and laying the disposal pipe line, a number of construction problems came up, a few among them are illustrated in brief as under :—

CONSTRUCTION OF LAGOON DYKE ON SLUSHY GROUND :

i) The lower portion of the valley where a portion of effluent treatment plant is located, has been a low lying area forming water pool for all the year round. Due to sedimentation of suspenned solids in this area for number of years, a deposition of slushy layer to the extent of about 8 meter depth has formed. Constructing the last dyke in this area had real problems. After detail investigation it was decided to construct the dyke by displacement of the slushy mass with the overburden of the material filled for the construction of dyke. A portion of the dyke had slip-failure but stabilized and completed successfully.

ii) A similar problem was faced during laying of disposal pipe and providing manholes in the slushy area. The manholes are being constructed on short piles whereas the sand bed has been provided for laying the disposal pipe line.

iii) Laying of effluent disposal pipe through high railway embankment was solved by providing inverted syphon under the nearest railway culvert.

iv) Power cable of submerged type for the aerators was originally decided but such cable was not available indigenously. All such overhead arrangement for laying the cable over the R.C.C. Poles required specias consideration.

Indian Water Pollution Standards-A Case for Revision

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SUMMARY

The paper touches upon water pollution standards in United States, Canada, Sweden, Japan, Australia and Brazil. A comparison is made of these international standards with Indian water pollution standards, which shows the need for revising Indian water pollution standards in case of paper industry to judge each mill on its own merits.

The difficulties in achieving maximum water recycling in Indian context are discussed. A strong R & D effort encompassing universities, research institutes and industry all over the country is necessary to evolve low cost industrial waste treatment processes. Liberal help from Government agencies and financial institutions is essential to solve the problem of industrial pollution.

INTRODUCTION

The need to protect environment for common good is urgent and cannot be over-emphasized. Fresh air, clean water and fertile land form the essentials of healthy community. In this respect, water pollution act by Government of India in March 1974 was a step in the right direction.

The state polution control boards are mostly guided by Indian standards on water pollution, viz, IS : 2490-1974 for discharge of the effluents into in-land surface water and IS : 3307-1965 for utilising the effluent on land for irrigation. The above Indian standards offer tolerance limits for all industrial effluents and do not distinguish industrial effluents based on the kind of industry, type of process in the specific industry, the

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location of the industry, the nature, flow and end-use of the receiving water streams into which the effluent is discharged, the degree of pollution caused to the receiving streams, etc.

Pulp and paper industry comes under a special category in view of its huge consumption of water, A 100 TPD (tonnes per day) integrated paper mill consumes around 7.5 MGD (million gallons per day) of raw water. The nature of pulp and paper industry was taken into account abroad both in the developed and developing countries in formulating their standards for pollution control.

INTERNATIONAL WATER POLLUTION STANDARDS

The following is a brief account of the position on water pollution standards in some of the foreign countries :

UNITED STATES

The Federal Water Quality Act (1965) required states to adopt water quality criteria applicable to in-transtate waters. It generally required discharges to provide for removal of all settleable solids and the equivalent of secondary treatment.

By 1976, the paper industry was advised to remove 95% of the suspended solids in its waste water through primary treatment and reduce biological oxygen demand (BOD) by 90% through secondary treatment. Furthermore, the federal water pollution control act amendments declared (to be the national goal) that the discharge of pollutants into navigable waters be eliminated by 1985—which is commonly referred to as zero effluent discharge. In attaining this goal, an attempt has been made to spread the economic inpact over two five-year interim goals. No later than July 1, 1977 most industrial sources must achieve effluent limitations which require application of "the best practicable control technology currently available". No later than July 1, 1983, effluent limitations must be achieved by most industrial sources which require application of "the best available technology economically achieveable". Besides, the Act created National Study Commission charged with making full investigation of all the technological aspects of achievement, and the total economic, social, and environmental effects of achieving or not achieving the 1983 interim goals.

CANADA

The country has national baseline regulations established under the Fisheries Act, Effluent standards specify the concentration of substance which any water user may discharge. For pulp and paper industry these allowances are set in terms of the basic pulping processes as given in Table 2.

TABLE – I

PERMITTED DEPOSITS OF TOTAL SUSPENDED SOLIDS IN THE EFFLUENT OF MILLS IN POUNDS PER TON*

Sl. No.	Component Process Category	Existing Kraft Sulphite or Semi-chemical Mill	New Expanded or Altered Kraft Sulphite or Semi-chemical Mill	Existing Mechanical Mill	New Expanded or altered Mechanical Mill
1.	Wood rewashing	5	5	5	5
2.	Debarking Hydraulic Process	5	5	5	5
3.	Debarking—Wet Drum Process	10	8	10	8
4.	Pulping	7	5	13	10
5.	Bleaching	6	4	2	2
6.	Pulp Sheet Formation	2	1	5	4
7.	Integrated Single Product Paper Making	3	2	5	4
8.	Integrated, Specially Single-product Paper Making	6	4	10	8
9.	Tissue Paper Making	15	10	20	15
10.	Fine and Specialty Multi-product Paper Making	25	20	25	20
11.	Cylinder Paper or Paperboard Manufacture	15	12	15	12
12.	Neutral Sulphite Semi-chemical Corrugating Medium	7	7		

* "Ton" means in respect of a component process category in :
a) items 1 to 3, an over-dry ton of wood processed without the bark,
b) items 4 to 6, an air-dry ton of product and
c) items 7 to 12, a ton of product as produced.

Source : Canada Gazette Part II, Vol. 105, No. 22 (Reference) Nov. 1971.

SWEDEN

The 1969 law forbids any pollution of the environment which is technically and economically possible to avoid; the law also defined the role of the National Environmental Protection Board (NEPB). The Board however has not adopted any standards (as such) for mill effluents. Every case is judged on its own merits.

JAPAN

The 1972 regulations specify different provisional standards for different products in the pu'p and paper industry. The national minimum standards based on clean water act specify pollutants to be within a BOD of 120 ppm and TSS of 150 ppm by 1976. It was proposed to change the pollution control concept from the parts per million (ppm) concept to total load concept.

AUSTRALIA

The guidelines for water pollution control in Australia for pulp and Paper miils are given in Schedule III (Regulation 3). part I, Statutory Rules 1974, No. 56 Pages 7 & 8.

The biological oxygen demand of the emission from a process specified in column I of the following table shall not exceed that specified in column II of the table with respect of that process :

Column I Process	Column II Maximum BOD/Kgs. Per day Air dry product
Full chemical pulping.	25
Cold caustic chemical pulping	45
Other semi-chemical	90
Full chemical pulp bleaching	15
Semi-chemical pulp bleaching	55
Paper and board manufacture	10
Hardwood manufacture	90

Furthermore, the non-filterable residue of the emission shall not exceed 200 milligrams per litre.

BRAZIL

The standards for effluent discharge in the state of Sao Paulo (as of 1975) in Brazil are given below :

pH	: 5 to 9
Temprature	: Under 40°C
Settling matters	: Under I ml/litre in sedimentation test of 1 hour in Imhoff cone.
Rate of flow	: Maximum 1.5 time the daily average.
Absent	: Floating matter, gases, combustible liquids or solids, explosives or corrosives; toxic products.

Furthermore, the state classifies water bodies in Table 3. Indian Water Pollution standards VS International Standards :

TABLE II

PERMITTED DEPOSITS OF OXYGEN-DEMANDING DECOMPOSIBLE ORGANIC MATTER IN POUNDS OF BOD PER AIR-DRY TON OF PRODUCT.

Type of Process	Ex sting Mili	New, Altered and Expanded Mill
Sulphite pulping yield of 55% or less	255	170
Sulphite pulping yield of more than 55% and less than 65%	170	115
Sulphite pulping yield of 65% or more	150	75
Sulphite bleaching (market pulp)	35	35
Kraft pulping	64	33
Kraft bleaching	27	27
Neutral Sulphite Semi-chemical pulping	80	60

Source : Canada Gazette Part II, Vol. 105, No, 22 (Refe rence), Nov. 1971.

Thus, in Australian and Canadian standards, due allowance has been given for the basic pulping process, whether the millis old or new or employing old technology or latest technology. For instance, Canada permits a BOD discharge of 41 kgs per air dry ton of bleached pulp as against 40 kgs in Australia. Many Indian Mills discharge much less BOD than 40 kgs/ton, viz. BOD of 25 kgs/ton in the case of Central Pulp Mills.

Indian water pollution standard for discharge into inland surface water (IS : 2490-1974) should also lay down flexible guidelines for the pulp and paper industry taking into an account the history of the pulp and paper mills, their location in an urban or rural setting, the nature and amount of effluent discharge from each mill, the flow rate in the receiving water stream and the end use for which its water is used and the extent of pollution caused to the receiving stream It will be advisable to specify a range of limits both in concentration (ppm) and in pollution load (kgs or tons/day). Due

emphasis on pollution load will goal the mills to achieve maximum possible recycling. In the final analysis, the guidelines should be flxible enough to empower the state water pollution board to judge each paper mill on its own merits. The recent legislation on water cess (enacted in Dec. 1977) will encourage the industry to adopt better water management in its operations, thereby cutting down its fresh water intake and reducing its pollution load to the sewer.

IN-PLANT CONTROLS

The first and foremost step consists in achieving maximum water recycling and thus cutting down pollution load to the sewer. Table No. 4 shows how far the industry progressed in reducing water consumption in the last decades through process modifications and efficient in-plant control measures.

As against water consumption of about 60,000 gallons/ton in bleaching in 1960s, the figure achieved today in some Scandinarian and North American pulp mills is around 4500 gallons/ton as given in Table 5.

It is worthwhile mentioning the dramatic modifications such as dynamic bleaching and sequential chlorination enabled almost complete recycling of bleach plant effluent in the bleached pulp mill. In paper mill too, fresh water make could be brought down to less than 1000 gallons/ton of paper for many varieties. Table 6 lists fresh water consumption per ton of paper (from pulp to paper) in some non-integrated paper mills.

It should, however, be remembered that developments in pulping, bleaching and papermaking called for huge investments, which could be met by the advanced countries with an established industrial base and ready capital market unlike in developing countries such as India.

It is estimated to cost twice as much to reduce BOD load from 35 kgs/ton to 15 kgs/ton of pulp by external treatment processes, compared to in-plant controls. In this connection, the attempt of Ontaric Paper Company in Canada in achieving zero effluent discharge is worthy of special mention. This is based on Rapson-Reeve process engineered by Enviromental Technical Services, Salt Cake City, Utah, USA.

POLLUTION TREATMENT IN INDIAN PAPER INDUSTRY–SOME PROBLEMS

Indian paper industry uses chlorination, extraction, hypo-chlorite (stage 1) and hypochlorite (stage 2) bleaching sequence (CEHH) to produce 75-80 GE brightness pulps. The lack of 317 stainless steel indigenously and its expensive cost inhibits recycling of chlorination effluent (which accounts for nearly fifty percent of the effluent in the bleaching plant). This is a key research area, where pulp and paper technologists, materials engineers and enviromental engineers could work together to develop suitable materials of construction to handle the highly acidic and corrosive chlorination effluent.

TABLE—III

CLASSIFICATION OF WATER BODIES IN THE STATE OF SAO PAULO

	Class I	Class II	Class III	Class IV	Special Class
Floating matter	N	N	N	Water intended for waste removal. Its pollution characteristics are defined by the fiscal agent, after studying each particular case.	Discharge of effluents not allowed even if treated.
Oils and fats	N	N	N		
Smelly substances or those having a toaste	N	N	N		
Toxic or potentially toxic substances	N	N	N		
Color	N	N S	N S		
Turbidity	N	N S	N S		
Phenols	0,001 mg/l	0,001 mg/l	N S		
Coliofrms (NMP)	5,000/100 ml	10,000/100 ml	20.000/100 ml		
BOD_5	Upto 3, Omg/l	Upto 5, Omg/l	Upto 7, Omg/l		
Dissolved oxygen	70% of saturation point	60% of saturation point	50% of saturation point		
pH	5 to 9	5 to 9	5 to 9		

N = Nil or traces
NS = Not specified

It is not possible to substitute chlorination with chlorine dioxide in India as is done abroad, without significantly increasing the production cost of pulp and paper. The question of going in for CEDED sequence, used in developed countries abroad, does not arise for a long time to come in this country, in view of the high capital expenditure necessary for chlorine dioxide generation and chlorine dioxide bleaching equipment and also

TABLE IV

WATER CONSUMPTION IN PULP AND PAPER MILLS IN NORTH AMERICA IN 1950s.

Sl. No.	Type of Mill	Average water consumption, gallons/ton
1.	Fine Paper Mills (Writing/Printing)	44,911
2.	Paper Mill (Wrapping)	24,200
3.	Paper Mill (Tissue)	19.000
4.	Paper Mill (Absorbent Filter)	1,00,000
5.	Paper Mill (Glassine)	79,000
6.	Board Mill	16,500
7.	Pulp Mill (Sulphite)	86,750
8.	Pulp Mill (Kraft)	50.000
9.	Pulp Mill (Soda)	34,600
10.	Pulp Mill (Ground wood)	10,000

because of the increase in bleaching operation costs. Again, Rapson's zero effluent discharge system is prohibitively expansive as it calls for more corrosive resistant equipment made up of Hastealloy-C or Cadmium (for example, bleach plant washers). Furthermore, to use Rapson's process, calcium ion in bleach liquor in India has to be replaced by sodium ion which leads to increased production cost in view of caustic soda's higher price compared to lime.

Despite the above problems, with judicious recycling measures it will not be difficult to achieve a water consumption of 35,000-40,000 gallons/ton of bleached pulp in a 100 TPD bleached kraft pulp mill.

Water consumption per ton of paper (from pulp to paper) could be brought down to 20,000 gallons/ton of paper. In fact, one of the India Paper mills could achieve a water consumption of around 9.000 gallons/ton of paper at a production rate of 200 Tonnes/day. Thus, it is possible to bring down water consumption to around 50,000 gallons/ton of paper in 100 TPD integrated paper mill based on bamboo/woods. The effluent load from such a mill will be around 4.5 MGD, as against 7.0 MGD in most mills at present.

REASERCH & DEVELOPMENT

As stated earlier, if chlorination effluent accounting for nearly 1.5 MGD in a 100 TPD bleached pulp mill is successfully recycled, water consumption could be brought down to 25,000 gallons/ton of pulp in the India paper industry. The problems to be studied in depth here are the reprecipitation of lignin when chlorination effluent is used for diluting unbleached pulp stock, besides corrosion of the equipment. In our hot and humid tropical mill working conditions corrosiveness is more promounced than under temperature wastern mills working conditions. It is doubtful even if 317 SS will stand continuous recycling of chlorination effluent in our setting. This aspect has to be examined in greater detail and a suitable (both technically and economically) material of construction has to be developed.

Again, the external treatment process working successfully abroad often run into problems under Indian conditions. Indepth laboratory and pilot plant work will have to be conducted on the pulp and paper mill effluents before a really successful and economical low cost effluent treatment system is evolved. This holds especially true for small and medium scale paper mills, where the cost for effluent treatment facilities could form a highly significant part of the total project cost. Meaningful results will be possible only when universities, pollution control authorities, research institutes and the paper mills work hand in hand on common research programmes. It may be mentioned that Rapson-Reeve process was fonded through a liberal grant from the Canadian Environmental Pollution Control Pro-programme. The work of National Environmental Engineering Research Institute, Nagpur and Central Salt, Marine and Research Institute, Bhavnagar, needs special mention.

TABLE V

TRENDS IN BLEACH PLANT WATER CONSUMPTION

Sl. No.	**Technology Level**	**Gallons/Air dried Ton**
1.	Old Technology, 1967	28.000-60.000
2.	Today's typical technology	12,000-32.000
3.	New technology	11,000-12,000
4.	Average for 20 North American bleach plants with	
	a. CEDED Sequence	8,100-13 700
	b. CEHDED Sequence	14,200-22 700
5.	Achieved today for CEDED Sequence	4,600
6.	Achievable based on laboratory experience with CRDED Sequence	1,600

TABLE VI

WATER USAGE PER TON IN NON-INTEGRATED PAPER MILLS

Sl. No.	Product	Location	Waterusage gallons/Ton.
1.	Board	West Germany	880
2.	Board	Western Canada	2200
3.	Coating raw stock	United Kingdom	1012
4.	Fluting medium	U.K.	594
5.	Crepe paper fluting and liner	West Germany	330
6.	Fluting and liner	WG	374
7.	Board	USA	275

It is indeed gratifying to note that NEERI, Nagpur, is studying the effect of soil in various parts of the country for the use of paper mill effluent in irrigation. The effect of trace elements in the mill effluent such as boron and also of salinity (NaCl) needs to be thoroughly studied on different kinds of soil.

LOCATION-A CRITICAL FACTOR

The present water pollution laws do not consider location as an important factor in environmental pollution control. Pollution from a factory in an industrialised metropolitis has more damaging effects than does pollution from the same factory in a backward rural area or forest. This fact is now recognised by the government in its over-all aspect and guidelines are made to encourage the setting up of new industries away from cities and urban areas.

Pollution control really starts at the drawing table in the planning and design stage. A judicious selection of site, incoporating built-in advantages of natural sedimentation and areation for the effluent on its way to the river, plays a vital part in combating pollution. Central Pulp Mills, for instance, provided a distance of 8 Km for its effluent to pass through, before meeting river Tapti. Table 7 shows the analysis of the mill effluent at the mill site, at various points on the way of the effluent to river and at the mixing point of the river.

TABLE—VII

ANALYSIS OF MILL COMPOSITION EFFLUENT AT DIFFERENT PLACES OF THE WAY TO GHODA NALA

Particulars	IS.3307-1965	Cen-pulp Mill Site	Vagada Village (1½ KM)	Ghoda Village (4 KM)	Pathadra Village (6 KM)	Mixing Point of River Tapti (8 KM)	IS.2490-1974
Colour (Pt-Co Units)		1150	160	200	85	80	
Conductivity (Micromhos/cm)		1337.8	961.4	66.8	459.8	443.0	
pH	5.5 to 9	8.5	9.0	8.4	8.2	7.9	5.5 to 9
P Alkalinity as $CaCO_3$ ppm		4	12	5	1	Nil	
M Alkalinity as $CaCO_3$ ppm		190	185	176	165	155	
Total suspended solids ppm		172	115	72	8	8	100
Total dissolved solids ppm		1220	680	420	260	220	
Chlorides as Cl		365	221	92	83	48	
Oxygen absorbed (4 hrs)		356	107	88	16	14	
COD ppm	500	1161 6	670	451	104	90	250
BOD (5 days at 20°C) ppm		180	80	57	13.5	10	30
BOD_5 reduction %			50	75	92	94	

The results in Table 7 clearly show that the effluent at the mixing point of the river is well within Indian Standard IS: 2490-1974 for discharge into inland surface water. It is also seen that the river water upstream and downstrehm is practically same, clearly indicating that river is not polluted. Besides the flow rate in river Tapti is never less than 10,000 cusecs (as against the mill effluent of 12 cusecs) and when the hydraulic turbines from Ukai hydroelectric plant run in full swing the river flow rate will be always greater than 20.000 cusecs providing trendous dilution for its effluent. This high dilution ratio of 1 : 1670 is responsible for maintaining water quality downstream the same as at upstream.

The present water pollution standards are not realistic enough to take account of the natural advantages to the mill based on its location, even though the community does not suffer the least from the mill's effluent and the river is not polluted.

GOVERNMENTAL ASSISTANCE

Investment in pollution treatment facilities, if the latter are deemed essential, is unproductive and adversely affects the mill's economy. The American Paper Institute Study, titled Economic Impact of Pollution Costs, conducted by URS Research Co. San Mateo, California, USA predicts a huge capital spending of $ 12.5 billion to meet Federal air and water standards by 1983. The study noted this spending could in stiffling of capacity expansion, leading to shortages, increased product prices, serious industry unemployment and add significantly to inflationary forces.

Should effluent treatment be essential, liberal, participation and help from federal and state government agencies and financial institutions in terms of equity participation, interest free long term loans, tax rebate, etc will be very much needed to offset the impact of unproductive investment on paper mill's economy and the ultimate paper prices. Land at nominal cost should be made available to the mills for using their effluent for irrigation. In case the effiueut volume is small as in small and medium paper mills, water at cheap price should be supplied to the mills to dilute their effluents to satisfy pollution standards.

CONCLUSION

The present Indian Water Pollutton Standards are too rigid and general. Unlike industrialised countries, there are no limits laid down specific to pulp & paper industry based on the pulping process, the age of the mill, location of the mill, the nature of the receiving water stream, the extent of pollution caused to the surface water, etc.

Indian standards are tougher than those of industrialised countries like Canada and Australia viz. with respect to biological oxygen demand (kgs/ton) emissions from a pulp/paper mill. There is an urgent need to make water pollution standards flexible enough to judge each paper mill's case on its own merits. These standards should judiciously serve the purpose of environmental protection without putting industrial growth in geopardy.