Environment Problems in Pulp & Paper Industry Vis-a-vis A Case Study of Orient Paper Mills : Amlai.

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INTRODUCTION ;

The Pulp and Paper industry plays an important role in the chain which links a vast primary resources of forest ecological systems as well as agricultural wastes to an essential commodity like paper. In the modern world today, paper consumption has become a barometer for determining advancement of civilization as it meets the cultural, educational, industrial and other human requirements. However paper manufacturing also creates environmental problems which disturb the ecological balance. As such, it is necessary that environmental consideratians are integrated with the planning, operation and up-keepment of paper mills and in case of new paper mills environmental considerations are gjven priority from the initial stage of planning and design itself.

In India there are 288 paper mills with an installed capacity of about 27.0 lac tons and total production of 16.5 lac tons of different varieties of paper. About 50% of this production is from 10% mills with more than 20,000 M.T/annum installed capacity. These large mills are mostly utilising fibrous raw materials of bamboo aud mixed hardwood in a ratio varying from 80 : 20 to 60 : 40. The characteristics of these raw materials are different from the raw materials used by different mills in the North American and European countries. It is, therfore, necessary to understand that the technology used for abatement of enviromental pollution in these countries cannot be adopted in India.

Production of pulp and paper affects the environment from the process waste discharges in air and water. Such discharges originate broadly from the fibrous components of raw materials process chemicals, and burning of fuels for steam and power generation. To protect the environment, it is necessary that the level of these pollutants are restricted to the accepted limits, by taking proper inplant control measures as well as by installing suitable treatment systems. It is, however, observed that sometimes it is difficult to introduce necessary control systems in the old mills and the total treatment system often becomes unwieldy for the unit to sustain its costs. Proper discharge levels have therefore, to be fixed in to account historical background for setting of such mills and all other relevant factors.

The Orient Paper Mills, Amlai have been conscious of their responsibilities for protection of environment and have taken effective steps for abatement of pollution, as explained here after.

EFFLUENT TREATMENT AT O.P. MILLS AMLAI

In Plant measures were taken at the planning stage itself to contain pollution to a minimum possible level by installing Disc Saveall in Paper Machine to reduce fibrous discharges into the effluent ; ehemical recovery boiler along with electrostatic precipitator, to control process chemical discharges into the atmosphere as well as effluents ; recycling of backwater at various stages in process to reduce effluent discharges ; multicyclone separators in boiler to reduce SPM discharged in atmosphere ; and dust and fume extractors in different plants, Immediately after start up of the mills, and much before the enactments of present anti-pollution laws by the Government, an extensive rescarch work for evolving a suitable effluent tereatment system was undertaken in collaboration with CPHERI (now NEERI) Nagpur. The total drainage system was so planned as to segregate effluents depending upon their colour and other characteristics. The physio-chemical characteristics of waste water from different plants were strudied in detail and were found as given in Table–I

*Orient Paper Mills, Amlai.

Table—1

Physio–chemical characteristics of difierent drains of Gr. II and III effluents at O.P. Mills. Amlai

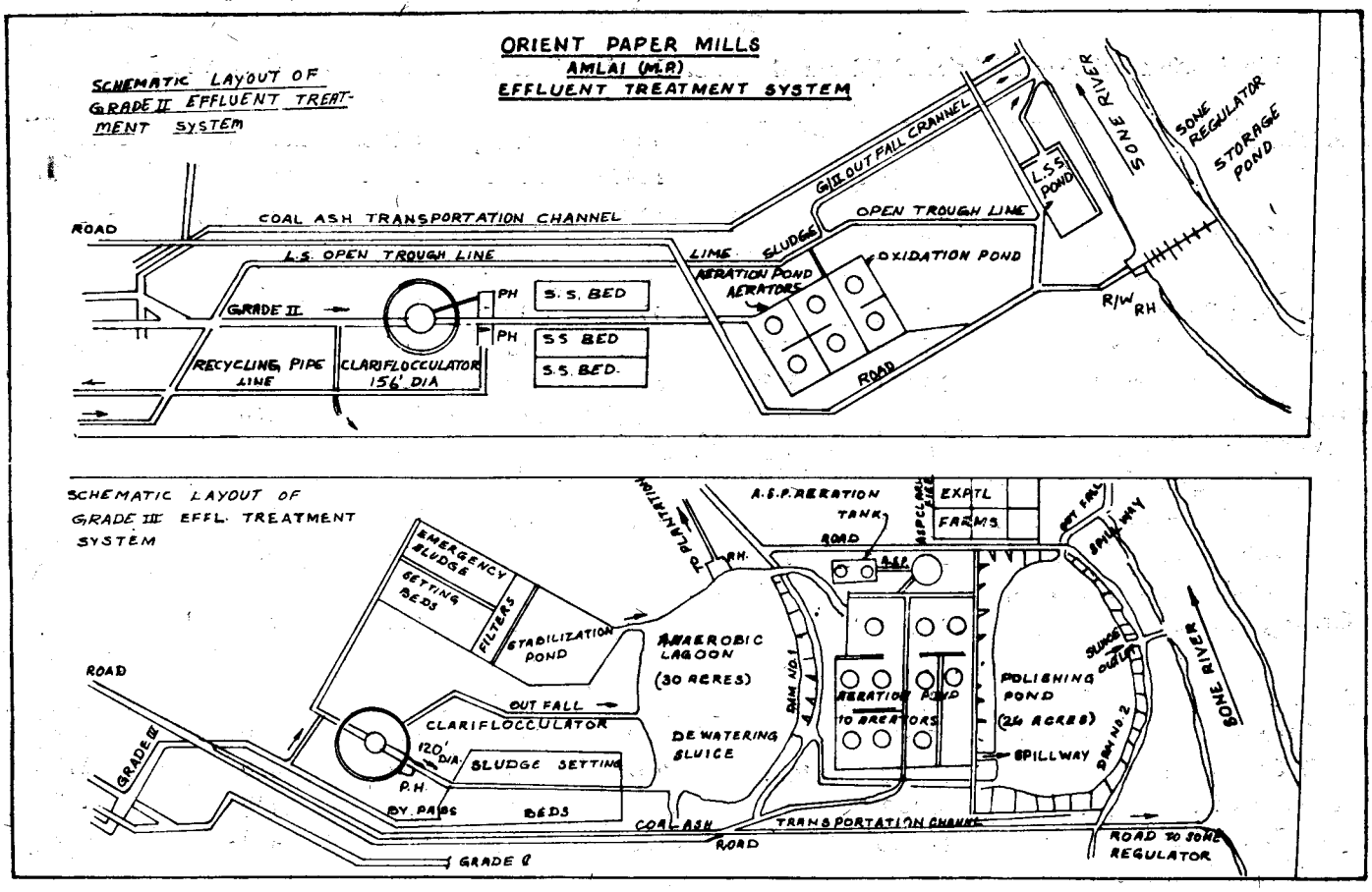
S. No. Sections	Flow M^3/day	pH	Colour Pt-Co Unit	BOD_5 Mg/l	COD Mg/l	Suspended solid mg/l	Chloride mg/l
I. Grade-II							
(i) Pilot Plant	1,000	5.7	175	10	88	680	91
(ii) Paper Machine	6,630	7.9	350	10	112	60	127
(iii) Chlorine Washer	14,340	3 6	600	20	160	170	710
(iv) Hypo Whasher	,,	7.3	150	20	128	160	774
(v) Chipper House Tail end drain	9,890	9 0	500	20	80	640	135
No. 1 (combined I & II)	8,630	6.5	370	40	180	750	84
Tail end drain No.3 (combined III & IV)	14,340	4.2	500	50	640	350	550
Gr. II Untreated	31,860	6 0 to 10.5	300	45	180	500-800	490
II. Grade-III							
(i)Washing and screcning drain	7,060	9.0	6000	450	1500	650	250
(ii) Caustic Washer	10,040	10.0	8000	550	1800	450	210
(iii) S/R Malone Filter	4,140	10.5	3500	150	350	150	150
Tail end drain No. 2 (combined I & III)	11,200	9.0	4000	250	960	450	450
Tail end drain No. 4 (only II)	11,500	10 5	5000	350	1200	220	420
Gr. III Untreated	22,700	6.5-9.5	4000	200	700	400	520

It was seen that Grade -II effluent from Paper machine and hypo and chlorination stages of bleach plant was having lower BOD, COD and colour as compared to the Grade–III effluent discharged from the caustic wash stage of bleach plant, as well as washing and screening plants of pulp mill etc. As such separate treatment systems were evolved for these two categories of effluent. After carrying out Pilot plant level studies during 1959 to 1973, a full scale treatment plant was set-up, thereafter, in stages as given in Appendix–I and the treatment plant as it exists today is detailed in Appendix–II.

Simultaneously inplant controls were introduced to prevent spillages, leakages, overflows etc. Steps were also taken to improve process plant effi:iencies by improving vacuum of brown stock washers and lime mud washing with installation of additional mud washers, and overhauling blow heat recovery and disc Saveall units. Further effluent discharged was reduced by utilizing clarified Grade II effluent for process and pumping partly treated Grade III effluent in plantation areas.

MONITORING OF EFFLUENT TREATMENT SYSTEM

For effective control, the working of the effluent treatment system, is regularly monitored. Hourly composite samples are collected daily from inlet and



outlet points of every stage of treatment and these samples are analysed for the parameters of BOD5, COD, Suspended solids, pH, Chloride concentration, temperature etc. in the R & D Laboratories. Random Checking is also being done by MPPNM staff at site.

TOXICITY TEST

Effluent is tested from time to time to determine its toxicity. The testing is being carried out according to IS–6582–1971 using locally available Rohu (Cyprinus Carpio) fish of 5 to 7 cm length. Results indicate that both the Grade II and Grade III effluents are non–toxic.

DISCOLOURATION OF GRADE III EFFLUENT

The coloured Grade III effluent, after its treatment, even though is non-toxic and is not harmful, it is non-asatethic and is not readily acceptable to human beings. Constant efforts are being done by the mills to develop a viable process for decolouration of Grade III coloured effluent.

Dr. Pillai, who had done similar work fo Kerala HPC Newsprint unit was invited for investigations. It was oberved by him that the process developed for Kerala Newsprint unit was not viable for Amlai Gr. III effluent. Agencies like CPPRI, Dehradun were also called. It was observed that alum, even though is useful in coagulatating non-biogradable materials like ligno-compounds, the process involves further treatment as effluent pH was getting reduced below acceptable limits, and overall costs are extraordinarily high.

Simultaneously R & D Division of the mills had taken up this project. The experiments indicated that effluent colour can be reduced by addition of calcium hypochlorite to the treated effluent. This decolouration is due to oxidation of ligno compound and reduction in COD and BOD_5 values was also available. Based on these findings, the mills started adding hypochlorite in polishing pond regularly for past one year, while maintaining chlorides below prescribed limits of 1000 mg/l. About 60–65% reduction in colour has been achieved after this treatment.

FINAL EFFLUENT CHARCTERISTICS AND QUANTITY D.SCHARGED

The final characteristics of the effluents discharged are given in the Appendix–II alongwith details of the plant. Total BOD_5 ond Suspended solids load of the effluents discharged in terms of kg/ton of paper have been tabulated in Table-2 alongwith data regarding water consumption and quantity of total effluent discharged in m^3/ton of paper.

It can be observed that, during past 5 years, BOD load has come down from 12.17 kgs to 6.04 kgs/ton of paper while Suspended solids are reduced from 13.09 kg to 11.03 kg per ton of paper. Simultaneous reduction in consumption of water and discharge of effluent have also been achieved.

Permissible BOD load in different countries in kg/ton of paper produced has been presented in Table–3. On comparing Table–2 with Table–3, it is clear that O.P.M. effluent discharge is well within the International acceptance limits except that of U.S.A.

Table—2

Quantity of water consumption effluent discharged, BOD load and Suspended solid load.

S No.	Particulars	1982-83	1983-84	1984-85	1985-86	1986-87
1.	Water consumption M^3/ tonne of paper	332.59	292.69	318.67	294.22	283.33
2	Trade Effluent discharged total M^3/tonne of paper	238.09	223.12	216:01	193.67	179.57
3.	BOD load of total effiuent discharged kg/tonne of paper	12.17	12.42	10.51	8.72	6.04
4.	Suspended solids of total effluent discharged kg/tonne of paper.	13 09	13.65	13.81	11 82	11.03

Table–3

Permissible BOD load unit in various countries

S. No.	Name of country	Product	Unit	Maximum BOD load
1.	Canada	Kraft pulping	Kg/A.D M.T.	29
	Canada	Kraft bleaching	Kg/A.D.M.T.	12
2.	Finland	Sulfate integrated bleached	Kg/M.T.	25
3.	France	Kraft bleached	Kg/Ton	9
4.	Japan	Kraft bleached	B.O.D. Mg/1	120
5.	Sweden	Kraft bleached	$B.O.D_1$/Kg/Ton	8-9
6.	Australia (Tasmania)	Full chemical pulping	Kg/Ton of A.D.	25
	,,	Full chemical pulp bleaching	Kg/Ton	15
	,,	Paper and Board Mill	Kg/Ton	10
7.	U.S.A.	Sulfate bleached integrated	Kg/Ton	10.6 (24 hrs)
		,,	,,	5.5 Monthly
		,,	,,	3.1 Yearly

Data is taken from "Compendium of environmental guide lines and standards for Industrial discharges"

The mills are continuing their efforts to further improve the characteristics of effluents. An activated sludge treatment plant has been commissioned recently for further improving treatment of Grade III effluent and reduce pollution load further.

LIME SLUDGE DISPOSAL

Storage of about 120 tonnes of daily lime sludge waste from recausticizing plant of chemical recovery area is done into two large storage tanks, constructed along the left bank of the Sone river. The clear supernatant of this sludge settling pond is added into Gr. II effluent while the sludge deposits are flushed out by water jets during high monsoon floods with consent of MPPNM.

COAL ASH DISPOSAL

The coal ash from boiler house is hydro-excavated in the from of slurry and is transported by gravity through a speeially built open channel into settling ponds. Unbrunt coal pieces along ash cinders etc. are settled in these open ponds while overflow is discharged into the river Sone at a point, downstream of Grade II discharge channel.

The settled unburnt coal, coal ash and cinders are wet screened and disposed off to brick and low grade cement manufacturers.

INSTALLATION AND OPERATING COSTS OF EFFLUENT TREATMENT

The mills have spent about Rs. 2.0 crores, on construction of different effluent treatment works including ASP during past 12 years. The present recurring annual cost in running and maintenance of this treatment plant is about 35 lacs and works out to about Rs, 52/- per ton of paper, without taking into consideration interest charges on the capital investments, and depreciation etc.

IRRIGATIONAL UTILIZATION OF EFFLUENT

The R & D Division of O.P. Mills have been carrying out detailed investigations about utilization of coloured effluent for irrigational purposes, for past 14–15 years. Studies for agricultural irrigation with effluents were undertaken in collaboration with NEERI, Nagpur and it was concluded that crops like wheat, barley, oats, paddy, maize, jowar, bajra, eoconuts, banana, sugarcane etc. can be raised with advantage, without any adverse effects from treated Grade III effluent.

Similar study on raising eucalyptus and other plantations is being carried out in collaboration with BISR Simultaneously soil conditions are being investitigated. Effect of flooded irrigation of eucalyptus with Gr. III effluent is also being studied for last 7–8 years. It was observed that better wood volume is available with such irrigation with an advantage of less denser wood and comparatively longer fibres. Modifications in sowing and planting practices of agricultural crops have been worked out to counter the salinity trends with effluent irrigation.

These studies have indicated that coloured pulp and paper mill effiuents can be effectively utilised on land for raising agricultural crops as well as plantations Such utiiisation shall not only improve ecological balance and solve asethetic problem of coloured effluent discharges but also provide vital products for the Industries and mankind.

AIR POLLUTION ABATEMENT

The mill have taken steps from the planning stage itself to control air pollution. Electrostatic precipitation in Recovery Boiler and multi-cyclone separators in Power Boilers were installed to check SPM discharges into the atmosphare through stacks. Wet bamboo chipping and washing fine chips mixed with dust etc is incorporated in Chipper house process. To reduce fly dust during chipping operation, dust extractors have also been provided in the plant to reduce fugutive emissions. Fume extractors have also been provided in other plants wherever necessary.

Detailed air pollution survey was conducted in collaboration with NEERI, Nagpur and it was observed that even though SPM discharges through chimneys are marginally higher in comparison to the standards laid down for power plants the ambient air particulate matter in the surrounding area was within limits

To reduce the SPM and other chemical discharges a new ESP unit with 98.5% efficiency is being installed in the Recovery Boiler. Further improve-

ments based on the recommendations of NEERI are being studied in details for their implementations.

The mills have developed a plantation in about 200 hectare area around the mills and have planted about 1,28,000 additional trees in the last three years. The mills have also distributed 1,37,000 sapplings to the farmers around the mills to develop social forestry and improve environment. Simultaneously R & D Division has taken up the project to undertake the study for the effect of air pollution around the mills

EFFORTS PLANNED FOR FURTHER IMPROVEMENTS

The experiments for developing a viable process for complete de-colourisation of coloured effect are continuing in R & D Laboratories.

2 It is proposed to increase the plantation of eucalyptus and other pulpable varieties in the surrounding areas as a social forestry project and improve environment.

3. The mill is proposing to construct a holding lagoon for coloured effluent so as to reduce its discharge into the river during lean summer months.

The Khanna committee for the River Sone pollution abatement have also recommended for construction of such a lagoon and the local Government authorities have now initiated steps for necessary land procurement. Immediately after the availability of the land the mills propose to construct this lagoon having a retention period of minimum 75 days.

4. A new ESP with 98.5% efficiency is being erected in chemical recovery boiler to reduce SPM chemical discharges through the stacks.

5. Power boiler manufacturers and other consulting agencies are being contacted for improving the multicyclone separator efficiency for reducing SPM discharges through their stacks.

Constant effort is being done by the mill to improve environment and reduce pollution both in air and water.

ACTION PLAN SUGGESTIONS FOR PAPER INDUSTRY

Based on the experiences, gained while solving the environmental problems, the following suggestions are made.

1. Inplant control measures and good house keeping prevent formation of pollutants and should be taken up on priority basis.

— Preventing spillages, leaks, overflows etc. recycling them into the process after collection if necessary.

— Avoiding overloading of process equipments to prevent accident losses/leaks.

— Improving process and equipment efficiency and to close the system as far as possible.

REDUCING WATTER CONSUMPTION

The standards laid for discharge can be easily met by diluting the effluents, but it is no solution to the problem. Recycling process backwater, as such or even after partial treatment shall reduce the total pollutants discharged and should be planned to the maximum extent possible.

3. DEVELOPING IRRIGATIONAL FACILITIES WITH COLOURED EFFLUENT

The coloured effluent after its treatment can be effectively utilised on land for raising agricultural crops as well as plantations in the surrounding areas. This will not only solve the water pollution problems, but also develop natural cover for abating air pollutant while providing additional resources to increase GNP of our country.

An integrated approach from Local Government authorities State Irrigation and Forest departments and the Paper Industries is necessary for such utilisation.

4. UTILISATION OF SOLID WASTES FOR AUCILLIARY INDUSTRIES :

There is a big possibility of utilising the solid wastes of the paper industry particularly Coal and fly ash and lime sludge etc. for manufacture of special bricks, medium grade cement etc.

5. Technology and knowledge is today available for bringing down the pollution impact to a low level but such measures are highly expensive for implementing, particularly in existing mills. It is therefore necessary to define and fix appropriate discharge levels for the mills on the basis of historical background and environment impact with an ultimate aim to achieve national standards/Minas, in a phased manner.

In the present conditions, the responsibility of abating pollution is thurst upon, more less, entirely on the Industry while greater part of the benefits arising from such measures are flowing to the entire Nation. The Government in larger interest should come forward to help the Industries in setting up well designed comprehensive pollution control system by giving suitable technical advice and cash subsidy both in capital and recurring expenditure as well as by providing soft loans for setting up of such units.

Proper representation should be given to the representative of Paper Industry on the Central and State Pollution Control Boards to provide them a sense of involvement in the environment protection programme alongwith foaum for expressing their view points.

APPENDIX—I

DETAILS OF EFFLUENT TREATMENT PLANT CONSTRUCTION STAGES

1. The drainage system was laid to collect different qualities of effluent separately for their suitable treatment.
2. Discharge of lime sludge to the river not done in fair weather but was stored.
3. Two nos. of lagoons for settling Suspended solids and one 380,000 KL capacity anaerobic lagoon no. 1 was constructed for treatment of Grade III effluent in the year 1973–74. This anaerobic lagoon is having a retention period of 20 days and is regularly being charged with seedling materials and neutrients for anaerobic action to reduce BOD and COD of the effluent. Another lagoon no. 2 covering a storage of about 15 days was constructed in the year 1975–76 as polishing pond to settle down the biological mass which further reduces pollution load.
4. Utilisation of 0.5 mgd of Grade III effluent by pumping for irrigation of eucalyptus plantation on 30 acres was also started in the year 1976–77.
5. One 156′ dia clariflocculator alongwith underflow sludge ponds was commissioned in the year 1978 for treatment of Gr. II effluent.
6. A uniclarifier was installed in the year 1978–79 to improve lime sludge washing and reduce alkali carry over into the effluent.
7. An aeration cum oxidation pond comprising 6 nos. of surface aerators was commissioned In the year 1979–80 to further reduce BOD load of Grade II effluent.
8. An aeration pond comprising 10 nos. of surface aerators was constructed in between lagoon no. 1 and 2 to further reduce BOD load of Grade III brown coloured effluent and was commissioned in the year 1980.
9. A pumping plant was installed to pump about 0.5 MGD effluent near lagoon no. 1 spillway on plantations near Guest House. This was commissioned in the year 1980. In 1985–86 the pumping capacity was increased to 1.0 MGD.
10. One 120′ dia clariflocculator was commissioned in the year 1982 for primary treatment of Grade III effluent.
11. Simultaneously in 1985 – 86 action was taken to pump Gr. III effluent for land disposal on available land and plantation of south side of factory but had to be discontinued due to objections raised by WCL (Now SECL).
12. One pumping unit was installed in the year 1980–81 to recycle about 1.5 to 1.8 MGD of clarified Grade II effluent in the mill process and reduce Grade II effluent discharge.
13. One 80′ dia white water clarifier was constructed and commissioned in 1982–83 for clarifying paper machine effluent and recycling about 1.5 to 1.8 MGD of this clarified effluent in the mill process and reduce Gr. II effluent discharge.
14. One mud washer was installed in the year 1984–85 to further improve lime mud washing and reduce alkali carry over in effluent.
15. Two nos. lime mud sludge settling pond were constructed to store sludge and discharge the same only during rainy season as permitted by M.P.P.N.M.
16. About 300 ppm calcium hypochlorite addition in polishing pond (Lagoon no. 2) was started in April 1986 and still continue to reduce the colour as Well as BOD and COD of Gr. III effluent.

17. Simultaneously many other minor jobs have been undertaken like deepening of Lagoon no. 2, diverting Pilot Plant effluent into Gr. II, inplant control, recycling, plant leakages and spillages in the process.

18. The mills have commissioned an activated sludge treatment system after anaerobic Lagoon no. 1 with equipments supplied by M/s Hindustan Dorr–Oliver, Bombay. The process is being stabilished with build.up of MLSS to obtain guaranteed results.

APPENDIX–II

DETAILS OF EFFLUENT TREATMENT PLANT AT ORIENT PAPER MILLS : AMLAI

Introduction :

The orient Paper Mills have been alive to the problem of pollution from the industry and have taken steps to control it from the inception stage itself The pioneering work from Pollution Control has been started by the mills even before the enactments of the Pollution Control Act.

The effluent at O.P. Mills is segregated into three grades depending upon the quality of the discharge.

Grade–I

The Grade–I effluent is clear water of condensates and cooling system of various equipments. It is directly recycled in the process.

Grade–II Effluent

The effluent which is biologically degradable in nature and pale yellowish in colour is termed as GradeII. It comprises of :—

1. White water from Stock Preparation and paper machine.
2. Out flow from chlorination and hypo sections of the bleach plant.
3. Wash water from Chipper House and grit collector.
4. Supernatent from the Causticizer plant of the Soda Recovery Section.

Grade II Raw Effluent Characteristics

Quantity	:	27300–31100 M^3/day
pH	:	7.0–9.0
BOD_5	:	100–150 mg/l
COD	:	150–230 mg/l
Suspended solid	:	300–800 mg/l
Chlorides	:	300–500 mg/l

To reduce the quantity of this effluent and recycle it to the maximum extent a white water clarifier with presettler and storage tank has been provided to process part of the paper machine effluent and use the same in pulp mill. The particulars of this clarifier as follows :

White Water Clarifier

Volume	—	9100 M^3/day
Dia	—	24.38 M
Side water depth	—	3.66 M

About 7000–8000 m^3/day of this clarifier effluent is reused in the pulp mill.

Remaining effluent is given 2–tier treatment in clariflocculator and aeration cum oxidation pond, the details of which are as below :

(a) Primary Clariflocculator

Primary treatment in Clariflocculator :
Volume of the wash water

1. Present flow	—	About 27300 M^3/d
2. Design flow	—	36000 M^3/d
Diameter of the clariflocculator		47.55 M
Inner floculating chamber		
Diameter	—	15.92 M
Side water depth	—	3.05 M
Retention time	—	45 minutes in flocculator chamber 3.5 hrs. in the clarification Zone for the flow of 36×103 m^3/d
Volume of sludge	—	730 m^3/d
Solid concentration in the sludge	—	1.0–2.0

After primary tteatment about 7900–8200 m/day of Gr. II effluent is pumped back for reuse in flume line of Chipper House and remaining effluent is given

secondary treatment in the aeration cum oxidation pond.

(b) Secondary treatment

Inlet volume of effluent	— 18000–23000 M^3/d
Depth of lagoon	— 3 2 m
Retention time	
(i) for present flow	— 7 days
(ii) for design flow	— 5 days
Number of aerators	— 6

(EIMCO — KCP surface Aerators are used)

Total horse power	— 135 HP (5 × 25 HP + 1 × 10 HP)
Oxygenation capacity of aerators	— 1,5 kg Oxygen/HP/hr
Total Oxygen transfer anticipated (95% of rated capacity)	— 205 kg/hr

The characteristics of final treated effluent are as follows ;

pH	— 7.0–8.5
BOD_5	— 15–30 mg/l
COD	— 80–150 mg/l
Suspended solid	— 25–50 mg/l
Chlorides	— 300–450 mg/l

Grade III effluent

The effluent which is biologically non–degradable in nature and blackish brown in colour is termed as Gr. III effluent, It is comprised of :

1. Wash liquor from Pulp mill.
2. Brown stock washer.
3. Black liquor spills leakage from digester house.
4. Caustic extraction effluent from the pulp mill bleach plant.

Grade III raw effluent characteristics

Quantity — 20,000	— 22,700 M^3/d

Characteristics

pH	— 7.0–10.5
BOD_5	— 100–400 Mg/l
COD	— 400–800 Mg/l
Suspended solid	— 200–500 Mg/l
Chlorides	— 500–700 Mg/l
Colour	— 4000–6500 Pt–Co Unit

Details of its treatment equipments are as below :

Primary treatment

Clariflocculator :

Volume of wash water	— 20000–22700 M^3/d
Diameter of the Clariflocculator	— 30.73 M
Inner flocculating chamber diameter	— 15.39 M
Side water depth	— 3.60 M
Detention time	—45 minutes in flocculator chamber 3.5 hrs. in the clarification zone
Volume of sludge	— 545 M^3/d
Solid concentration in the sludge	— 1.0%

Secondary treatment :

1. Stage I—Anaerobic treatment in Lagoon No. I of 380,000 m^3 capacity with 20 days retention period.

Nutrients addition – Urea – 150 – 200 kgs/d
Superphosphate 250–300 kgs/d

Anaerobic Lagoon

Capacity	— 0.386×106M^3 (with an area of 13.4 hectares)
Water depth	— 1 M to 10 M
Detention time	— 20 days

To reduce its discharge, three pumping stations of following capacities have been provided to pump the effluent into the available plantation area

North side	—
Pump No. 1	— 2270 M^3/day
Pump No. 2	— 4550 M^3/day
South side	
Pump No. 3	— 5500 M^3/day*

(*Stopped since one year as there was seepage into the underground coal mines just below it)

Remaining Grade III effluent is further given aerobic treatment and stabilized in the polishing pond.

Stage II—Aerobic treatment

Aerated Lagoon :

Depth of aeration pond	— 2.74 M

No. of aerators (EIMCO–KCP)	— 10
Total horse power	— 115 (1 × 25 HP + 9 × 10HP)
Oxygenation capacity	— 1.59/kg/HP/hr
Total Oxygen transfer	— 182 Kg Oxygen/hr
Detention time	— 7 days for the present flow

Stage III

Polishing pond :

Area	— 12 hectares
Detention time	— 15 days

Tertiary treatment

Addition of Calcium hypochlorite	— Inplant at the caustic extraction stage about 2.0 T/day. At the inlet of polishing pond about 8.0 T/day

The present characteristics of Grade II_I effluent after above treatment are as below :

pH	— 7.5–8.5
BOD_5	— 40–50 Mg/l
COD	— 220–250 Mg/l
Suspended solid	— 60–90 Mg/l
Colour	— 600–650 Pt. Unit

Activated sludge plant

Activated sludge process equipments of following specification have bee installed before the polishing pond in Sept. 87.

1. Nutrient addition tank with agitators – 2 Nos.
2. Aeration tank – 40 m × 40 m × 3.3 m S.W.D. fitted with 4 nos. 30 H.P. surface aerators.
3. Clarifier tank – 35 m dia × 3.3 m S.W.D. with Central drive.
4. Return sludge pumps – 2nos capacity 370 M^3/hr.

The plant has been commissioned in September 1987 and is being stabilized to obtain desired results, as guaranteed by M/s Hindustan Dorr–Oliver.

The characters of BOD, COD, SS of finalled combined and treated discharge (effluent) should have been given, to assess the efficiency of all equipment installed.