Charter on Corporate Responsibility for Environmental Protection (CREP) in Pulp & Paper Industry Implication & Compliance

Suresh Panwar, Nitin Endlay, M.K.Gupta, Shivaker Mishra, R.M.Mathur and A.G.Kulkarni

The introduction of CREP has brought a major revolution in the Indian pulp and paper industry both in large as well as small sector in respect to technological upgradation and environmental management with added advantage of quality , development of product and resource conservation . CREP is going to have a significant impact on over all sustainability, technological & environmental status as well as global competitiveness of our pulp and paper industry. The paper reviews the implication of various issues addressed under CREP and the preparedness of the industry in complying with the CREP requirements.

INTRODUCTION

The year 2003 will go down as a water shed year in the history of Indian pulp & paper industry as this year marked the introduction of *Charter on Corporate Responsibility for Environmental Protection* (CREP) which not only resulted in the reorientation of the outlook / approach of the mills in addressing the environmental issues but also catalyzed the process of adoption of modern / appropriate technology / system to meet the CREP deadline. Thus the coming years will be significant in shaping the future of Indian paper industry It is heartening to note most of the mills have taken up the challenge thrown by CREP in a positive manner and have accordingly adopted or are in process to adopt appropriate process and technologies to address to various issues indicated the CREP Charter. The issues addressed under the Charter can be grouped into:

- Issues Common to Both Large & Small Mills
- Issues Related to Large Mills Only
- Issues Related to Small Mills Only

ISSUES COMMON TO BOTH LARGE & SMALL MILLS

(a) Reduction in Waste Water Discharge Level

In recent years, with growing awareness as well as water scarcity, significant decline in level of water consumption and consequently waste water discharge has been observed among the mills in recent years. Today, in general water discharge level range between 120-160 m^3/t_{paper} among large paper mills and 100- 200 m^3/t_{paper} in small mills. A detailed sector wise

Table -1 : Waste Water Discharge Level in Indian Pulp & Paper Industry

Large Scale Mills	Volume of Waste Water Discharged, m^3/t_{paper}
Writing & Printing	
(a) With Conventional Technology	120-160
(b) With Modern Technology	65-90
News print	65-125
Rayon Grade	110-160
Small Scale Agro Based Mills	
W & P Mills with Chemical recovery	100-110
W & P Mills without Chemical recovery	115-150
W & P Mills making Specialty Paper	185-215
Mills making Unbleached Variety	45-125

CPPRI , Saharanpur

waste water discharge level figures are indicated in Table -1.

In this context the target level of 100 m^3/t_{paper} for large mills and 150 m^3/t_{paper} for small paper mills appears fairly appropriate and achievable in most of the cases due to the ongoing modernization & expansion programme by various mills in accordance with CREP. Some of the mills are even trying to put all efforts to reduce the water consumption as much as possible not only due to CREP but also due to scarcity of water Further the mills in both the categories with high discharge levels need to identify and explore the areas to be tapped to reduce the discharge level such as :

- Use of high efficiency pulp washers
- Increased reuse of white water & improved performance of fiber recovery systems
- Recovery of condensates
- Recycling of cooling & boiler condensate
- Recycling of bleach filtrate
- Reuse of treated waste water

(b) Upgradation of Existing ETP

Most of the mills have adequate effluent treatment facility for treatment of effluents. consisting of mainly primary clarifier , ASP and secondary clarifier . Some agro absed mills have anaerobic lagoons/ bioreactors for treatment of black liquor separately. However there is a great variation performance of the treatment system as indicated below:

Parameters	Reduction Efficiency%	
	Large Mills	Small Mills
COD	40-90	10-76
BOD	70-98	11-92
Colour	5-60	17-89
AOX	18-67	15-62

The variation in the performance efficiency depends upon the monitoring practices, process operations, raw material used , end product etc . Most of the existing ETPs specially in the agro based mills are operating below the optimal level mainly due to inappropriate design specifications in respect to the existing pulp mill capacity leading to poor performance efficiency. The large variation in the performance efficiency of the existing ETP in these mills and consequently discharge of high pollution load is primarily due to:

- Lack of knowledge of basic fundamentals as well as biochemistry of the system
- In majority of mills the level of MLSS & DO is quite low (optimum 2000-4000 mg/l & 2 mg/l respectively).
- Similarly the distribution of aerators in the aeration basin is not proper and adequate leading to inadequate aeration as well as dead zone formation.
- The quality of biomass in ETP is also not monitored leading to sludge bulking / low SVI which ultimately results in loss of biological sludge and low efficiency of Secondary Clarifier

Most of these mills lack flow measurement facilities and also regular ETP monitoring facilities leading to poor performance efficiency. As such there is an urgent need for upgradation of ETP for adequate handling and treatment of effluent to stipulate discharge norms

Recently some of the large mills have switched over to diffused aeration system for ensuring proper aeration. Further the mills should practice segregation of high pollution load and low pollution load streams for improved ETP management . Maintaining and monitoring separate waste water streams from different sections can help in managing waste water Segregation allows reuse and recycling of less polluted waste water which minimizes waste water quantity directed to ETP . Tertiary treatment involving chemical precipitation / coagulation should also be adopted to upgrade the quality of treated effluent further and its increased recycle and reuse.

(c) Utilisation of Treated Effluent for Irrigation

At present around 80% of treated effluent is discharged by large scale mills into surface water while around 20% only on land .The impact of effluent depends upon the assimilating capacity of the receiving medium. Irrigation is the most commonly land application method for disposal on land by paper mills. Some mills are utilizing a fraction of their treated effluent for horticultutre , plantation etc or are providing to the nearby farmers for irrigation of crops. The soil acts as a biochemical reactor and helps in reducing the pollutants by adsorption and microbiological decomposition in the soil The existing scenario of land disposal of treated effluent by Indian mills is indicated in Table -2

The land disposal is a good option specially in cases where the receiving streams are stressed or enough water is not available through out the year in receiving stream. However for effective application it is necessary to properly design the waste water irrigation system after giving due consideration to various factors viz :

Land Area (General basis : 50 - 200 hectare for around 10,000 m^3/ day) ,Soil Characteristics (texture, structure permeability) , Loading rate, Electrical Conductivity, Salinity, SAR - (Sodium Absorption Ratio - Proportion of Sodium to Calcium & Magnesium Content), Organic content in the effluent , Presence of trace elements / heavy metals in the effluent, Ground water level,Climate of the region, Type of crop to be irrigated etc.

Though SAR value recommended by CPCB for suitability of effluent for land application is 26, waste water with SAR less than 3 is most suitable for land application provided hydraulic loading rate is maintained The general level of SAR in Indian mill effluent is indicated in Table -3

Table -2 Extent of Land Application of Treated Effluent Practised by Indian Mills

% Disposal of treated effluent	% of Mills
1-25	36
25-49	14
50-74	14
75-99	7
100	29

As indicated in the above table most of the mills require adequate treatment to treat the effluent to achieve desired SAR level for long term irrigation of crops.

(c) Colour Removal from Effluent

With increasing number of large mills going for modified / modern fiber line pulping and bleaching technologies such as oxygen Delignification, extended delignifia-ction, chlorine dioxide substitution etc . , the colour level is expected to reduce significantly.

Table-3 SAR Level in Treated Waste Water

LARGE MILL	SAR
Writing & Printing	3-10
Newsprint	9-12
Rayon Grade	4 - 7
SMALL SCALE (AGRO BASED)	
Writing & Printing	4 -13
Unbleached	14-16

The expected reduction is as under

Technology	Approximate Colour Reduction
Combination of extended delign-ification and oxygen delignification	60% - 65%.
ClO_2 substitution	50% - 60%
Oxygen enriched caustic extraction	20%
Eop (Peroxide at E-stage)	50%

Though various technologies have been reported for end of pipe (EoP) treatment for colour reduction, except chemical coagulation and membrane technology none of the other treatment methods have been used on commercial scale. Chemical coagulation particularly with polymer probably has a role to play in limiting discharge in existing mills. Other options are selective applications of membrane technology for high colored stream with which color reduction up to 85-90% can be achieved . The results of studies conducted by CPPRI potential of electro flocculation on lab scale has been found to be quite encouraging

Table 4 : Colour Reduction Through Electro flocculation Process

Effluent	Reduction %
Kraft Bleach effluent	96
Mechanical Pulping Effluent	97
Bagasse Black Liquor	94
Mixed Agro Based Black Liquor	98
Mixed Agro based Combined Bleach Effluent	98
Agro based E Stage Effluent	99

(Table -4). However, the economic feasibility trials of process on commercial scale is under progress. Similarly the lignin separation process discussed later can also provide colour reduction in agro based black liquor up to 75 -85 %

ISSUES RELATED TO LARGE MILLS ONLY

(a) Discharge of AOX up to 1.0 kg / t_{Paper}

The AOX standard proposed for large mills is also realistic and achievable. The general level of AOX in finally treated effluent among large mills is observed to be between **0.04 - 1.0 kg/ t_{paper}** (in mills modern pulping & bleaching process) and **0.6 - 1.5 kg / t_{paper}** (in mills using conventional process) With most of the mills already switching over to modern fiber line technologies like oxygen delignification and chlorine dioxide bleaching as well as adoption of new generation of pulp washers, not much problem is foreseen in achieving the AOX level below1.0 kg / $_{tpaper}$. Further some group of paper companies are acquiring / plan to acquire pulp mills abroad to meet their pulp requirement which will also reduce their mills pollution load (including AOX)

(b) Burning of NCG (Odorous) Emissions in boiler/ lime kiln

CREP has done well by addressing the issue of foul odor through making burning of odorous emissions mandatory. This will bring to an end a long standing stigma associated with pulp and paper mills using kraft process The burning options for odorous emissions are mainly lime kiln, recovery boiler and

Incineration Option	Advantages	Limitations
Lime Kiln	• Availability of high temperature & long residence time ensure complete incineration in presence of excess oxygen • Utilization of NCGs heat of combustion in lime kiln leading to possible marginally reduction in fuel consumption. • Control in loss of S as SO_2 (formed during incineration) as it is absorbed in lime and remains within the process	• Possibility of increased formation of stones and rings in the kiln due to excessive formation of sodium sulphate. • Very small capacity for incineration of dilute NCG. • Due to Feeding of NCG very limited space may be available to combustion air leading to decrease in availability of oxygen in the kiln resulting in incomplete combustion occasionally
Recovery Boiler	• Recovery of NCG is sulfur to green liquor • Calorific Value of NCG is recovered to heat & power • Higher tolerance towards load variations	• Increased Fouling / Slagging • Difficulty in maintaining of SO_2 emission level. • Ammonia present in NCG may oxidize on incineration to NO_x and add to the NOx originated from liquor combustion
Dedicated Incinerator	• Operation is independent of the process • Some Dilute NCGs can also be used as combustion air in stand alone incinerator	• High capital investment • May not accommodate all of dilute NCG • High acid dew point of the flue gases from the boiler will only permit a low energy recovery from the incinerator other wise there will be high acid corossion

dedicated incinerator, the merits and limitation of which are indicated above :

In general the level of NCGs in Indian paper industry is indicated in Table6

Among the Indian mills only APPM has dedicated incineration system to control odorous emissions. Investment costs of collection & incineration of odorous emission is around USD 5-6 million in new mills and USD 6 - 10 million in existing mills of production capacity 1500 tpd. In Indian perspective it comes to around Rs 2.5 -4.5 crores. Other options for reducing the NCG level are use of continuous digester, scrubbers ,chemical treatment, use of pulping aid , use of additives etc .

Table -5 : Source Points of NCG Emissions in Indian Pulp & Paper Mills

Process	MM ppm	DMS+DMDS ppm	CH3OH ppm	H2S, ppm
Digester relief	75 983	227-4000	BDL-100	BDL-27
Digester Blow	385 -11500	1227-32196	BDL-10000	BDL-800
Black liquor storage tank	5-124	12-255	BDL	BDL
Evaporators	1305-221650	1405-37125	BDL-19300	198-30000
Smelt dissolving tank	10-210	18-360	BDL-1000	BDL-240

MM = Methyl Mercaptan, DMDS =Dimethyl Di Sulphide, DMS =Dimethyl Sulphide

However before adopting the NCG control system / appropriate options, the mills needs to assess the level of NCG emissions from various sources like digester blow/ relief, evaporator vent, smelt dissolving tank, lime kiln etc . CPPRI can provide services in assessing the level of these Non Condensable Gases.

INSTALLATION OF LIME KILN

On an average around 0.6 -0.8 million tonnes of dry lime sludge is generated annaually from around 20 large mills currently in operation. which is equivalent to 0.5 -0.6 t/ t paper.This is considerably high when compared to global level of 0.01 t / t paper . At the time of introduction of CREP only 40% of the total mills were having lime kiln while the rest were dumping lime sludge in open land fills. Installation of lime kiln can serve dual purpose i.e. resource conservation / reduction of solid waste through reburning of lime sludge as well as incineration of NCGs.

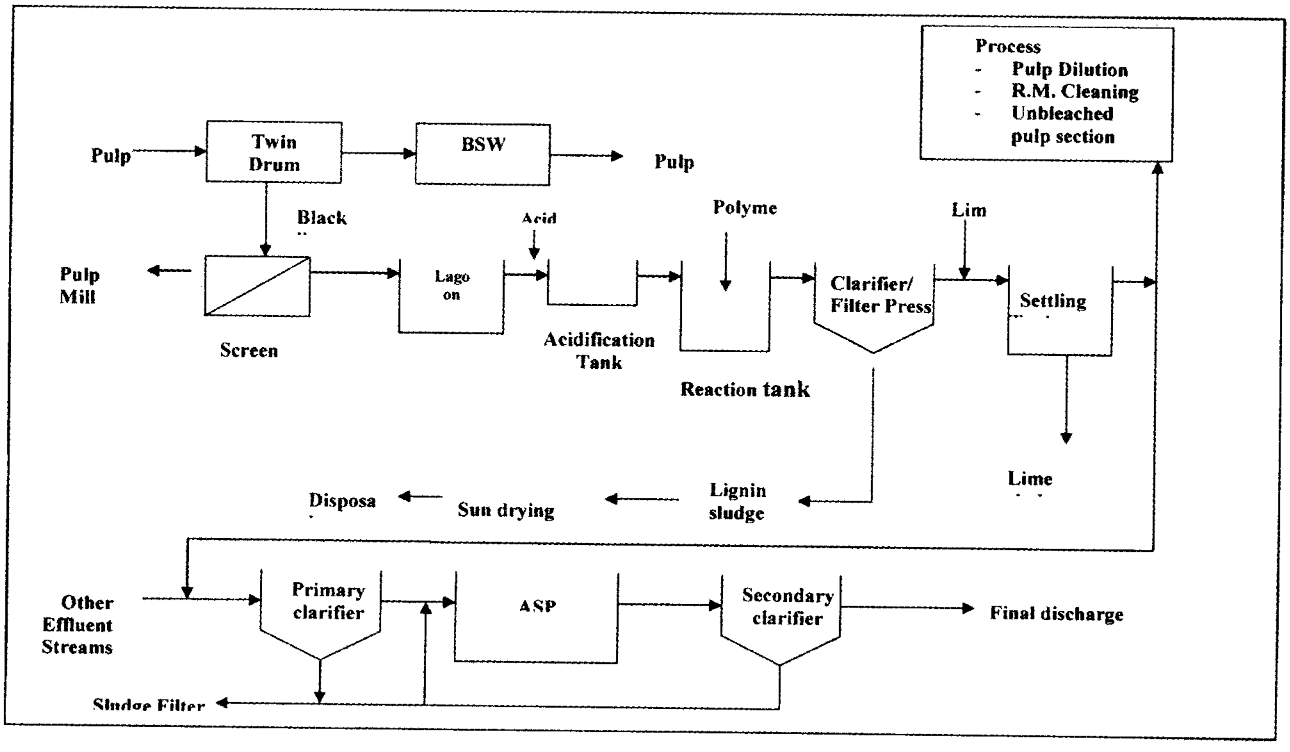
ISSUES RELATED TO SMALL MILLS ONLY

(a) Compliance of Standard of BOD COD & AOX

Due to obsolete technology and equipment and absence of chemical recovery system most of the agro based mills have been discharging their black liquor as such or after partial treatment along with other effluent streams leading to high pollution load . Further, in addition the mills manufacturing bleached grade of paper produce pulp of high kappa number due to economical reasons and major part of lignin is removed during bleaching using high dosage of chlorine leading to high level of chlorinated phenolic compounds (AOX) in their bleach effluent which is toxic to flora and fauna.

With strict environmental guidelines the mills are required under CREP to immediately adopt Chemical Recovery System or alternate treatment options or switch over to recycled fiber . The success of Shreyans (Modified Chemical Recovery System) & Abhishek (Conventional Chemical Recovery) is now being replicated by Naini , Satia and many other mills along with expansion in pulp mill capacity. However , it is technically feasible and economically viable for mills producing at least 150 tonnes black liquor solids per day which is equivalent to about 100 tonnes chemical pulp per day . Further, the high capital investment as well as inherent problems in agro residues black liquor such as low calorific value and low solid content of weak black liquor, high level of silica, suspended solids, viscosity are other constraints which needs to be addressed effectively. At present, from the mill's experience , the economics is not very profitable as the conventional recovery depends upon the market price of NaOH while that of Modified Chemical recovery on market price of soda ash. Further with increasing number of mills opting for modified chemical recovery due to low cost , the market price of soda ash is likely to decline in coming days. Moreover there is no recovery of steam in the modified recovery system Other mills which are not in a position to undertake capacity expansion due to financial

Fig 1 : Lignin Separation Process



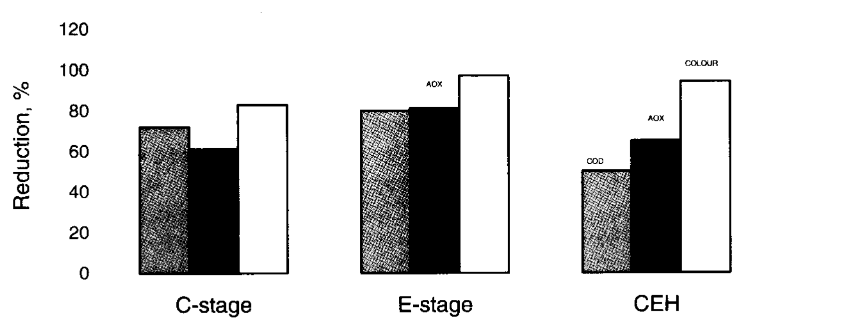
constraints are exploring alternate treatment options like lignin recovery, biotechnological treatment etc.

CPPRI has reviewed all the other available options for management of black liquor and has come to the conclusion that Lignin Separation Process is, at present, the only viable alternate option for treatment of black liquor in agro based mills with pulp mill of capacity less than 50 tpd . The adoption of Lignin Separation Process (Fig 1) developed by CPPRI makes black liquor (after lignin separation) compatible for recycle / reuse into unbleached pulp section as well as further treatment by conventional Activated sludge Process. The effluent including excess black liquor after lignin separation can be treated effectively to meet the acceptable discharge norms provided Lignin Separation System as well as Activated Sludge Process are operated under optimal conditions. The removal efficiency of lignin from black liquor collected from various mills vary from 80 - 92% which prove the technical feasibility of lignin separation technology. The calorific value of separated lignin is around 5000- 6500 kcal/kg in mills producing bleached variety of paper and 4700 kcal /kg in mills producing unbleached variety of paper . It is estimated that about 300 kg lignin equivalent to about 600 kg rice husk can be separated out per tonnne of pulp which can support the operating cost of lignin separation system .The sustainability of the system can be further improved depending upon the use of lignin as value added product as lignin has enormous industrial uses like ceramics , insecticides, emulsifier, rubber , binder / adhesives etc . Mills like ABC , Hanuman Agro, , Sainsons have already adopted this system while many other mills are in process of adoption of Lignin Separation System .

Parameter	Reduction %	
	Chemical Treatment	**Electro floculation**
COD	50-80	88-94
AOX	50-80	70-97
Colour	84-97	87-90

REDUCTION / ELIMINATION OF AOX

The small scale agro based pulp & paper mills producing writing & printing grade of paper produce pulp of higher kappa number (18 -30) due to economical reasons as well as absence of chemical recovery system. The major part of delignification is thus carried out during bleaching which is usually done using high amount of chlorine (130 -200 kg/ t pulp) leading to high level of AOX generation (4.0- 4.5 kg /tpaper). In general 10% of the total elemental chlorine used ends up as AOX during bleaching. The adoption of modern fiber line technologies like Oxygen Delignification / ECF Bleaching technologies is difficult for such low scale of operation due to techno-economic reasons. As an alternate strategy CPPRI has conducted exhaustive studies on physico-chemical treatment methods/ enzymatic prebleaching for reduction of AOX as well as toxicity of bleach plant effluents. The results of chemical treatment & electroflo-culation studies are summarized as above :



The efficiency of chemical treatment in reducing COD, AOX & Colour is also indicated in Fig 2 The cost of treatment is influenced by the nature and characteristics of the effluent , chemical used , initial & end pH and removal efficiency required. The cost incurred in chemical treatment using lime alum & polymer is around Rs 300-400 (USD 6-8) $/t_{pulp}$. The enzymatic prebleaching reduce consumption of chlorine by 10-15% and AOX by 15-20 % .

In all a integrated approach to reduce the AOX in agro based mills involves :

- Kappa No. should be below 20.
- Improved pulp washing to minimize carryover of COD along with unbleached pulp.
- Incorporation of by Enzymatic Pre bleaching.
- Bleaching by CEpH (Peroxide reinforced Extraction)
- Increased recycle / reuse of bleach liquor filtrate to the process
- Optimal use of ETP for treatment of effluent.

CONCLUSIONS

Though meeting all the requirements of CREP may at first place look a enforced burden but on long term basis it will help mills in improving the Global Competitiveness , resource conservation as well as sustainability of the paper industry along with overall improvement in technological & environmental status . The coming months will be critical for the paper industry and the survival of the paper mills will depend upon the mills efforts / efficiency and adaptability in meeting CREP requirements. The post CREP scenario will infact reflect the well known fundamental of Darwin Theory i.e. " The survival of the fittest" i.e. the mills which will timely rise to meet the CREP requirements will be able to sustain themselves and the rest will perish.

REFERENCES :

1.CPPRI Internal R&D reports

2.All About Paper : Life Cycle of Pulp & Paper Industry,CSE Publication

3.Chaturvedi G, Panwar S, .Kulkarni AG, Environmental Issues in Pulp & Paper Industry A Fresh Look. Proceedings of International Conference on Pulp & Paper & Conversion Industry held at New Delhi on December 2005 , 541-550.

4.Panwar S, Mathur R.M., Kulkarni AG, Control of AOX Discharge in Pulp & Paper Industry The Role of New Fiber Line ,Ippta Convention Issue March 2002,57 -62

5.Panwar S, Mishra S, Endlay N, Mathur RM, Kulkarni AG, Toxicity Reduction of Bleach Plant Effluent by Using Chemical Additives, Ippta, Vol 16,No.3 July Sep 2004., 45-52