,000 gallons per ton. Pollution free paper mills with completely recycled water systems are still not a universal reality, though a few such mills have reportedly been started in western hemisphere in past two or three years.

Pollution from the paper industry can be broadly put under three categories :—

1) Liquid effluent—Wastewater from chip washing section, cooking and pulp washing section, bleaching section, paper machine and chemical recovery section.
2) Solid waste—Like lime sludge, bark, grit and other rejects.

3) Gases—released from digester house and chemical recovery section.

Of the three categories the first, liquid effluent is the major area of concern to paper industry. The later two categories, though recognised pollution factors are, never the less, not a serious load on health and environment. Water pollution, therefore, is the area where paper industry has concentrated maximum research and development effort.

PROBLEM TYPICAL TO PAPER INDUSTRY IN INDIA.

There are about 75 small and large size paper and board mills in India at present. These are mostly integrated units with their own pulping plants. An important and unique fact of the paper industry in India is its fibrous raw material. The main raw material used in paper industry in India is bamboo and tropical hardwoods, whereas western countries use soft woods. Unique nature of raw material affects the physical and chemical nature of the effluents. Hence when the problem of effluent treatment in India is reviewed in the light of the western experience, it becomes obvious that the programming and carring out of the effluent treatment work in this country has to be on different plane and direction. Findings of the effluent treatment works in other countries cannot be used as such here. At best these can serve as broad guidelines for further research here.

EFFLUENT TREATMENT AT AMLAI

Among the very few and probably the first to look into the problem of water pollution by pulp and paper industry in this country are Orient Paper Mills, Amlai. Long before the Government and other industries started looking into the problem of pollution, the O P. Mills had taken concrete steps to investigate various treatment methods suitable for its effluent.

The Orient Paper Mills at Amlai went into production in 1965 and from 1967 the mill had started research work for the treatment of its wastewater in collaboration with CPHERI (Now NEERI) Nagpur, the only national institute that took up research work on industrial and municipal wastes. Based on the laboratory studies and pilot plant findings full scale effluent treatment plant had been set up few years ago. The waste water coming out from different sections of the mill have been classified into three grades as per their characteristics.

GRADE I—It comprises of condensates, cooking water and leakages from glands etc. It is practically uncontaminated water, hence collected and recycled in the manufacturing process at suitable points.

GRADE II—This effluent consist of white water from the paper machine, chlorination and hypochlorite washing from bleach plant & wash water from the Chipper house. Volume of this waste is about 7 million gallons per day.

GRADE III—This effluent comprises of digester house leakages, pulp washing, caustic extraction effluent from bleach plant and waste water from chemical recovery section. This is dark brown in colour, highly alkaline (pH—10-10.5) and its volume is abut 3.5 million gallons per day.

Characteristics and volume of the effluent coming out from the different sections of the mills are presented in Table I.

TREATMENT OF GRADE II EFFLUENT

PRIMARY TREATMENT—(removal of settleable and floating suspended solids)—In the first stage of treatment Grade II effluent is taken into a clariflocculator of 156′ dia, where its suspended solids are being removed. In the inlet channel leading to the clariflocculator bar screen and mechanical screens have been provided to remove floating solids like bamboo and wood chips. The clariflocculator is provided with a thickener where settleable suspended solids get accumulated and are discharged into a mud tank constructed outside the clariflocculator. From where the mud is pumped out by sludge pump to three big settling ponds, where the mud gets settled alternately.

The sludge is removed manually and disposed off as, landfill. The clarified effluent is led by a separate channel to oxidation pond fitted with six surface aerators. During clarification about 90% suspended solids are removed, which reduces the effluent BOD by 20-25 percent. The results are given in Table 2. Slight change in pH is due to equalization of wastewater in clariflocculator.

About 2 million gallons of this clear effluent is being recycled in the mill for bamboo transportation and chips washing, successfully. Studies are going on to use clear Grade II effluent for cinder transportation from power plant to river side. About 2 million gallons of effluent will be required for cinder transportation. Thus nearly 60% of the clarified Grade II effluent will be reused in the mill.

SECONDARY TREATMENT (AEROBIC-TREATMENT) - Clarified Grade II effluent is

TABLE I

AVERAGE CHARACTERISTICS OF INDIVIDUAL & COMBINED WASTEWATERS

Sections	Flow (average) $M^3 \times 10^3$/day	pH	Total Solids mg/l	Suspended solids mg/l	COD mg/l	BOD_5 mg/l	Chlorides mg/l	Sulphate mg/l
1. Chipper house	10-89	6.8–8.2	600-1000	400-600	400-590	35-70	30-40	42-130
2. Pulping (cooking & washing)	5.06	10-11.8	1600-2000	300-600	800-1700	270-400	40 80	74-120
3. Chlorination & hypochlorite	14.34	1.6-3.2	1900-2500	150-300	500-700	80-150	800-1400	35-60
4. Caustic-extraction	10.04	8.8-10.4	1100-1500	120-200	700-1600	130-200	200-285	40-80
5. Paper machine	8.63	5.9-8.8	850-1600	500-850	460-800	100-160	30-50	150-500
6. Grade II (1+3+5)	33.06	5.8-8.5	1100-2000	300-550	450-720	80-135	350-760	80-150
7. Grade III (2+4)	16.07	9.8-11.0	1400-1900	200-440	800-1630	200-350	100-220	60-110
8. Lime sludge	1.8	12-12.6	—	4.3%-10%	—	—	30-40	Nil

TABLE—II

CHARACTERISTICS OF GRADE II EFFLUENT IN THE DIFFERENT STAGES OF TREATMENT

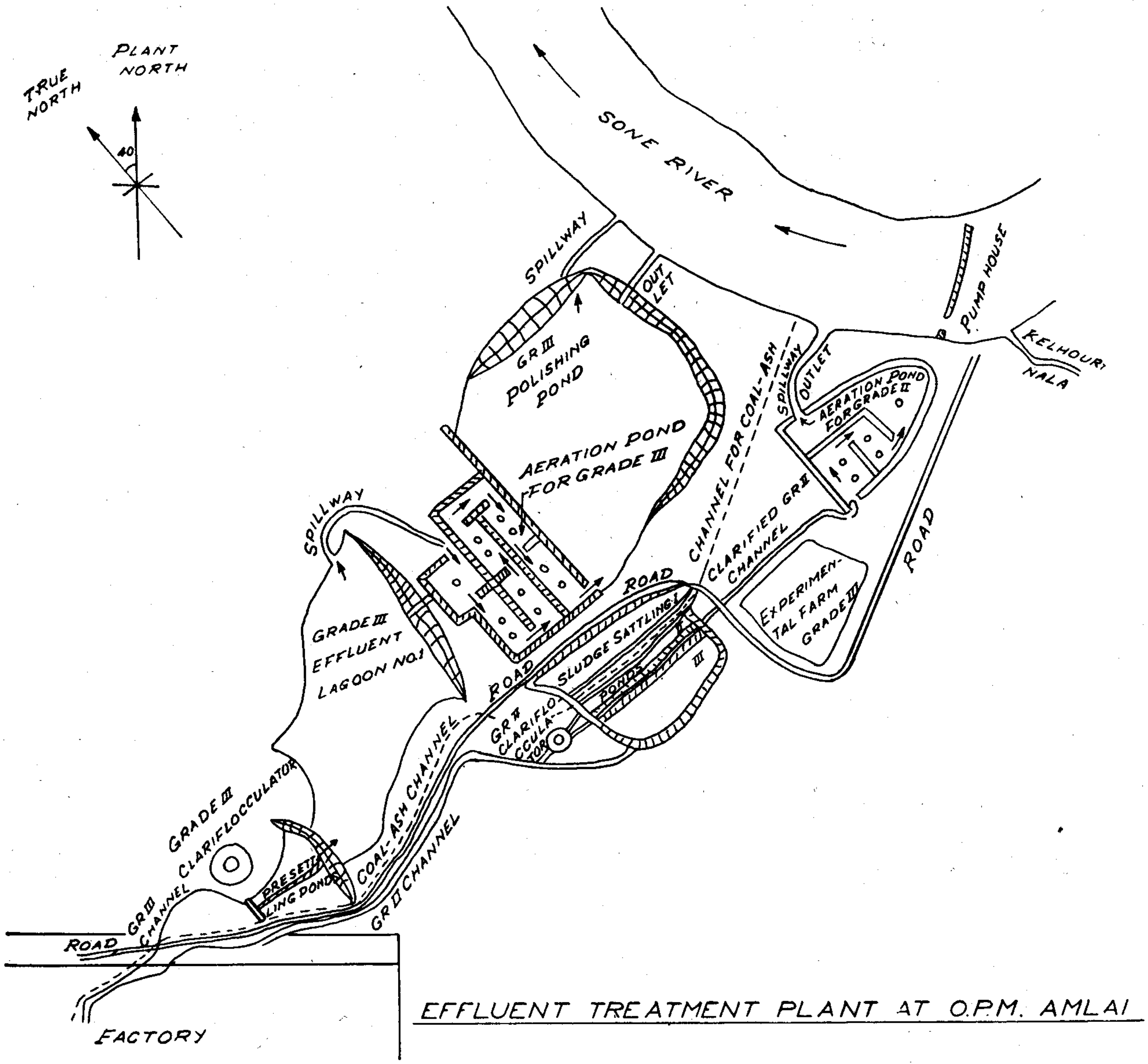
Parameters	Raw grade II waste water.	Grade II after clarification	Grade II after aerobic treatment.
1. pH	5.8—8.5	6.6—8.4	7.0—8.0
2. BOD_5 mg/l	80—135	60—100	15—30
3. COD mg/l	450—720	370—470	200—260
4. Suspended solids mg/l	300—550	30—50	30—40
5. *Chlorides mg/l	350—760	380—700	400—650

*Note—Average chloride concentration remain the same, the change shown in the table is due to equalization of waste water in aeration ponds.

TABLE—III

CHARACTERISTICS OF GRADE III EFFLUENT AT DIFFERENT STAGES OF TREATMENT

parameters	Raw grade III waste water.	Grade III after primary treatment.	Grade III after an aerobic treatm nt	Grade III after aerobic treatment	Grade III after polishing pond.
1. pH	9.8—11.0	8.0 - 8.8	7.8—8.4	8—8.4	7.9—8.4
2. BOD_5 mg/l	200—350	180—300	100—186	50—70	45—60
3. COD mg/l	800—1630	800—1550	700—1120	500—770	480 - 700
4. Suspended solids mg/l	200—440	100—160	70—110	70—100	55—80
5. Chlorides mg/l	100—220	300—450	300—430	300—430	325—400



EFFLUENT TREATMENT PLANT AT O.P.M. AMLAI

treated aerobically in oxidation cum aeration pond, where it is detained for 5 days. In aerobic treatment complex organic matter present in the wastewater is oxidised to gaseous end products. The gases produced in aerobic treatment are almost completely oxidised. In the oxidation pond six surface aerators are fitted, out of which 5 are of 25 H.P. and one of 10 H.P. (thus total 135 H.P.). These aerators transfer oxygen from atmosphere to effluent at the rate of 3.5 lbs or 1.58 Kgs/H.P./Hr. Hence designed capacity of aerators for oxygen transfer per day is $135 \times 24 \times 1.58 = 5128$ Kgs. Average BOD of clarified grade II effluent is 80 mg/l and its volume is about 7.0 million gallons per day. So BOD load/day is $\frac{7 \times 4.55 \times 80 \times 10^6}{106} = 25480$ Kgs. only. Looking to the above figures it is clear that the aerators were designed for about double capacity.

After treatment in oxidation pond BOD of the effluent is reduced by 60-70 percent and COD by 30-35 percent. Results are given in Table 2. After this treatment grade II effluent confirm I.S.-2490-1974, Part-I (limits for the discharge of industrial effluent into inland surface water) presented in Table-4.

TREATMENT OF GRADE III EFFLUENT

PRIMARY TREATMENT—As mentioned in Table 1, this effluent is highly alkaline (pH 10–11.0) in nature, which may inhibit biological activity during secondary treatment. Hence the pH of Grade III effluent is lowered upto the range of 8-8.5 by mixing about 1 millon gallons of chlorination & hypochlorite effluent, from bleach plant. After mixing bleach plant effluent Grade III effluent is settled into two settling ponds working alternately. The capacity of each pond is about 2 million gallons, where Grade III effluent is detained for about 12 hrs, thereby reducing suspended solids to 60%. One baffle is provided at the outlet of these settling ponds to prevent the floating matters from entering the anerobic lagoon. These settling ponds also act as stablisation ponds, proper mixing of chlorination effluent with Grade III, take place in these ponds. Even after settling in ponds about 150-200 mg/l of suspended solids are going in lagoon No. 1 (anaerobic lagoon), where it creates an extra load on anaerobic treatment. Hence laboratory experiments were started to remove the remaining S.S. present in Grade III effluent. Now on the basis of laboratory experiments a clariflocculator of 96' dia is under construction which will remove about 80% of S.S. from Grade III effluent before anaerobic treatment.

SECONDARY TREATMENT

ANAEROBIC TREATMENT—After settling Grade III enters into lagoon No. 1, where it gets anaerobic treatments, microbial seeds were developed in this lagoon with the help of cowdung and sewage. During anaerobic treatment the complex organic matter present in wastewater is degraded to simpler gaseous end products by micro-organisms. These gases escape out in the atmosphere leaving comparatively clear water behind.

The capacity of lagoon No 1 is about 80 million gallons, where Grade III is detained for 20 days. Since Grade III effluent lack in nitrogen & phosphorus, chemical nutrients (urea to provide nitrogen and superphosphate to provide phosphorous) are added in the ratio of 100: 2:0.5 of BOD: N:P. These chemicals are separately dissolved in two small concrete tanks and added to the flow of effluent as a continuous drippings. About 40% reduction in BOD_5 and 20 percent reduction in COD are recorded during this treatment. Low reduction in COD is due to presence of lignin and its compounds which are biologically non-degradable. Results are given in Table-3.

AEROBIC TREATMENT—The end gaseous products produced during anaerobic treatment are not completely oxidised hence they create odour nuisance. More over anaerobic treatments degrades only 40% of the organic matter present in the effluent. So anaerobically treated effluent is further treated aerobically in aeration ponds. Grade III effluent after anaerobic treatment enters into aeration ponds where it is detained for 5 days. 11 surface aerators (total 125 Hp) are fitted in aeration ponds to supply atmospheric oxygen to wastewater. A further reduction in BOD (about 60%) and COD (about 30%) are found after this treatment.

POLISHING POND—After aerobic treatment Grade III effluent is taken to polishing pond where it is detained for about 15 days. The biological

TABLE—4

LIMITS FOR THE DISCHARGE OF INDUSTRIAL EFFLUENTS INTO INLAND SURFACE WATER (I.S. 2490—1974, part—I)

Parameters	Discharge limits
1. Total suspended solids mg/l Max.	100
2. pH	5.5—9.0
3. Temperature	Shall not exceed 40°C
4. BOD_5 at 20°C, mg/l Max.	30
5. Oil & grease ,, ,,	10
6. Phenolic compounds ,,	1.0
7. Cyanides as CN ,, ,,	0.2
8. Sulphides as S ,, ,,	2.0
9. Radioactive materials	
a—Emitters Max.	10^{-9} Mpc/m
b—Emitters ,,	10^{-8} ,,
10. Insecticides	Nil
11. Total residual chlorine mg/l Max.	1.0
12. Flourides as F ,, ,,	2.0
13. Ba, As, Cr, Cu, Pb, Hg, Ni, Se, Ag, Zn	Not to exceed 1.0 mg/l individually or collectively.
14. COD mg/l Max.	250

mass produced during aerobic treatment gets settled in this and releases clear effluent to the river. In addition about 10–15% reduction in BOD is also achieved in polishing pond. Composite effluent samples are collected from every stage of treatment system and analysed in the laboratory for different parameters (eg., BOD, COD, S.S. pH etc) to keep a tight watch on the working of the system.

LAND DISPOSAL—The treatment methods described above removes BOD, COD, and S.S. of the Grade III effluent, but there is no change in colour. It is because colour in Grade III is due to lignin and its derivatives which are biologically nondegradable. Though colour is an aesthetic pollution, even its presence makes the water disagreeable. With this object in view the mill has strated land disposal of Grade III effluent for irrigating eucalyptus plantation around the mill. At present about 1.5-2 million gallons of Grade III effluent is used for irrigating eucalyptus plantation, covering an area of about 200 acres.

In the meantime efforts have been started to develop some economical method for the colour removal of Grade III effluent.

A separate research is going on "Agricultural utilisation of grade III effluent."

LIME SLUDGE DISPOSAL—At present lime sludge coming from the recausticization plant is being segregated and stored separately as landfill. But a lime sludge strorage tank of 8-9 months capacity is under construction by the river side, so that during monsoon periods of floods the same could be discharged into river. The quantity of lime sludge is 100–120 tons per day.

The mill has spent about 1 crore of rupees on the treatment of effluent. The recurring annual cost running and maintenance of the various effluent works is nearly 5 lakhs rupees. The effluent treatment measures adopted by the Orient Paper Mills, Amlai are the most upto date and effective measures carried out by any mill in India so far. The mill has done whatever is scientifically possible and economically feasible from a practical stand point. Efforts are still continuing to further improve the quality of wastewater.

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