Environment Management in Pulp and Paper Industry Beyond Current Legislations and CREP Commitments

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INTRODUCTION

Indian pulp and paper industry has progressed moderately from the first start of the mechanized paper mill based on jute and grass in Shrirampore in West Bengal in 1832. There are, at present, around 400 pulp and paper mills in India with an installed capacity of 6.25 million tonnes. Per capita consumption of paper is about 5 kg and the paper demand is growing at the rate of 6.5% for annum. There are only 28 wood based large paper mills in the country contributing about 37% of the total production. There are about 372 agro and wastepaper based mills with an installed capacity of 4 million tonnes per annum. The share of the papers produced in agro based and waste paper based sectors are 33 and 30 % respectively.

Wood based mills are concentrated in four states, viz. Andhra Pradesh, Assam, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu and Uttar Pradesh. Agro-residue based and waste paper based mills are spread throughout the country.

There is a direct impact of the pulp and paper making on the different components of the environment e.g. water, air, land and flora and fauna.

WATER

Water is a precious commodity and nature's greatest gift to the living kingdom. Total utilizable water resources in India in 2005 has been estimated to be 1122 billion m^3 per year and 38% of which is presently exploited for total national use (1). Water consumption in agriculture, industrial sector and domestic purposes are 85.3, 8.0 and 6.6% respectively. Water use in industrial sector is 34 billion m^3 per year which is estimated to increase by four folds by 2050. Central Pollution Control Board in a survey in 2001 estimated the sector wise water consumption (Table 1). Pulp and paper industry is the third largest water consuming industrial sector in the country.

Table 1: Sector wise water consumption in different industries

Sector	Water consumed (billion m^3/year)	Proportion (%)
Thermal power plant	30	87.87
Engineering	1.7	5.05
Pulp & Paper	0.773	2.26
Textile (cotton)	0708	2.07
Iron & Steel	0.441	1.29
Sugar	0.186	0.54
Fertilizer	0.166	0.49
Distilleries	0.0628	1.18
Organic Chemicals	0.0416	0.12
Others	0.0405	0.12

Fresh water consumption in the wood based, agro based and waste paper based mills is 125-200, 125-225, 75-100 m^3 per tonne of paper respectively (2); average water consumption was 151 m^3 per tonne of paper in 2004. With the maderate per capita paper consumption of 10kg, water demand in this sector might increase to more than 1.5 billion cubic metre with the current rate of water consumption.

With the continuously increasing demand and strong competition among industrial, agriculture and domestic sectors, water availability will be severely affected perticularly to the large consuming industrial sectors like pulp and paper. Present national norm of water consumption per tonne of paper is 200 and 250 m^3 in agro, and large pulp and paper sectors whereas that set up World Bank is much lower (56 and 5.5 m^3 per tonne of pulp and paper). By reducing the water consumption to 75 m^3 per tonne of pulp and paper the paper industry can produce double the amount of paper with the existing water allocation/draw.

Central government has formulated the National Water Policy in 1987 and updated the same in 2002. According to this policy allocation priorities are : drinking water, irrigation, hydropower, ecology, agro-industries, non agro-industries, navigation and other uses.

With the continued growth of population, and industrial and agricultural expension the per capita water availability has decreased from 3450 to 1880 m^3 within the period 1951 and 2006. It is estimated that by 2025 and 2050 water availability will fall within 1500 and 760 m^3 respectively. According to World Bank estimate two thirds of the world population will be under moderate to high water stress condition and India will be under severe water stress condition in 2050 (as water availability will fall below 1000 m^3).

MEASUREMENT OF WATER

First and formost important step in the water conservation drive is the measurement of water by accurate, precise and advanced online flow meter like orifice, venturi, magnetic or ultrasonic flow meter, and its periodic

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calibration through recognized laboratory. This needs no exaggeration that what is not measured can not be monitored. Precise determination of water draw and distribution at major point/plants is extermely important for effective water conservation measures.

MANAGEMENT'S COMMITMENT ON WATER CONSERVATION

As water is common environmental resource and couse of concern to everybody in the universe management's strong commitment and proactive role are two most singular important considerations in achieving the goal. Awareness amongst employees and total participation of them are the prerequisites in the drive towards water conservation. As water was plenty available till now, wastage in its use are rampant. Three questions are very pertinent in this connection:

- Do we need fresh water in the concerned activity?
- Can we not replace the fresh water with recycled water?
- How can we reduce overall water consumption and attain international norms?

WATER CONERVATION MEASURES

Pulp Mill

- Raw material washing should be done with treated effluent
- Washing efficiency of pulp washers should be improved
- Paper machine back water should be used in the pulp dilution in the unbleached tower
- Backwater should be used in centricleaning of pulp and vacuum pump sealing
- Bleach plant filtrate should be recycled in pulp dilution in tower and vat, and shower sprays in the preceding stage.

Chemical Recovery

- Steam condensate recovery should be enhanced
- Foul condensate of soda recovery plant should be recycled in the brown stock washing

Paper Machine

- Efficiency of fibre separation with gravity saveall, krofta or disc filter should be increased to the best possible extent.
- Clarified back water of the fibre separator equipment should be used in pulper and head box dilution
- Clarified backwater should also be used in all showers except in felt cleaning
- Cooling tower for vacuum pump and winder brake drum water should be installed and the water should be recycled
- The condensate recovery in paper machines should be increased and reused in DM water make-up
- Back water should be utilized for alum/ PAC, filler and other chemical preparation

Boiler House

- Treated effluent should be used in ash quenching
- Membrane based process for water softening should be installing in place of conventional chemical process

Miscelleneous

- Treated effluent can be utilized wherever possible like mill and colony gardening, fire hydrant pipeline charging, road cleaning, wetting of fly ash/coal ash in the dumping site

WATER POLLUTION

Water pollution discharge in Indian pulp and paper industry is in higher level due to non-processing of black liquor in small agro based, relatively lower recovery efficiency and less efficient unbleached pulp washing in large pulp and paper industry. Current COD norm in the sector is 49 - 52.5 kg per tonne of paper (Table 2) which is much higher compared to European Union and World Bank standard of 15 kg per tonne of pulp, 5 kg per tonne of paper from recycled fibre origin, and 1.25 kg per tonne of virgin fibre based origin (Table 3).

BOD standard in the sector is marginally higher (3.6 - 4.5 kg per tonne of paper) as compared to BOD standards in European Union and USA. In case of the former standards of BOD discharge is 1.5 and 1.0 kg per tonne of paper of forest based origin and waste paper origin respectively. In USA the BOD standards in the bleached paper grade of kraft and soda mills are 4.52 and 2.41 kg per tonne of paper on daily maximum and monthly basis repectively.

These two parameters viz., COD and BOD in final effluent can be reduced with the following measures:

- Recovery of black liquor (96 - 98% chemical recovery)
- Strengthening of black liquor spill control system
- Improved pulp washing to attain soda loss of 10-12 kg per tonne of pulp (3)
- Oxygen delignification of unbleached pulp of kappa number of 10-12
- Adequate secondary biological treatment of effluent

At present there is no national standards on *colour* control as per CREP commitment Indian pulp and paper industry needs to develop the appropriate treatment technology in collaboration with Central Pulp and Paper Research Institute in a time bound manner. Though there is no colour regulation in most of countries like European Union, USA, Canada, colour control is extremely important in India particularly in the summer months when the water flow in the receiving water body reaches to an extremely low level.

Table 2: National environmental standard in pulp and paper industry (from 1st April, 2005)

Parameter	Agro based mills	Large pulp and paper mills
A. Water Pollution		
Effluent discharge, m^3/t AD Paper	150 from 1st April, 2006	< 140 from 1st April, 2005 < 120 from 1st April, 2007 < 100 from 1st April, 2003 for mills set up after 1992
COD, mg/l	350	350
BOD, mg/l	30 (100**)	30 (100**)
AOX, kg/t AD Paper	2.0 from 1st March, 2006 1.0 from 1st March, 2008	< 1.5 from 1st April, 2005 <1.0 from 1st March, 2008
Upgradation of ETP	Within 1st April, 2004	-
Colour removal	IARPA to take up project with CPPRI	IPMA to take up project with CPPRI
Utilization of treated effluent for irrigation	Wherever possible	Wherever possible
B. Air Pollution		
Particulate matter, mg/Nm^3	150	150
SO_2, mg/Nm^3	Proper gas dispersion (governed by stack height)	Proper gas dispersion (governed by stack height)
H_2S, mg/Nm^3	10	-
Cl_2, mg/Nm^3	15	15
NCG	Incineration system from 1st April, 2007	Incineration system from 1st April, 2007
C. Hazardous wastes		
	Spent chemicals	Spent chemicals
	Corrosive wastes arising from use of strong acid and bases	Corrosive wastes arising from use of strong acid and bases
	Sludge containing adsorbable organic halides	Sludge containing adsorbable organic halides
D. Solid wastes		
Fly ash utilization	• Free availability of fly ash upto 2013 • 20% utilization within 2006 • Progressive increase in use every year upto 2018 • 100% utilization 2018	• Free availability of fly ash upto 2013 • 20% utilization within 2006 • Progressive increase in use every year upto 2018 • 100% utilization 2018
Utilization of lime sludge	Installation of lime kiln for lime sludge reburing within 1st April, 2007	

- Colour in the treated effluent can be significantly controlled by the above mentioned steps.
- Additionally colour can be further brought down by external physico-chemical treatment involving coagulation - flocculation, electroflocculation, membrane separation etc.

Control of *Adsorbable organic halides* (AOX) is an extremely contentious issue. AOX is a collective parameter of the total range of organochlorine compounds which are generated during the bleaching of pulp with chlorine, hypo chlorite and chlorine-di-oxide. Another parameter called Extractable organic halides (EOX) is really a measure of the effluent toxicity. EOX might be about 5-10% of the AOX compounds. World pulp and paper industry is sharply divided into two blocks between European union and Canada which have done extensive study on the acute and chronic toxicity related issues of pulp and paper mill effluents (4). United States of America falls within these two blocks. Whereas European Union controls both Dioxin/Dibenzofuran and AOX in the effluent as a part of commitment of Persistent Organic Pollutants (POP). Canada controls only Dioxin/Dibenzofuran in the Federal level (5). European Union and USA have both fixed very low level of AOX compounds discharge

Table 3: World Bank Environmental Standards of Pulp and Paper Industry

Parameter	Pulp mill	Paper Mill
A.. Water Pollution		
Effluent volume, m^3/t ADP	50	5
pH	6-9	6-9
Temperature	<3°C rise from that of receiving body	<3°C rise from that of receiving body
COD, kg/t ADP	Kraft and CTMP:15	Mechanical and Recycled fibre based: 5 Virgin fibre based: 1.25
AOX, kg/t ADP	Retrofit mills: 0.4 New mills: 0.2	0.02
Total P, kg/t ADP	0.05	-
Total N, kg/t ADP	0.4	-
B. Air Pollution		
Particulate matter, mg/Nm^3	100	100
H_2S, mg/Nm^3	15	
Total S, kg/t ADP	1.0	
Nox, mg/Nm^3	2.0	
C. Solid wastes, kg/t ADP	Kraft pulp mill: 150	-

Table 4: Control of POP in different countries

Area of activity	POP and concentration
A.. Canada	
Boilers	Dioxin/Dibenzofuran limit <500 pg/m^3 TEQ for existing boilers by 2006 <100 pg/m^3 TEQ for new boilers
Effluent	2,3,7,8 TCDD : Non detectable 2,3,7,8 TCDF : Non detectable
Defoamer	Dibenzofuran: < 40 ppb Dibenzo-para- dioxin: <10 ppb
Wood chips	Dibenzofuran: < 40 ppb Dibenzo-para- dioxin: <10 ppb Polychlorinated phenols: Non detectable
B. European Union	
Boilers (cofiring effluent treatment plant sludge)	Dioxin/Dibenzofuran limit <100 pg/ Nm^3 TEQ
Effluent	*Kraft pulp processing* Bleached pulp : 0.25 AOX/t AD Pulp Unbleached pulp: No value *Sulphite pulp processing* Bleached pulp : No value *Mechanical and Chimimechanical pulping* Non integrated CTMP mills: No value Integrated mechanical pulp and paper mills: <0.01 kg AOX/t AD Paper *Recycled fibre (RCF) processing* • Integrated RCF mills without de-inking: <0.005 kg AOX/t AD Paper • RCF paper mills with de-inking: <0.005 kg AOX/t AD Paper • RCF based tissue mills: <0.005 kg AOX/t AD Paper

Table 4: Control of POP in different countries – *contd.*

C. United States of America	
Effluent	Existing bleach plant effluent: • TCDD : < Detection level • TCDF : < 31.9 pg/l (1 day maximum) • Chlorinated phenolics: < Detection level • Chloroform: 6.92 g/t AD Pulp (1 day max) • Chloroform: 4.14 g/t AD Pulp (Monthly average) • AOX final effluent: 0.951 kg/ t AD Pulp (1 day max) • AOX final effluent: 0.623 k/ t AD Pulp (Monthly average) Pretreatment standards for existing bleach plant effluent : • TCDD: < Detection level • TCDF : 31.9 pg/l (1 day max) • AOX : 2.65 kg/ t AD Pulp (1 day max) • AOX: 1.41 k/ T AD Pulp (Monthly average) New source performance standards for bleach plant: • TCDD: < Detection level • TCDF 31.9 pg/l (1 day max) • Chlorinated phenolics: < Detection level • Chloroform: 6.92 g/t AD Pulp (1 day max) • Chloroform: 4.14 g/t AD Pulp (Monthly average) • AOX: 0.476 kg/ t AD Pulp (1 day max) • AOX: 0.272 k/t AD Pulp (Monthly average) • AOX: 0.208 k/ t AD Pulp (Annual average) Pretreatment standards for new sources bleach plant effluent: • TCDD : < Detection level • TCDF : 31.9 pg/l (1day max) • AOX: 1.16 kg/ t AD Pulp (1 day max) AOX: 0.814 k/ t AD Pulp (Monthly average)
D. Japan	
Effluent	Dioxin / Dibenzofuran for both existing and new facilities: 10 pg TEQ/l
E. Australia	
Boilers	Dioxin/Dibenzofuran limit: <100 pg/m^3 TEQ for new boilers
Effluent	Total chlorinated compounds: 0.03 Cl mg/t
F. Germany	
Boilers	Dioxin/Dibenzofuran limit: <100 pg/ Nm^3 TEQ

(0.25 - 0.476 kg per tonne of bleached pulp) (Table 4). USA in the recent promulgation of Clean Water and Air Act has also regulated release of 12 higher chlorophenolic compounds as well as chloroform basides Dioxin/ Dibenzofuran. Though world's scientific community has not conclusively established the relationship between AOX content in effluent an chronic toxicity of the same EU and USA have adopted the precautionary approach and tried to control the discharge of AOX compounds in treated effluent to contain POP.

Indian pulp and paper industry has adopted the formal norm of 1.0 kg AOX per tonne of paper (or 1.2 kg per tonne of pulp) as part of CREP commitment in 2003 (6). India is a signatory to the Stokholm Convention in 2001 to contain POP. Dioxin/Dibenzofuran is the identified POP in pulp and paper industry. Hence Indian pulp and paper industry should be prepared and voluntarily eliminate the formation of most dreaded toxic pollutants (Dioxin/ Dibenzofuran) by suitably modifying / updating the pulp bleaching process.

It can either switch over to Elementary chlorine free (ECF) bleaching or substitute elemental chlorine with 50-60% ClO_2 in the C_D stage and follow bleaching sequence of $OC_DE_{OP}D_1D_2$ or $OC_DE_{OP}D_1P$. This ClO_2 substitution level will remove the chance of Dioxin/Dibenzofuran formation (4).

Oxygen delignification might be optional depending upon the kappa number of unbleached pulp.

Though there is no national standard some of the mills in India monitored *Acute toxicity* (96 hours bioassay test), N,P under the instruction of the state regulatory agencies. Indian mills should carry out research study on the *acute* and *chronic toxicity* of effluent in the present operational condition as well as after the change of bleaching sequence. Control of N and P in the treated effluent should also be taken-up as future *improvement strategy.*

AIR POLLUTION

There are five parameters through which the air pollution in the pulp and paper industries are/will be regulated viz., Particulates (SPM), H_2S, Cl_2 emission; SO_2 dispersion; and malodourous non-condensable gases (NCG) incineration.

World Bank recommends a little lower particulates emission at the level of 100 mg/Nm^3, control of sulphur and NOx emission in the level of 1.0 and 2.0 kg/t AD Paper respectively. SPM can be controlled through appropriately designed and operated ESP in the power and recovery boilers.

SO_2 can be controlled with the installation of wet scrubber and NOx can be minimized by controlled combustion of fuels in the furnaces.

Though at present there is no cap on Green House Gas control as per Kyoto protocol India an China might be in a position to control the CO_2 emission from 2012 onwards because of higher energy consumption. In that scenario it will be made mandatory for each industry sector to cut the CO_2 emission by various measures. Industry should proactively work and reduce energy consumption (present usasge of energy is 31-70 GJ/BD t Paper) (7).

SOLID WASTES

There is no national regulation or permit on solid wastes disposal in the Indian pulp and paper mills. In 1999 Fly Ash Utilization Notification as per EP Act 1986 has been promulgated which stipulates that fly ash generating industries need to make plan for utilization of fly ash, bottom ash and cinder over a period of 15 years (8). There are some mills in the country that have adopted Circulation Fluidized Bed Combustion technology in steam generation and have been disposing entire quantity of fly ash in cement plants. There are a few mills in the country that utilize entire quantity of fly ash in brick making.

With the installation of Lime sludge reburning kilns from 2007 part relief will be experienced from the nuisance of this solid waste. As Indian raw materials contain varying proportion of silica some amount of lime sludge that is rich in silica needs to be discarded to make the residual lime sludge reburable. Black liquor desilication process can completely remove the problem of silica and make the lime sludge suitable for reburning in entirety.

Fibre and fines recovery, and recirculation in the paper making process can reduce the Effluent treatment plant sludge.

World Bank recommends to restrict the solid wastes disposal within 150 kg per tonne of pulp in kraft pulping process.

HAZARDOUS WASTES

Presently three categories of wastes are classified under the Hazardous wastes viz., Spent chemicals, Corrosive wastes arising from use of strong acid and bases, and Sludge containing adsorbable organic halides. The first one is manageable by cleaning the containers and burning the chemicals in the power boilers along with coal or in a didicated incinerator. The second can be utilized for neutralization of acidic or alkaline effluents.

Effluent treatment plant sludge (primary and secondary both) contains AOX compounds as per the generation of the same in the process. It is note worthly that AOX compounds also remain the produced paper and treated effluent. It has already been described that AOX is a extremely debatable and controversial parameter to classify any waste as toxic and hence hazardous. AOX content in sludge will progressively reduce with the improvement of pulp bleaching process. It will be extremely difficult for pulp and paper industries in India to comply this stipulation. No where in the world Effluent treatment sludge is classified as hazardous based on AOX content.

United States Environment Protection Agency has regulated the sludge from its use in land application

based on the Dioxin and dibenzofuran contamination (9). Maximum sludge TCDD/TCDF concentration of 50 ppt TEQ and maximum soil concentration upto 10 ppt TEQ are permitted for agricultural application.

CONCLUSION

Indian pulp and paper industry which has made progressive growth over the years will be under vulnerable condition due to its high consumption of environmental and natural resources. Its sustainability needs to be improved by self motivated and volunatary target setting in environmental performance. Reduction in water consumption, control of water and air pollutants, reducing solid wastes generation beyond existing stipulation and CREP commitments are the urgent necessity for its competitiveness in the global business environment. Scientific principles should be the guiding principles on the part of the regulators to classify any material as toxic and hazardous waste.

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