

**REPORT  
ON  
ECOLOGICAL & ENVIRONMENTAL FACTORS  
IN PAPER INDUSTRY**

**VOLUME-I  
EXECUTIVE SUMMARY**

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**PREPARED  
FOR  
INDIAN PAPER MANUFACTURER'S ASSOCIATION**

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## **PREFACE**

The Paper Industry in India is expected to grow at rapid rate in the coming decades due to increased demand for paper and paper products. However, the growth and sustainability of paper industry to a large extent will be influenced by new & emerging environmental issues. Unfortunately, the industry still continues to operate on obsolete technologies, which are environmentally not compatible and as a consequence the pollution problems faced by some segments of the industry are severe and these segments will have to address these environmental issues on high priority. Even most modern mill in the country continue to face the environmental challenges like; reduction in AOX levels, collection & burning of malodourous gases and control of particulate emission.

In the present report an attempt has been made to review the state-of-art technology in the various segments of Indian Paper Industry and relate the technology with pollution problems. The report is a comprehensive one covering the growth of the paper industry, National & International regulatory standards and need for following standard testing procedures and also technological over-view of Indian Paper Industry with possible solutions & measures for improved environmental management.

The report has been prepared based on the discussions with Experts and information available from different sources and also based on the questionnaire sent to the mills and information given by them & through mill visits. This report should become a source of information for the paper industry and particularly should help in bridging the technological gap, introduction of cleaner production techniques & HRD in the areas of environmental management. The recommendations made should become a prelude for formulation of strategy in improving the over-all environmental situation in our paper industry.



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## **EXECUTIVE SUMMARY**

### **I. BACKGROUND:**

It is well recognised all over the world that industrial development will only be truly sustainable on sound ecological foundations. Industry has always been and continue to be the prime cause of economic development all over the world. The new liberalisation policy aims at accelerating the process of industrial development. However, such a high rate of development must be within the framework of sustainable development and must not allow the present generation to deplete the resource base of the country. With this prime objective, Central Pulp & Paper Research Institute undertook the report preparation work on "Environmental & Ecological Factors in Paper Industry". This report is based on the available data and information published in various journals, periodicals, its own data bank and from time to time discussions with technical persons in the field. The details have been covered in the following five volumes comprising of :

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|-------------------|--|
| <b>Vol. - I</b>   | <b>Executive Summary</b>   |
| <b>Vol. - II</b>  | <b>Status &amp; Perspective of Paper Industry: A Global &amp; Indian Scenario.</b>                                   |
| <b>Vol. - III</b> | <b>Technological Overview in Indian Paper Industry with Suggestive Measures for Improved Environment Management.</b> |
| <b>Vol. - IV</b>  | <b>National &amp; International Regulatory Standards for Water &amp; Air Quality Monitoring.</b>                     |
| <b>Vol. - V</b>   | <b>Standard Testing Procedures for pollution related analysis, Methodologies &amp; Terminology.</b>                  |

A brief account of each volume is as below.

**Volume – I** covers the summary of the project along with the general issues and recommendations.

**Volume – II** gives the comparative overview of the Indian Paper Industry vis-à-vis other developed nations of the world including Asia Pacific Region. The volume has primarily focussed on the present status and growth of the paper industry, the raw material availability, the forest plantation scheme and the strategies adopted for future requirements in other nations. Besides, the fundamental problems due to the complex structure of the Indian Paper Industry and use of wide ranging raw materials, unplanned growth of small paper mills, insufficient infra-structural facilities, product mix and by and large use of obsolete technology, which has resulted in low operational efficiencies,

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have been discussed. The environmental issues predominant in other countries and those pertaining to India have been discussed. The main environmental issue worldwide is due to the discharge of chlorinated organic halides and the emission of green house gases.

In developed countries, the industry has made advancements right from raw material to the paper making. It has switched over to a single equipment instead of multiplicity of equipment. In developed countries, three aspects are covered:

- \*Reduced environmental impact
- \*Improved safety standards and
- \*Cost effective productivity with quality

The mills have shifted over to batch from continuous, multistage to single stage washing, fourdrinier are replaced with twin wire formers, which are able to retain fillers and fibres. This has reduced the water consumption from 200m<sup>3</sup> to 50 m<sup>3</sup> and other basic utility items resulting in pollution reduction at source.

Remarkable achievements have taken place in effluent treatment plants.

On the other hand, the Indian paper industry is confronting with problem of:

- uniform raw material quality
- lack of process technology & process equipment for our kind of raw material
- lack of resources for modernization of unit
- sensitivity of the industry to Government policies and therefore it is difficult for the industry to compete globally.

The environmental issues are in general differ from one segment to another.

- In large mills, color and AOX are predominating issues.
- In medium sized paper mills, the handling of spent liquor and recovery of chemicals is of important concern, whereas
- In case of small paper mills, obsolete technologies & machineries and lack of trained manpower and environmental problems like disposal of sludge are the major issues.

**Volume-III** has four chapters. **Chapter-1& 2** give an overview of the current technological status prevailing in different segments of the Indian paper industry. The in-plant processes starting from raw material handling, pulping & bleaching to papermaking have been discussed. Some of the process up-gradation measures and state of art technologies, which can be implemented in large and medium sized mills are discussed and the good house keeping measures are also summarised. A brief summary of the technologies is as follows:

**Raw Material Handling/Preparation:**

- New efficient chippers.
- Modern chip screening system
- Bamboo & wood chips, straw & bagasse washing system

**Pulping:**

- Improved pulping practices to get lower kappa number of pulp at improved pulp strength.
- Extended delignification employing modified continuous /batch pulping like RDH, Superbatch etc. which are available on commercial scale.
- Blow heat recovery and cold blow system should be the integral part of the pulping process.
- Collection and incineration of digester relief gases as successfully practiced in developed nations to avoid obnoxious odour problems and maximum sulphur recovery.
- Effective recycled fibre collection system so as to restrict the entry of the contraries.

**Pulp Washing & Screening:**

- Improvised pulp washing system for maximum soda recovery at high black liquor solids concentration and for reducing the subsequent bleach chemical demand.
- Closed screening, shall facilitate the lesser consumption of water requirement.

**Pulp Bleaching:**

- The major environmental challenges are posed due to the discharges of AOX and color. Serious effort should be made to reduce the elemental chlorine requirement in bleaching by adopting some of the following measures:
- Multistage chlorination/split chlorine addition
- Reduction or total elimination of elemental chlorine for bleaching of pulps and substituting with other bleaching chemicals like  $\text{ClO}_2$ ,  $\text{O}_3$ ,  $\text{H}_2\text{O}_2$  etc.
- Adoption of oxygen delignification and oxidative extraction stage with peroxides and oxygen for mills which can afford such systems.
- Exploring the possibilities of the use of enzymatic pre-bleaching of the pulps for reduced requirement of bleaching chemicals.
- Maximum recycling of back waters in bleaching stage.

### **Stock Preparation & Papermaking:**

Since the paper making process requires large volumes of water, efforts are required for complete closing of the system.

- In the stock preparation system, efficient equipment and pulp to handle high consistency stocks be introduced to reduce water & energy consumption.
- Up-gradation of existing paper machine with adequate process control and high level of process control like online measurements, thyristor drive, use of thermocompressor etc.
- Modern high speed machines for value added papers.
- Reduced fines and fillers losses by appropriate control in Paper machine.

### **Chemical Recovery:**

The old chemical recovery system which are not environmentally compatible must be upgraded appropriately, so that the entire chemical recovery system meets the environmental requirements. Some of the measures are given below:

- Modern evaporation system to remove DCE, which is the major source of air emissions from kraft mills.
- Collection and treatment of condensates through anaerobic biological treatment as a step towards energy recovery.
- Collection and incineration of non-condensable gases.
- Desilication of silica rich black liquors for improved steam economy in the evaporators and to enable mills to go for lime sludge reburning in the rotary lime kiln.
- Bagasse based mills should go for thermal treatment of black liquor so as to overcome high viscosity and poor combustion problems.
- Installation of efficient electrostatic precipitators.
- Where possible, common chemical recovery should be sought for medium and small agro based mills.

### **Process Variable And On-Line Control Systems:**

To compete globally in terms of quality & cost, it is essential to produce products of uniform quality and consistency. To achieve this, it is essential to go for the installation of continuous on-line or intermittent measuring and controlling systems. The important process variables, which need to be monitored, are:

- ☐ Flow
- ☐ Level
- ☐ Pressure and temperature

- ❑ Consistency
- ❑ Speed
- ❑ Moisture
- ❑ Basis weight
- ❑ Tension and draw
- ❑ Caliper, etc.

**Utilities:**

Conversion of conventional grate type coal fired boilers to fluidised bed boilers having higher thermal efficiency with electrostatic precipitators.

**Chapter-III & IV** of Volume-III describe the Environmental situation in the Indian paper industry. The sources and magnitude of pollution in large, medium and small paper mills and the impact of pollution on environment and ecology is discussed. The intensity of pollution in terms of solid, liquid and air emissions from wood based, agro based and recycled fibre based units are depicted.

Besides, the conventional pre-treatment, primary and secondary treatment, the methods which can take care of the color, chlorinated organic halides are the advanced effluent treatment methods like ultra-filtration for low volume high concentration effluents, adsorption techniques, combination of aerobic-anaerobic systems, pure oxygen system, high rate biomethanation system with provision for sulphur entrapment, etc. The air pollution problem can be substantially overcome with installation of effective electrostatic precipitators and collection and incineration of non-condensable gases.

**Volume-IV** covers the discharge standards for liquid waste and air pollutants prevalent in India and other developed nations. The Chinese industry has been compared as China like India is a large producer of agro based pulps and having industry structure similar to India. The cluster rule under implementation by the United States Environment Protection Agency has been discussed, which has stipulated the regulatory standards for 12 chlorinated organic compounds, besides proposing MACT for air emissions. The Kyoto protocol for green house gaseous emissions is briefly discussed.

**Volume-V** gives the standard methodologies for analysis of the pollution load determining parameters, the analysis required for optimising the performance of effluent treatment plants and the methodologies for cleaner production selection, bench marking and environmental audit. The standard terminology used in this report is also incorporated. There is a lack of required information of testing procedures in medium and small paper mill, which is very important to assess the pollution load. Most of the mills do not have requisite facilities for measuring such parameters. The mills should get the environmental auditing done at least twice a year. Mills which lack the facilities to

carry out the environmental auditing should get the same done from agencies like CPPRI, NEERI.

## **II. GENERAL ISSUES:**

Some of the basic issues before the Indian paper industry are:

- Sustainable supply of fibrous raw materials and plantation of industrial woods
- Thrust R& D areas
- Human Resource Development & Training
- Participation of Industry in adoption of Cleaner Production Methodologies/ Waste minimisation & reutilisation.
- Role of Regulatory Bodies

### **1. Sustained Wood Supply & Plantation Of Industrial Woods:**

With rising paper demand in the coming years, one of the major factors restricting the growth of wood based paper industry is feared to be the acute shortage and high cost of wood based raw materials. The raw materials cost input is the highest at a level of nearly 30% of the total input cost at present, which is further likely to increase with forest growth rate remaining more or less stagnant. Concrete steps are therefore required for adoption of a new forestation policy, where industrial plantation should be encouraged. Government should consider the involvement of corporate sector in afforestation of available degraded forest land as suggested by domestic pulp & paper industry.

- Further, to ensure protection of interest of local villagers and best possible technical inputs for high productivity, a **tripartite management committee** may be formed for each major site, consisting of experts from Industry & Forest Department and representatives of local Village Council and to **avoid monoculture**, a minimum of specified species may be grown.
- The entire investment and responsibility for operations and high quality technical inputs in field of tree genetics, seed selection, nursery raising and planting, etc. could be that of the industry. To ensure development of agro-forestry and community as well as private planting, the industry will be allowed an area for planting which will meet only a part of its raw material requirement. This will encourage the industry to provide financial and technical support and purchase guarantee at prevalent assured prices to encourage local villagers to plant trees in their land for meeting their own requirement.

## **2. R&D:**

Basically the R&D can be grouped into two categories

- Identification & development of Energy Efficient & Eco-friendly process technologies.
- Setting up of Demonstration scale plant for evaluation and adoption of technologies which have been successfully tested on bench/ semi-pilot scale.

Though some technologies have been developed by leading R&D organizations, they have not reached the industry, primarily because of lack of interface between R&D and user industry. Such an interface can be provided by involving the companies for marketing the technology & / or by opening a marketing cell in the R & D institutes.

**The thrust R&D areas are for:**

- Exploring the Biotechnological applications in –
  - Development of tissue culture & plantation of fast growing species
  - Raw material storage
  - Biopulping & biobleaching
  - Biomass conversion into bioenergy and
  - Effluent treatment especially for decoloration /detoxification of effluents

The other areas are:

- efficient raw material handling & preparation
- adoption of modified pulping processes
- advanced washing techniques
- new generation of recovery & power boiler
- chemical recovery for medium/small pulp & paper mills
- advanced effluent treatment and disposal technique
- solid waste recovery & reuse

## **3. Human Resource Development & Training:**

For sustained performance of the industry, the ability to conserve energy, chemicals and raw materials so as to cut down cost and simultaneously maintain an ecological balance is essential. These challenges can be faced only by a competent & skilled manpower at all levels, who will help industry to renovate, modernise and expand in

an acceptable manner. The availability of the technically skilled manpower in Indian paper industry is much less than what is deployed in other countries, especially R & D personnels working in pulp & paper sector is much less. In India, 15% of the total staff employed is technically qualified as compared to developed countries, where it is 85%. So there is need of development of human resource in

-R&D

-Handling of the treatment plants

The premier institutions should reformulate their training programs keeping the requirement of the industry & should conduct training programs for middle management level & the shop floor personnels.

#### **4. Participation Of Industry In Adoption Of Cleaner Production Techniques/ Waste Minimisation & Reutilisation Programs:**

Cleaner technologies of production are the practical application of knowledge, methods and means so as to provide the most rational use of natural resources and energy and to protect the environment.

A clean technology is more efficient to achieve the following:

- Waste prevention and minimisation by reduced consumption of raw materials.
- Modification and upgradation of the process so that optimal utilisation of natural resources is achieved.
- Adoption of a preventive, rather than a corrective approach to pollution abatement (through better in-plant control measures rather than concentrating on end of pipe treatment technologies.)

Cleaner technologies are dependent upon innovation and high level of co-operation within the industry between different levels.

- Waste minimisation/cleaner production involving raw material substitution, process changes, reuse, equipment redesign and product reformulation and ultimately cleaner technologies.
- Waste utilisation technologies involving reclamation and utilisation of wastes as secondary raw materials in other industrial units.
- End of the pipe treatment technologies involving recovery of raw materials, energy and useful by-products.

## **Bench Marking the Performance:**

In recent years, the bench marking concept has gained prominence. It means comparison of different factors of an individual mill with the best or worst mill in its time of activity.

Benchmarking is a useful concept to mills that are serious about improving its environmental performance. First benchmarking can help a mill determine, where opportunities exist so that it can target its effects selectively. It helps the mills to compare certain aspects of its operation with mills using similar raw material, equipment etc. For instance, a mill may determine that its specific water consumption is much greater than the industry & set targets average indicating that this area is worth examination.

## **5. Role of Regulatory Bodies**

### **5.1 Environment Legal and Policy Framework:**

#### **a. Legal Framework:**

India has a large body of laws and regulations governing the environment. These include laws enacted by parliament, regulations issued by Central and State Governments as well as an increasing body of judicial decisions affecting industrial activity that generates pollution. The major Environmental Acts are discussed in Vol. III of this report. However, the agencies involved in Environmental protection, besides, improving legislation's are also required to promote the concept of Total Environment Management (TEM) by way of participating indirectly in organising training programmes in disseminating information & in promoting the environment:

#### **b. Policy Framework:**

Environmental Policy for industry in India, till recently, had focussed mainly on pollution control through end-of-the pipe (EOP) treatment. With due recognition of the future raw material and energy scenarios, the impact that the industry and its products have on the natural resource base and environmental quality and the necessary thrust being given to the industrial growth in our country, the Ministry of Environment & Forests has formulated comprehensive policies for promoting sustainable development.

These are policy statement for Abatement of Pollution and the National Conservation Strategy and the Policy Statement for Environment & Development.

The Policy Statement for Abatement of Pollution emphasises that it is not enough for the Government and Government agencies to notify and enforce the laws which are to be

complied with and affirms the Government's intention to integrate environmental and economic aspects in development planning with stress on preventive aspects of pollution abatement and promotion of technological inputs to reduce industrial pollutants. The overall policy objective is to integrate environmental considerations into decision making at all levels like EPA in USA. The policy aims at:

- Prevention of pollution at source;
- Encourage, develop and apply the best available practicable technical solutions;
- Ensure that the polluter pays for the pollution and control arrangements;
- Focus on the protection of the heavily polluted areas and river stretches and
- Involving the public in decision making.

In all these policies the emphasis is on prevention of pollution and conservation of natural resources. This becomes all the more necessary in the liberalised environment so that the cleaner technologies and better management practices being adopted are efficient to enable our Indian industry to compete in the International market.

## **6.0 Initiatives For Promoting Cleaner Production/Waste Minimisation:**

Pursuant to the Policy Statement for Abatement of Pollution several initiatives have been taken for promoting cleaner technologies of industrial production. These are:

### **(i) Economic Instruments:**

In an effort to integrate economic and environmental planning, Government of India is promoting a variety of incentives to adopt efficiency enhancing waste minimisation practices. These include:

#### **a. Water Cess**

The Water (Prevention and Control of Pollution) Cess Act, 1977 provides for the levy and collection of cess on water consumed by industries and local authorities. The present water cess rates are being increased by three-fold to motivate the conservation of water which is increasing by becoming a scarce natural resource in our country.

**b. Effluent charges:**

Effluent charges based on nature and volume of the effluents released are being considered. The scope of the charges will be extended to emission and solid wastes. These charges provide a continuing incentive towards optimal releases and encourage new technology production processes.

A study has been undertaken through National Institute of Public Finance and Policy to analyse the market based instruments such as taxes/charges for pollution abatement.

**c. Financial Assistance By Way Of Credit And Loans At Reduced Rate Of Interest:**

World Bank Assisted Industrial Pollution Prevention Project is mainly targetted at introducing cleaner technologies in industrial units. Under the investment component of the project, world bank line of credit is available to industrial units for pollution abatement, with a focus on waste minimisation and adoption of cleaner methodology production. The technical assistance component supports to:

- Establishment of a "clean technology institutional network" discussed in vol. – II of this report designed to promote the development, diffusion and transfer of technologies with environmental benefits for the industrial sector; and
- Extension services for the identification of appropriate waste minimisation and abatement methods and organisation of waste minimisation circles.
- The clean technology cell in the Ministry of Environment & Forests would be the Host Center and would facilitate the interaction between the network and international agencies besides providing inputs to the policy framework
- The Central clearing House for clean technologies would be housed at the NEERI. This in turn would network with Consortium of CSIR laboratories and other research and academic institutions like CPPRI, IPT, etc.
- The clearing house is expected to collect information on clean technologies from all over the world and make information available to entrepreneurs intending to establish new units or those who plan to improve the existing units.

**d. Strengthening of Standards:**

- In order to promote the conservation of water use by industry, rules relating to standards for consumption of water by polluting industries have been notified.

- To promote the shift from pollution control to pollution prevention, rules relating to **load based standards instead of concentration based standards** have been notified.

**e. Eco-labelling:**

Eco-labelling scheme of Government of India supports cleaner production policies as there is strong emphasis on cleaner manufacturing processes in the criteria for grant of Eco-labels.

**f. Environmental Statement for Environmental Audit:**

The Policy Statement for abatement of pollution provides, for an environmental statement by all polluting units, which would subsequently evolve into an environmental audit. Pursuant to this policy, Government of India has made submission of environmental statement mandatory through Gazette Notification issued under the Environment (Protection) Act, 1986. The statements are to be submitted once in every year. The notification requires that industry provide information on:

- water and raw material consumption
- Pollution generated
- Information on hazardous wastes and solid wastes along with disposal practices.

The industries are also required to make an assessment of the impact of pollution control measures on the consumption of natural resources.

The Environmental Statement enables units to take a comprehensive look at their industrial operations and facilitates understanding of material flows and focuses on areas where waste reduction and consequently savings in in-put costs is possible.

**g. Scheme "Adoption of Clean Technologies":**

The main aim of the scheme is to promote the development and adoption of clean technologies and best practice techniques including waste reuse and recycling for environmental benefits. The scheme provides:

- Financial assistance for undertaking waste minimisation and demonstration studies in selected sectors,
- Preparation of sector-specific manuals on waste minimisation

- Demonstration project
- Creation of data base on the availability of clean technology or
- Present status of clean technology used in the industries
- Identification and diffusion of clean technology to the industries and
- Training and awareness programmes among the shop floor personnels for adoption of pollution prevention and waste minimisation measures.

**A. Major Barriers In Promotion Of Cleaner Production:**

There are certain barriers which prevent industry from adopting the relatively new concept of cleaner production/waste minimisation in existing or new production facilities, with exception of few mills:

**(i) Organisational Barriers:**

- Non-involvement of workers in cleaner production
- Authority only with the owner
- High employee turn over
- Payment on production basis

**(ii) Systemic Barriers:**

- Poor record keeping and reporting
- Inadequate and ineffective management system
- Lack of systems for professional up-gradation of employees

**(iii) Technical Barriers:**

- Poor infrastructure
- Miniature size operation
- Lack of infrastructural facilities
- Moderate level commitment to innovation with exception of few mills
- Limited access to technical information

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- Technology limitations
- Obsolete technology & equipment and poor process control instrumentation & automation

### **(IV) Process Barriers:**

- High utility consumption /unit
- Low availability of forest raw materials & forest management
- Poor recycling of waste paper
- Recovery of chemicals from agro based black liquors (exception of 5 mills out of 111)
- Decolorization & detoxification
- Air pollution problems

### **(V) Economic Barriers:**

- Prevalence of production quantum over production costs
- Resource pricing and availability
- Capital availability and costs

### **(VI) Attitudinal Barriers:**

- Lack of good housekeeping culture
- Resistance to change due to fear of failure

### **7 Strategies For Promotion And Adoption Of Cleaner Production/Waste Minimisation :**

In order to overcome the above stated barriers, a range of enabling measures are proposed. An analysis has also been carried out of catalysts available/to be made available for further support these enabling measures (1). These are summarized below:

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Catalysts	Enabling Measures
<b>i. Organisational Barriers:</b> <ul style="list-style-type: none"> <li>- Family Supervision</li> <li>- Sharing of information</li> <li>- Direct involvement and supervision from owners</li> </ul>	<ul style="list-style-type: none"> <li>- Organise a capable project team</li> <li>- Recognise waste minimisation</li> <li>- Assign costs to production and waste generation .</li> </ul>
<b>ii. Systemic Barriers:</b> <ul style="list-style-type: none"> <li>- Proper documentation and planned layout</li> <li>- Good housekeeping</li> </ul>	<ul style="list-style-type: none"> <li>- Training of plant level waste minimisation team</li> <li>- Top down housekeeping drive</li> <li>- Dissemination of success stories</li> </ul>
<b>iii. Technical Barriers:</b> <ul style="list-style-type: none"> <li>- Technically skilled in-house staff</li> <li>- In-house fabrication facilities</li> </ul>	<ul style="list-style-type: none"> <li>- Dissemination of waste minimisation techniques and technologies</li> <li>- Need-based support for environment driven R&amp;D</li> </ul>
<b>iv. Process Barriers:</b> <ul style="list-style-type: none"> <li>- High Utilities consumption</li> <li>- Availability of forest raw materials</li> <li>- Poor recycling of waste paper</li> <li>- Chemical recovery in medium /small agora based mills.</li> <li>- Decoloration &amp; detoxification</li> </ul>	<ul style="list-style-type: none"> <li>- Good housekeeping and Maximum recycling/resource recovery</li> <li>- Encourage farm forestry, clonal plantation, joint sector plantation</li> <li>- Organised waste paper collection system</li> <li>- Chemical recovery where clusters of such mills are available</li> <li>- Employing biotechnological route</li> </ul>
<b>v. Economic Barriers:</b> <ul style="list-style-type: none"> <li>- Financially attractive waste minimisation options</li> <li>- Companies financially sound</li> <li>- Poor recycling of waste paper</li> <li>- Chemical recovery in agora based mills</li> </ul>	<ul style="list-style-type: none"> <li>- Planned investments</li> <li>- Assign cost to waste streams</li> <li>- Financial incentives</li> <li>- Organised waste paper collection</li> <li>- Chemical recovery in areas where clusters of mills are located.</li> </ul>
<b>vi. Attitudinal Barriers:</b> <ul style="list-style-type: none"> <li>- Early success of waste minimisation implementation</li> <li>- Employee involvement in waste minimisation</li> </ul>	<ul style="list-style-type: none"> <li>- Encourage experimentation</li> <li>- Publicise early success</li> <li>- Management review of WM progress on a regular basis</li> <li>- Decolourization detoxification.</li> </ul>

**OBSERVATIONS AND RECOMMENDATIONS:**

The Indian Paper industry will have to go for structural changes for sustainable development and to meet the new challenges. Various measures to be taken by the Indian Government and industries for cost, quality competitiveness and environmental improvisation of pulp and paper industry have been discussed.

- In the last few decades, the industry has not been successful in handling the environmental problems. There is a need for a long term strategy for containing the pollution problems.
- Although the wood requirement by the pulp & paper industry is less than 1% of the total wood harvested annually, nevertheless, massive plantation programs by group of mills /individual mills should be taken by utilising waste lands and degraded waste lands so as to plan its requirement for next few decades so that the mills based on forest based raw materials will not face problems ,due to unavailability of raw material from state owned forests.
- Industry irrespective of the fibrous raw materials and size must plan to reduce the pollution loads at source, since it is difficult to meet the discharge limits by external treatment particularly in case of medium sized pulp & paper mills, where the pollution load is due to black liquor.
- Modernization of chemical recovery and other areas is also important in terms of environmental impact particularly in control of gaseous and particulate emissions.
- Already the chemical recovery system for agro based mills are now proven and with five successful installations, all the medium size mills should increase their capacity and make their sizes suitable for installation of chemical recovery systems.
- As far as domestic market is concerned, the industry should be oriented towards the customer preference, whether the customer requires high brightness paper or paper produced with less bleach chemicals.
- The industry as a whole should rationally change the bleaching parameters by going in for minimum elemental chlorine usage by manipulating the bleaching techniques, so that the color and AOX levels are within an acceptable limit.

- The study conducted by CPPRI clearly indicates that some of the industries, which have taken adequate measures have succeeded in reducing the AOX levels.
- Required steps should be taken for lime sludge reburning to avoid solid waste disposal problems.
- The fibres and filler losses should be controlled through appropriate fibre recovery practices and through a maximum closing of the system.
- Although, the tolerance limits for color are not stipulated for all Indian states, but color is going to be the major issue as far as liquid waste is concerned. There is need to evaluate all the technologies so that the discharged color is tolerable to the receiving streams.
- There are other parameters which needs to be monitored in liquid waste like Chlorides, sulphate and sodium for mills which are planning to use the treated effluents for the purpose of irrigation as the irrigation in context to our country is the ideal way of disposal of treated effluents.
- Since it is not possible for all the mills to go for the incineration technologies, the adoption of simpler techniques like biomethanation and composting should be planned by every mill.
- The modern treatment methods like dispersed aeration, diffused aeration, combination of aerobic and anaerobic should be evaluated on mill to mill basis, so that the treatment facilities are adequate and acceptable both technically and economically.
- Rapid Environmental Impact Assessment (REIA) should be made and agencies like NEERI, CPPRI may be contacted for annual assessment of the mill for EIA.
- Government should not only act as an enforcing agency, but also should help in implementing the environmental programs.
- The indigenous home grown technologies, which have an impact on environmental improvisation must be promoted by TIFAC, PASTER, IDB, ICICI & world bank and these agencies should make an effort in organizing financial assistance for setting up demonstration plants based on modern technologies.
- Soft loan/subsidy should be given by the Government to encourage the industry to adopt new energy efficient and environment friendly technologies.