Total Water Management in Pulp & Paper Industry with Focus on Achieving 'Zero Effluent Discharge' Status.

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ABSTRACT

The pulp and paper industry is one of the largest and most polluting industries in the world; it is the third most polluting industry in North America. In India also, the industry falls under the category of most polluting industries.

Eliminating pollution from organochlorines has been the primary concern of the Pulp & Paper Industry research in the last decade. New technologies have emerged in the areas of oxygen de-lignification, ECF and TCF bleaching sequences which result in reduction in AOX discharge to water bodies. The average water consumption of Pulp and Paper mills in India is to the tune of about 200-259 cubic metres per tonne of paper. Hence, the Industry is no where near the goal of achieving 'Zero Discharge' status. The approach to be taken for closure of water systems is outlined in this paper.

INTRODUCTION

Pulp and paper is one of the world's largest industries, producing 178 million Tonnes of pulp , 278 million Tonnes of paper and paperboard, and consuming 670 million Tonnes of pulpwood. Growth for the next decade is expected to be between 2% and 3.5% annually,

Paper Industry is one of the core sector industries in India. Total installed capacity of this industry is approximately four million Tonnes. The capacity is distributed in terms of the raw material usage as follows:

Forest based	43%
Agricultural residue based	28%
Waste paper based	29%

Total number of paper mills is 380 with only 36 units having an installed capacity more than 24000 Tonnes. Most of the installations are old having less than contemporary installed technology.

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ENVIRONMENTAL CONCERNS

Pulp Mill

There are about 500 kraft mills (1), and many thousands of other types of pulp and paper mills, in the world. Primary concerns include the use of chlorine-based bleaches and resultant toxic emissions to air, water, and soil. With global annual growth forecast at 2.5%, the industry and its negative impacts could double by 2025. While society needs paper products, we also need to move to sustainable, environmentally safe production.

Pulp mills are voracious water users. Their consumption of fresh water can seriously harm habitat near mills, reduce water levels necessary for fish, and alter water temperature, a critical environmental factor for fish.

Effluent coming out of Pulp Mill operation contains the following pollutants:

- AOX into surface waters every day;
- Solid waste from re-causticizing operation;
- High levels of BOD, COD, suspended solids, dissolved solids and color in the water effluent

IMPACT OF AOX

Dioxins and furans are highly toxic organochlorines produced when chlorine compounds are used to bleach pulp. Environmental concerns arising out of AOX are due to the fact that many organochlorines have been shown to have toxic effects. Organochlorines are a significant component of effluent from pulp mills that still use chlorine compounds for bleaching.

Many organochlorines have been linked to health problems, such as cancer, birth defects, endometriosis, low sperm counts, and impaired foetal development. Organochlorines have also been shown to cause genetic damage and low survival rates of salmon and other fish. Organochlorines can last a long time in the environment (they are persistent) and build up in soils and animal, including human, tissues (they bioaccumulate).

Eliminating pollution from organochlorines has been the primary concern of the Pulp & Paper Industry research in the last decade.

PROCESS CHANGES REQUIRED FOR AOX REDUCTION

In the developed economics, Pulp and Paper Industry has been continually investing in the cleaner manufacturing technologies since early 80's. New technologies have emerged in the areas of oxygen de-lignification, ECF and TCF bleaching sequences, recovery of solids and almost zero -discharge concept. Aim of all these developments has been to reduce pollutant loads of SS, BOD, COD, Organic Chlorine Compounds (AOX) and wastewater discharge.

Totally chlorine-free, zero discharge pulp mills, which produce no liquid effluent and minimize the quantity and toxicity of air pollution and solid waste, are a desirable and achievable goal.

Closed -loop operations will eliminate all toxicity to aquatic environments by eliminating all discharge into them. This is important because some toxicity continues to cause harm, even in mills using no chlorinated compounds. Additionally, water use will be significantly reduced, leaving more water for fish habitat and other uses.

Oxygen-based kraft pulps show no appreciable shortcomings in pulp quality compared to products bleached with chlorine dioxide.

TCF mills have the lowest wastewater toxicity and by not using dangerous chlorine compounds, the closed-loop systems are more feasible.

Converting an existing mill to a TCF mill requires significant capital investment.

In 1992, British Columbia passed one of its most important pieces of environmental legislation: the Pulp Mill and Pulp and Paper Mill Liquid Effluent Control Regulation, also known as the "Zero AOX" law (2). The law gave mills 10 years to eliminate organochlorines (AOX) from their liquid effluent.

The law has to stages. The first stage required pulp mills to reduce the amount of organochlorines in

wastewater from an average of 10 kg per air-dried tonne (kg/adt) of pulp to 1.5 kg/adt by 1995. The second stage reequires that there be no organochlorines (Zero AOX) in mill effluent by 2002. Today, about three years from the deadline, industry has stalled at around 0.7 kg/adt AOX.

In India, the Central Pollution Control Board has asked the Industry to reduce AOX discharge to a level 2 kg per tonne of pulp.

AOX is a good indicator of technological advancement. Because of the improvements required to eliminate AOX, mills achieving Zero AOX are among the most technologically advanced. They make efficient use of energy, water, and other resources. Worldwide, mills capable of Zero AOX are also those mills capable of extremely low or Zero Discharge (closed-loop recycling) of their liquid wastes.

With the present state of technology advances, it appears that oxygen based, closed loop kraft pulp mills are the best route forward to a successful and ecologically responsible kraft pulp industry.

Effluent from Pulp Mill and Chemical Recovery Plants, after the removal of AOX as stated above, has high level of BOD, COD, suspended and dissolved solids.

The pulp mill effluent stream is mixed with paper mill effluent and sent to conventional effluent treatment facility.

PAPER MILL

Liquid effluent coming out of Paper mill operation contains the following pollutants:

- BOD, COD and dissolved solids
- Cellulose fibres

TABLE-1

Water Consumption in the Pulp & Paper Industry in India.		
Large Mill	:	150-250m³/t
Small Mill	:	250-300m³/t
Waste Paper Based Mill	:	100-150m³/t

- Inorganic fillers such as clay, Talc, TiO_2, Calcium Carbonate etc.

This effluent is easy to deal with in conventional ETP operation.

INDIAN SCENARIO

The water consumption figures for various categories of mills in India is given in Table 1 (3). Average water consumption for large units is about 200 cubic metres per tonne and 250 cubic metres per tonne for small units. Quality of un-treated effluent being generated is given in Table 2 (3). Quality of effluent generated from different sections of the mill is given in Table 3(4).

As can be seen from Tables 1, the Indian Pulp and Paper Industry is no where near the goal of achieving 'Zero Discharge'status.

The approach to be taken for closure of water systems is:

- Adopt cleaner manufacturing technology
- Recycle and re-use to the extent possible

CLEANER MANUFACTURING TECHNOLOGIES

To combat water pollution issues, it is necessary that attempt should be made to reduce the generation of pollutants. Lesser load of pollutants would enable easier and more efficient treatment of the total effluent from the unit.

TABLE-2

The un-treated effluent being generated by various mills

	SS	BOD	COD
Large Mill	100-150	35-50	150-200
Small Mill	90-240	85-270	500-1100
News Print	100-130	45-50	135-140
Waste Paper Based Mill	50-80	10-40	50-90

- Effluent Characteristics (kg./T of Paper)

TABLE-3

EFFLUENT QUALITY GENERATED FROM DIFFERENT SECTION OF THE MILLS

CHARACTERISTICS	EFFLUENT FROM						COMBINED EFFLUENT
	CHIPPER HOUSE	DIGESTER HOUSE	PULP WASHING	CHEMICAL RECOVERY	PULP BLEACHING	PAPER MACHINE	
FLOW IN CU.M PER TON	20 TO 60	5 TO 10	20 TO 40	FLOW DATA NOT AVAILABLE	140 TO 180	40 TO 90	240 TO 360
COLOUR	MUDDY	DARK BROWN	DARK BROWN	LIGHT BROWN	BROWN	WHITISH	BROWN
pH Value	6.4 TO 8.0	9.0 TO 10.0	8.5 TO 9.6	7.0 TO 9.0	6.0 TO 9.0	5.3 TO 8.1	6.5 TO 8.2
TOTAL SOLIDS IN mg/l	540 TO 900	1000 TO 2500	1400 TO 2500	1270 TO 2800	2100 TO 2900	850 TO 1250	1200 TO 2000
Suspended solids in mg/l	240 TO 520	140 TO 190	350 TO 1000	400 TO 760	140 TO 220	450 TO 900	350 TO 450
C.O.D. in ppm	175 TO 450	1850 TO 2200	900 TO 1700	320 TO 610	550 TO 790	520 TO 780	600 TO 750
B.O.D. in ppm	30 TO 50	300 TO 360	230 TO 480	90 TO 180	125 TO 155	100 TO 160	110 TO 235

This is possible with the help of the following processes:

- Fibre and filler recovery installations
- Recovery of cooking chemicals
- Efficient recovery of spent water and its reuse in process.

THE TREATMENT PHILOSOPHY

1. Adopt more eco-friendly bleaching sequences in Pulp Mill to control AOX.

FIGURE- 1

WATER CONSUMPTION PER UNIT OF PRODUCTION AT I.T.C. LTD.

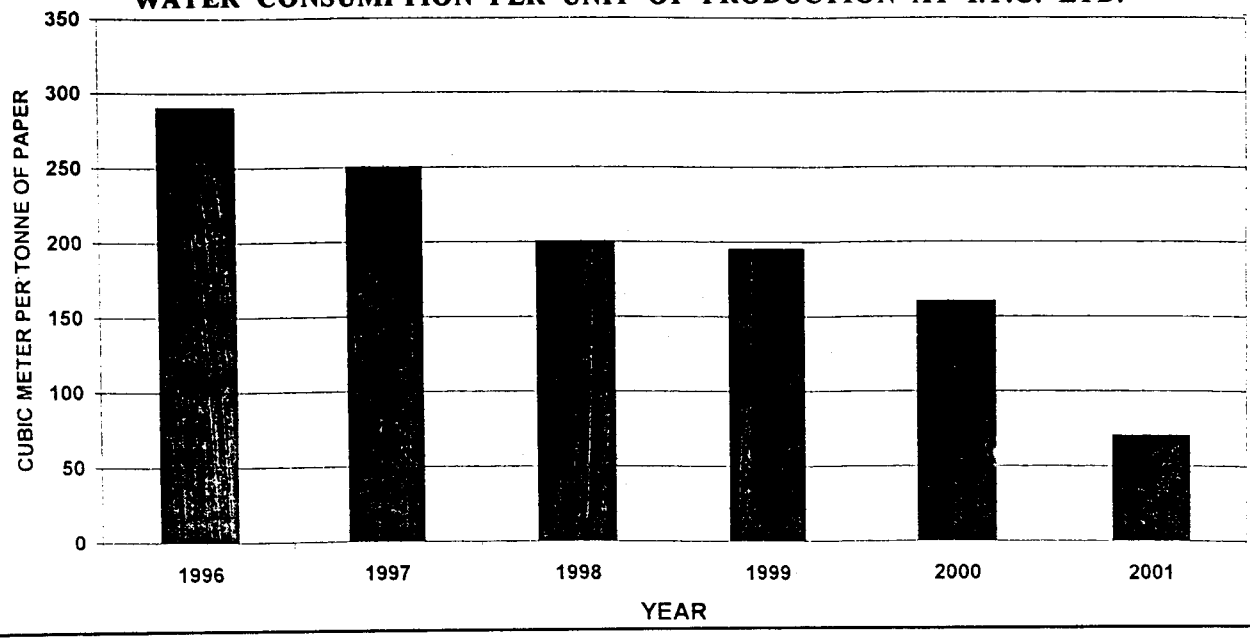

TABLE-4

WATER QUALITY REQUIREMENT AT DIFFERENT SECTIONS OF THE MILL

type of mill	tolerance in ppm						
	Ca and Mg as $CaCO_3$	HCO_3 AS $CACO_3$	FE AS FE	TURBIDITY	COLOUR	TOTAL SOLIDS	pH
Fine paper	50	75	0.1	5	5	200	---
Kraft bleached	100	75	0.2	5	5	300	6.8-7.3
Kraft unbleached	200	150	0.5	25	80	500	6.5-8.0
Ground-wood	200	150	1.0	50	30	300	---
Soda & sulfate pulp	100	75	0.1	25	5	600	---
Rayon pulp	8	50	--	5	5	100	---

2. Maximize usage of paper machine backwater by installation of save-all on all paper machines.

3. Re-use paper machine excess backwater and machine /stock preparation drains water by treating the same in Water Re-cycling Plants. These Plants using clariflocculation followed by moving sand filtration should yield treated water having suspended solids less than about 5 ppm. The treated water can be used for wire showers and other applications.

4. The excess water from paper machines and pulp mill effluent and other process water drains are then treated in the second stage of treatment in the Effluent Treatment Plant Activated Sludge Process is most commonly used by all paper mills.

5. In order to achieve maximum closure of water systems, the following methodology can be adopted:

   A. Treat Pulp Mill and Chemical Recovery effluent using Ultrafiltration followed by Reverse Osmosis. This would result in

   - Separation of organic dissolved solids
   - Color removal
   - Water quality suitable for re-use in different sections of Pulp Mill

   B. Treat Paper Mill effluent and excess stream from Pulp Mill in activated sludge process ETP.

   This should be followed by:

   - Clarification and filtration
   - Removal of residual BOD and COD using Photo-chemical Oxidation techniques

   The final treated water should be sent back to the mill for re-use in various applications using guidelines (4) stated in Table 4.

The above mentioned treatment philosophy has been adopted by the speciality paper manufacturing unit of I.T.C. Ltd.. The reduction in water consumption per unit of production achieved and envisaged is shown in Figure 1.

CONCLUSION

Most of water treatment practices adopted in the Pulp & Paper Industry today are of age-old technologies - which do not give the benefit of recovering the water. This is because paper mills in earlier days adopted a "Piece Meal" approach in water treatment.

The treatment methodology outlined in this paper should help the Indian Pulp and Paper Industry in reducing the water consumption in all its operations. Paper mills - in order to conserve water - need to adopt

the "Total Water Management" concept. Total water management concept is nothing but understanding the optimum water quality requirement of each section of the mill and treat the water only to those limits while fully exploring the possibility of recovering the water.

These approaches will lead to both - end of the pipe treatment as well as recovery and reuse from the source resulting in 'Zero Discharge' operation.

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