Technological Advancement of Fiber Line in Indian Paper Mills.

Dr. S. Raghuveer

The Paper Industry in India, has shown significant progress during the successive Five Year Plans. The growth of the Paper Industry gathered momentum during 1955-60.Bamboo was the major raw material for the pulp and paper industry. Earlier, natural forests provided a ready available source, but with increasing anthropogenic pressures resulting in shrinkage and deforestation, this source has drastically dwindled over the years. The shift in raw material sourceing was to Hard woods, agro-residues like bagasse, straws and secondary fibers. Large sized mills , based on bamboo, wood and bagasse are producing pulp with conventional kraft process and are well equipped with chemical recovery system while the small and medium size paper mills based on agro- residues are following soda process without chemical recovery. Now these mills are increasing their capacity for putting up the chemical recovery systems. Stringent environmental legislations, increasing cost of energy, chemicals and other utilities and increasing demand of high brightness paper are forcing the paper industry to adopt improved pulp washing systems and modifications in bleaching practices. Apart from this, the industry is also gearing up to grow its own raw material. The promotion of wood based industry, carries the potential to make a vital contribution towards the creation of rural livelihood and the restoration of ecological balance.

INTRODUCTION

The paper Industry in India has shown significant progress during the Nation's successive Five year plans. It gained momentum during 1955 - 60 when the capacity was increased to 4,00,000 TPA. with 25 mills, with capacity utilisation of 87% (1).Today, the Indian Paper Industry is with more than 600 mills producing a range of paper varieties: cultural, industrial and news print , with a capacity utilisation of 70% on an average producing about 4.25 million TPA. The paper and paperboard production over the years is shown in Table-1. Although the country is self sufficient in the manufacture of most of varieties of paper and paperboard, some specialty papers are imported. The industry has always has presented a fragmented picture with a mix of large, medium and small paper mills with capacities ranging from 2 TPD to more than 1000 TPD. The industry has a turnover of over Rs.16, 000 crores and employs about 0.3 million persons directly and 1.0 million indirectly.(2)

PRESENT STRUCTURE OF PAPER INDUSTRY IN INDIA AND ITS RAWMATERIALS

Bamboo was the major raw material source for the Indian paper Industry. As the production increased, various hard woods found is way in papermaking. With the setting up of small paper mills, agricultural based raw materials gained importance. Today, Indian paper industry can be classified into three Categories.

*ITC Ltd., PS PD, Unit, Bhadrachalam, Vill. Sarapaka, Distt. Khammam (A.P.)

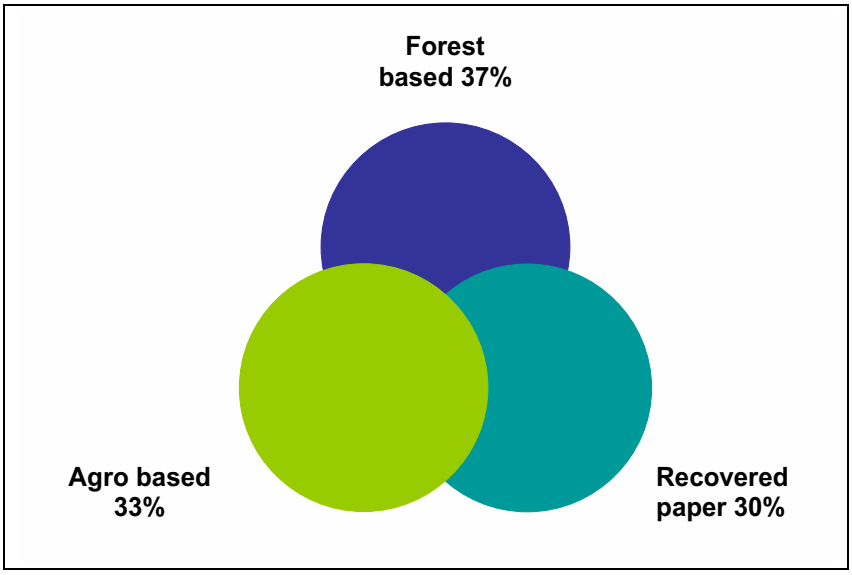

Fig. 1.
VARIOUS FIBROUS RAWMATERIALS USED TO PRODUCE PAPER AND PAPERBOARD IN INDIA (2006)

TABLE - 1

NATION`S PAPER AND PAPERBOARD PRODUCTION

Year	Production(000)T	Year	Production(000)T
1950 – 51	116	1999 – 00	3059
1960 – 61	349	2000 – 01	3090
1970 – 71	755	2001 – 02	3176
1980 – 81	1149	2002 – 03	3412
1990 – 91	2088	2003 – 04	3684
1997 – 98	2922	2004 – 05	3848
1998 – 90	3114		

❖ **Forest based rawmaterial;**
Large integrated paper mills use bamboo and hard woods as the major fibrous raw material and are equipped with full-fledged chemical recovery and effluent treatment plants. This section contributes about 37% of total production.

❖ **Agro based rawmaterial;**
Medium and small paper mills use straws, bagasse, and other annual grasses as cellulosic fibrous rawmaterial. Very few mills are equipped with Chemical recovery system. This segment contributes about 33% of the total production.

❖ **Based on recycled paper;**
This segment covers small and medium paper mills using waste paper as major rawmaterial and contributes nearly 30% of the total production.

Contribution by various segments is shown in Fig. 1.(3)

WOOD BASED FIBRE RESOURCES

The Indian Paper industry uses a variety of fibrous rawmaterials such as bamboo, wood, agro residues and recycled fiber. Currently, the paper industry is meeting its demand for the forest-based rawmaterials from government sources and farmers. The industry is also successful in raising plantations in marginal lands held by farmers but this may not be adequate to ensure sustained supply to meet the challenges of the growing needs of the paper consumption. It is estimated that the Indian paper industry will be requiring about 9.0 million tonnes of wood per annum by the year 2010. To meet this requirement, about 1.0 million hectares of land for plantations for which the industry has approached the government for allocation of degraded lands near the mills on long term lease for growing plantations.(4).

CONCEPT OF FIBRE LINE

Modified kraft pulping is a way to get more lignin out of wood fibres during pulping than conventional kraft pulping. If conventional pulping continued too far, serious reduction in both the yield and the strength of the pulp occurs. Modified pulping equipment producers developed over recent years for both batch and continuous pulping are now commercially proven. One of the key operations in chemical pulp production is pulp washing. New generation washers have been designed in response to the demand for improved efficiency and reduced operation maintenance and capital costs. Increasing demands for paper quality created challenges to the pulp screening process. Two of the most important qualities of pulp is pulp brightness and its cleanliness.

A modern screening operations meets the following objectives: (5).

❖ Low specific energy consumption
❖ High reliability
❖ High flexibility
❖ High screening efficiency & good cleanliness.

The introduction of oxygen delignification before pulp bleaching leads to a reduced kappa number, which is beneficial for pollution abatement. Waste water parameters like BOD, COD,AOX, colour etc are directly correlated to the kappa number of the pulp to be bleached. One of the two oxygen delignification systems operate at either high or medium pulp consistency, the medium pulp consistency system is dominating the market.

BLEACHING OF CHEMICAL PULP

The purpose of bleaching is to remove remaining dark colored lignin impurities in the pulp and thus meet certain quality criteria. Bleaching of chemical pulp is carried out in several stages. In modern mills, the bleaching starts with oxygen delignification for a reduction of the consumption of more expensive bleaching chemicals and a reduced effluent load from the bleach plant. The predominant bleaching methods are ECF (elemental chlorine free) and TCF (totally chlorine free). In classic chlorine bleaching, molecular chlorine or chlorine gas are used with other chlorine-containing chemicals such as hypochlorite. For environmen--tal and quality reasons other bleaching chemicals are replacing molecular chlorine and hypochlorite. In TCF bleaching, available chemicals for TCF bleaching are oxygen, hydrogen peroxide, ozone and peracids. In ECF bleaching chlorine dioxide is used with chlorine-free chemicals.

Bleaching is performed in stages.
The early stages remove remaining lignin; final stages brighten the pulp is usually washed between stages to remove any soluble organic material

Classes of bleaching chemicals (6).

❖Oxidising Chemicals
❖Alkali
❖Metal removal agents

♦ **Elemental chlorine (Cl_2)** is an effective delignifying agent. As it breaks lignin bonds, it adds chlorine atoms to the lignin degradation products, thus producing significant amounts of chlorinated organic material.

♦ **Ozone (O_3)** is also an effective delignifying agent. It also brightens the pulp as well. Ozone has not been used in the past because mills have not been able to improve its selectivity - ozone attacks the cellulose fibre as well as the lignin. Recent technological developm-

STRONG OXIDIZING AGENTS

Oxidizing chemicals can either degrade the lignin or remove colour from the pulp depending on operating conditions.

C	**D**	**H**
Elemental Chlorine	Chlorine Dioxide	Hypochlorite
Z	**O**	**P**
Ozone	Oxygen	Hydrogen Peroxide

-ents, however, have solved this problem and have allowed mills to take advantage of this cost-effective bleaching agent.

♦ **Chlorine dioxide (ClO_2)** is a highly selective chemical that can both delignify and brighten pulp. It oxidizes lignin, but does not add chlorine atoms onto lignin fragments; however, small amounts of elemental chlorine and other chlorine compounds formed during the chlorine dioxide bleaching process react with degraded lignin to form chlorinated organic compounds. Chlorine can be partially substituted with chlorine dioxide.

♦ **Oxygen (O_2)** is an inexpensive, highly effective delignifying agent that is usually used at the beginning of the bleaching process. It has intermediate selectivity.

♦ **Hypochlorite** is an inexpensive delignifying agent formed by mixing elemental chlorine with alkali at the mill. Mills are phasing out the use of hypochlorite because it generates large quantities of chloroform when it is used to bleach pulp.

♦ **Hydrogen peroxide (H_2O_2)** is mainly used to brighten pulps in the final bleaching stages. Peroxide is often used at the end of a conventional bleaching sequence to prevent the pulp from losing brightness over time. Researchers have found operating conditions under which peroxide will delignify pulp, and are working on technologies that will consume less.

CONCEPTS ON NEW BLEACH - -ING SYSTEMS

❖ **ECF** or **Elemental Chlorine - Free** is a bleaching process that substitute chlorine dioxide for elemental chlorine in the bleaching process. Compared to elemental chlorine bleaching processes, ECF bleaching reduces the formation of many chlorinated organic compounds. However, the quantity of effluent from the mill is not reduced.

TABLE - 2

Various bleaching sequences available :

Elemental Chlorine	**CEH** **CEHH** **CEH OED** **CE OED**
Elemental Chlorine Free	**D_0 E_{OP} D_1** **D_0 E_O D_1E D_2**
Totally Chlorine Free	**OZEP**

❖**Enhanced ECF with extended or oxygen delignification** removes more lignin from the wood before bleaching. Therefore, fewer bleaching chemicals are required. In addition, compared with traditional ECF, this process reduces energy consumption by 30%, improves the quality of mill wastewater, and reduces the quantity of mill wastewater by nearly 50%.

❖ **Enhanced ECF with ozone** substitutes ozone for chlorine or chlorine dioxides as a brightening agent in the initial stages of the bleaching process. (Final stage uses chlorine dioxide.) This process further improves the quality of the wastewater and enables recovery of most mill wastewater. In addition, this process reduces mill wastewater by 70 to 90% compared to traditional ECF.,

❖**Processed Chlorine Free (PCF)** is the best type of chlorine free (TCF) processing. PCF uses oxygen-based compounds instead of chlorine based compounds in the bleaching process. PCF products contain post consumer recycled fiber content that has been re-leached using this process.

❖**Totally Chlorine Free (TCF)** bleaching uses no chlorinated bleaching agents to bleach the pulp. Instead, bleaching agents such as oxygen and peroxide are used.Various bleaching sequences are shown in Table-2.

EXISTING CLEANER BLEACHING SYSTEM AT BHADRACHALAM

Agumentation of PRE *ECF* pulp bleaching

Before adopting ECF bleaching , the bleaching sequence followed by the mill is shown in Table-3.The bleaching capacity enhanced from 200 TPD to 300 TPD to meet the additional pulp requirement.

Twin roll press Washer

This washer has 3 washing stages on the twin roll press and the inlet consistency is 3-6%. The availability of pulp at 30% consistency from the press minimizes tanks makes the washing system flexible and economically attractive both with regard to investment and ease of operation.

Screening

Pressure screening has undergone drastic improvements, especially in profiled and wedge wire screen drums. This has made use of very narrow slots possible and for pressure screens to efficiently remove small dirt particles. Due to improvements in rotor and profiled slot drum technologies, it has been possible to replace centrifugal cleaners with pressure screens. The development of new wedge wire drums has made it possible to increase screening capacity and use even narrower slots. This has improved energy consumption, investment costs and cleaning efficiency. A three stage pressure screening system is adopted.

Oxygen Delignification

Oxygen delignification has emerged as an important processing technology worldwide; even the industry, driven by legislative an market forces searches

for economical, environmentally friendly, alternatives to chlorine. Oxygen delignification serves as a beneficial economical transition between the kraft cook and the bleach plant. There comes a point when digesting becomes less selective and continuing the process would decrease pulp yield and lower the pulp quality. The benefits of introducing the oxygen delignification stage are substantial.

Typical retention times in the various towers are as follows:

D1 Tower	min	45 60
Eop pre-reaction tube	min	30 45
Eop Tower	min	90-120
D2 Tower	min	180-210

E C F BLEACHING

Pulp after oxygen delignification is led to a post oxygen washer and then bleached to a brightness level minimum 88% ISO, by employing **D1 EOP D2** bleaching sequence.

For supplying the requirements of chlorine dioxide for bleaching, chlorine dioxide generation plant is installed.

The waste water characteristics and the advantage of chemical saving and pulp quality improvements after ECF bleaching are shown in Table-4&5 respectively. The number of mills practicing complete replacement of chlorine with chlorine dioxide continues to grow. Most grades are bleached to high brightness, commonly 88-90°GE. The environmental concerns related to the use of elemental chlorine and hypochlorite have given birth to the Elemental Chlorine Free (ECF) bleaching. The exact combination for use of these non elemental chloro bleaching agents is basically governed by the quality of end product, the brightness level to be attained and the economics of the requirement. Environmental considerations play a decisive role in meeting the requireme--nts and in choice of correct bleaching agents.

NEW EXPANSION

The mill has now embarked upon a project for the installation of a new pulp mill with a fiberline of capacity 1,35,000 tpa. bleached pulp and a paper machine. With this the production capacity of this unit will go up to 5,20,000 tpa. The mill will be adopting a Lo-solid cooking system. will also adopt a new bleaching sequence by partial replacement of chlorine dioxide with ozone.

CONCLUSION

The future of Indian Paper Industry is bright as the industry utilizes the renewable rawmaterials. Apart from this; the literacy rate and consumerism is on the raise. The industry has started adopting cleaner technologies in pulping and in pulp bleaching along with energy conservation measures. The research is in the direction of removal of lignin-rich and heavy metal ion rich fines fractions by mild mechanical treatment and the distribution of metal ions in different morphological parts of the pulp fibre. Research in the area of TCF bleaching is mostly focused on development of new bleaching sequences (oxygen, hydrogen peroxide, organic peroxides etc.), metal management (chelation, ion exchange) and possibilities of lowering the bleaching chemical consumption. The use of chelating agents and ion exchange to modify the metal ion profile of solid wood is also being investigated. However, the market forces govern the future of the Indian paper industry, which are cyclic, since, they follow international trends. In fact, many analysts, feel that the performance of the Indian paper industry greatly influenced by global macro- economy factors and demand supply situation.

TABLE – 4
WATER POLLUTION LOADS PER DAY

Parameter	Before ECF (200 TPD)	After ECF (300 TPD)	Reduction %
TSS (TPD)	9.23	7.22	21.8
BOD (TPD)	5.99	4.12	31.2
COD (TDP)	18.45	10.32	44.1

TABLE -- 5
REDUCTION IN CHEMICAL CONSUMPTION & IMPROVEMENT IN PULP PROPERTIES

Parameters	Before ECF	After ECF
Chlorine kg/T(BP)	69	0
H_2O_2 kg/T(BP)	13	6
Na_2So_4 kg/T(blown pulp)	42	15
Kappa No.	21.5	12.5(ODL)
Pulp Viscosity (Cp)	7.1	8.2
Brightness(ISO)	84	88

REFERENCES

1.Production of selected Industrial Products(Paper and paperboard). The Hindu, Indian Industry survey 2006.pp294.

2.Gitanjali Chaturvedi, Jain R.K., Singh K., and Kulkarni A.G., Indian Paper Industry Growth and Prospects. IPPTA J.vol.18 No2.Apr-June 2006.pp73.

3.Ansari P.M., Key note address on CREP in Pulp and Paper Industry. IPPTA J,vol.18.No.4.Oct-Dec2006.pp 41.

4.Proceedings of Second workshop on Frontier TechnologiesCPPRI June 2005.

5.AET (1996) Trends in World Bleached chemical Pulp Production 1990-1996 Publ. Altiance for Environmental Technology March 1996 pp4

6.PPI(1995) Annual Review. Pulp & Paper International July 1995.

ACKNOWLEDGEMENT

The author acknowledges his sincere thanks to the management of ITC Ltd. PSPD Unit: Bhadrachalam, for providing the information and permitting to present the paper at IPPTA seminar. (MUMBAI. FEB. 2007)