REPORT

ON

STUDIES ON
BENCHMARKING /INPUT NORMS
FOR PULP AND PAPER INDUSTRY

SUBMITTED TO

CESS GRANTS AUTHORITY

(Development Council for Paper, Pulp & Allied Industries)

BY

CENTRAL PULP AND PAPER RESEARCH INSTITUTE

SAHARANPUR, U.P., INDIA

www.cppri.org.in

Project Profile

Project	:	**Studies on Benchmarking /Input Norms For Pulp And Paper Industry**
Objective	:	To optimize the input norms for paper industry with an objective to reduce and conserve the scare resources like; fiber, water, energy and chemicals, so that the industry based on the input norms as a guide line can monitor their process efficiency.
Duration	:	***August 2001 to June 2004***
Research Team		
Technical Advisor	:	**Dr. A. G. Kulkarni** **Director** **Central Pulp and Paper Research Institute Saharanpur, U. P., India**
Principal Investigator	:	**Dr. R. M. Mathur** **Scientist E-II** **Chemical Recovery & Energy Management Division**
Associates	:	**Dr. B. P. Thapliyal, Scientist E-I** **Sh. Alok Kumar Goel, Sc.B** **Sh. Arvind Jain, SRF** **Sh. Veerendra K.Bhorale, SRF**

Contents

Chapter - 1

INTRODUCTION

INTRODUCTION

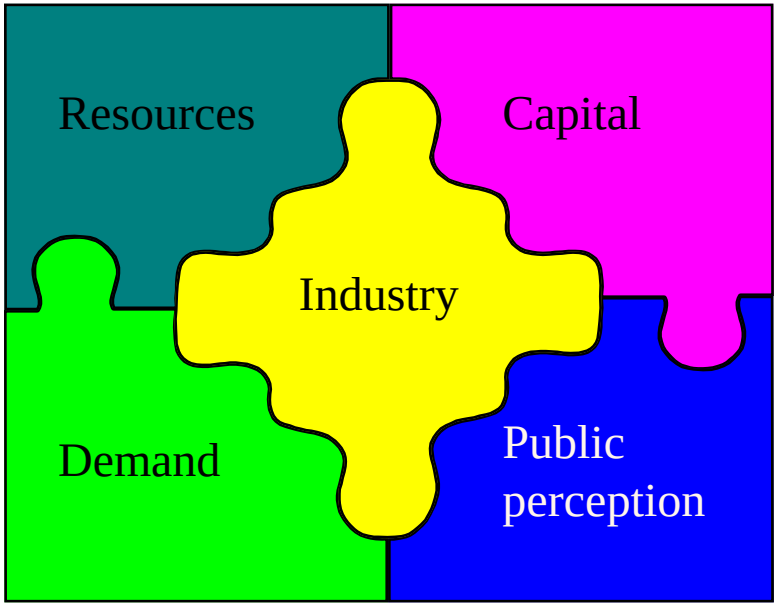
- Quality and cost effective production
- Basic inputs
  - Fibrous Raw materials
  - Chemicals
  - Non-fibrous additives
  - Energy
  - Water
- Benchmarks and Norms for inputs
- The project - Objective and Line of Investigations

Paper ..... Quality & Cost Effective Production

Paper is one of the essential commodities and Paper Industry forms the core sector of our country's economy. Paper and paper products contributes to other sectors also such as education, communication and product packaging. The uses and applications of paper and paper products are virtually limitless and new speciality products are continuously being developed.

The per capita consumption of paper is considered as a benchmark of modernisation of any country. Per capita consumption of paper & paper products in India is 5.5 kg, which is very low when compared with developed countries. The reasons attributed for low consumption are; Low level of literacy, slow industrial growth, lack of modernisation etc.

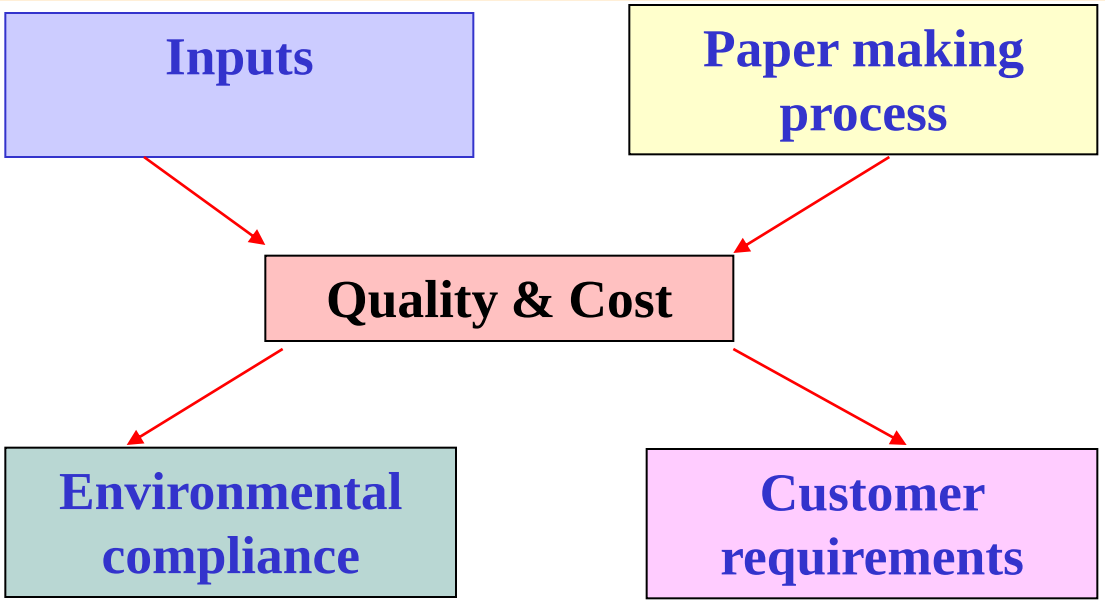
Despite the revolution in electronic media and a tough competition from computers and Internet connectivity, the demand forecasts clearly indicate rise in requirement of the paper & paper products in the years to come. With rise in its literacy rate, per capita consumption in India is expected to double within next 10 years. Indian paper industry has a tough task ahead and has to gear it self for facing the growth in demand. However, there are several bottlenecks industry has to overcome and one of the biggest hurdle is the availability and utilisation of inputs to match quality with cost effective production.



Paper .....Quality & Cost Effective Production

The production process is based mainly on the use of natural fibers-primarily of wood but with significant reliance on non-wood fibers in the developing world. Apart from this a large number of other inputs also affect the production of paper & its products. The predominantly contributing factors are; chemicals, water, fillers and energy which play a significant role in quality and cost effective production of paper products. This reliance on harvested products makes the sector an important customer of the forestry and, to an extent, the agricultural sectors. It therefore forms an integrated part of the development and welfare of rural areas across the globe.

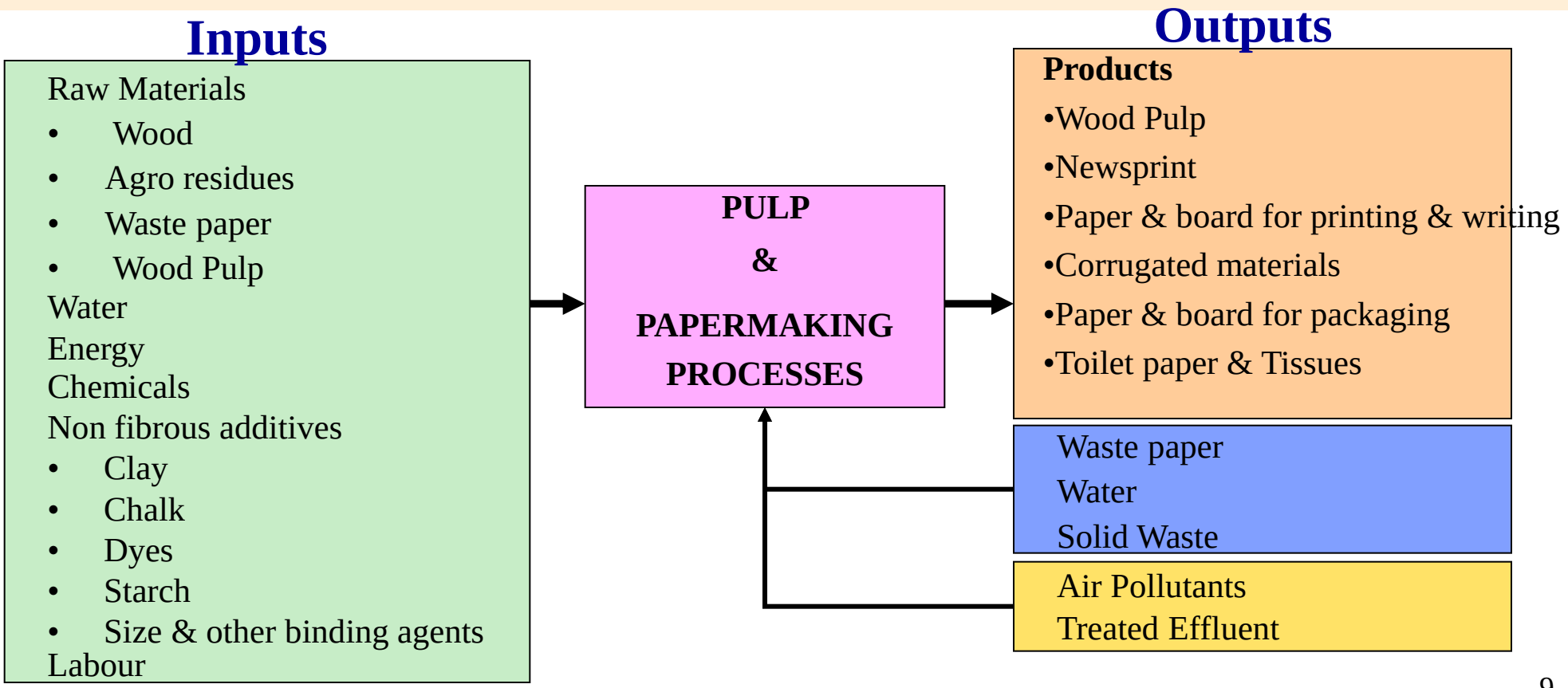
Being mainly based on renewable raw materials, and with process and products compatible with environmental needs, the paper industry is striving to meet the statutory requirements for its sustainability. The need for maintaining a balance between Inputs, paper making process, quality, cost and environment, is the industry's greatest challenge.



Inter-Relationship of Materials & Processes

Basic Inputs ..... The cost factors

A wide range of fibrous raw materials, chemicals, fillers & additives, water, energy and labour are utilised during the pulping and papermaking process. Their availability, price and quality to a large extent determine the cost of production. The industry has to strictly monitor these basic inputs for its market positioning and competitive advantage. Better utilisation of the inputs and reuse of by-products / wastes is a key factor which controls the economics of pulp and paper manufacturing.



Basic Inputs ..... The unusual trend

As compared to other industries like the cement and chemical industry, the input consumption in Pulp and Paper industry is very high and the output is comparatively very low. The input-output ratio is 8:1.

Fibre, energy, water and chemicals are the important inputs in paper manufacture. Both from the quality aspect and also from the cost of production point of view, it is very important to have some norms of the basic inputs, so that the cost of production is maintained at minimum level without sacrificing the quality of production.

The quantum of these inputs varies with raw material to raw material and has a direct bearing on the over all efficiency of the paper industry. The variation in quantity of major inputs is vary large in Indian mills. The power consumption varies between 1200-2000 kWh, steam from 10-18 ton, coal 2-4 ton, water 80-250 m^3, cooking chemicals 60-400 kg/t paper. For improved efficiency there is a need to optimally utilise these primary inputs. This calls for a detailed study of the paper sector to identify consumption pattern and their effect on competitive positioning of the Indian paper industry in global market.

Unit costs in selected Asian countries 2002

	Hardwood USD/m3	Labour (operating) USD/person/a	Fuel (coal) USD/GJ	Purchased power USD/MWh
India	**45**	**1000**	1.69	**87**
Indonesia	**23**	1603	**0.70**	**32**
China	**45**	3870	1.29	72
Malaysia	28	**11263**	**2.50**	45
Thailand	30	3571	1.30	39

Basic Inputs ..... Operational Efficiency w r t primary inputs

The operational parameters of various processes and operations shows a wide variation. This is due to significant differences in raw material, processes adopted and end products. Lack of optimised operations, level of modernisation and automation are the major factors which govern the variation in operational efficiency.

Parameters	Proposed Norm	Range under which most of the units fall
Bleached pulp yield, %	45	38-44
Chemical consumption, TTA, kg/t of unbleached pulp	330-350	340-355
Chlorine consumption, as available Cl_2 kg/t	80-110	90-130
Washing loss, kg/t	10-12	20-25
Fibre loss, %	0.25-0.30	0.30-0.70
Finishing loss,%	4.0-5.0	6.0-10.0
Machine down time, %	10.0	15.0-25.0

Source: CPPRI

Basic Inputs ..... Raw materials

The best raw materials for pulp and paper manufacture is as per the customer requirement and industry norms are derived from soft woods and some of the hard wood species. In India due to dwindling forest resources, the pulp and paper industry depends only on bamboo and mixed hardwood. Industry utilizes alternate raw material to a large extent along with the farm plantations. Fibrous raw material is the single largest component influencing the manufacturing cost of paper. Any perceptible increase in the cost of fibre from these raw materials has a considerable impact on the manufacturing cost.
For sustained supply of raw materials, the industry has to use renewable sources to the maximum extent.

The fibre resources used by the Indian pulp and paper industry come from three sources:

Forests

Including bamboo and mixed hardwoods from forest felling, and eucalyptus wood from plantations (both organized plantations and farmers' fields/agro forestry plots)
In India all forests are Government owned and largely not accessible to pulp and paper industry. Plantation is being done by farmers on private lands and the produce is sold to pulp and paper industry. However, the effort is still small and meets some 10-15 % of wood needs of the industry.

Agricultural residues

Such as bagasse, rice and wheat straws and cotton stalks.

Waste paper

Includes domestic and imported waste paper.

Basic Inputs ..... Waste Paper Recycling

There is huge potential for conservation of natural resources and reduction in pollution by increased recycling of secondary fibres. The waste paper recycling yields fibre at low chemical and energy inputs thereby considerable cost reduction. The energy consumption in waste paper based mills is 30-40% less than that of an integrated pulp & paper mill. The effluent problem is also considerably less severe for waste paper based mill. A wide range of boards, lower grade writing papers and tissue papers may be produced from waste paper . Investment for processing equipment is lower as compared with chemical pulping equipment . Despite all these the recovery rate of waste paper in our country is very low as compared to Germany, Netherlands, Japan, Taiwan etc. where it is above 40% as compared to 25% in our country. This is mainly due to lack of conservation awareness. Waste paper recycling is going to be a very important for survival of paper industry and its recovery rate should be increased to maximum possible levels. For enhancing the waste paper recycling, following factors need close consideration;

- To increase the waste paper recovery the collection method need to be improved by reorganising the collection system.
- Scope of sorting of waste paper at source should be explored.
- Proper selection of individual equipment for defibering, contaminants removal and deinking etc. is needed as many times, equipment which is excellent as individual equipment does not fully function in the system.

Basic Inputs ..... Chemicals

Majority of chemical usage is in pulp mill during chemical pulping and bleaching operations. In Indian mills, kraft and soda alkaline pulping processes are used predominantly for chemical pulping. The main delignification chemical in these pulping processes are caustic soda and sodium sulphide in kraft (or sulphate) process and caustic alone or with anthraquinone in the soda/ soda AQ pulping processes. The other pulping methods used are the Neutral sulphite semi-chemical (NSSC) process utilising conventional chemical treatment process followed by gentle defibring in the refiners to breakdown the woodchips into separate fibres. Chemi-mechanical pulps are also produced by some mills by both mechanical and chemical means. The conventional thermo mechanical pulp is treated with chemicals prior to refining and heating, to produce chemi-thermo mechanical pulp (CTMP).

There are many different types of bleaching processes, involving different chemicals and conditions. In India most of the bleached varieties are produced by chlorination of pulps. The widely used bleaching sequence in India is CEH / CEpH / CEpHH. Chlorine, hypo, caustic and peroxide are the main chemicals used by these mills. When compared with developed countries, our industry lacks the technological developments as the trend in these countries is towards elemental chlorine free (ECF) and totally chlorine free (TCF) bleaching

Basic Inputs ..... Non-fibrous additives

A wide range of chemicals are utilised in papermaking stock to impart or enhance specific sheet properties or to serve other necessary purposes. Additives such as alum, sizing agents, mineral fillers, starches and dyes are commonly used. Chemicals for control purposes such as drainage aids, defomers, retention aids, pitch dispersants, slimicides and corrosion inhibitors are added as required. The order of addition is important, to enhance retention in the paper sheet.

Not all papermaking chemicals are added to the wet stock. Sizing solutions are often applied to the dried sheet at a later stage in the process (e.g. at the size press) and pigment coatings are used for the better quality publication grades. Increased paper mill chemical and mineral consumption is anticipated mainly for coatings. The highest tonnage additive is clay, over half of which is used as part of surface coating formulations.

Wet end chemicals and mineral additives

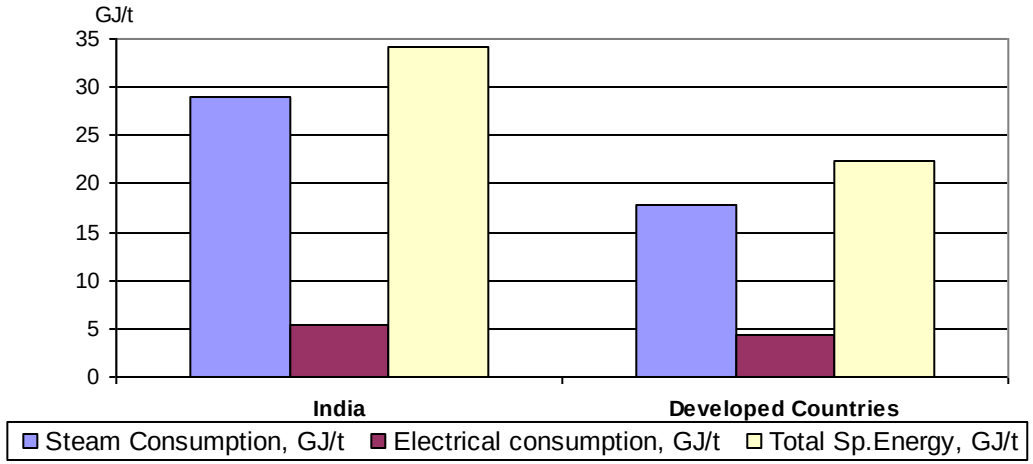
Additives	**Applications**
Acids and bases	Controls pH
Alum	Controls pH, fix additives onto fibres, improve retention
Sizing agents (e.g.rosin)	Control penetration of liquids
Dry strength adhesives (e.g.starch,gums)	Improve burst and tensile, add stiffness and pick resistance
Wet strength resins	Add wet strength to such grades as toweling and wrapping
Fillers (e.g.clay, talc,TiO_2)	Improve optical and surface properties
Coloring materials (dyes & pigments)	Impart desired color
Retention aids	Improve retention of fines and fillers
Drainage aids	Increase water removal on wire
Optical brightner	Improve apparent brightness

Basic Inputs ..... Energy

Energy is the second largest cost component influencing the manufacturing cost. The energy consumption is still very high when compared with developed countries. There is a considerable potential of substantial savings of energy. Studies carried out by National & International Agencies have clearly indicated a potential saving to the tune of 20%, based on reliable calculations. The amount of energy saved should be sufficient for 0.8 million tons of additional capacity. By and large in all the pulp & paper making sections there is scope for energy conservation.

The industry has historically been an intensive user of energy, which is needed primarily for the drying process. In India, paper industry is the 5th most energy intensive industry accounting for 7% of the nation's total industrial energy use and about 3% of all of the country's energy use. In Canada, the pulp and paper sector is the largest industrial energy user: and it is the 4th largest energy consumer among countries such as China, Indonesia, Thailand and Korea.

Fig. 4.1 Energy Consumption in India & Developed Countries

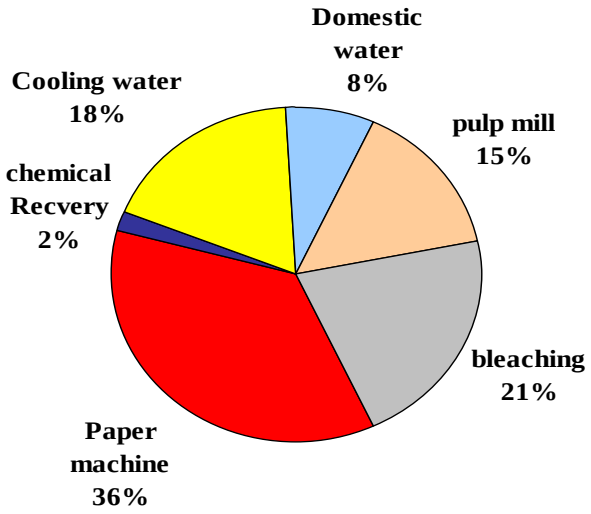


Basic Inputs ..... Water

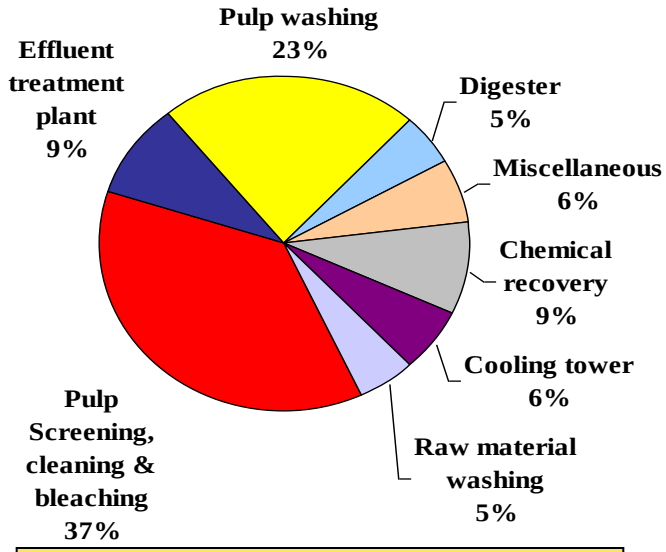
In paper industry, water is used practically at all stages. Huge quantities of water are required for low consistency operation. Water is now considered as one of the valuable resource, and mills are forced to reduce their water consumption levels. Charter on corporate responsibility (CREP) has also included water discharge limit for liquid effluents. Thus, if the water consumption is to be kept at a reasonable level, a systematic recycling and reuse of process water should be practiced. This will not only provide the basic advantage of reduction of fresh water consumption and consequent discharge of the effluent but would also result in the other additional major advantages such as;

1) Substantial recovery of fibres giving better yield from the raw material;
2) Savings in capital required for treatment of effluent.
3) Less storage areas, energy for pumping etc.,

Besides environmental effect, reduced energy consumption is associated with reduction in water consumption. Energy consumption is low for a closed cycle plant, when compared with a mill without system closure.



Water consumption pattern



Waste water generation

Paper Industry…Benchmark & Basic Input Norm for improvement

Both from the quality aspect and also from the cost of production point of view, it is very important to have some norms of the basic inputs, so that the cost of production is maintained at minimum level without sacrificing the quality of production. Indian paper industry is based on wide range of fibres like; cereal, straw, bagasse and forest based raw materials and there is a wide variation in the basic inputs for production processes based on different raw materials. As a result, cost of production is more than what it actually should be. For instance; for production of 1 tonne of paper, mills use raw materials ranging from 2 to 3 tonnes, energy from 1000 to 2000 kWh, water from 125 m^3 to 300 m^3 / t of paper, and labour / manpower from 5 to 30. Considering consumption of all these basic inputs, it is impossible to achieve the cost effective production and compete in the open economy. Further, keeping in view the need for resource conservation, particularly raw material, chemical, water, and energy, it is very important to arrive at the input norms. For Indian paper industry no such study has been carried out in the past and only brief studies were carried out on energy norms for paper industry. Looking into the importance of the subject, it was recommended by the Research Advisory Committee (RAC) of CPPRI that the Institute must prepare norms for basic inputs for paper industry in the form of a document.

The Project …… Objective & Line of Investigation

Objective:-

To develop the benchmark/norm for basic inputs, such as fibre, energy, water and chemicals for Indian pulp & paper industry, a project was submitted to Cess Grants Authority with a focussed approach to help the industry to identify their process efficiency, to optimize the inputs and achieve cost competitive production.

The main objective of the project was to optimize the input norms for paper industry with an objective to reduce and conserve the scarce resources like; fibre, water, energy and chemicals, so that the industry based on the input norms as a guideline can monitor their process efficiency.

Line of Investigation:

- Selection of mills on the basis of size, raw material used, products etc. in consultation with mill associations.
- Development of data collection sheets / procedures to have uniformity among different categories of mills producing different types of products from varying inputs.
- Systematic collection of data on consumption of raw materials, water, energy, labour etc. per unit production.
- Compilation of basic input data of different mills and comparison with best achievable national and international standards.
- Arriving at the Benchmark / Norm using various statistical and marking techniques for different types of mills like; newsprint, agro, waste paper based etc.
- Dissemination of information on industry:- Basic Input Benchmark / Norm

Report Preparation:- Preparation of Standard Testing Procedures as a manual for industry will also be taken up. The uniform testing procedures are a prerequisite for the industry to monitor their basic inputs in order to study data on the various inputs like; raw materials, energy, water, chemicals etc. CPPRI has prepared a comprehensive Standard Testing Manual, which is available on demand.

Chapter - 2

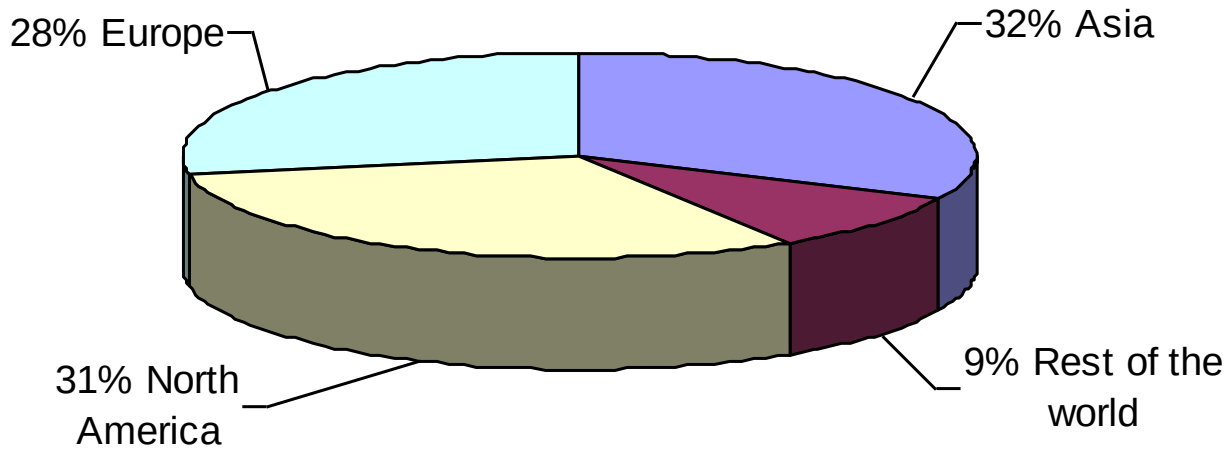
Status of Paper Industry

Paper Industry…….. Global Scenario

The global consumption of paper was approximately 350 million tonnes in 2003. The writing and printing segment accounted for 32 percent of this consumption while packaging, tissue and sanitary and newsprint accounted for 50 percent, six percent and 12 percent respectively.

The global consumption of paper and paperboard increased 5.9 percent CAGR from 171 million TPA in 1980 to 350 million TPA in 2003, driven in the later years largely by higher Asian economic growth (7-10 percent annum).

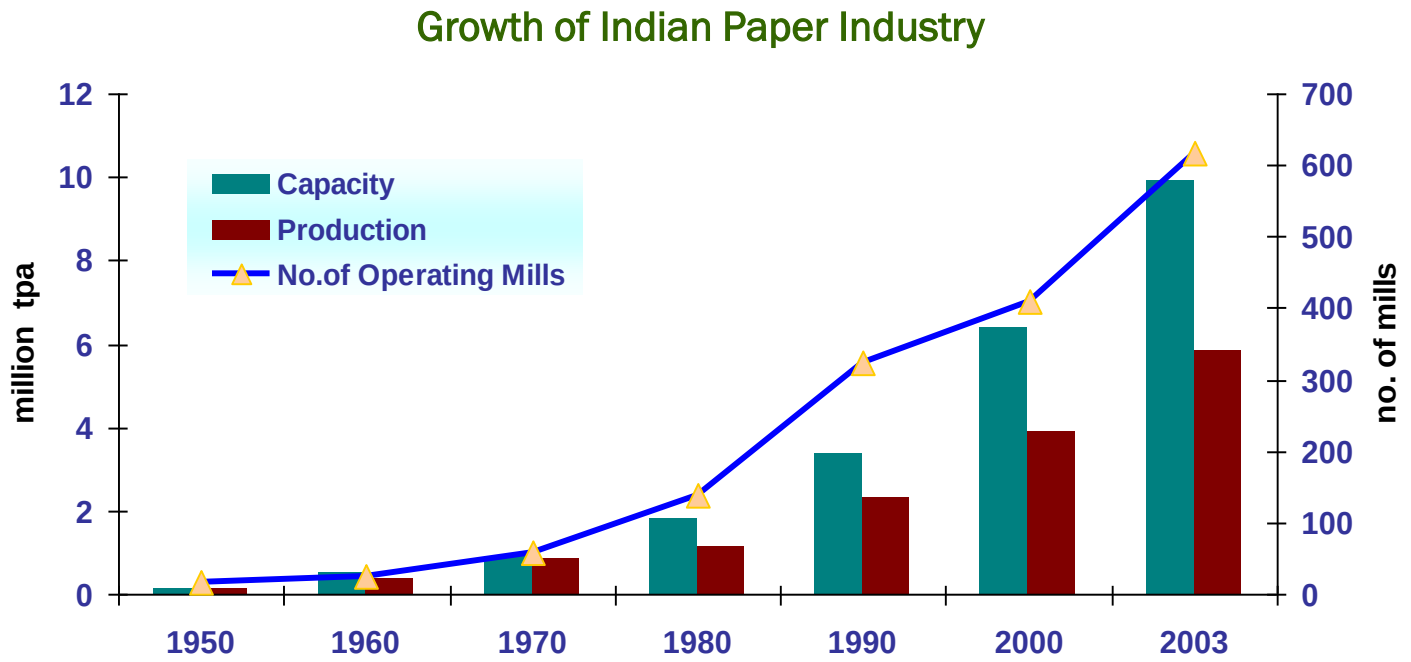
Global paper & paperboard market: 2003



Indian Paper Industry…….. Capacity and Production

The Indian paper industry comprises of more than 600 mills with mill capacities ranging from less than 1000 tonne per annum to over 1,00,000 tonne per annum. Most of the mills are small, only 60 mills have a capacity of over 33,000 tonnes per annum. In 2003, the country's total paper and paper board capacity amounted to 8.8 million tonnes of which about 5.1 million tonnes per annum was registered as operational while the balance 1.1 million tonnes per annum was reported as idle capacity.

India accounts for less than two percent of the global paper and paper board consumption. However, the Indian paper industry is growing at almost six percent annual growth rate, three times the annual global growth rate.



Paper Industry…….. Paper products

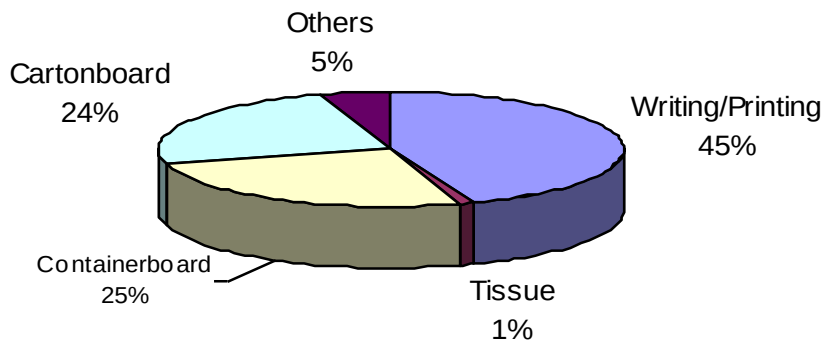
In India about 618 pulp and paper mills produce variety of paper products such as writing & printing paper, kraft, board, newsprint etc. The capacities of the mills range from 500 to 180,000 tonnes per year (tpa). There are about 540 small and medium size units which account for 60 percent of the total capacity and the fragmentation is higher in the industrial paper segment. The domestic paper industry, with a present market size of 5.5 million tonnes (exclusive of newsprint), can be broadly classified into writing and printing paper, industrial and speciality paper segments.

1.Cultural Paper : This includes writing & printing paper produced from 100% chemical pulp. The share of cultural paper is around 44.8% of total demand. This finds usage mainly in the publishing and stationary sectors.

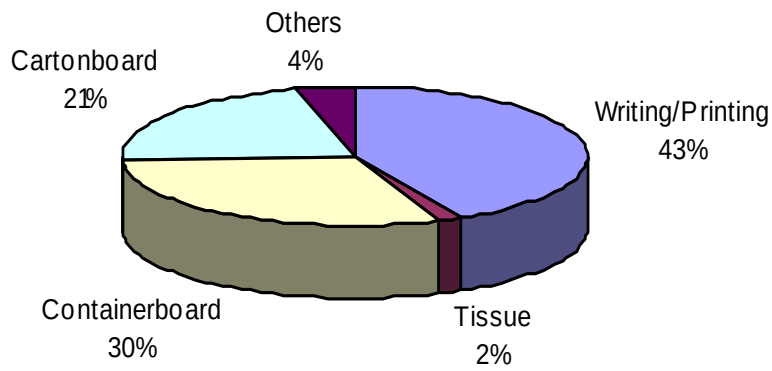
2. Industrial paper: This includes kraft paper, pulp board, duplex board and sack paper all of which have packaging applications. It is used for paperboards where middle layer of chemical pulp is partially substituted by inferior grade pulp. Kraft paper is a high strength paper.

3. Speciality paper includes tissue papers, absorbent paper, toilet paper, electrical & reprographic and security papers.

2004



2010

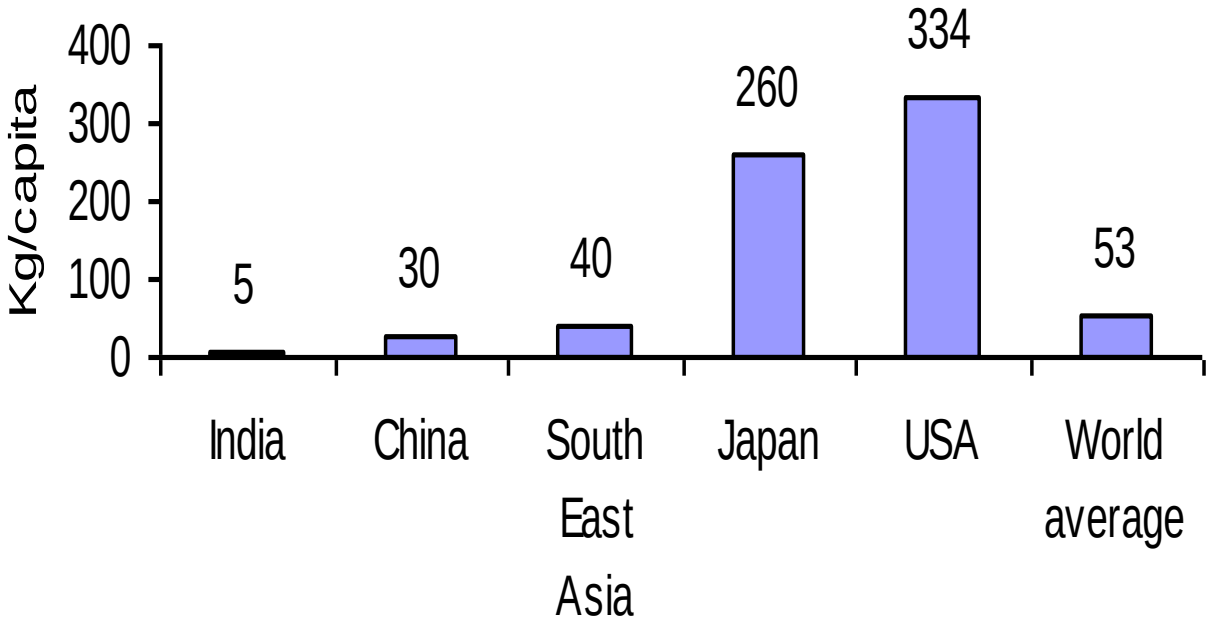


Paper Industry…….. Per capita consumption & growth potential

Even though the growth of the Indian paper industry has been commensurate with the GDP growth, the country's per capita consumption continues to be low compared to other countries. It is dismally low when compared with World Average, developed countries and some of the Asian countries. The consumption has recorded a growth over the last decade from 3 kg in 1991 to 5.0 kg at present.

Within Asia, India is expected to report the sharpest demand on account of increasing literacy, population and economic growth. Estimates made by ICRA and IPMA project that by 2012, the country could be consuming more than 10 million tonnes of paper, twice its existing national production.

Country / Region wise paper consumption (kg per capita)



Paper Industry..... Demand & supply

The international paper industry is cyclic, influenced by economic growth, advertising expenditure, population growth and supply dynamics. As a result, demand growth is influenced by slow growth in the developed countries and aggressive growth in the developing ones.

Drivers and off take

Print advertising: Graphical paper (newsprint, magazine and coated fine varieties).

Commercial activity: office paper.

Disposable activity: Tissues and personal care paper

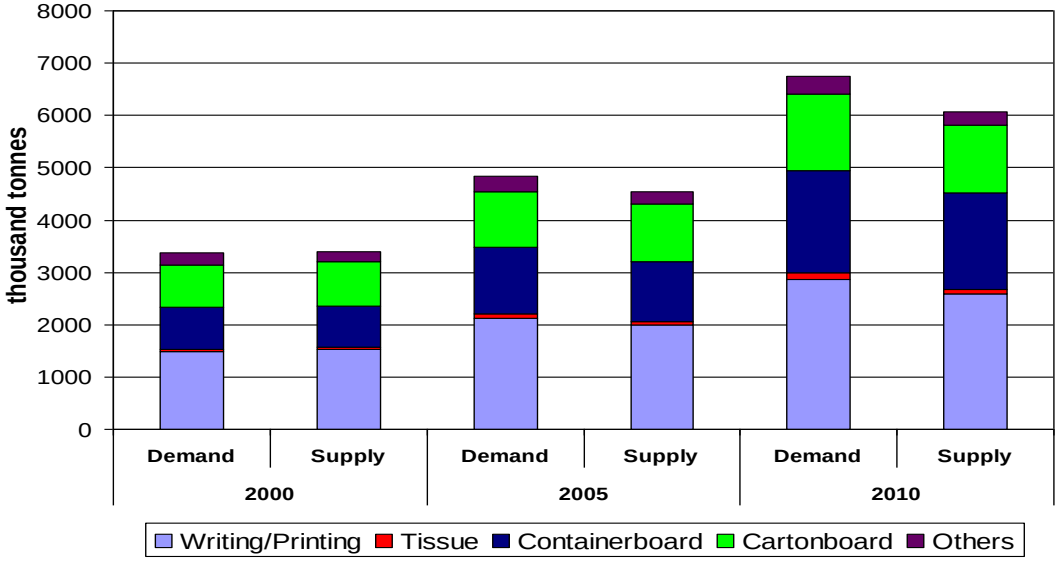
Industrial activity: Packaging

Growth rate (% per year)

Growth rate (percent per year)	1980-1985	1996-2010
North America	2.3	1.8
Western Europe	3.1	2.5
Eastern Europe	-4.2	4.4
Middle east	5.4	4.3
Japan	3.5	1.5
China	10.1	4.9
Rest of Asia	8.4	4.3
Latin America	3	4.2
Africa	2.6	3.6
India	5	6.5

Paper Industry…… Demand & supply

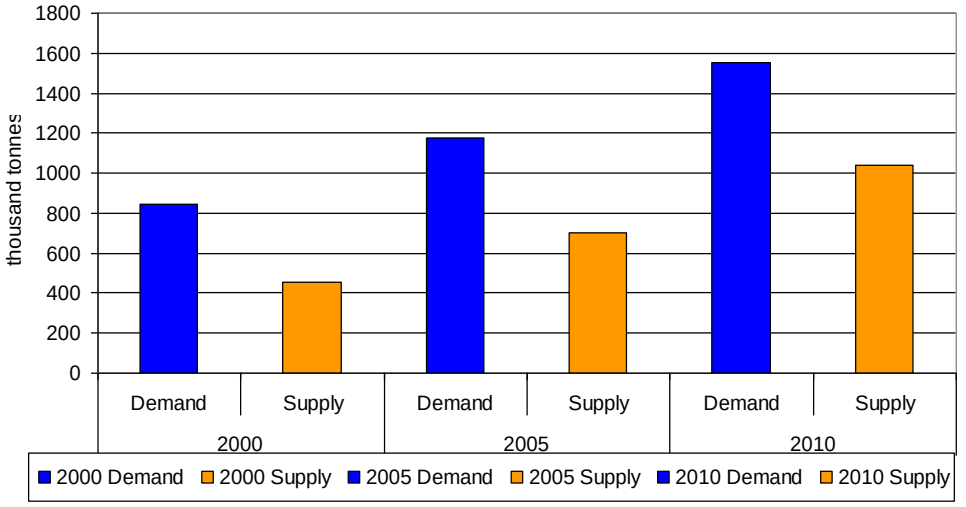
Demand & Supply for Paper & Paper board in India



According to a recent by study CRIS-INFAC, the global demand for paper and paperboard is expected to rise at a compounded annual growth rate of 5.8 percent, even as capacity is expected to increase by 2.1 percent only, translating into enhanced realizations. However, Jaakko Poyry, a leading paper industry consultant, has projected a 7.0 percent CAGR growth in demand up to 2005.

According to a study undertaken by ICRA advisory services, the consumption of paper including newsprint is likely to rise from 6.7 million tons in 2003-04 to around 7.3 million tons in 2004-05 (including newsprint). This growing demand is likely to be met through imports as capacity growth is likely to be constrained by high capital cost and fibre scarcity.

Demand & Supply for Newsprint in India



Paper Industry…….. Demand & supply

Within the overall average projected growth rate of 7 percent CAGR, segmental growth rates vary, largely determined by the end use of the product variety:

Segment	Growth rate		Growth drivers
	2000 – 01	2005 - 10	
W & P Cream wove	6.1%	5.1%	Textbooks, notebooks
Maplitho – SS	6.2%	10.5%	Publishing, office applications
Coated	8.2%	11.1%	High quality printing
Specialty	6.6%	7.9%	Tissue, labels, fax etc.
Industrial	5.6%	6.2%	Packaging/ FMCG
Newsprint	6.0%	6.0%	Newsprint

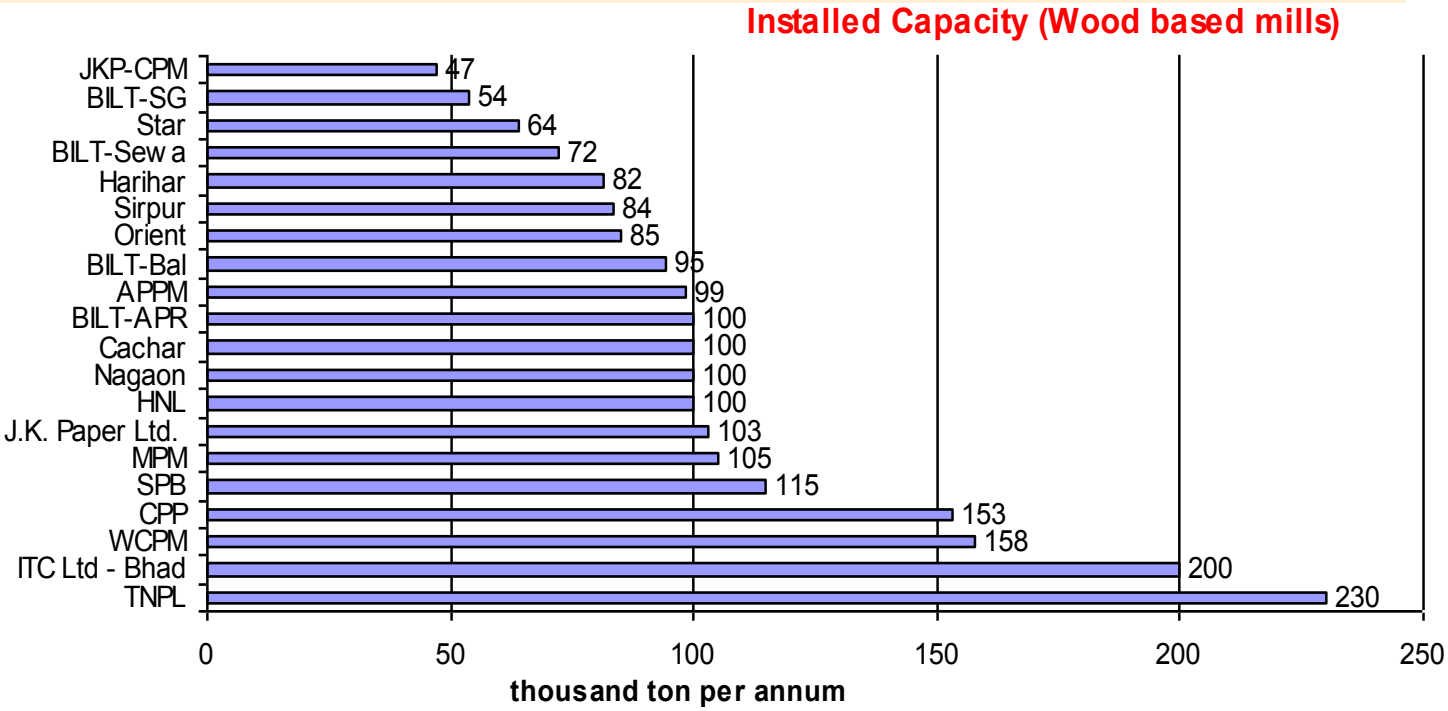
Paper Industry…….. Structure of the industry

The industry is highly fragmented and complex with variation in sizes, products, raw materials. The mills use different technology inputs. Top five producers account for about 25% of the capacity. The largest paper companies in India are typically owned by large private industrial conglomerates, or by the state. The paper companies belonging to major industrial groups have a better financial structure to carry out large expansion or modernization investments. Most of Indian pulp and paper companies are small, independent producers running only one mill. Most of them are village scale producers with limited influence beyond their respective market areas.

The biggest producers focus on printing and writing papers, newsprint and cartonboards

The structure of industry is complex due to variety of raw materials, capacity of plants, products and different ages of plants with different technological levels.

The industry been categorized based on raw material, capacity and products. A brief review of structure of industry is shown in next pages



Paper Industry…….. Structure of the industry

Based on capacity Indian pulp and paper industry can be categorized into three sectors i.e. large paper mills, medium paper mills and small paper mills.

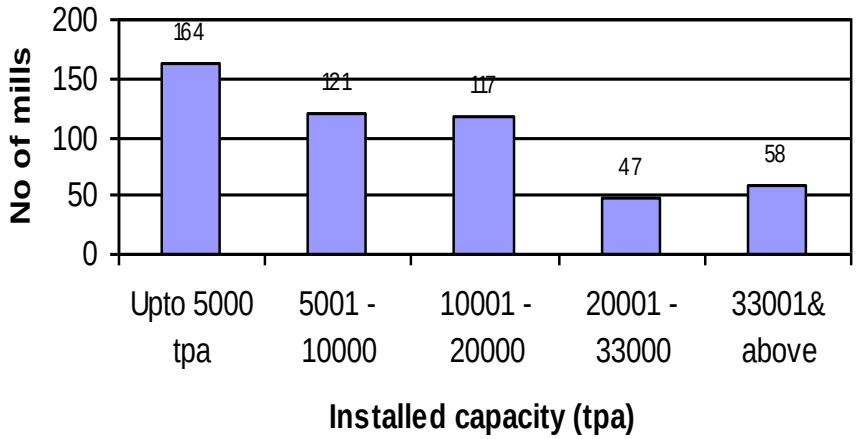
Large Paper Mills: These mills are invariably based on Bamboo, wood and other forest raw materials having a capacity of 33,000 tonnes or more per annum. Also during last two decades large number of agro based small and medium mills set up are gradually expending their capacities to 33,000 tpa and above.

Medium Paper Mills: These mills are primarily based on Agro based raw materials and indigenous/ imported waste paper respectively. The annual installed capacity of these mills is between 16,500-33,000 tpa.

Small Paper Mills: A large number of small paper mills of capacity below 16,500 tonnes/ annum are operating in India. These mills employ both indigenously available as well as imported waste paper and they contribute to nearly one third of the total paper production of the country. Figure below shows the complex structure of Indian paper industry with large number of small & medium mills distributed between 5000 to 20000 tpa capacities.

Categorisation of Mills Based on Installed Capacity

S.No.	Category of mills	Annual installed capacity (tons/annum)
1.	Large - Integrated (including Newsprint)	Above 33,000
2.	Medium	16,500-33000
3.	Small	Upto 16,500



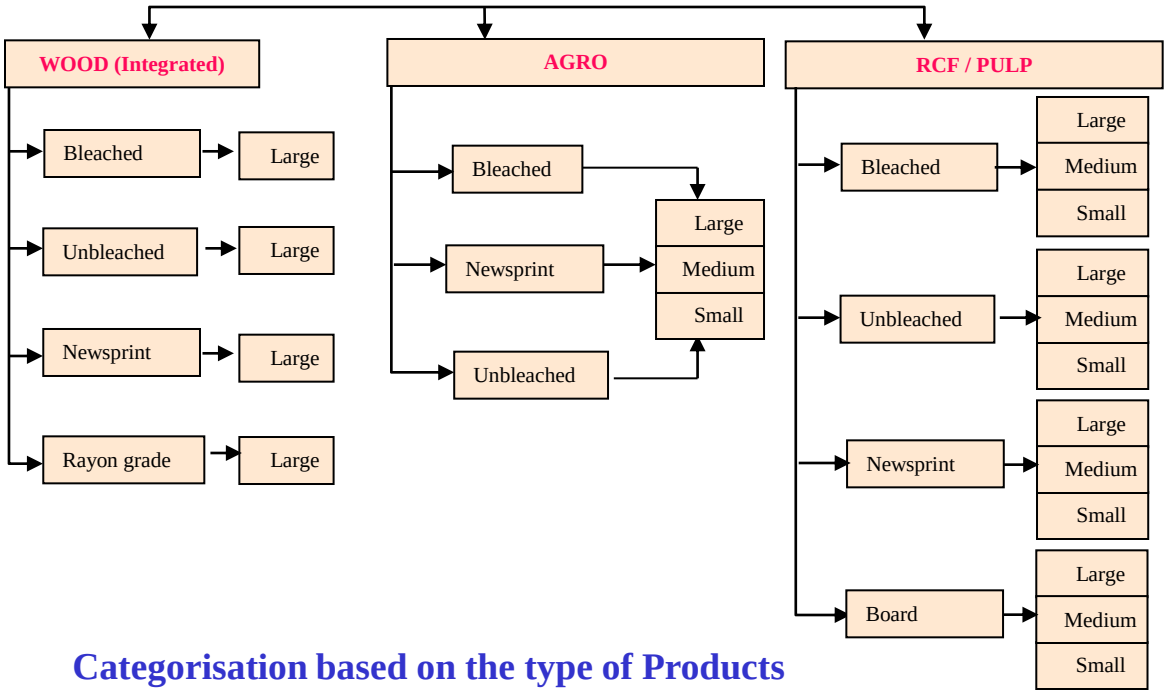
Paper Industry…… Structure of the industry

On the basis of raw material usage paper mills can be classified into three distinct segments.

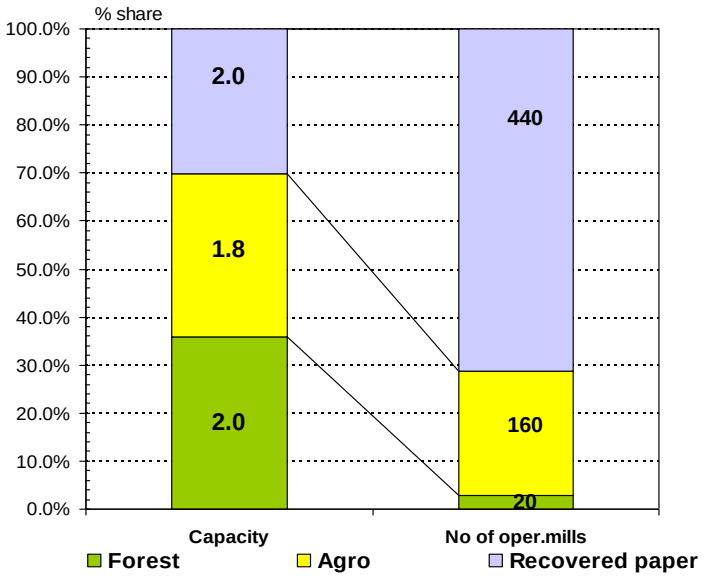
- Forest based
- Agro residue based and
- Others primarily based on waste paper and secondary fibres

The capacity and production is equally divided amongst these categorise, however it does not represent an equal share in market economy.

There are very few forest based mills having a capacity of more than 33,000 tpa and are termed as large paper mills. A large number of agro based mills are shifting towards RCF due to stringent environmental regulations. The share of forest based, agro based and waste paper based paper mills in the total paper production is shown here.



Categorisation based on the type of Products



Structure of industry based on raw material utilisation

Large Integrated Mills :

A) Wood / Bamboo Based

The mills belonging to this group are integrated with chemical recovery & co-generation systems. They represent about 34% of effective production. The mill capacities in this category ranges from 150 to 600 tons/day. This category of mills also includes newsprint mills and rayon grade pulp mills. At present there are 22 wood based mills with installed capacity above 33,000 tpa. The major problems faced by large paper mills are :

-sustained availability of forest raw materials
- Infrastructural requirements
-Technological obsolescence
-High investments for modernisation
-Declining profitability etc.

B) Agro Based Mills

A large number of agro based mills have under gone expansion of capacities and this has resulted in increase in number of mills under this category. In 1990 there were no agro mills under this category. Whereas today there are 13 mills producing more then 33,000 tpa. Many other agro based mills also are planning to install the chemical recovery systems to meet the CREP requirements as specified by CPCB.

C) RCF Mills above 33000 tpa capacity :

There are about 25 mills based on recycled fiber and waste paper processing which produce above 33000 tpa. In 1990 there were no mills under this category, however, due to moderate expansion and modernization requirements, a large number of medium mills have enhanced their capacities. A large number of Agro based mills are also using up to 50% recycled fibre in their furnish to meet the environmental regulations.

Medium Mills :

The mills belonging to this group do not have chemical recovery and cogeneration system and are based on annual plants such as bagasse, straws, grass etc. They represents nearly 28% of effective production of paper in the country. The capacity range for large number of mills is 10,000-33,000 tpa., however most of the units fall in the range of 16,500-20,000 tpa capacity. Most of the agro residue based units use waste paper in varying quantities and some of the larger units producing better qualities of paper also use imported pulp. The agro paper mills which are playing a vital role in supplementing the fiber supply are not free of problems like ;

- the seasonal availability of bagasse and other agro residues,
- their high volume/weight ratio and
- scattered availability resulting in high transport / infrastructural costs.

The alternative use of bagasse and straws, like in the generation of power and cattle feed, may also restrict their availability to the paper industry. This category of mill has reduced the burden on natural forests. Today this category of mills is facing serious threat for not complying with regulatory standards. These mills which use diverse cellulosic raw materials, are still trying to find solution for having techno-economically viable chemical recovery system and without which it might be difficult to contain the pollution problems. The agro based medium paper mills were encouraged with the following objectives.

1. To create additional paper making capacity and to meet future growing needs of paper with short gestation periods and low capital investment per ton of paper.
2. To encourage utilisation of annually renewable agricultural residues and waste paper for paper manufacture in view of the resource conservation and waste recycling.
3. To develop and employ appropriate / intermediate technology to utilise agro residues and create a sustained and non-hazardous alternative sector to conventional raw materials.
4. To disperse industries in rural areas and promote economic development and provide rural employment with a large objective of integrating industry & agriculture.

Small mills :

The mills belonging to this group mainly utilise the secondary fibres, i.e. waste paper as their raw materials. Some of them also utilise agro-residues for their chemical pulping systems and have little /no technology involvement. They represent about 32% of effective production.

This category of mills is totally dependent on indigenous process technology and equipments . Since the segment is primarily engaged in the production of low grades of paper and paper products, with very low operating capacities, there is little chance for making any investments in the area of modernisation.

Status of RCF Mills

S.No.	Category of mills	Annual installed capacity (tons/annum)	Number of mills
1.	Large	Above 33,000	25
2.	Medium	16,500-33000	121
3.	Small	Upto 16,500	301

Paper Industry…… Structure of the industry

Newsprint :

Newsprint is a grade of paper made out of maximum proportion of wood containing pulp (mechanical pulp), to lower cost of production and to withstand high speed of off-set printing machines. For newsprint the paper need not have high mechanical strength properties. The manufacture of newsprint in the country started with the commissioning of National Newsprint & Paper Mills (Nepa Mills) in 1955 at Nepanagar (M.P.). Till 1981, it was the only unit manufacturing newsprint with a licensed capacity of 75,000 tpa. The mill was using wood as the raw material however now the mill has switched over to recycled fiber. At present, there are three units engaged in the manufacture of newsprint from wood and bagasse. Hindustan Newsprint Limited, is producing the newsprint with about 33% waste paper in the furnish. Apart from this a large number of RCF based mills are also producing Newsprint.

S No.	Name of Unit producing Newsprint	Raw Material	Production (Newsprint)	
			Year of Commencing	tpa
1	Hindustan Newsprint, Kerala	Wood	1982	100495
2	RamaNewsprint and Papers Ltd.	RCF	1996	68326
3	Coastal Papers	RCF	1976	31126
4	Emami Papers	Agro / RCF	1983	25595
5	Tamil Nadu Newsprint, Tamil Nadu	Wood/ Bagasse	1985	20496
6	Mysore Paper Mills, Karnataka	Wood	1982	77000
7	Nepa Mills,M.P.	RCF	1955	20215
8	Sun Paper Mill Ltd.	RCF	1961	18881
9	Khatema Fibres Ltd.	RCF	1990	9030
10	GVG Paper Mills Pvt. Ltd.	RCF	1986	7848
11	Amravathi Sri Venkatesh Paper Mills Ltd.	RCF	1965	6696
12	Ruby Macons Ltd.	RCF	1989	38451
13	Pudumjee P&P Mills Ltd.	RCF	1964	1567

Paper Industry…….. Structure of the industry

Rayon Grade Pulp Mills :

Rayon grade pulp mills are as old as paper industry and like paper industry are dependent on forest based cellulosic fibre. The technology up to pulp production stage is identical to that of paper industry.

M/s Gwalior Rayons put up the first Viscose staple fibre unit in the country at Nagda, Madhya Pradesh with a capacity of 15 tons per day in 1954 and thereafter increased the capacity of their fiber plant to 100 TPD by early 1960. M/s Gwalior Rayon Silk Mills secured another milestone with the successful completion by their Harihar Polyfibres Division of a project in Karnataka for the production of Rayon grade pulp from hybrid eucalyptus. This development is probably the first successful effort in the world to produce rayon grade pulp from a hardwood like eucalyptus. The achievement is most impressive because research on the process innovation as well as on the development of new engineering designs was done by the company in India, and most of the equipment was fabricated within the country. The quality of pulp has been approved already for the production of filament yarn and for improvement to make it suitable for tyre cord yarn.

At present there are two mills which produce Rayon grade pulp. These mills are Harihar Polyfiber and AP Rayons. Some of the mills also produce Rayon grade pulp as one of the product along with Chemical pulp for paper making. Century Pulp & Paper is one such mill which produces rayon grade pulp along with chemical pulp for papermaking.

S No.	Name of Unit producing Newsprint	Production (Rayon Grade)	
		Year of Commencing	tpa
1	BILT- Unit: A.P.Rayons	1979	87412
2	Grasim Industries Limited - Unit: Harihar Polyfibers	1972	70495

This page is kept intentionally blank

Chapter - 3

Technological Status of Processes & Equipment-Analysis of data

Technological status

Paper making was treated as an art till 19th century. However with the advent of automatic control system, today it is more of technological setup and process optimisation planning within a unit which makes a company competitive. The chemistry of basic unit operations of pulping and paper making has not changed much since industrialization of paper making but the process technologies have been remarkably upgraded due to increased understanding of the processes.

In this chapter the technological status of processes and equipment / prevalent in Indian paper industry is discussed in following categories of paper industry

1.Wood based mills

2.Agro based mills

3.RCF based mills

There is a large difference in status of processes & equipment in these categories and the analysis shows areas where improvements are required to achieve better efficiency levels.

This page is kept intentionally blank

WOOD BASED MILLS

Wood Based Mills…… Status

There are at present 22 mills which use hardwoods as major raw material. These mills are also using bamboo, agricultural residues and RCF in their furnish. They produce about 2.0 million tonnes paper and paper products in India. These mills are large integrated mills located in various parts of the country. The mills are owned by large business houses and corporate groups and professionally managed. These mills produce all varieties of pulp & paper products. The mills maintain good quality standards and products are competitive within the country. Some of the producers have their presence in overseas markets also.

Major products of this category of mills are;

- Writing printing papers
- Packaging papers
- Newsprint
- Rayon grade pulp
- Board
- Specialty papers

Main Unit Operation are;

- Raw material preparation
- Pulping
- Washing, Screening & Centricleaning
- Bleaching
- Stock Preparation
- Paper Machine
- Chemical Recovery
- ETP
- Power House

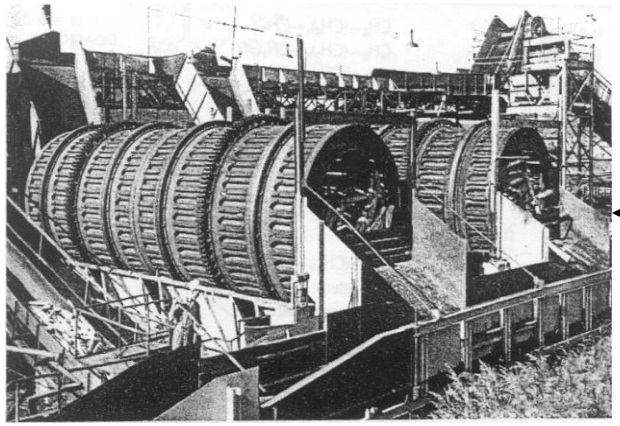
Raw material preparation ..... Preparation of wood

WOOD PREPARATION:- Wood preparation consists of a series of operations which convert woodlogs into chips, suitable for the subsequent pulping operations. Wood is unloaded from truck or trailors to the storage yard where these are stored over a period of time. The stored logs are then used for debarking & chipping.

DEBARKING:- Log debarking is necessary to ensure that the chips are free of bark and dirt. Bark Contains 8-17% of the dry weight of the wood and consists of epidermis, coloring material, extractives etc. Removal of bark is practiced to ensure that following discrepancies are controlled.

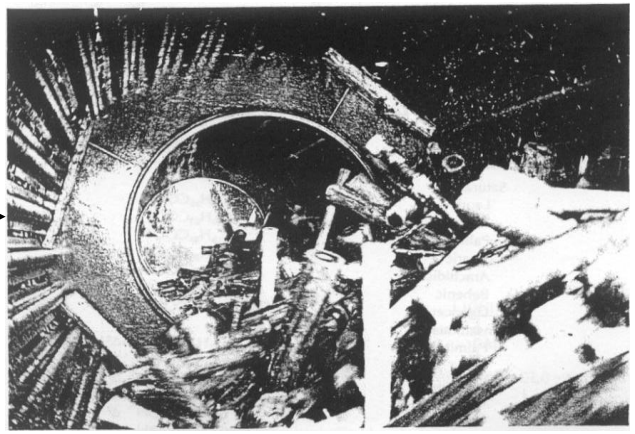
- Lower digester efficiency.
- Higher pulping chemical consumption.
- Lower yields.
- Higher bleach chemical consumption.
- Entry of sand, dirt and various non-process elements with bark.

Several types of mechanical as well as hydraulic debarkers are used. The drum debarker or debarking drum is the most common type of mechanical debarker and is available in a number of design variations.The hardwoods procured by many mills is debarked at the cutting point. Some mills use chips with bark also. At present no mill in India is debarking wood logs within their premises.



Drum debarkers

Inside view of the debarker

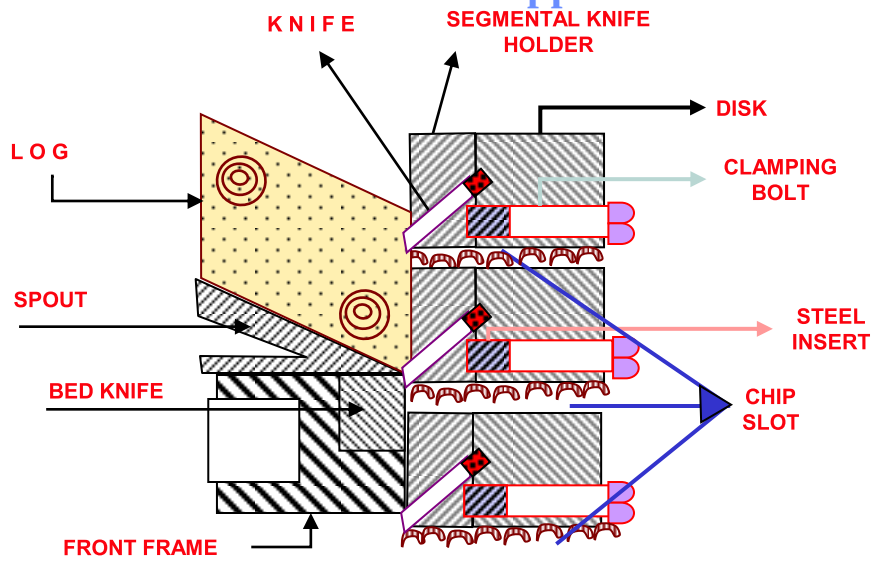


Raw material preparation ..... Chipping

CHIPPING:- After debarking the logs are converted to chips suitable for the subsequent pulping operations. Several design of chippers are used, the most common being drum type & disc type. The drum type chippers are common in Indian paper industry, however, a large number of mills have started using disc chippers. In disc chippers the flywheel-type disc has a series of blades mounted radially along the face and projecting 20mm. The logs are usually fed through a sloping spout to one side of the rotating disc so that the knives strike at an angle of 35 to 40^{o} from the axis of the log. The logs can also be fed horizontally through a disc mounted at the proper angle. Generally, the horizontal feed provides better control, but is less suitable for scrap wood pieces.

Proper speed control of chipper & maintenance of knife sharpness will give satisfactory results. The ideal chip is about 20mm long in the grain direction and 4-5mm thick, but all chips 10 – 30mm long and 3-6 mm thick are prime materials for pulping. Off size chips adversely affect the pulping process and the quality of the resultant pulp.

Section of chipper



Raw material preparation ……. Chip Quality Control

The status of chippers used in Indian wood based mills is given below.

Name of Mill	Chipper Type	Make	No.	Capacity, tph	Chip Prod., tpd
APPM	Drum	VECO PLAN	3	3 x 25	850
BILT-Sewa	Drum	VECO PLAN	1	25	500
BILT-APR	Drum	Vecoplan	1	40	900
SPB	Disc	KMW	2	2 x 20	500
JK- CPM	Drum	Vecoplan	1	25	385
Star	Disc & Drum	Disc- norman carthage, Drum- Swetha, Veco Plan	Disc-1, Drum-3	60, 6+6+25	349
Orient	Drum	L&T, T.M.T	3	3 x 20	506
HNL	Disc & Drum	KMW & Pallman	2+3	33.4+20	191+95
Cachar	Drum	Klockner	6	6 x 20	650
JK- Raygada	Drum	Veco Plan	3	3 x 30	980
Nagaon	Drum	Klockner	6	6 x 20	800
Sirpur	Drum	L&T, T.M.T	1+1	2 x 20	500
WCPM	Drum & disc	Pallman, Voith	1+4	32+(4 x 8)	550+400
MPM	Drum & disc	Pallman & GR	2+4	20+11.5	400
Century	Drum, disc & disc	L&T, GR & GR	3+3+3	3 x 10 + 3 x 12.5+ 3 x 12.5	300 + 360 + 445
BILT-SG	Drum	Vecoplan & Swetha	2+1	2 x 25 + 5	600
BILT-Bal	Drum	Pallmann	3	3 x 24	959
TNPL	Rotary disc	L&T / Carthage	2	2 x 18	390
Harihar Polyfibers	Disc	Fulghum	2	2 x 25	622

Raw material preparation …….. Chip Screening

Chips of acceptable size must be isolated from fines and oversized pieces by passing the chips over a series of screens. The oversized chips are rejected to a conveyor which carries them rechipper for reduction into smaller fractions.

Older style screens segregate chips only on the basis of chip length. In recent years, chip thickness has come to be recognized as an important pulping variable, and modern disc type or roll type screens which segregate according to thickness are now widely accepted as the industry standard.

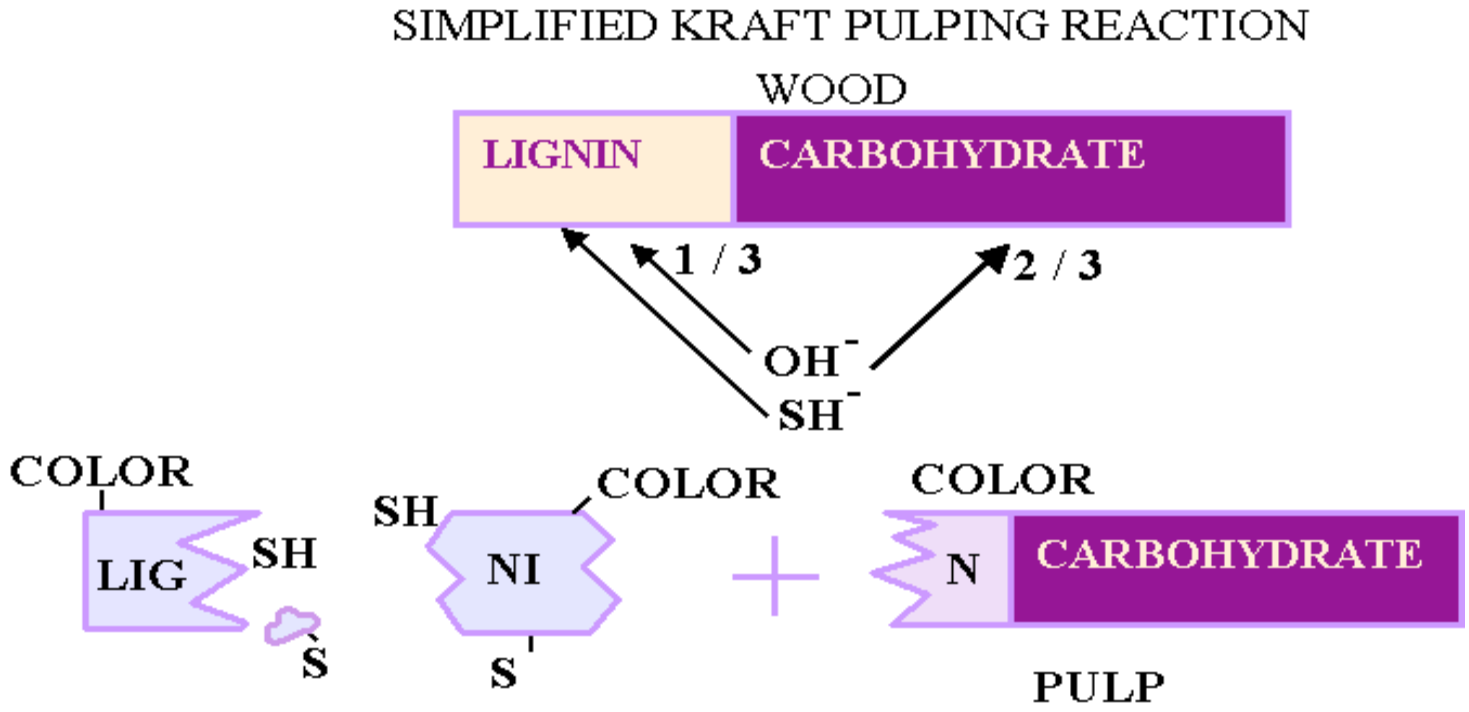
Raw material preparation ..... Chip Screening

In Indian mills vibrating screen are mostly used. Details are given in the table.

Name of Mill	Type	No.	Chip size, mm	Accept, %	Reject, %	Rechipper Cap, t/hr
APPM	Vibrating	2	N.A.	94	3	5
BILT-Sew a	Vibrating	2	25 X 15 X 5	94	2.5	3
BILT-APR	Vibrating	3	25 X 25 X 5	80	20	3
SPB	Oscillating	3	25x18x12	90	10	5
JK- CPM	NA	3	28 X 12.5 x 2.0	88	8.5	5
Star	Octaganol	3	N.A.	95	5	NA
Orient	Oscillating	6	N.A.	92	N.A.	2
HNL	Gyratory	2	16x14x3	96	2	5
Cachar	NA	2	25 x 12 x 5	93 - 95	5-7	10
JK- Raygada	Octaganol hanging	3	25 X 12 X 6	93	7	5
Nagaon	Oscillating	2	N.A.	95-97	1-2	6
Sirpur	NA	2	N.A.	96	3	2
WCPM	Vibrating	2	25 x 20 x 5	90	9	6
MPM	Gyratory & oscillatory	7	N.A.	72-73	22-23	4
Century	Vibrating	2+3	25 x 20 x 5 + 25x19x3	97	3	2
BILT-SG	Vibrating	3	22 x 17 x 11	93	7	4
BILT-Bal	Gyratory	4	30 x 25 x 5	93	4	2
TNPL	Oscillating	1	N.A.	98	2	9

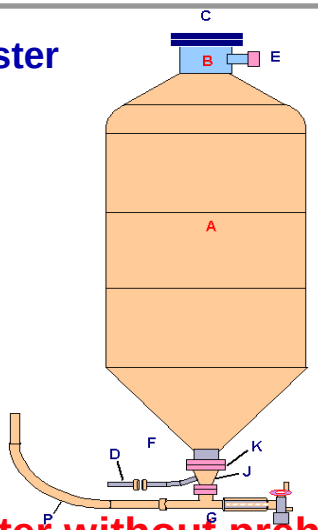
Pulp Mill……Pulping

PULPING:- Pulping refers to any process by which a fibrous raw material is reduced to a fibrous mass. During pulping of wood, the chemical bonding within the wood structure are systematically ruptured. This rupturing can be accomplished mechanically, thermally, chemically or by combination of these treatments. Existing commercial pulping processes for wood pulp in Indian wood based mills are broadly classified as mechanical and chemical (Kraft).

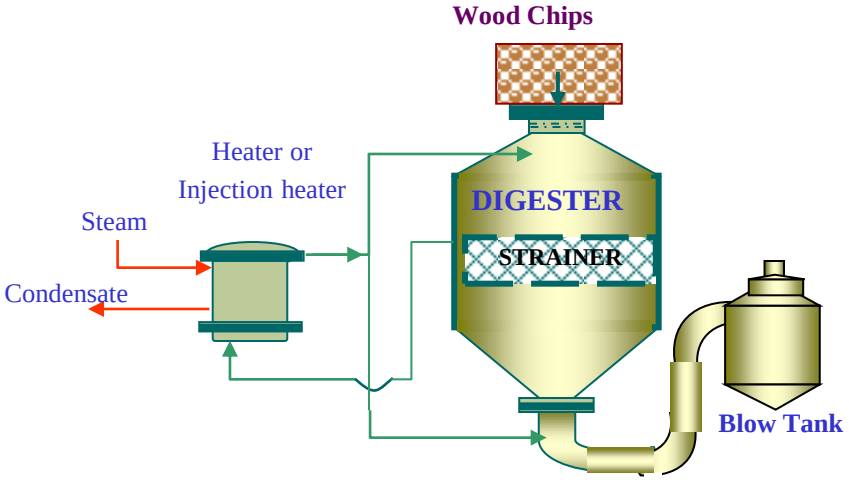


Pulp Mill..... Batch Digesters

Direct Cooking in Digester



Stationary Digester without preheater



Stationary Digester with preheater

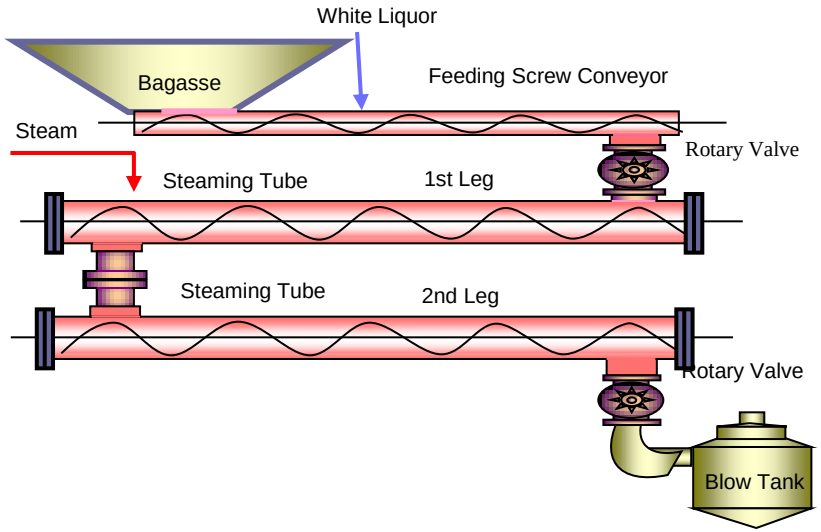
Steam consumption for continuous digesters is generally lower than for conventional batch units because low-pressure flash steam from the liquor can be readily recycled to preheat and precondition chips. Steam demand is also more constant for continuous digesters.

Most of the mills in India use Batch Digesters. The production with available raw material favors batch digesters as frequent changes in raw material furnish due to its flexibility of operation can be easily matched with the production requirements. The capacities of the batch digesters in these mills varies significantly. Most of the mills have PLC controls and many mills are now opting for DCS controls.

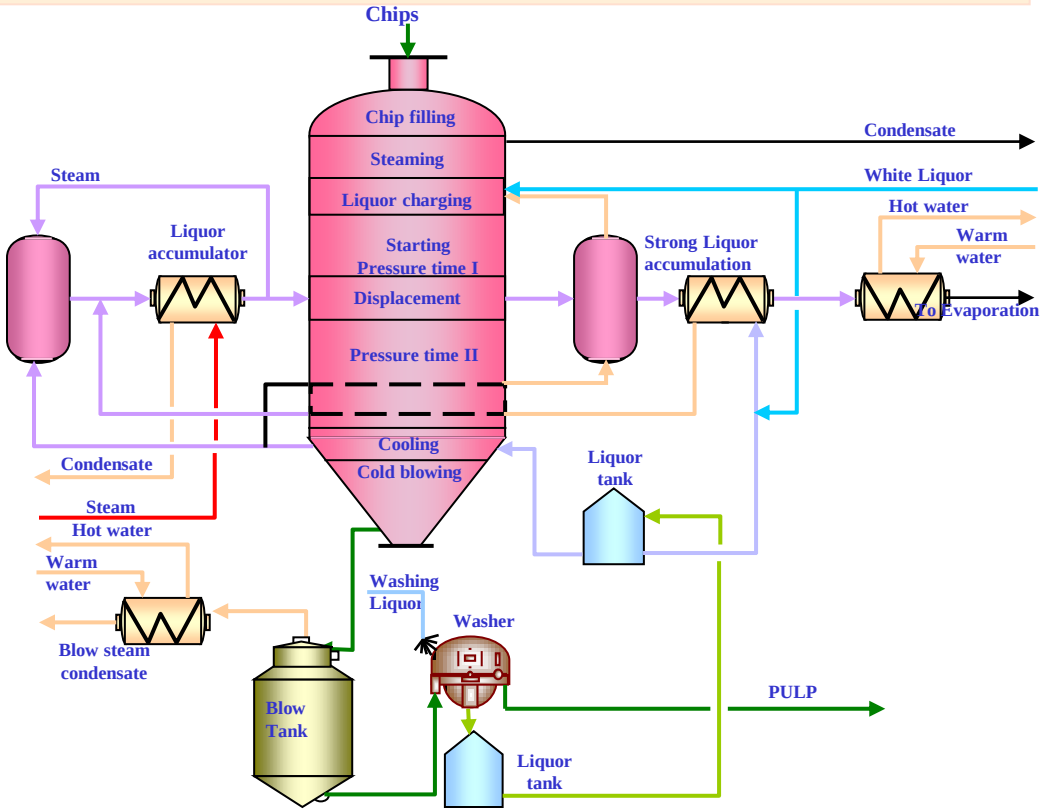
Many mills still use the direct steaming with convection mixing. A circulation system with external liquor heater is the preferred system to bring the contents in digester to pulping temperature. It eliminates the steam condensation leading to low liquor dilution, thereby maintaining higher alkali concentration during cook.

Pulp Mill..... Continuous Digesters

Only two bamboo based mills in India utilize continuous digesters for pulping. These are Kamyr digesters with single vessel installed in 1984. Although the basic operating principle has not changed, however a number of improvements and modification have evolved. These modification include development of two vessel system and application of extended delignification to Kamyr system. Continuous Pandia digestors are used for agricultural residues. Three mills in India also practice bagasse pulping using the Continuous Pandia digesters.



Continuous Pandia Digester



Kamyr digester (Single vessel)

Pulp Mill..... Status of Digesters

The status of the Digesters in the mills is given below;

Name of the Mill	Process employed	Type		Mode of heating
		Batch	Continuous	
APPM	Kraft	13		Indirect
BILT-Sewa	Kraft	5		Indirect
BILT-APR	Kraft	9		both
SPB	Kraft	4	2	both / Direct
JK- CPM	Kraft	5		Indirect
Star	Kraft	6		Indirect
Orient	Kraft	7		both
HNL	Kraft	5		Indirect
Cachar	Kraft	NA	1	Mixed
JK- Raygada	Kraft	3		Indirect
Nagaon	Kraft	NA	1	Direct
Sirpur	Kraft	14		Direct
WCPM	Kraft	12		Indirect
MPM	Kraft	6		indirect
Century	Kraft	3+5	1	indirect+direct
BILT-SG	Kraft	3		indirect
BILT-Bal	Kraft	10		indirect
Harihar	Kraft	9		indirect
TNPL	Kraft	5	5	indirect+direct

Pulp Mill……Modified Pulping

Improvement of Pulp Yield:- Two prominent "adds on" techniques in use are anthraquinone (AQ) and polysulphide. The yield increases provided by AQ & polysulphide are additive and several mills are utilising both techniques together to obtain a maximum yield.

Anthraquinone, a yellow powdery organic compound is virtually insoluble in water, but is typically supplied as a dispersant which dissolves in the alkaline medium of a kraft cook. A small addition of AQ accelerates the kraft pulping reactions, gives a 1-2 % increase in yield and lowers the effective alkali requirement. When added to a soda cook, kraft- type yields, cooking rates and pulp strength are possible.

Modern methods of **polysulfide liquor** generation do not require additional sulfur and therefore do not upset the soda / sulfur balance in the recovery cycle. Rather the polysulfide is obtained by selective oxidation of sulfide already present in the white liquor.

Extended Delignification:- To control bleach chemical requirement, it is preferable during the production of bleachable grade pulps to delignify the wood raw material as much as possible at the time of cooking, and thereby minimize the amount of residual delignification required during bleaching. It is now possible to obtain kraft pulps with kappa number as low as 12-15 compared to conventional kraft pulps at kappa number 30. The prolonged cooking times and higher residual effective alkali concentration characteristic of extended delignification processes often result in greater carbohydrate removal and lower pulp yield. This will overload the recovery furnace which is a bottleneck in many kraft mills.

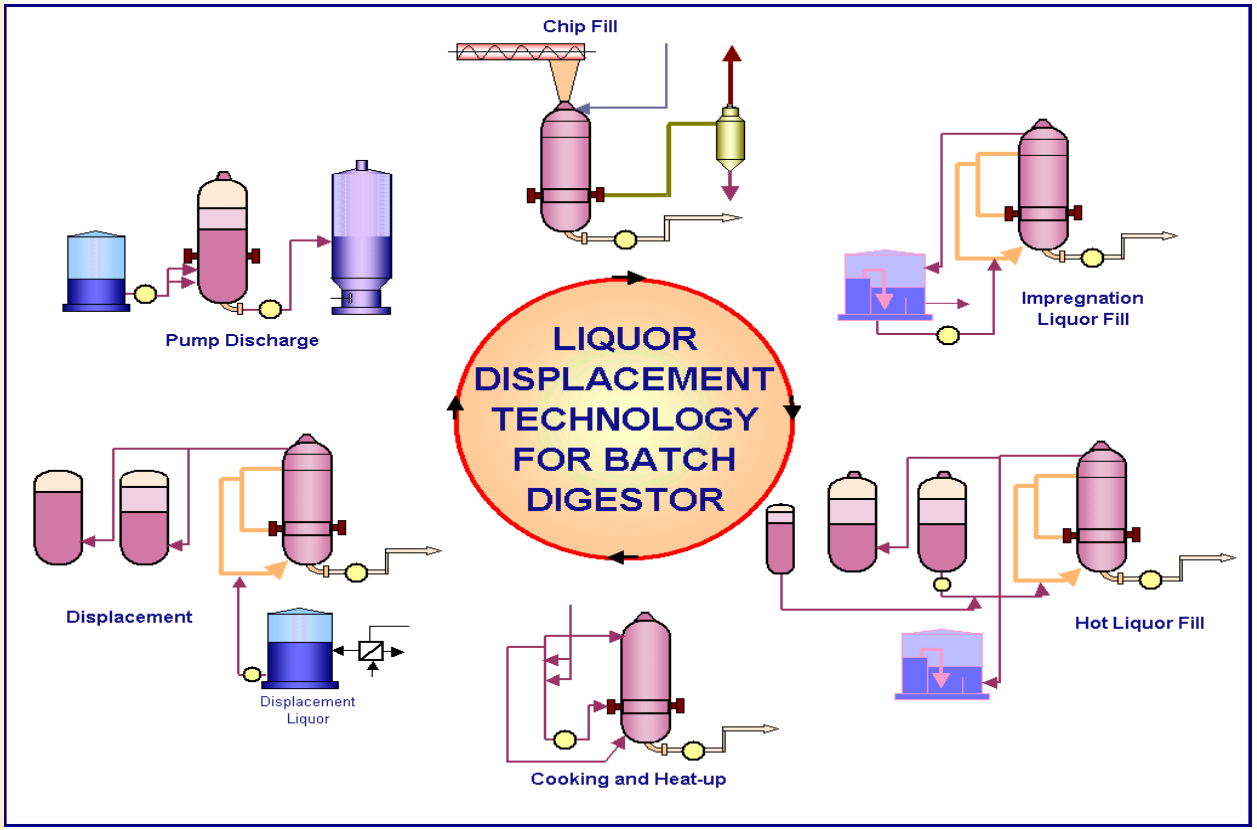
Displacement heating has emerged as a modification in batch digester for energy saving. Rapid displacement heating (RDH) process can enhance delignification, apart from the energy saving, due to better process integration. It results in delignification to significantly lower kappa no. than the conventional batch process, without loss of strength. One mill in India practice RDH process.

Pulp Mill……Modified Pulping

Displacement chip digesters require a higher pressure rating and are typically fabricated from stainless steel. The RDH method involves pumping liquors of increasing temperature and alkalinity through the packed digester to heat the chips and prepare them for cooking. When cooking is complete the hot residual black liquor is displaced by washer filtrate and transferred under pressure to a storage tank.

Two methods of displacement heating developed to reduce steam consumption of batch cooking involves same technology and are called "Rapid Displacement Heating - RDH method" and "Super Batch or Cold Blow system".

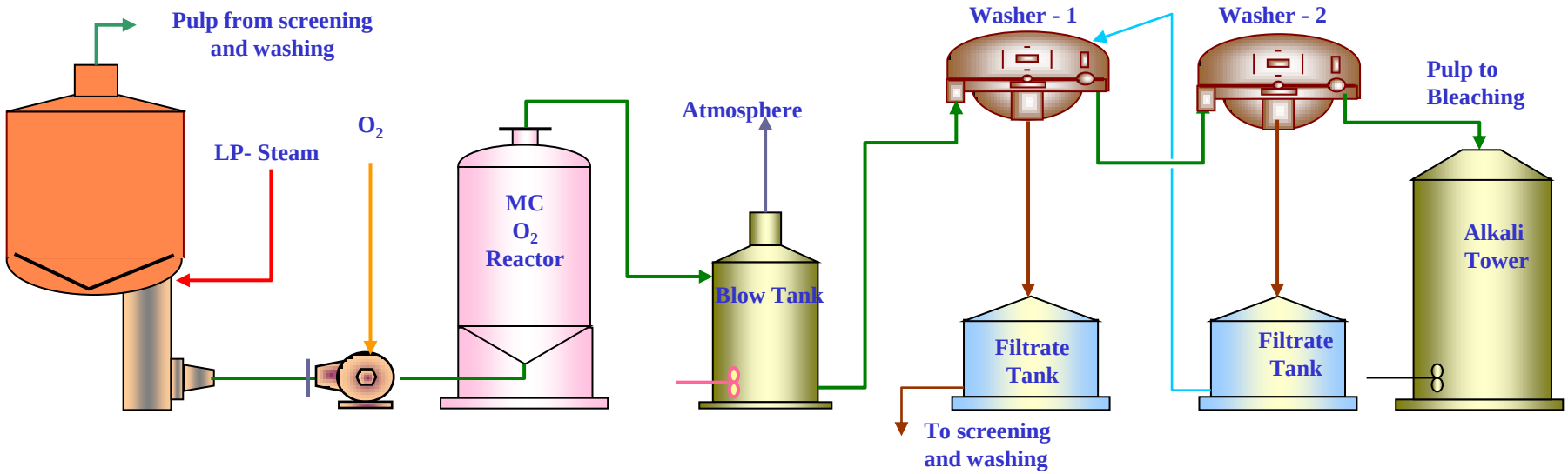
Modification in Batch Process



Displacement Batch cooking (Sunds Defibrator)

Pulp Mill.....Modified Pulping

Oxygen Delignification:- is another method of reducing the lignin content of pulp before conventional bleaching. Although technically independent, oxygen delignification is compatible with the kraft recovery process because its caustic effluent can be added to black liquor and processed through the recovery furnace.



MC - OXYGEN DELIGNIFICATION

Pulp Mill.....Blow Heat Recovery

Blow heat Recovery system for conventional batch digesters accomplishes two objectives;

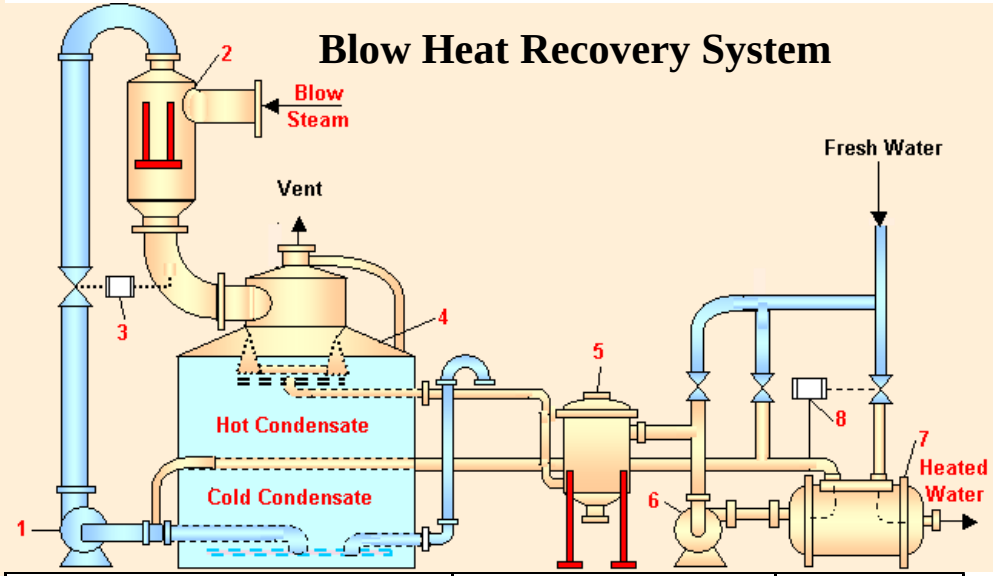
- Recovery of usable heat from the flash steam
- Total entrainment of the associated foul smelling vapors.

The quantity of steam released during a conventional batch cook is substantial and amounts to about 1 tonne per tonne of pulp produced. The steam flashes from the liquor due to drop in pressure from about 7 – 8 kg to atmospheric, while the pulp spontaneously cools from 170 ^{o}C to about 105 ^{o}C.

In a typical kraft batch digester blow heat recovery system, the flash steam with black liquor entrainment, condenses in the accumulator producing hot contaminated condensate. This hot dirty condensate is used to indirectly heat fresh, clean water for washing.

In large integrated mills, the blow heat recovery is practiced and a summary of hot water generated is given below;

Cold condensate is pumped (1) to the condenser (2) through a temperature – controlled flow valve (3). The accumulator (4) provides surge capacity by means of a moving interface between hot and cold sections. Hot condensate is extracted through a filter (5) and is pumped (6) to a heat exchanger (7) where the condensate is cooled before return to the accumulator. Fresh water flow to the heat exchanger is temperature controlled (8).

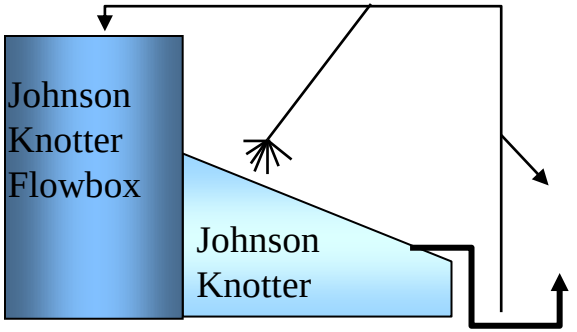


Name of Mill	Hot Water Generation, m3/day	Final Temp, Deg. C
BILT- Sewa	170	70
BILT - Ballarpur	7200	48-54
BILT - Yamunanagar	1500-1600	68
BILT - AP Rayon	5000	90
Cachar Paper Mill	No Blow Heat Recovery	--
Century Pulp & Paper (Bagasse / Wood / Rayon)	No/300/1500	No/80/70
Harihar Polyfibers	3205	88
Hindustan Newsprint Ltd.,	Not mentioned	--
J. K. Paper Ltd., Unit Rayagada	3600	70
J.K. Paper Ltd., CPM, Songarh	No Blow Heat Recovery	--
Nagaon Paper Mill	No Blow Heat Recovery	--
Orient Paper Mills	2000-2400	90-95
Seshasayee Paper & Boards Ltd.,	2400	70
Star Paper Mill Ltd.,	NA	60-65
Tamil Nadu Newsprint & Papers Ltd.,	NA	70
The Andhra Paper Mills Ltd.,	6000	60
The Mysore Paper Mills Ltd.,	3000	65
The Sirpur Paper Mills Ltd.,	2500	70
The West Coast Paper Mills Ltd.,	2000	60

Pulp Mill.....Deknotting

In a low-yield chemical pulping operation, knots are generally defined as the fraction of pulp that is retained on a 3/8" perforated plate. These rejects are most often composed of irregular shaped unreacted wood pieces or overthick chips, but sometimes normal-size uncooked chips are present. Knots are separated from the pulp prior to washing, and are usually returned to the digester in feed, but in some cases may be disposed as waste. The repulping of knots and other screens rejects involves a 10-30% lower yield on this material (depending on the composition) and a poorer quality pulp is produced as compared to that from regular chips. However, since the repulped material is only 2 to 4 % of total pulp production, the impact on overall productivity and quality is not significant.

As a control procedure , it it is good to monitor the level of knots (as % on pulp). A high level of knotter rejects, usually indicates poor cooking uniformity and can be reduced by optimization and process modifications. For example, optimization of pulping parameters and liquor circulation improvement can results in significant reduction in knotter rejects.



Most of the mills use vibrating screen knotters and an analysis of knotter rejects in mills is shown below;

Name of Mill	Rejects,%
BILT- Unit Sewa	0.58
BILT Unit- Ballarpur	3.45
BILTUnit - Yamunanagar	0.68
BILTUnit AP Rayon	8
Cachar Paper Mill	2.09
Century Pulp & Paper	0.1-0.5
Harihar Polyfibers	NA
Hindustan Newsprint Ltd.,	0.13
J. K. Paper Ltd., Unit Raygada	0.91
J.K. Paper Ltd., CPM, Songarh	1.06
Nagaon Paper Mill	3.88
Orient Paper Mills	2.12
Seshasayee Paper & Boards Ltd.,	NA
Star Paper Mill Ltd.,	2.62
Tamil Nadu Newsprint & Papers Ltd.,	NA
The Andhra Paper Mills Ltd.,	16.07
The Mysore Paper Mills Ltd.,	0.82
The Sirpur Paper Mills Ltd.,	9.36
The West Coast Paper Mills Ltd.,	1.2

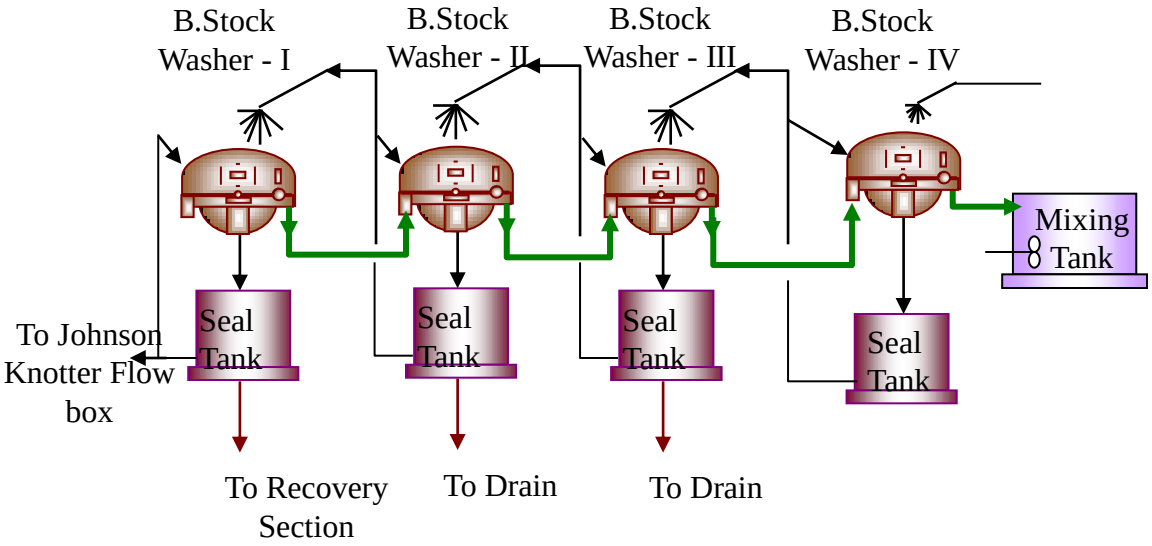
Pulp Mill.....Brown Stock Washing

The cooked pulp from the digesters is washed, with the objective to

- remove residual liquor to reduce downstream bleach chemical requirements and minimize addition of spent liquor solids to the mill effluent.
- recover the maximum amount of spent chemicals with minimum dilution (for subsequent regeneration of cooking chemical through evaporation, burning & recausticising).

These objectives are achieved with a multi stage counter current washing sequence. The cleanest wash water is applied to the last stage having the cleanest pulp. This filtrate is then used as a wash water for the preceding stage.

Mills use multistage (3-4 stage) counter current rotary vacuum washers. The efficiency of these washers is low and inevitable soda losses occur with the pulp on account of a large number of variables which affect displacement efficiency. Today, a number of alternative methods are available to challenge the predominant position of the rotary vacuum washer. Modern mills often combine different method such as displacement, diffusion and dilution / extraction within the same processing line to achieve a target washing efficiency.



Factor affecting Brown Stock Washing displacement efficiency

Fiber Characteristics
-Pulping Process
-Stock hardness
-Stock Freeness
-Species

Shower Characteristics
-Temperature
-Distribution
-Method of application

Sheet Formation / Thickness
-Specific loading
-Vat consistency
-Vat rotational speed

Operating Factors
-Dilution factor
-Stock temperature
-Air moisture
-Liquid solid level
-Fabric mesh characteristics
-Fabric fouling
-Vacuum

Pulp Mill..... Brown Stock Washing

Status of Brown Stock Washing is given below

Name of Mill	Type of Washer	No of Stages	Soda Losses kg/tpulp	Power consumption, kWh/tpulp
BILT- Unit Sewa	Rotory vacuum Drum Filter	4	21	66
BILT Unit- Ballarpur	Rotory vacuum Filter	4	25	NA
BILTUnit - Yamunanagar	Rotory vacuum Filter	4	21	80
BILTUnit AP Rayon	Rotory Drum Filter	4	23	23
Cachar Paper Mill	Rotory Drum Filter	1	15	6
Century Pulp & Paper	Rotory Drum (Wood street)	4	30	99
	Vacuum Filter (Bagasse street)	3	15	60
	Press washer (Rayon street)	3	20	99
Harihar Polyfibers	Pressure Washer	4	4.5	98
Hindustan Newsprint Ltd.,	Rotory vacuum Drum Filter	3	8	130
J. K. Paper Ltd., Unit Rayagada	Two Stage vacuum washer & Two stage displacement press	4	21	119
J.K. Paper Ltd., CPM, Songarh	Rotory vacuum Filter	4	8	65
Nagaon Paper Mill	Vaccum Drum Filter	1	13	9-10
Orient Paper Mills	Rotory vacuum Drum Filter	4	11	NA
Seshasayee Paper & Boards Ltd.,	Vaccum Drum Filter	4	15-25	NA
Star Paper Mill Ltd.,	Rotory vacuum Filter	4	13	NA
Tamil Nadu Newsprint & Papers Ltd.,	Rotory vacuum (Wood street)	3	20	NA
	Rotory vacuum (Bagasse street)	7	20	NA
The Andhra Paper Mills Ltd.,	Chemi Washer	5	9.5	9.5
The Mysore Paper Mills Ltd.,	Rotory vacuum (Wood street)	4	20	165
	Rotory vacuum (Bagasse street)	4	33	136
The Sirpur Paper Mills Ltd.,	Rotory vacuum Filter	4	35	NA
The West Coast Paper Mills Ltd.,	Twin roll press	3	13	70
	Drum washer (stand by)	3	15	80

Pulp Mill……Bleaching

To produce high quality stable paper pulp (as well as dissolved grade), bleaching sequences are used to deliginify in the early stages and employ oxidizing agent to scavenge and destroy the residual colour in later stages. The entire bleaching process is carried out in such a manner that strength characteristics and other papermaking properties are preserved. Different sequences used in Indian mills are;

- ❖ Chlorination (C) - reaction with elemental chlorine in acidic medium
- ❖ Alkali Extraction (E) – Dissolution of reaction products with NaOH
- ❖ Chlorine Dioxide (D) – Reaction with ClO_2 in acidic medium.
- ❖ Oxygen (O) – Reaction with molecular oxygen at high pressure in alkaline medium.
- ❖ Hypochlorite (H) – Reaction with hypochlorite in alkaline medium.
- ❖ Peroxide (P) – Reaction with peroxide in alkaline medium.

In developed countries chlorine and hypochlorite were used until early 1990's. These chemicals are low cost and effective bleaching agents, but have been discarded due to environmental effect of chlorinated organic compounds. Hypochlorite has been identified as a major source of chloroform formation. Elemental chlorine used was largely phased out in 1990's and bleached pulps produced without elemental chlorine or hypochlorite are referred to as ECF pulps. The residual delignification is usually carried out nowadays in oxygen stage and / or a dioxide stage with alkaline extraction.

Pulp Mill.....Bleaching

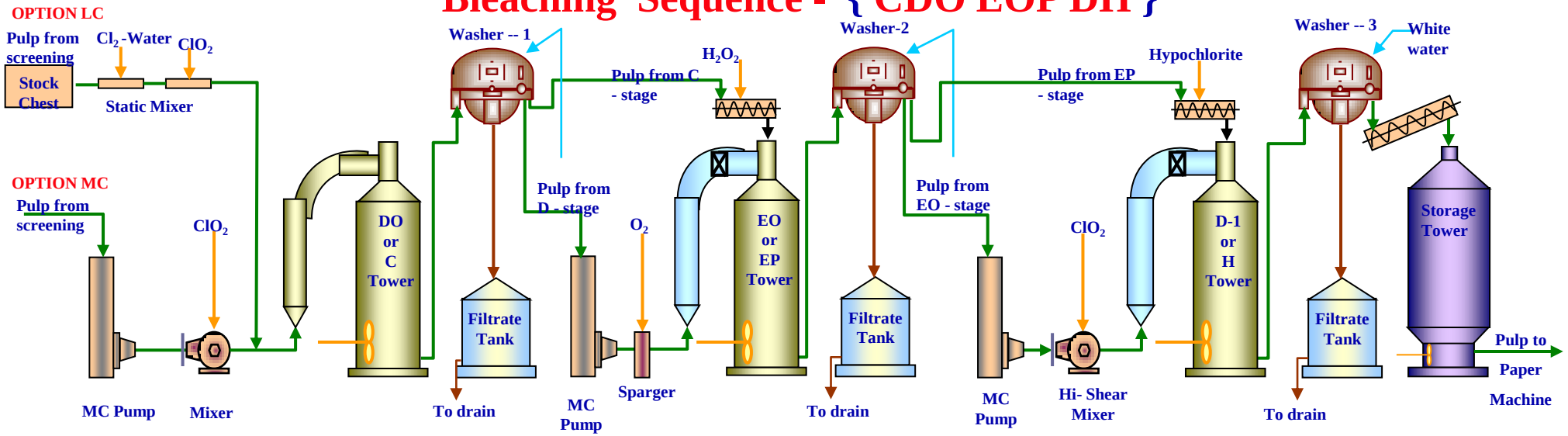
In the 1970's CEDED was the most common sequence in developed countries for full bleached pulp. In the 1980's a comparable sequence was (C + D) (Eo) DED. Today the most common mill bleach sequence is D(Eo)DED or D(Eop)DED. To meet ever more stringent waste water standards, a few mills in North America and Scandenavia have gone to totally chlorine free bleaching by elimination of chlorine dioxide and use of sequences using oxygen, ozone, peroxide, enzymes, chelates and peracids.

The most common bleaching sequence used by Indian paper mills using Hardwood / Bamboo is CEHH. Many mills have started using chlorine dioxide and oxygen bleaching in the early stages of bleaching for substitution of elemental chlorine. Only one mill in India i.e. ITC Bhadrachalam Ltd. has eliminated the use of elemental chlorine. J.K.Paper mill is using oxygen delignification of the pulp. APPM has adopted chlorine dioxide and sulphur dioxide in its bleaching sequences. Many other wood based mills are using dioxide in bleaching sequences. The overall trend is toward improvement and wood based industry has impressive plans for adoption of environmentally compatible sequences. The industry has to ensure good monitoring & control of process variables to achieve world class quality standards.

A bleaching stage begins with the addition of chemicals to the pulp and ends with the washing of the pulp. Within each stage a number of process variables are required to be controlled to ensure a satisfactory end result.

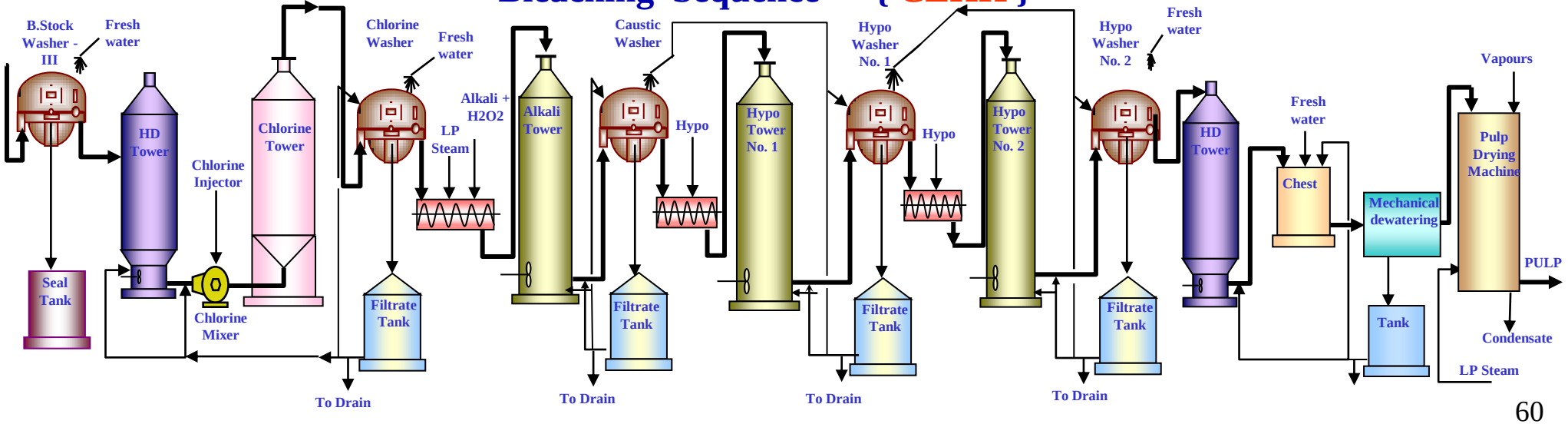
- Chemical application
- Chemical consumption
  - Consistency
  - Temperature
  - Retention time
  - pH

Bleaching Sequence - { CDO EOP DH }



Bleach Plant – { C or DO Stage } { EO or EP Stage } { D1 or H Stage }

Bleaching Sequence – { CEHH }



Pulp Mill.....Bleaching Sequences

The bleaching sequence, characteristics and steam & power consumption in most of the wood based mills are listed below;

Name of the Mill	Bleaching Sequence	Brightness, %ISO	Bleached pulp yield, %	Bleaching loss , %	Steam Consumption, %	Electrical Cons., %
APPM	C-EP-H-H	80	40	12	0.6	120
	C/D-Eop_D-E-D-SO_3	86	40	12	0.5	110
BILT-Sewa	C-EP-H-H-D	88	41.5	10	1.6	93.6
BILT-APR	C/D-Eop-H-D-Ep	88-89	-	10	N.A.	126
SPB	CEpHH	80-82	41	7-10	N.A.	N.A.
JK- CPM	CEpHH	81-82	42.5	10	0.7	127
Star	C-Ep-H-H	82-83	43-44	9-10	NA	160
Orient	C-Ep-H-D	82-87	37-38	9-11	N.A.	N.A.
HNL	P (Chemi-Mechanical)	64	80	3	0.25	120
	C-Ep (Kraft Pulping)	68	45	10	0.6	160
Cachar	C-Ep-H-E-D	85-86	45	10	1-1.5	125-140
JK- Raygada	C/D -EO P -D	89	40	6.5-7.0	0.5	95
Nagaon	C-EP-H-E-D	85-86	44-45	10	1.5-1.8	N.A.
Sirpur	CEpHH	82	36	15	N.A.	N.A.
WCPM	C/D, E/D, H, D	88	42	7	1.1	170
MPM	P (Mechanical)	30-55	80	5	0.3	NA
	CE/P-H-H	80	40	10	0.4	130
Century	CEHHD (Wood street)	85	42	3	N.A.	92.5
	C/D -EO -D (Bagasse)	89	47.5	7	1.25	75
	C EpH D/SO2 (Rayon street)	89	31.5	8	1.1	200
BILT-SG	C/DEoD1D2	88.5-89	44-44.5	10	0.9	150
BILT-Bal	CD EOP HHD	88.5	45	10	0.78	144.84
TNPL	CEpHH (Wood street)	80-83	45	10	1.6	117
	CEpH (Bagsse street)	85-88	50	8	2	90
Harihar	C-E/Oo-H-E-D-SO_2	95.5	33	5	0.56-0.6	182.4

Pulp Mill..... Screening

In most pulp & paper processes, some type of stock screening operation is required to remove oversized, troublesome and unwanted particles (shives) from good paper making fibers. The major types of stock screens are vibratory, gravity centrifugal and pressure (centrifugal or centripetal). They all depend on some form of perforated barrier to pass acceptable fiber and reject the unwanted material. In most instances, it is the size of the perforations (usually holes or slots) that determine the minimum size of debris that will be removed. Arrangement of screens is very important for concentration of debris and return of good fiber to the process. Cascade arrangement of screen is utilized for this purpose.

Variable affecting screening performance

•Stock Characteristics

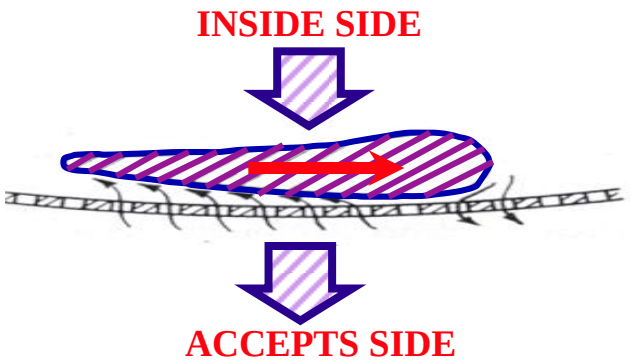
-Type of fiber
-Characteristics of debris
-Debris level

• Design of Screen

-Flow configuration
-Type of plate cleaning mechanism
-Type of perforation (holes or slots)
-Rotor speed (rpm)

• Operating Variables

-Stock flow rate (or pressure drop across screen)
-Feed consistency
-Rejects rate
-Screen plate perforation size
-Stock temperature
-Dilution flow to screen



Principle of a typical pressure screen is illustrated

The leading edge of the rotating foil accelerates the stock. The negative pulse under the sweeping foil momentarily reverses the flow, effectively purging the screen openings.

Pulp Mill…… Screening

The type of screening system in wood based mills and their power consumption (kWh/t of pulp) is shown below;

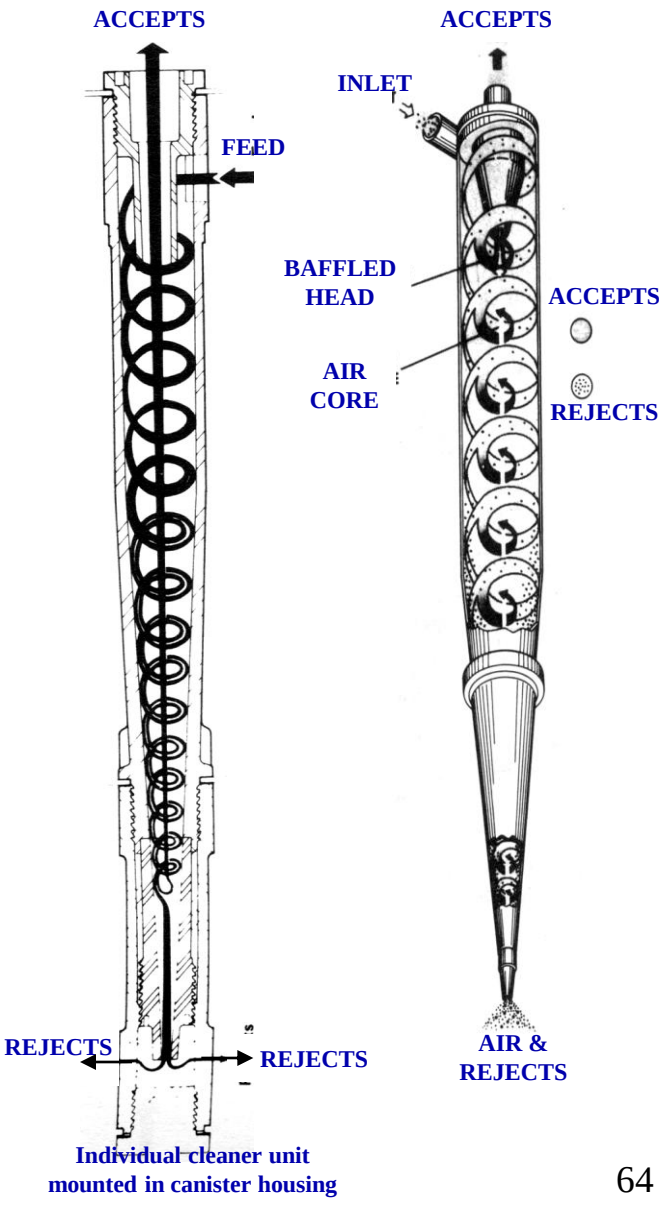
Name of Mill	Type	Power consumption, kWh/t pulp
BILT- Unit Sewa	Centricleaner	40
BILT Unit- Ballarpur	Centricleaner	145
BILTUnit - Yamunanagar	pressure	30
BILTUnit AP Rayon	Centricleaner/pressure	77
Cachar Paper Mill	Centricleaner/pressure	50
Century Pulp & Paper (Wood/Bagasse/Rayon)	Centricleaner	26/70/138
Harihar Polyfibers	Centricleaner/pressure	NA
Hindustan Newsprint Ltd.,	Centricleaner	130
J. K. Paper Ltd., Unit Raigada	Delta Screen	NA
J.K. Paper Ltd., CPM, Songarh	Centricleaner	108
Nagaon Paper Mill	pressure	NA
Orient Paper Mills	Centricleaner	NA
Seshasayee Paper & Boards Ltd.,	Centricleaner/pressure	NA
Star Paper Mill Ltd.,	Centricleaner/pressure	NA
Tamil Nadu Newsprint & Papers Ltd	pressure	NA
The Andhra Paper Mills Ltd.,	Centricleaner	170
The Mysore Paper Mills Ltd.,	pressure	NA
The Sirpur Paper Mills Ltd.,	Centricleaner/pressure	NA
The West Coast Paper Mills Ltd.,	Centricleaner/pressure	55-60

Pulp Mill..... Centrifugal cleaning

CENTRIFUGAL CLEANING:- Early mills used “riffler” to remove high specific gravity contaminants such as sand and dirt solids from pulp suspensions. This device was essentially a modified settling trough through which low consistency stock was slowly channeled, allowing the heavier particles to settle out. These units were bulky, inefficient, and required frequent manual cleaning.

A better method was provided through application of the centrifugal cleaner. This device consists of a conical or cylindrical-conical pressure vessel with a tangential inlet at the largest diameter of the cone or cylinder. Also centered axially at the large diameter end is the vortex finder or accepts nozzle. At the opposite end or minimum – diameter end is the underflow tip or rejects nozzle.

The centrifugal cleaner removes unwanted particles from pulp & paper stock by a combination of centrifugal force and fluid shear. Therefore, it separates both on the basis of density differences and particle shape. All centrifugal cleaners work on the principle of a free vortex generated by a pressure drop to develop centrifugal action. The power source is the pump. The stock enters the cleaner tangentially, the inlet scroll guides the flow to impart a rotating motion. As the stock flows inward, the velocity increases, resulting in high centrifugal forces near the centre which carry dense particles outward and away from the accepted stock. Good fiber is carried inward and upward to the accepted stock outlet. The dirt, held in the downward current, continues toward the tip. As the diameter narrows, the flow is forced inward against increasing centrifugal force which concentrates the dirt and releases good fiber to the accepts flow.



Preparation of Papermaking Stock

Stock preparation is the interface between the pulp mill or pulp warehouse and the paper machine. In an integrated mill, stock preparation begins with dilution of the heavy stock at the discharge of the high density pulp storage chests and ends with the blended papermaking furnish in the machine chest. In the independent paper mill, stock preparation begins by feeding pulp bales into the repulping system.

The basic objectives in stock preparation are to take the required fibrous raw materials (pulps) and non-fibrous components (additives), treat and modify each furnish constituents as required, and then combine all the ingredients continuously and uniformly into the papermaking stock. The primary concern is to produce a uniform paper making furnish to ensure stable paper machine operation and a high standard of paper quality. The following operations are usually involved :

Refining (or beaters)

The fibres are subjected to mechanical action to develop their optimal papermaking properties with respect to the product being made. The operation is usually continuous, but some non-wood and specialty pulps are still treated batch wise.

Utilisation of wet end additives

A wide variety of mineral and chemical agents are added to the stock, either to impart specific properties to the paper product or to facilitate the paper making process.

Metering and Blending

The various fibrous and non fibrous furnish components are continuously combined and blended to form the papermaking stock.

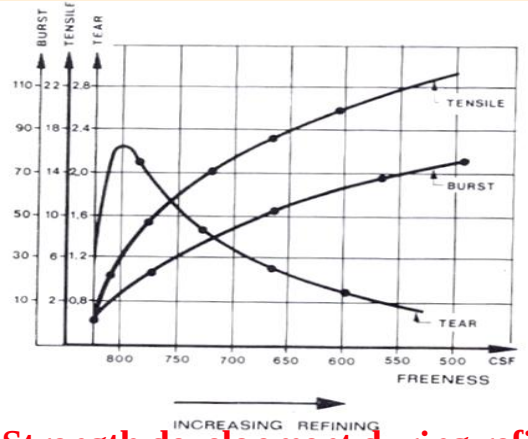
Addition operations may be carried out as part of stock preparation depending on the particular system requirements.

Stock Preparation……Refiners

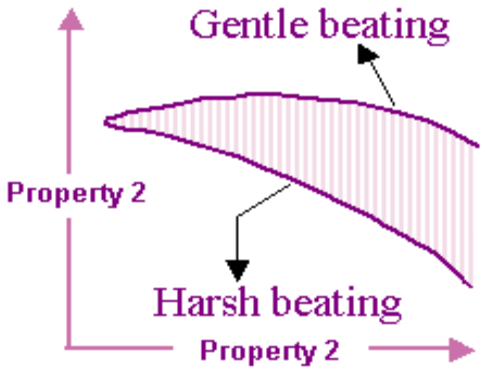
Refining:- The term beating or refining is often used interchangeably. Beating refers to mechanical action of rotating bars opposing or stationary bed plate on a circulatory bed plate in a circulatory fiber suspension. Refining refers to the mechanical action carried out in continuous conical or disc type refiners where the fibres move parallel to bar crossings. The objective is to develop or modify the pulp fiber in optimal manner to meet particular paper furnish demands.

The initial action of refining is to remove the primary wall which prevents the fiber from swelling. Removal of P-layer exposes the secondary wall and allows water to be absorbed into the molecular structure rendering fibres to be soft & flexible. This so called internal fibrillation is regarded as the most important primary effect of refining. Fiber shortening also occur during refining due to shearing action of bar crossings. Fines are produced and the pulp drainability is rapidly reduced as refining proceeds.

Effect of Refining on Paper Properties:- The response of refining depends on the type of pulp fibres, the equipment used and operating conditions. Tear strength generally decreases with refining due to strength attrition of individual fibres. Other strength parameters (eg. Burst, tensile, folding endurance) increases due to increased fiber to fiber bonding. One property is evaluated as a function of other property in order to characterize the papermaking potential of pulp over the complete range from gentle to harsh refining.



Typical Strength development during refining



Papermaking potential of a pulp in respect to properties 1 and 2

Stock Preparation……Refiners

Types of refiners:- Two major types of refiners are disc & conical refiners. The conical refiners can further be differentiated into low angle (Jordans) and high angle (Claffins) type.

Disc refiners are available in a wide variety of designs and disc patterns.

-rotating disc opposing stationary discs.

-Two opposing rotating discs.

-Rotating double sided disc between two stationary discs.

Disc refiners offer significant advantages over conical refiners.

The major advantages are:-

-lower no-load energy consumption

-Use of higher stock consistencies.

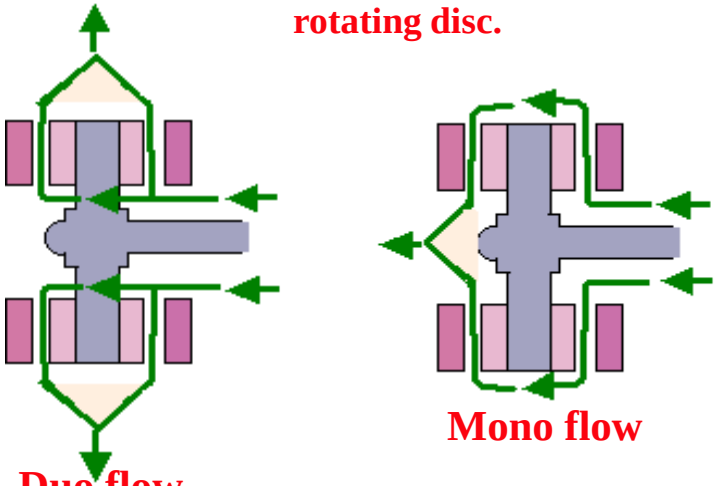
-Higher loading

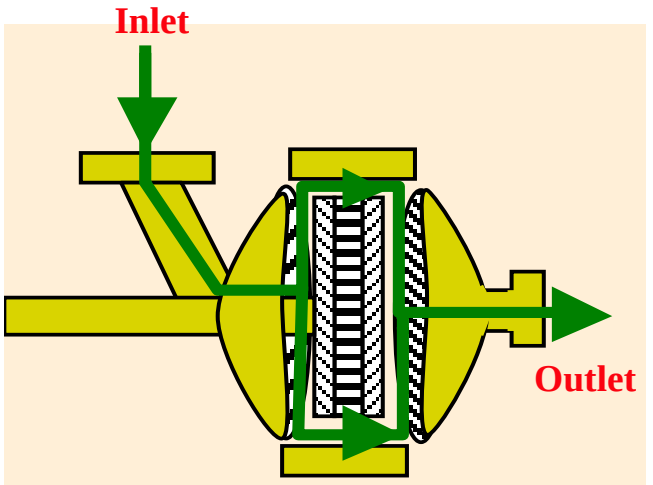
-More compact design.

-Lower capital cost per tonne of production.

Plates for disc refiners consist of a variety of bars cast onto base plate. The configuration is significant in determining the specific refining effect. The coarser patterns provide a high intensity action which is more suitable for cutting fibres. The finer pattern are more appropriate for strength development.

Alternate flow paths for refiner with double-sided rotating disc.





Single disc, Monoflow Refiner

Stock Preparation……Refiners

In wood based mills variety of refining treatment is given to the fiber by using different types of refiners in succession. The details of the refiners, initial & final freeness and refining power (kWh/t) used by various mills is given in table below.

Name of the mill	Type	No. of refiners	Initial pulp freeness °SR	Final pulp freeness °SR	Refining power kWh/t pulp
APPM	DDR, Sprout-Waldron	1	16	28-30	10.5
		1		26-28	12.5
		1		34-35	21
	DDR - Beloit	1	16	32	6.3
	DDR - L&T	2	16	26/28 ; 34/35	12.5; 21
BILT-Sewa	DDR, Sprout-Waldron	2	17-20	29-35	84
SPB	Disc-Utmal	3	28	32-35	12
JK- CPM	DDR-Servall	4	16-18	26-28	10
	DDR- Servall	3	16-18	30-40	10
Star	Parason / Sprout Waldron	8	17-18	31-32	NA
		4	17-18	34-35	NA
Orient	DDR+SDM+Deflaker	5	NA	NA	NA
HNL	Double Disc-Voith Utmal	2	15-16	36-38	408
Cachar	Double disc -Voith	5	16-17	38±3	NA
	Double disc - Jessop	5	16-17	38±3	NA
JK-Raygada	DDR28"- Jythavaran	3	15	24	80
Nagaon	Double Disc-Beliot	5	15±1	35-40	100-115
	Double Disc-Voith	5	15±1	35-40	
Sirpur	DDR	7	16-18	32-36	NA
WCPM	Disc-Parson/Sprout Waldron	15	18-20	28-32	80-100
MPM	DD 30" - Beloit Jones	10	19-Chem; 32-Mech	35-Chem; 51-Mech	5
Century	DDR- L&T	4	15-16	22-28	11
BILT-SG	DDR- Beliot Sohns	3	19	28	225-275
	DDR- Parason	2	16 - 17	25 - 26	
BILT-Bal	DDR- L&T	2	19	38	166
		1		35	151
		1		30	58
	DDR- Utkal	2	19	32	86
TNPL	DD-Beliot / Parason	2	24-28	29-35	NA
	DD-Beliot / Parason	1	32	35	NA
	DD-Beliot / Parason	2	19-28	28-36	NA

Stock Preparation……Refiners

Conical Refiner (CR)					
Name of the mill	Type	No. of refiners	Initial pulp freeness	Final pulp freeness	Refining power
			°SR	°SR	kWh/t pulp
SPB	Conical-Sunds	9		32-35	8-10
	Conical - Jones Majistic	6	16-17	22-24	NA
	Conical	3	19-28	28-29	
	Conical	4	16-17	25-26	
Orient	Jones-Majestic	6	16-17	22-24	NA
TNPL	Conflo- Sunds	1	28-29	33-38	

Others					
Name of the mill	Type	No. of refiners	Initial pulp freeness	Final pulp freeness	Refining power
			°SR	°SR	kWh/t pulp
BILT-Sewa	Wide Angle - Clafin	2	17-20	29-35	89
Cachar	Brushing	3	42±2	42±2	207
	Wide Angle	2	38±3	42±2	210
BILT-SG	Jordan	2	28	29	
	Beater- Basand		13 - 17	89 - 90	

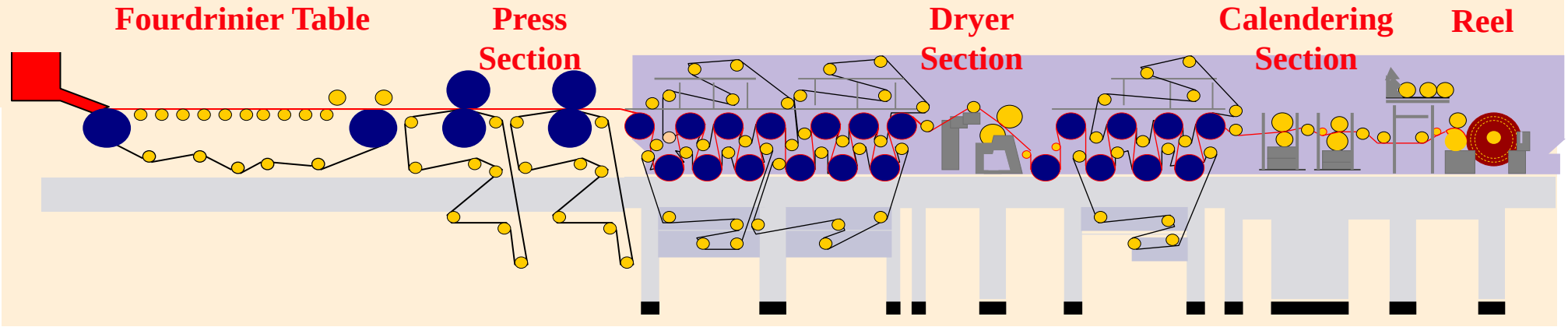
Triple Disc Refiner (TDR)					
Name of the mill	Type	No. of refiners	Initial pulp freeness	Final pulp freeness	Refining power
			°SR	°SR	kWh/t pulp
JK- Raygada	TDR17"	24	28	139	NA
	TDR24"	6	15	24	75
Sirpur	DDR&TDR	5	16-18	32-34	NA
		5	16-18	29-36	NA
	TDR & HSR	4	16-18	35-38	NA
		4	16-18	28-34	NA
		10	16-18	27-32	NA
MPM	Tri Disc- Parason	1	20	38	7.52
	Tri Disc- Parason	2	17	32-38	7.53
	Tri Disc- Parason	2 + 1(Stand by)	20	37	4.44
Century	TDR-- Parason	2	15-16	22-28	6
BILT-SG	TDR-- Parason	1	19	28	
	TDR-- Parason	1	16/17	25 / 26	
BILT-Bal	TDR-21- Parason	1+1	19	34 / 35	75 / 164

Paper Machine.....Wet end operation

PAPER MANUFACTURE

Paper continued to be made by hand up to the beginning of the 19th century. The first Paper Machine was designed in 1799 and successfully operated in England in 1803 by Fourdrinier brothers. The machine eventually became known as the Fourdrinier machine. Since then, the paper machine has undergone continual development, making it possible to produce a wider web of paper at ever increasing speed and to more exacting standards of quality. The major components of a modern machine are

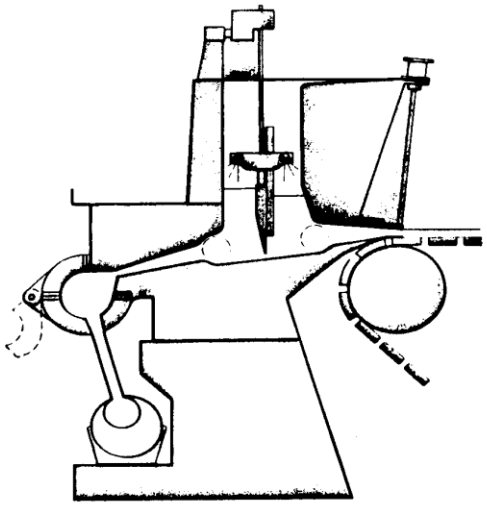
- The flowspreader takes the incoming pipeline stock flow and distributes it evenly across the machine from back to front.
- The pressurized headbox discharges a uniform jet of paper making stock onto the moving forming fabric.
- The endless moving Fourdrinier fabric forms the fibers into a continuous matted web while the Fourdrinier table drains the water by suction forces.
- The sheet is conveyed through a series of roll presses where additional water is removed and the web structure is consolidated.
- Most of the remaining water is evaporated and fiber-to-fiber bonds are developed as the paper contacts a series of steam-heated cylinders in the dryer section.
- The sheet is calendered through a series of roll nips to reduce thickness and smooth the surface.
- The dried, calendered sheet is accumulated by winding onto a reel.



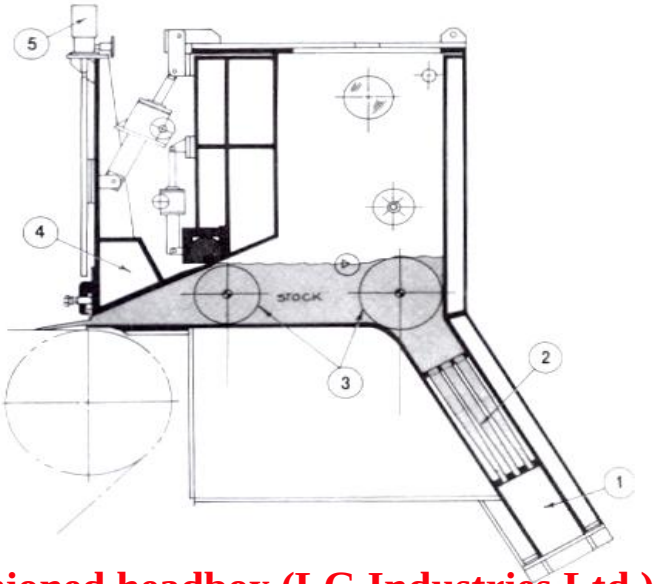
Paper Machine……Flow Spreader & Head box

The function of the head box is to take the stock delivered by the fan pump and transform the pipeline flow into an even rectangular discharge equal in width to the paper machine and at uniform velocity in the machine direction. Since the formation and uniformity of the final paper product is dependent on the even dispersion of fibers & fillers, the design and operation of the head box system is absolutely critical to a successful papermaking system. Head boxes can be categorized depending upon the required speed of stock delivery as open or pressurized types. Pressurized head boxes can be further divided into air-cushioned and hydraulic designs.

Open head boxes were employed with the early paper machines where gravity head of stock was used to give the correct discharge velocity. Open head boxes are today found on slow speed machines. New machines have pressurized head boxes.



Open headbox for pulp and board machines operating up to 200 m/min (Voith)



Air cushioned headbox (LG Industries Ltd.)

Paper Machine……Head boxes

The mills in India run with both open & pressurized head boxes. The details of Head boxes used in wood based mills are given below

Name of the mill	Type of head box	Machine Speed, m/min
APPM	Open/pressurised	175 / 200
	pressurised	370/600
	open	150
BILT-Sewa	Closed	470 / 450
BILT-APR	Closed	90
SPB	Pressurised	240 / 50-210
	Open	80-210
	Pressurised	150-350
	Hydraulic	450-900
JK- CPM	Closed	325 / 290
Star	Open	190
	Air cushioned pressurised	200
	Open	175
Orient	Pressurized / Open	230-610/ 40-100
	Pessurized	300-915
HNL	Press converging closed / flow	550-800
Cachar	W 9000 / Conveyor flow	550 / 510
JK- Raygada	Pressurized	100-300/270-300/100-250
	Pressurized	70-175
	Pressurized	200-300
Nagaon	Conver flow	550 (Operating)
Sirpur	Open	130 / 175
	Open	120 / 80
	open / Pressurised	300/403
	Open	107
WCPM	Air Pressure/ step diffuser	300 /240
	hydraulic	540
	Pressure Former / RF Vat	66-180 / 38-100
MPM	open type	40-90 / 40-100
	open type	50-260
	Conver flow	650
Century	Air press	300
BILT-SG	Open	100 / 115
	Pressurised	345
BILT-Bal	Open/close/close	270 / 185 / 250
	Open	140 / 220
	Closed Hydraulic	478
TNPL	conver flo / Gapjet CFD	750 / 950

Paper Machine.....Wire Part

The forming medium is an endless finely woven belt. Earlier only woven metal wires were used therefore the old terminology persists and woven forming media are called wires, whether of plastic or metal construction. The fabric travels between two large rolls, the breast roll near to the head box & the couch roll at the other end. The various elements between the breast and couch roll serve the dual function of wire support and water removal. A number of different arrangements can be used depending upon the particular requirement.

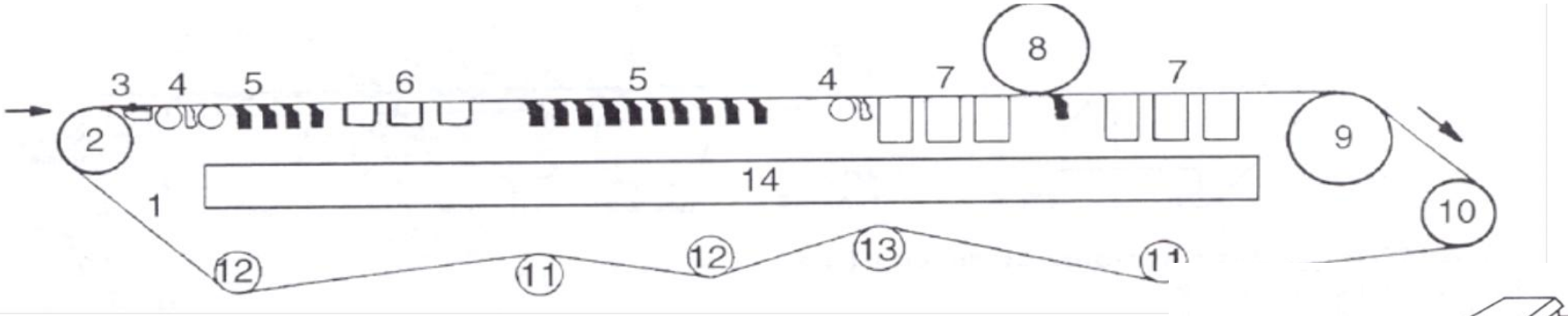
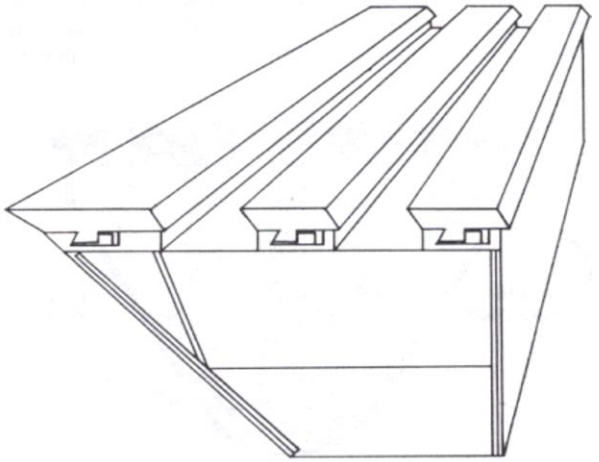


Diagram of Fourdrinier wet end. (1) Forming fabric (2) Breast roll (3) Forming board (4) Table roll (5) Foil (6) Wet suction box (7) Dry suction box (flat box) (8) Dandy (9) Suction couch roll (10) Wire turning roll (11) Guide roll (12) Stretch roll (13) Wire return roll (14) Wire tray .

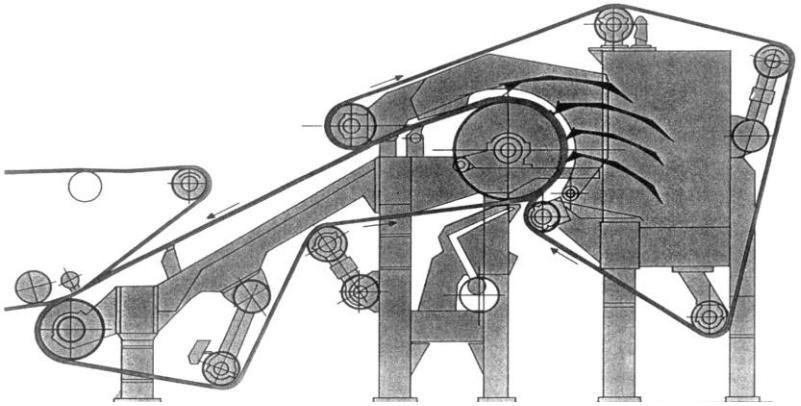


Representative forming board design (Albany International Company)

Paper Machine……Twin wire forming

The fourdrinier machines had inherent limitation of achieving higher operating speeds and improved product quality. The twin wire machine development provided the major improvements and are successfully operating worldwide.
In India many mills have adopted twin wire formers and are providing high quality products with higher productivity. The mills using twin wire frames are listed below

Name of Mill	Number of Machines	Machine Speed
Seshasayee Paper & Boards Ltd.,	One Machine (Du former), Capacity 200 t/day	450-900
Tamil Nadu Newsprint & Papers Ltd.	Two Machine, Capacity 360/400 t/day	750/950
The Mysore Paper Mills Ltd.,	One Machine, Capacity 312 t/day	650
The Sirpur Paper Mills Ltd.,	One Machine (Cylider Mould), Capacity 60 t/day	250-700
The West Coast Paper Mills Ltd.,	One Machine (Peproformer), Capacity 120-130 t/day	540
Hindustan Newsprint Ltd.,	One Machine, Capacity 360 t/day	550-800



Double-wire tissue former with a "C" configuration

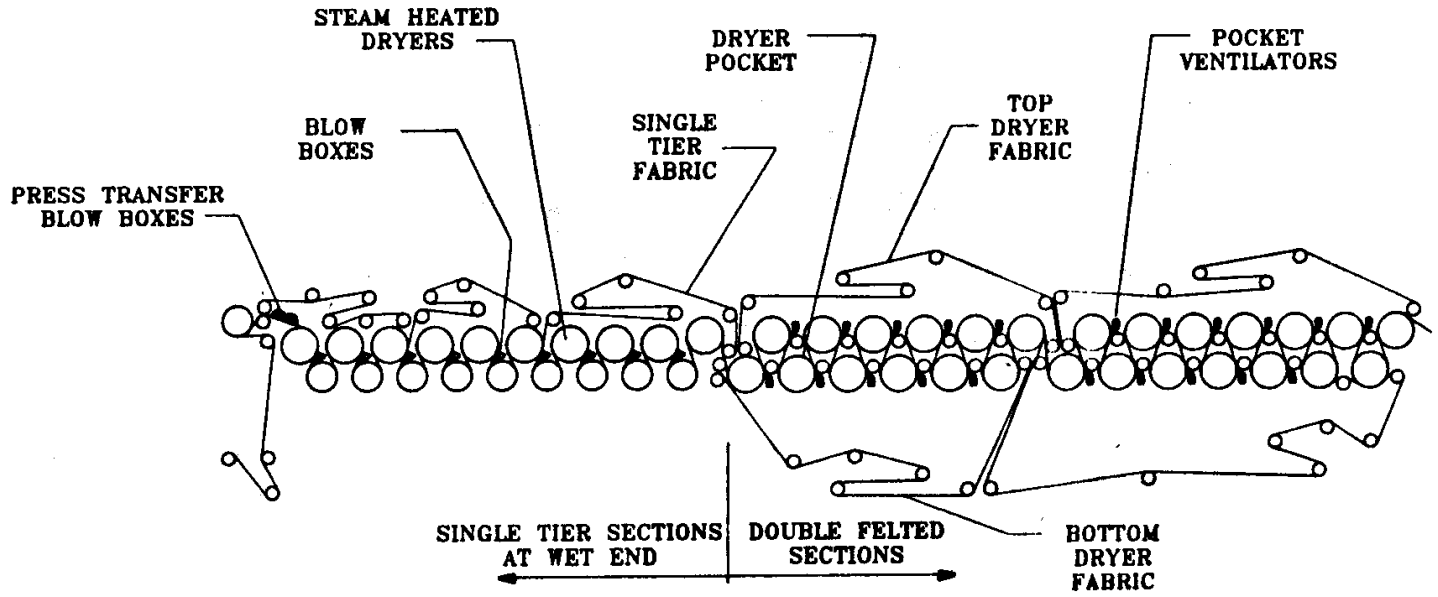
Paper Machine.....Pressing

The primary objective of paper pressing is to remove water from the sheet and to consolidate the web. The pressing operation may be considered an extension of the water removal process that is started on the wire. It is far more economical to remove water by mechanical means than by evaporation. Therefore, the objective is to improve pressing efficiency and reduce evaporation load in to the dryer section. The type of presses used in wood based mills and % dryness achieved is listed below

Name of Mill	Type of Press	% Dryness after press
BILT- Unit Sewa	Uni, Binip	39-44
BILT Unit- Ballarpur	Plain, Suction	26-42
BILTUnit - Yamunanagar	Open,	37-40
Cachar Paper Mill	Trinip	48
Century Pulp & Paper (Wood/Bagasse/Rayon)	Binip, GLE nip, Trinip, Solid	45/42/53
Hindustan Newsprint Ltd.,	Trinip	43.5
J. K. Paper Ltd., Unit Raigada	Suction, Solid, Dual, Uni	30-42
J.K. Paper Ltd., CPM, Songarh	Pickup, Straight through	38-41
Nagaon Paper Mill	Trinip	41-43
Orient Paper Mills	Straigth suction, suction	38-52
Seshasayee Paper & Boards Ltd.,	Suction,Pickup,DuoCentri	38/75/43
Star Paper Mill Ltd.,	Suction press	37-41
Tamil Nadu Newsprint & Papers Ltd	Shoe Press	44
The Andhra Paper Mills Ltd.,	Groved, Suction plain, Binip, Trinip	34-45
The Mysore Paper Mills Ltd.,	Plain, Trinip	30-42
The Sirpur Paper Mills Ltd.,	Suction plain	NA
The West Coast Paper Mills Ltd.,	Solid, Trinip	42-48

Paper Machine.....Dry end

After pressing, the sheet is conveyed through the dryer section where the residual water is removed by evaporation. The dryer section is the most expensive part of the paper machine in terms of capital cost. It is also the most costly to operate because of high energy consumption.



Typical dryer configuration for lightweight papers

Paper Machine.....Dry end

The status of dryer section in wood based mills is given below.

Name of Mill	Condensate System	Type of Hood	Nos. Dryers
BILT- Unit Sewa	Cascade	Semi Closed	Mc-1/48, Mc-2/37
BILT Unit- Ballarpur	Bucket, Cascade (Mc-3)	Semi Closed (Mc-1, Mc-3) Closed(Mc-2, Mc-4, Mc-5, Mc-	Mc-1/22, Mc-2/1,Mc-3/41, Mc-4/18,Mc-5/1, Mc-6/21
BILTUnit - Yamunanagar	Scoop, Bucket	Semi Closed, open(Mc-6), Closed(Mc-7)	Mc-1/27, Mc-2/27,Mc-3/36, Mc-5/28,Mc-6/8, Mc-7/16
Cachar Paper Mill	Cascade	NA	Mc-1/47, Mc-2/29
Century Pulp & Paper (Wood/Bagasse/Rayon)	Cascade, Bucket(Mc-4)	open, Closed(Mc-3), open (Mc-4)	Mc-1/24, Mc-2/28, Mc-3/40, Mc-4/36
Hindustan Newsprint Ltd.,	Stationary Siphon	NA	Mc-1/37
J. K. Paper Ltd., Unit Raigada	Siphon(Mc-1,2,3) Bucket (Mc-4,5)	open	Mc-1/49, Mc-2/1,Mc-3/24, Mc-4/18, Mc-5/29
J.K. Paper Ltd., CPM, Songarh	Rotary Siphon	NA	Mc-1/40, Mc-2/34
Nagaon Paper Mill	Cascade	NA	Mc-1/46, Mc-2/29
Orient Paper Mills	Rotary Siphon	Closed	Mc-1/44, Mc-2/14,Mc-3/1
Seshasayee Paper & Boards Ltd.,	Cascade, No (Mc-3)	open, Closed(Mc-5)	Mc-1/17, Mc-2/24,Mc-3/1, Mc-4/32, Mc-5/42
Star Paper Mill Ltd.,	Trap	High velocity Hood, Open(Mc-	Mc-1/25, Mc-2/19,Mc-3/1, Mc-
Tamil Nadu Newsprint & Papers Ltd.,	Stationary Siphon	closed	Mc-1/43, Mc-2/32
The Andhra Paper Mills Ltd.,	Conventional (Mc-1,2&4), Cascade(Mc-3&5)	Open(Mc-1,3,4,5), Closed (Mc-2)	Mc-1/10, Mc-2/15,Mc-3/35, Mc-4/1, Mc-5/34
The Mysore Paper Mills Ltd.,	Scoop, Rotary Syphon(Mc-4)	Semi Closed, Closed(Mc-4),	Mc-1/10, Mc-2/16,Mc-3/24, Mc-4/36
The Sirpur Paper Mills Ltd.,	Siphon(Mc-1,2,3,6,7) Bucket (Mc-3,5)	open	Mc-1/20, Mc-2/24,Mc-3/32, Mc-4/16,Mc-5/16,Mc-6/35, Mc-7/26
The West Coast Paper Mills Ltd.,	Cascade, Direct, Cascade, Rotory, Stationary	Open(Mc-1,2,3), Closed (Mc-4), open	Mc-1/35, Mc-2/15,Mc-3/38, Mc-4/39, Mc-5/24

Chemical Recovery

The recovery of chemicals from the spent cooking liquor, the reconstitution of these chemicals to form fresh cooking liquor, the realization of energy from the incineration of organic residuals, and minimization of air and water pollution are vital aspects of any chemical pulp mill recovery process. These objectives are shared by almost all kraft mills.

The steps involved in the chemical recovery are as follows:

- Concentration of the residual liquor in multiple effect evaporators to form “strong black liquor”.
- Further concentration of the residual liquor to form heavy black liquor. Salt cake can be added at this point to make up soda loss.
- Incineration of liquor in the recovery furnace.
- Dissolving smelt from the furnace to form green liquor. Soda ash can be added at this point to make up soda loss.
- Causticising green liquor with lime to form white liquor. Caustic soda can be added at this point to make up soda loss.
- Burning of lime mud to recover lime.

Chemical Recovery .....Evaporators

Black Liquor Evaporation:- Most commonly used evaporator in India is LTV rising film type evaporators. However, a few mills are still using short tube vertical (STV) evaporators. The falling film evaporators are becoming increasingly popular because these system are generally more energy efficient and have easier maintenance. Direct contact evaporator are out of service in mills in developed countries. However many mills in India use these evaporators after the LTV evaporators for concentration in final stage before firing. A few mills have replaced DCE with falling film evaporators in the finisher stage and have shown very good results. The wood based mills use different types of evaporators. The details are given below.

Name of Mill	Type	No. of effects	No. of street	Make	Evaporation capacity, t/hr	Black liquor feed concn, %	Black liquor outlet conc., %
APPM	FFFF	7	1	Rosenblad/ Enmass	120	15-16	52-53
BILT-Sewa	LTV-5 / FFFF-3	4+1	1	Enmass - pas retrofit	58	15.5	62
BILT-APR	LTV / FFFF	3+3		L&T / Enmass	128	16	68
SPB	LTV / LTV	4+5	1+1	Gaslin	15+60	14	50
JK- CPM	LTV / FFFF	5+1	1	Swenson / Pas const. P.Ltd.	55	17.05	52-53
Star	LTV / FFFF	6+1	1	Enmass Andritz	65	15	52
Orient	LTV	6+1	1	Swenson	117	13	48
HNL	LTV / FFFF	(5+1)+6	2	L&T / Alpha level	60/52.7	12/5	40
Cachar	LTV	5+1	1	BHPV-Unitech, USA	131.25	15	50
JK- Raygada	FFFF	7	1	Alfa Level + Ahlstorm	101	17.8	54.7/65.2
Nagaon	LTV / FFFF	6+3	1	Unitech/Andritz	145	15-17	70
Sirpur	STV/LTV	4+5	2	Rosenblade/ L&T	42/50	13.5	46
WCPM	FFFF	7	1	Alfa Level + Ahlstorm	100	16	65
MPM	LTV	5	1	TMT-Kurnool	100	13	45
Century	LTV / FFFF	6+7	2	Grasim/ Ahlstorm	85/127	11	67
BILT-SG	STV/STV	6+6	2	Rosenbalc/Scott	58-54/ 22-18	14	64
BILT-Bal	LTV	4+5+4+5	4	Inglis/B.Scott/B.Ambalal/PAS	9.2/54/35.6/28	16-17	28/48-50/37-40/37-40
	FCE	3		L&T	25		59-60
TNPL	RF/FF	6+7	2	L&T/ Alfa level	130/170	8	45

Chemical Recovery .....Recovery Boilers

The mills at present have many small recovery boilers, which are operated inefficiently. Over the last decade due to environmental regulation the mills have retrofitted the air distribution system and installed the ESP's. The type of recovery boilers used in wood based mills are shown below.

Name of Mill	Make	Capacity, BLS fired tpd	Final steam pressure, kg/cm^2	Steam production , t/t of BLDS	Reduction efficiency, %	Thermal Efficiency, %
APPM	B&W	120	33	2	90	40
	ABL	260	33	2.6	90-92	52
	BHEL	160	33	2.8	90-92	54
BILT-Sewa	Enmas - Alstrom	270	42	3.124	85	65
BILT-APR	ENMAS	638	45	4.34	93.5	69
SPB	B&W	135	10	405	92	
	GV	175	30	510	92	
JK- CPM	B&W, ENMAS (Retrofit)	252	42	2.1	83-84	53.12
Star	Enmas Andritz	280-300	20.0-20.50	3.54	95	
Orient	C.E. USA	400	63	2.5	89-90	52-55
HNL	BHEL	120	64	3	80-90	63
Cachar	BHEL	525	60	3.0-3.2	89	55
JK- Raygada	BHEL/BHEL	307/301	36	2.12/2.88	92	41.4/58.8
Nagaon	BHEL	500-525	60	3	90	58
Sirpur	BHEL/EAPL	230/120	35	2.7	88	
WCPM	BHEL	450	45	4.16	93-95	70
MPM	BHEL	230	63	840	80	60
Century	BHEL/ABL	310/340	46/62	40/50	92	67
BILT-SG	ABL/JMW	160/120	44	2.9/3	88/90	60/62
BILT-Bal	Steinmuller	325	38	2.86	93-94	59.5-61
	AVB	232	38	3	93-94	59.5-61
TNPL	Mitsubshi/BHEL	272/374	46	2.76	93	55

Chemical Recovery .....Causticisation

Recausticising plant converts sodium carbonate generated from combustion of black liquor into active sodium hydroxide and removes various impurities introduced from lime and the furnace. The causticisation operation is plagued from

- Poor or erratic causticising
- Insufficient removal of dregs
- Poor settling or filtering characteristics of lime mud

These can be controlled by optimization and good control over the process variable. Details of causticization section in wood based mills are given below.

Name of Mill	Lime consumption, tpd	Purity of Lime used, %	Type of slaker	Power consumed, kWh/m3 of WL processed
APPM	120	70	Stationary	2.9
BILT-Sewa	120	65	Rotary Drum Slaker	5.6
BILT-APR	140	82	Stationary	2.6
SPB	80	65	Rotary	4.6
JK- CPM	58.89	74	Rotary Slaker	6.7
Star	65-66	80-82	stationary	NA
Orient	95	60-62	Rotary	NA
HNL	30.5	70	Horizontal rotary	96.8
Cachar	160-170	60	Rotary	6.1
JK- Raygada	131	74.9	stationary cum classiifer	8.3
Nagaon	150	64-68	rotary Drum	4.7
Sirpur	105	48	Rotary	NA
WCPM	100	82-84	Donco	NA
MPM	70	62-65	Drum Slaker	7.1
Century	150	72	stationary	4.4
BILT-SG	56	75	Rotary drum slaker	7.4
BILT-Bal	130-135	62-65	drum	NA
TNPL	150	72	Stationary	35

Chemical Recovery ……Lime Kiln

The traditional limekiln continues to be the most popular equipment for calcination. There are only 8 mills having limekiln in India. A well controlled calcinations will yield a product which is 90-94% CaO and reacts rapidly with green liquor. The lime kiln operation and control is also very crucial for efficient operation. The status of limekilns in wood based mills is given below;

Name of Mill	Make	Lime Produced, tpd	Type of cooler	Furnace oil consumption, lt/t of lime prod.	Electrical energy consumed, kWh/t of lime produced
APPM	Fuller KCP	95	Planetary	180-185	88
BILT-APR	Fuller KCP	140	Satellite	160	54
Star	L&T Mumbai	67	Planetary	165-166	30
HNL	Grasim	30.4	External	217	88
WCPM	FFE	110	Sattelite Cooler	165	39
Century	Grasim	55	External	75	149
	Fuller KCP	105	Satelite	65	126
TNPL	FFE	120	Planetary	200	35
Harihar Polyfibers	Grasim	81	External	212	24

AGRO BASED MILLS

Agro Based Mills……Status

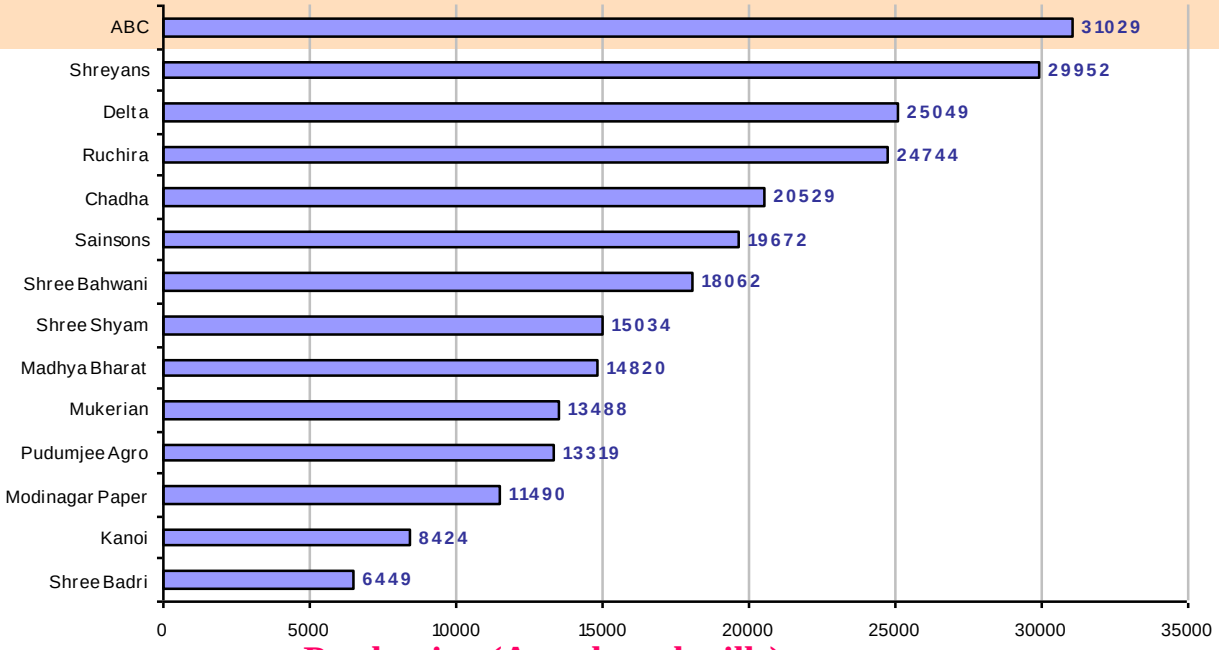
A large number of mills based on agricultural residues were set up in Late 1970 to augment paper famine in the country. These mill use bagasse, rice straw, wheat straw, local grasses as fibrous raw materials. Most of these mills produce unbleached products by soda pulping of these raw materials. Most of the mills, do not recover the spent pulping chemicals. Some mills produce bleached varieties also from soda pulps.

There are at present 160 Agro based mills which produce about 1.80 million tonnes of paper and paper products. Most of them are small and medium size. A few mills have capacity above 100 tpd and they have access to modern technology. Most of these mills are owned and managed by local business groups and lack modern technologies. Most of them produce unbleached paper & board and few produce bleached varieties and have chemical recovery

comparable with international quality standards.

Major products of this category of mills are;

- Writing printing grade papers
- Packaging grade papers
- Board and
- Specialty papers



Production (Agro based mills), tpa

Raw material preparation ..... Cleaning& depithing

Agro based mills use various raw materials which are processed before pulping. The major raw materials used are bagasse and straws. The processing of bagasse involves – cleaning & depithing. Straw is also processed by cleaning and cutting of the straws before taking them to the digesters. Details of depithers and cutters used in agro based mills are given below.

Name of the Mill	Type of Raw Material	Type of Depither/ Cutter	Capacity, tpd	Pith removal, %
Abhishek Industries	Wheat Straw, Wood Pulp	Dry	144	NA
Shreyans Industries Ltd	Straw, L. Fibre, waste Paper, Wood Pulp	Moist	120	30-40
ABC Paper	Rice & Wheat Straw, Grass, Bagasse, Wood pulp, RCF	Dry	120	16
ShreeBhawani Paper Mill	Straw, Bagasse, RCF, Jute, Cotton, Wood Pulp	Dry	288	18-20
Mukerian Papers Ltd	Straw, Cotton Linter, Staple Fibre,RCF, wood pulp	Dry	288	20
Delta Paper Mills	Straw, Bagasse, Waste Paper, Wood Pulp, gunny	Wet	288	18
Sainsons Paper Ind. Ltd.	Wheat Straw, Bagasse, Sarkanda, Hession, RCF	No	--	--
Shree Shyam Pulp & Board	Bagasse, Wheat Straw, Sarkanda, Rice Straw	Dry	240	20
Pudumjee Agro Ind. Ltd.	Bagasse, Waste Paper, Pulp	NA	NA	NA
Shree Badri Kedar Paper	Bagasse, Sarkanda, Waste Paper	Dry	NA	15-20
Modinagar Paper Mills Ltd.	Wheat Straw, Bagasse, Jute waste, Waste Paper	Dry	80	20
Ruchira Papers Ltd.	Bagasse, Wheat Straw, Sarkanda, Jute waste	Dry	200	18
Emami Paper Mills Ltd.	Paddy straw, grass, waste paper	No	--	--
Chadha Papers	Bagasse, Wheat Straw, Waste Paper, Others	NA	NA	NA

Pulp Mill ..... Digesters

The agro based mills use soda pulping process predominantly. The digesters used in most of the mills are spherical rotating batch digesters of different capacities. A few mills also use pandia type batch digesters which are more energy efficient. The status of digesters and pulping conditions used in agro based mills are shown below

Name of the Mill	Type of Raw Material	Type & No. of Digesters	Capacity, m3	Mode of heating
Abhishek Industries	Wheat Straw	Rotary Spherical-10	60 m3 each	Direct
Shreyans Industries Ltd	Wheat Straw, Sarkanda, Bagasse, Jute Waste, Veneer Chips	Batch-10	40 m3 each	Direct
		Continuous - 1	70 tpd	Direct
ABC Paper	Rice & Wheat Straw, K. Grass, Kahi Sabai Grass, Bagasse	Batch-13	40 m3 each	Direct
ShreeBhawani Paper Mill	Rice & Wheat Straw, Bagasse	Batch-10	40 m3 each	Direct
Mukerian Papers Ltd	Rice & Wheat Straw, Sarkanda, Bagasse	Spherical Batch-3	60 m3 each	Direct
Delta Paper Mills	Straw, Bagasse, gunny	Batch; Rotary-6, Mechano chemical-3	(27.9 & 36) m3 each	Direct
Sainsons Paper Ind. Ltd.	Wheat Straw, Bagasse, Sarkanda, Old Jute	Batch-16	25 m3 each	Direct
Shree Shyam Pulp & Board	Bagasse, Rice & Wheat Straw, Sarkanda	Batch-6	60 m3 each	Direct
Pudumjee Agro Ind. Ltd.	Bagasse, RCF, Pulp	NA	NA	NA
Shree Badri Kedar Paper	Bagasse, Sarkanda, RCF	Batch-4	60 m3 each	Indirect
Modinagar Paper Mills Ltd.	Wheat Straw, Bagasse, Jute waste, RCF	Batch-4	NA	Direct
Ruchira Papers Ltd.	Bagasse, Wheat Straw, Sarkanda, Jute waste	Batch-8	40 m3 each	Direct
Emami Paper Mills Ltd.	Paddy straw, grass, RCF	Rotary	NA	NA
Chadha Papers	Bagasse, Wheat Straw, RCF, Others	Batch, rotary globe-14	40 m3 each	Direct

Pulp Mill ..... Brown stock washing

The washers used for agro pulps are mostly rotary drum washers. A few mills use vacuum washers whereas a large number of mills which are medium sized mills, use Decker washers. These washers are inefficient and the black liquor generated has low solids content. Most of the mills discharge their black liquor in the receiving streams. Some mills having recovery systems, use rotary vacuum washers and utilize the black liquor for recovery of chemicals. The status of washers in the mills covered under study is given below.

Name of the Mill	Type of Washer	No of stages	Soda Loss, kg/t	Power, kWh/t of pulp
Abhishek Industries	BSW	3	20	NA
Shreyans Industries Ltd	Rotary Drum Vac. with barometric leg	4	28-32	75
ABC Paper	Drum Washer	3	30	35
ShreeBhawani Paper Mill	Vacuum Filter	4	NA	70
Mukerian Papers Ltd	BSW - Dorr oliver	3	NA	45
Delta Paper Mills	Drum Washer	2	NA	11.3
Sainsons	Potcher	2	NA	25
Shree Shyam Pulp & Board	Drum Washer	3	20	24
Chadha Papers	Vertical potcher	Single	NA	NA

Pulp Mill ..... Bleaching

Most of the mills produce unbleached grades, however, some mills also produce bleached varieties form agro residues. The bleaching sequences used mainly are CEH and CEHH. The status of bleaching in the agro based mills is given below.

Name of the Mill	Bleaching Sequence	Brightness, %ISO	Bleached Pulp Yield, %	Bleaching Losses, %
Abhishek Industries	CEHH	80-81	45-46	15
Shreyans Industries Ltd	CEoPHH	83-85	46	10
ABC Paper	XCEpH	75-80	46	10-12
ShreeBhawani Paper Mill	CEH	75	36	NA
Mukerian Papers Ltd	CEpHH	78-80	42.5	15
Delta Paper Mills	CEHH	75-78	33 - Rice straw 20 - Bagasse	NA
Shree Shyam Pulp & Board	CEHH	80	40	8

Stock Preparation……Refiners

In agro based mills refining treatment given to the fiber is relatively mild. Mills use different types of refiners in succession. The details of the refiners used by various mills is given in table below.

Name of the Mill	Type of refiners	No. of refiners	Intial Freeness, °SR	Final Freeness, °SR	Power, kWh/t of pulp
Abhishek Industries	TDR	3	16-17	32-35	--
Shreyans Industries Ltd	Nil	--	--	--	--
ABC Paper	DDR, TDR	1+1	12	22-25	96, 53
ShreeBhawani Paper Mill	TDR	2	35	38	55
Mukerian Papers Ltd	Conical	2	34-37	45-46	6
Delta Paper Mills	SDR, TDR	2+2	18	25	29
Sainsons Paper Ind. Ltd.	SDR, TDR	3+2	18-26	26-34	70, 50
Shree Shyam Pulp & Board	DDR, R2	2+4	36	41	NA
Pudumjee Agro Ind. Ltd.	TDR, DDR	2+1	18-30, 18-40	22-72, 35-45	130
Shree Badri Kedar Paper	Disc	3	18	28	--
Modinagar Paper Mills Ltd.	SDR, TDR	2+2	16-22	22-28	--
Ruchira Papers Ltd.	SDR, TDR	--	21	28-30	--
Emami Paper Mills Ltd.	SDR, TDR	--	36	42	--
Chadha Papers	TDR	3+3+1	NA	NA	NA

Paper Machine.....Paper machines

The agro based mills use mainly the old and slow speed machines. The head boxes are open type. Forming wire part also has many drainage elements which are not proper for gradual water removal and good formation of the paper web. Simple presses are used to consolidate the paper web. Dryness after press is usually low and this results due to slow drainage properties of the agro pulps. Dryers are usually not covered with hoods. Mills use a cloth to cover the dryer end to prevent the falling of condensate droplets & birds dropping. The details of Paper Machine in agro based mills are given below

Name of the Mill	Machine Speed	Type of Head Box	Type of Press	Dryness after press, %	No. of Dryes	Type of Hood	Steam cons. , t/t of paper	Power cons. , kWh/t of paper
Abhishek Industries	500	Closed	Bi Nip	35	25	Semi open	2.9	440
Shreyans Industries Ltd	470	Closed	Bi Nip/ St through	34-41	29	Open, close	2.8	393
ABC Paper	130, 130, 310	Open, Open, Pressurized	Plain, Plain, Bi-nip	37,37,40	16, 16, 22	NA	2.4, 2.4, 2.2	600, 600, 500
ShreeBhawani Paper Mill	80-290, 110-300	Open, Close	(Bi-Nip & Plain), Suction	(38 & 41), 33	14	Open, close	2.0, 3.5	513, 462
Mukerian Papers Ltd	200, 100-150, 325	Open, Open, Pressurized	Straigh, Suction, Binip	38, 38, 43	22, 1, 36	NA	3.5, 3.5, 2.5 (Total-5.5)	780
Delta Paper Mills	175, 210	NA	Suction Plain, Plain	38	30, 29	NA	4.8, 4.17	348
Sainsons Paper Ind. Ltd.	125, 70	Open	Plain	35, 36	19, 1	Open, High VelocityHood	3.2	297
Shree Shyam Pulp & Board	210, 185	Open, Open	Plain, Plain	35, 36	21, 12	Nil	4.5, 3.5	650, 620
Pudumjee Agro Ind. Ltd.	400, 330	Close, Pressurized	NA	NA	NA	NA	3.21, 3.07	322, 289
Shree Badri Kedar Paper	150	open	closed, open	71, 62	11	Nil	NA	NA
Modinagar Paper Mills Ltd.	variable	open	single nip	68-69	11	Nil	NA	NA
Ruchira Papers Ltd.	130, 175	open	Solid & plain covered	38	14		2.7	465
Emami Paper Mills Ltd.	180, 360	NA	NA	NA	NA	NA	NA	NA
Chadha Papers	160, 160	open	Solid	35, 40	17, 26	HSRH	5.0	467

Chemical Recovery .....

The chemical recovery system used in agro based mills are of the following types,

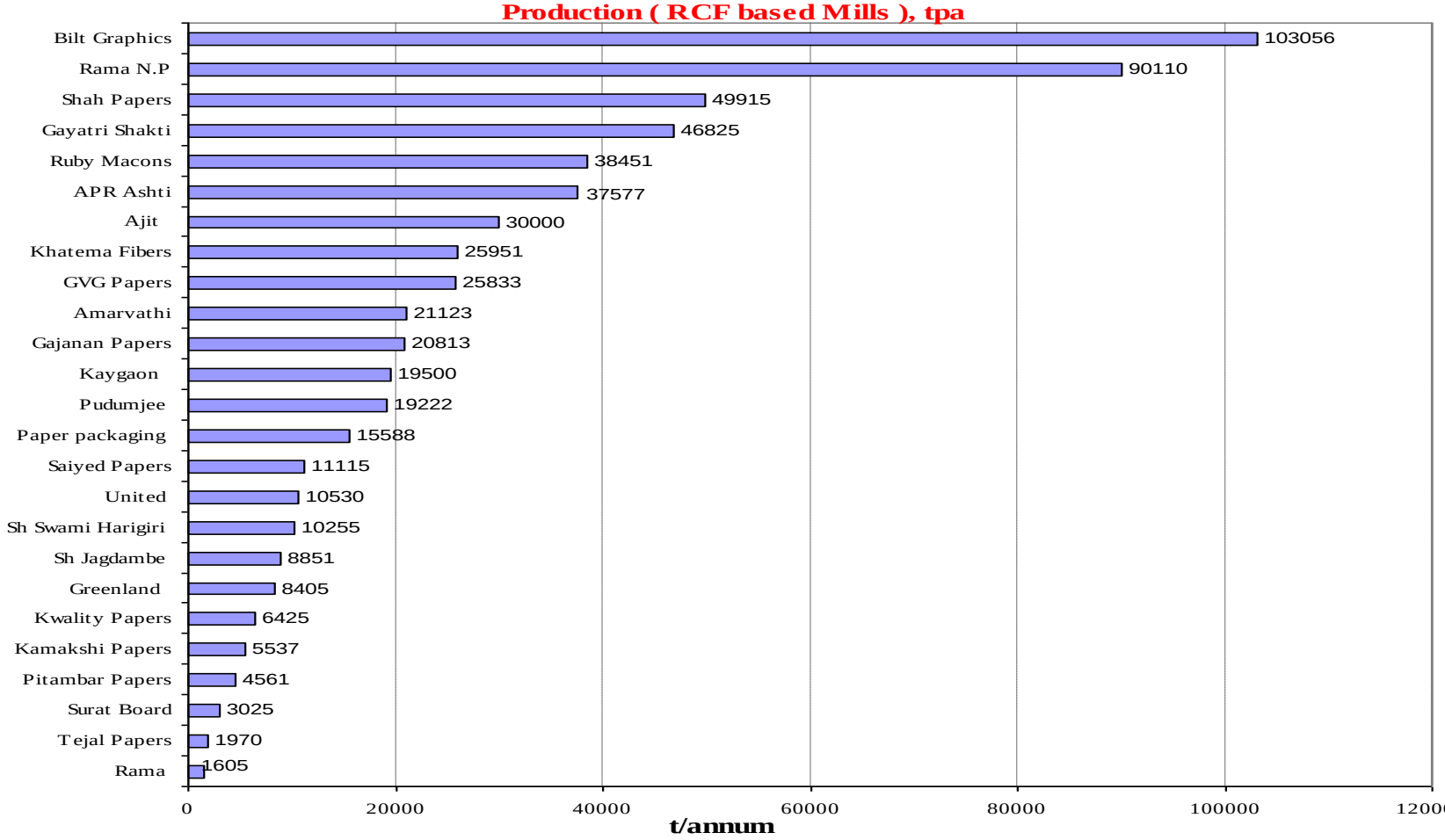
1. Conventional Recovery system using evaporators and conventional recovery boilers for incineration of black liquors. The green liquor generated is causticised to make white liquor for pulping of the raw material.
2. Copeland process – This Recovery system is also used to generate solid sodium carbonate after combustion of black liquor in fluidised bed incinerators. The mills have option to either causticise the green liquor generated after dissolving sodium carbonate or to sell the soda ash in the market as a by product. This soda ash is used in detergent formulations. None of the agro based mills have Lime Kiln for lime reburning. The status of chemical recovery system in agro based mills is given below

Name of the Mill	Type of Chemical Recovery	Type of Evaporators	Intial Conc. B.L Solids, %	Final Conc. B.Solids, %	Make of Recovery Boiler	Lime consumed , tpd
Abhishek Industries	Conventional	Falling Film	10-11	51-52	ENMAS	25-28
Shreyans Industries Ltd	Fluidised bed reactor	LTV	8	25	NA	NA

RECYCLED FIBER BASED MILLS

Production..... RCF based mills

A large number of mills based on recycled fibres were set up in Late 70's to meet the paper demand in the country. Since 1990 these mills are growing and expansion of capacities is a regular phenomenon. Today number of mills which started their operation as small mills are falling under the large category of mills. Most of these mills produce unbleached products. Some mills also produce good quality of white paper and newsprint.



Waste Paper ..... Pulping

COLLECTION OF WASTE PAPER:

Industrial waste paper is collected mainly from different sources such as publisher, printing house, converters & departmental stores, super markets and mostly dealers of industrial waste. Old newspaper, magazines and other wastepaper is collected by door-to-door basis, is another source of collection.

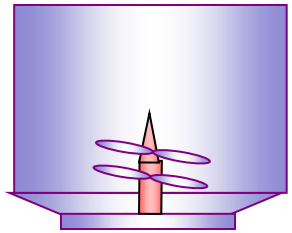
WASTE PAPER PROCESSING:

The 2 key goals of waste paper recycling operations are defibration and contaminant removal. Now a days the process generally include pulping, screening, cleaning and deinking by combination of soaking, flotation and washing depending upon the input raw material and final product.

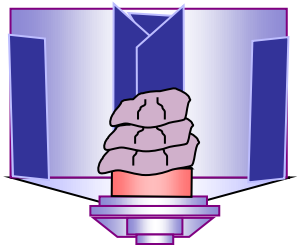
PULPING:

Pulping is the first unit operation in the recycling and deinking process. The pulping process is to facilitate the separation of the non-fibrous material from the fibres and to remove the contaminants in subsequent processes. Various options have been developed and are being used by industry.

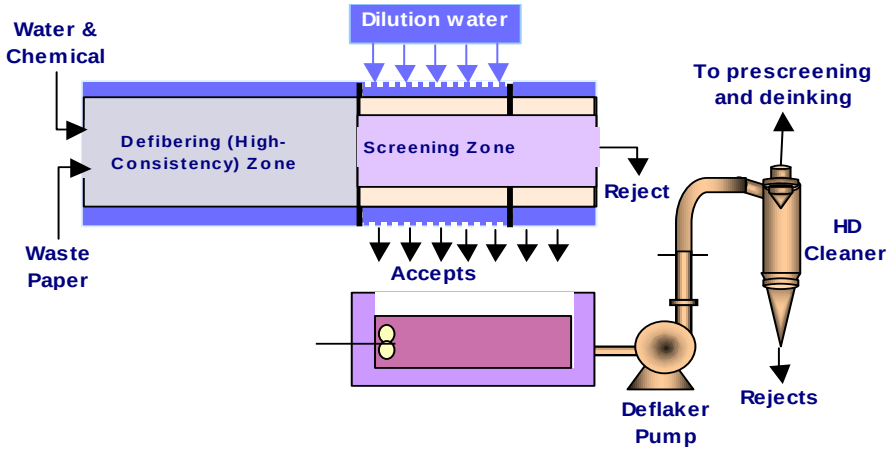
Low Consistency Batch Pulper



High Consistency Batch Pulper



High Consistency Continuous Drum Pulper



Waste Paper ..... Pulping

The status of waste paper pulping is given below

Name of the Mill	Type of Raw Material	No. of Pulper	Capacity, t/hr	Consistency - Type
Ruby Macons Ltd.	Purchased Pulp from ind. and imported	NA	NA	NA
Nepa Ltd.	Indigenous & Imported waste paper	1+4	NA	HC & LC
Bilt (Unit Bhigwan)	Purchased Pulp	NA	NA	NA
Shah Papers Ltd.	Indigenous & Imported waste paper	4	11	NA
Rama pulp and paper	Waste Paper	1	3	NA
Rama Newsprint	Indigenous & Imported Newspaper	3	11.3, 9.5	HC & LC
Gayatri Shakti P & B Ltd.	Indigenous waste paper	4	3	NA
Amravathi Sri Venkatesh Paper Mills	Waste Paper	2	3	HC
APR Pkging Ltd.	Domestic, Imported Waste Paper	1	5.5	NA
Pudumjee Pulp & Paper Mills Ltd.	Waste Paper	2	NA	HC
Coastal Papers	Indigenous waste paper, Market Pulp	1	2.5	MC
GVG Paper Mills Pvt. Ltd.	Indigenous & Imported waste paper	3	2	NA
Khatema Fibers Ltd.	Imported waste Paper	4	NA	NA

SCREENING & CLEANING:

The objective of both screening and cleaning is the removal of non-fibrous contaminants, with minimal losses of useful fibre. Separation depends on physical differences, for example, in screening size and shape are most important whilst in centrifugal cleaning density is the most important difference. The low consistency equipment is operated after high consistency to avoid the costs of consistency changes. The sequence used is also in the order of decreasing contaminant size.

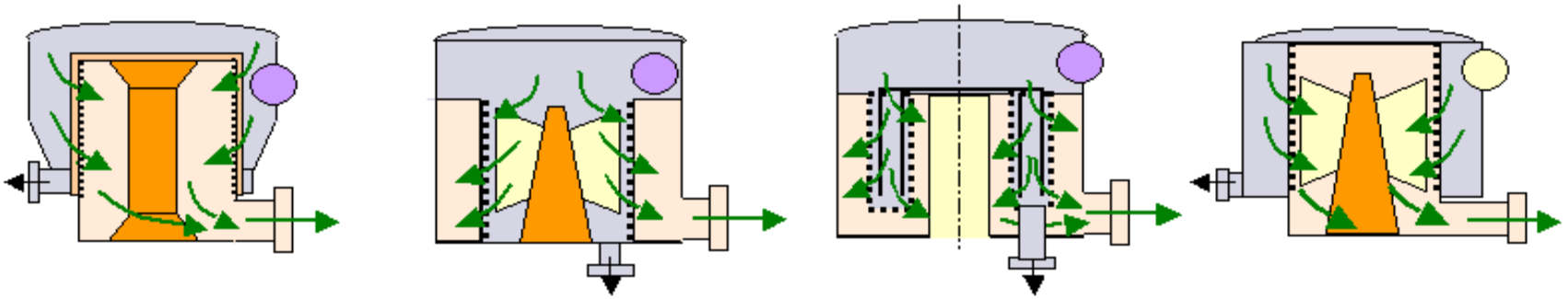
Pressure screens:- In this a wooden scraper or non contacting foil is used to provide the pressure pulse and to keep the face of the screen clear. A mat forms readily on the face of the screen since water passes through the screen plate orifices more easily than fibres. Fines perforations down to the size of 0.15mm can now be machined with accuracy in screen basket with advent of Laser rays. Screen control system is very complex has supervisory & regulatory loops for each screen.

Generally two types of screens are used for cleaning.

Coarse screens:- They are used to remove the debris, polythene, rigid particles which are larger than screen perforations normally 12-20 mm. Subsequent coarse screening is done by holed pressure screens with the perforation in the range of 1.2 to 2 mm with the consistency of 1 to 5% followed by a multistage fine screens if deinking is also done.

Fine screens:- They are slotted screen and can be operated at 0.5-1.0% consistency. The slot width varied from 0.25 to 0.4 mm and even now a days fine slots of width 0.1 mm are being used for better cleaning.

Four Pressure screen flow configurations



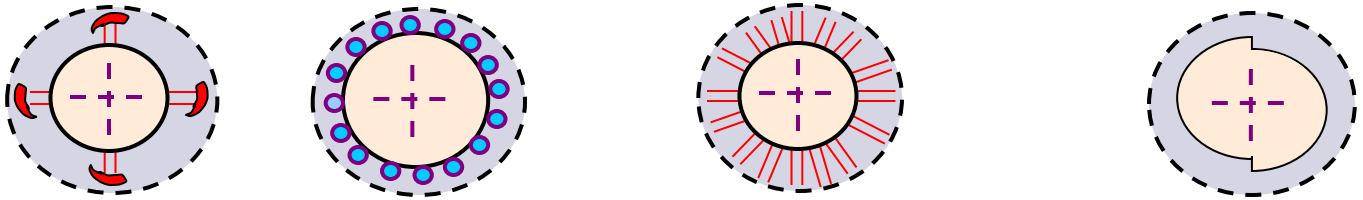
Centripetal inlet side foils

Centrifugal inlet side foils

Centripetal & Centripetal inlet side foils

Centripetal accept side foils

Typical Pressure screen rotors



Foils

Bumps

Radial vanes

Tapered surface

Status of Pressure screens in Indian Paper Industry (RCF mills) is given below

Name of the Mill	Type / Make of screens	Inlet consistency, %	Rejects, %	Power, kWh/t
Nepa Ltd.	Vertical Pressure	0.7	NA	6
Bilt (Unit Bhigwan)	Slotted	0.6-1	15	NA
Rama pulp and paper	Centrifugal	0.8	1	30
Rama Newsprint	Pressure Screen	0.8	8	NA
Gayatri Shakti P & B Ltd.	Vertical Pressure	0.6-1	1	3.68
Amravathi Sri Venkatesh Paper Mills	Vertical Pressure	1.2	10	12
APR Pkging Ltd.	Conical	0.32-0.36	10	11.53
Pudumjee Pulp & Paper Mills Ltd.	Vertical Pressure	NA	0.2-0.3	NA
Coastal Papers	6 Bird, VSL-05, 10B Bird	0.5-1	5-8	21.6, 30, 15
GVG Paper Mills Pvt. Ltd.	NA	0.8	10	
ITC Ltd. - Unit Kovai (Formerly BIPCO)	Centrifugal	0.5-0.8	0.1	17.5
Khatema Fibers Ltd.	3F Screen, Pressure	NA	NA	275

Waste Paper ..... Cleaning

Centrifugal cleaning is useful for removal of high and low density contaminants.

High density high consistency cleaners remove medium size contaminants with a high specific gravity such as paper clips, glass, grit, etc. It is the first cleaners after the pulping system and operates at high consistency. It operates more accurately at medium consistency between 2.5 to 5%. The outer orifice has a large diameter than lower consistency cleaners to prevent blockage by large pieces of debris. Lower diameter, low consistency and high pressure drop will give maximum cleaning efficiency.

High density low consistency cleaners are useful for removal of small contaminants with a high specific gravity (>1) like sand, grit, coating flakes, some inks, glass pins etc.

Low density low consistency cleaners are useful in removing of low specific gravity (<1) like wax, plastic adhesives etc.

All these systems operate with the same separation principle i.e., contaminants can be separated from fibre if they have different density. Although solid cellulose has a density of g/cm^3 but the specific gravity of various pulp fibres in aqueous suspension is in the range of 0.88-1.08 g/cm^3 which is due to occluded air in the lumen or central canal of the fibres.

Status of Centrifugal cleaning in RCF mills is given below

Name of the Mill	Type of Cleaner	No of stages	Inlet Consistency, %	Rejects, %	Power, kWh/t
Ruby Macons Ltd.	NA	3	0.7	NA	NA
Nepa Ltd.	Cyclean	4	0.7	0.1	30
Bilt (Unit Bhigwan)	Ahlstrom	5	0.6-1	1.5	NA
Shah Papers Ltd.	Simple	3	1	15	NA
Rama pulp and paper	Conical	3	1	2	30
Rama Newsprint	Twinver	4	NA	NA	NA
Amravathi Sri Venkatesh Paper Mills	Vortex Type	3	1	0.2	25
APR Pkging Ltd.	Vortex Type	4	0.9	0.5-0.6	275
Pudumjee Pulp & Paper Mills Ltd.	Celleco	4	0.46-0.56, 0.3-0.5	0.6-0.9, 0.3-0.8	NA
Coastal Papers	NA	3, 3	0.6-0.9	1.5	64, 26
GVG Paper Mills Pvt. Ltd.	Centrifugal	3	0.8	0.3	
ITC Ltd. - Unit Kovai (Formerly BIPCO)	Forward	3	1	1	30
Khatema Fibers Ltd.	Baur Type	3	1	NA	70

Waste Paper ..... Dispersion and Kneading

The emergence of polymeric inks used in laser printers and copier papers necessitated usage of dispersion and kneading equipment. It breakdowns large ink flakes to a size, which helps more efficient ink removal from the fibre. Dispersion also replaces deinking – ink is dispersed but not removed so that there is no specky appearance. Temperature up to 150^{o}C helps to melt the stickies and reduce biological activity. Only disadvantage is high energy cost.

Low-speed units:- They are usually known as **kneaders** and have single, double or triple shaft. The action is gentle shearing with a twisting & compressive action on fibres with no cutting since inter-fibre interactions forces are generated similar to high consistency pulper.

If required steam is added, exit temperature can be quite high (70-80^{o}C) due to the friction forces generated. The approach is effective for deinking when large specks are created for eg. Laser printed, xerographics, UV coated, offset, etc. A slow speed single shaft kneader reduces ink speck size successfully. Brightness fell very slightly and is a indicator that ink has dispersed. Smaller ink specks have a greater surface area and so absorb more light which results in a lower brightness. Kneading reduces the long fibre content and create some fines and results in small change in freeness.

High-speed units:- They are known as **dispersers** or dispergers and have single shafts similar to refiners with two plates one fixed & the other rotating at high speed. The reduction in brightness shows effective ink removal with no change in fibre length and no fines creation as in slow speed kneading, though freeness fell significantly. High speed dispersion units are installed at the end of a waste paper processing line. In this location they are very successful in contaminants dispersion, which substantially improves paper machine operation due to less deposition problems with stickies.Visual quality is improved due to speck size reduction. Some installation have high speed dispersion units following pulping in high quality printing & writing as well as OCC recycling.

Generally ink constitute 0.5 to2% of the mass of the waste paper. Deinking can be done by two methods, washing and flotation depending upon the requirement. The washing deinking is less effective in the removal of large ink specks >20 microns where as flotation deinking is less effective in removal of small ink specks <20 microns. Though smaller particles can be removed by flotation if they are agglomerated to form large particles. Better results are achieved by combination system of the above two methods. Although some ink is removed by screens as well as centrifugal cleaners. Most ink is removed by either or both flotation and washing.

WASHING DEINKING:

Ink is broken up on pulping and some of these ink particles are removed by subsequent wash stages with the washer filtrate. This is very effective even without pulping aids or without the use of chemicals such as caustic, sodium silicate, dispersant and H_2O_2 in pulper. Methods for wash deinking are thickening processes using a mechanical separation process. Ink particles are separated from fibres by a separating element frequently a synthetic wire. The efficiency of wash deinking is determined by the speed of mat formation & the thickness or basis weight of the mat. Washing efficiency is also affected by variables such as pH, temperature and treatment given before the washing stage usually during pulping. Screw presses have been used for many years in deinking both as wash units and thickeners. Drum washers or gravity deckers have become less popular with the introduction of belt washers. Disc & vacuum filters are used as thickeners rather than washers but with the same concept. The water ink emulsion is washed from the pulp and the ink is removed from the wash water by flocculation or flotation using suitable chemicals. The clarified water may be reused in the system. The counter current washing is common in washing deinking.

FLOTATION DEINKING:

Flotation is a process that separates materials based on the property of wettability. With the exception of water based inks, ink particles are more hydrophobic than paper fibres which is the basis of separation by flotation. Some fibre can be hydrophobic & some inks can be hydrophilic. Chemicals are added to increase this difference between fiber and inks. Hydrophobic materials are able to adhere to the air bubbles and rise to the surface, the process is carried out in flotation. Large ink particles size 10-50 micron can agglomerate and skimmed out from the slurry. The system efficiency depends upon the various factors like stock consistency, temp, pH, collector chemicals, water hardness, ink particle size, air bubble diameter, air to stock ratio and foam removal system. Ink removal efficiency is better at the lower consistency. At a temperature range of 40-45^{o}C and pH of 6-9 the best brightness are obtained.

Status of Deinking in RCF mills is given below

Name of the Mill	Type of Deinking Process	Efficiency, %	Power, kWh/t
Rama Newsprint	Black Clawson, UK	90	330, 450
Amravathi Sri Venkatesh Paper Mills	Floatation	95	70
Pudumjee Pulp & Paper Mills Ltd.	Maccell	99	410-470
Coastal Papers	Eco cel	NA	350, 375
GVG Paper Mills Pvt. Ltd.	Floating	NA	NA

Chapter - 4

Basic Input consumption pattern -Analysis of data

Basic Input .....Introduction

Data collected has been analyzed to understand the consumption pattern in different categories of mills. Following inputs were compared for overall assessment of inputs by the industry.

- Raw material consumption for different types of products by different categories of mills.
- Energy inputs
  - Coal, oil & other fuel consumption
  - Electricity consumption
  - Steam consumption
- Section wise electricity & steam consumption
- Water consumption
- Chemical consumption in following processes
  - Pulping chemicals
  - Bleaching chemicals
  - Chemical additives

The inputs have been assessed for following categories of mills

- Wood based mills
- Agro based mills
- Recycled fiber mills

This page is kept intentionally blank

ANALYSIS OF

WOOD BASED MILLS

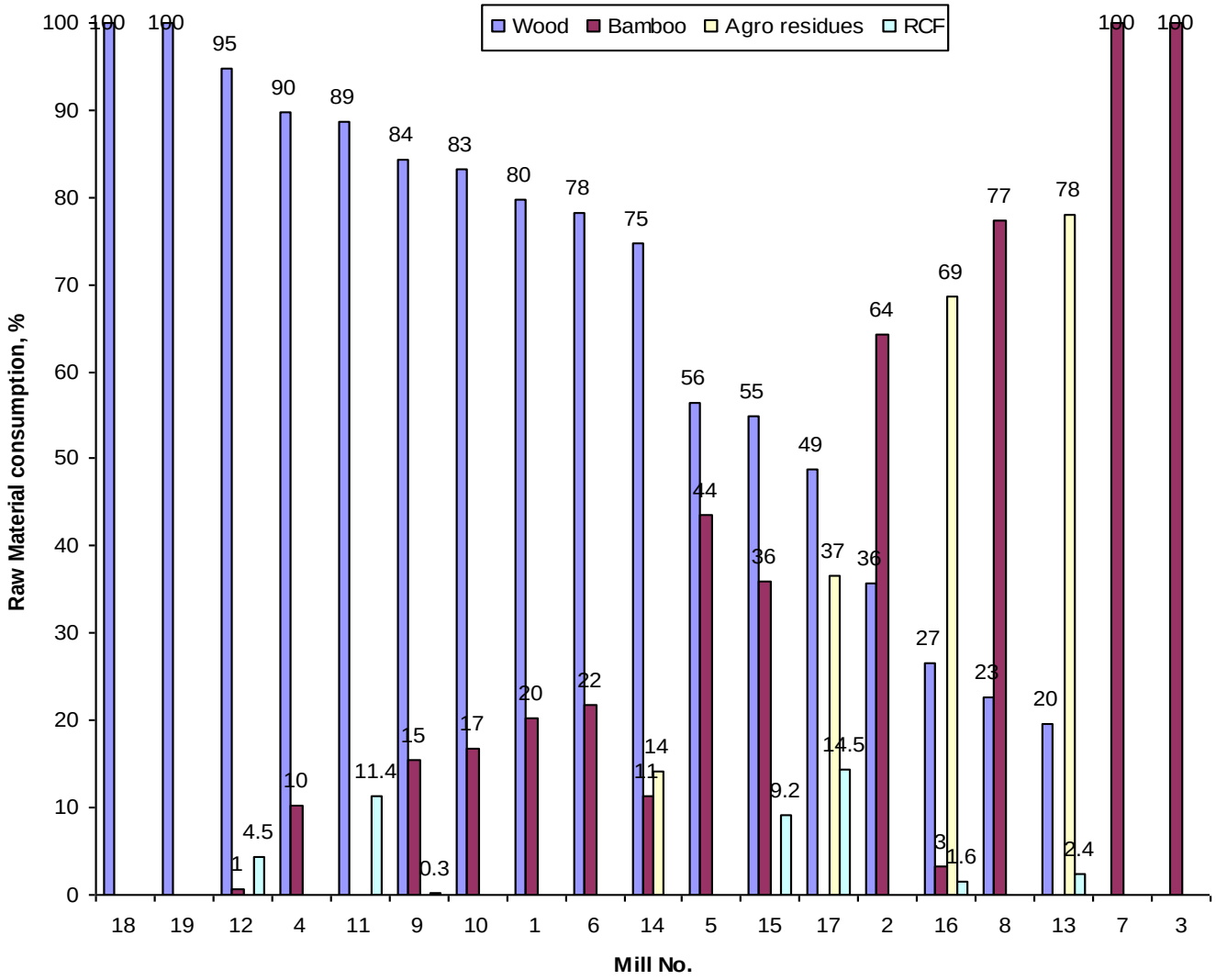
Raw material…….. Consumption by major producers

Raw material consumption pattern shows that mills use mixed hard woods, bamboo, agro residues and recycled fiber in different proportions to meet their requirements.

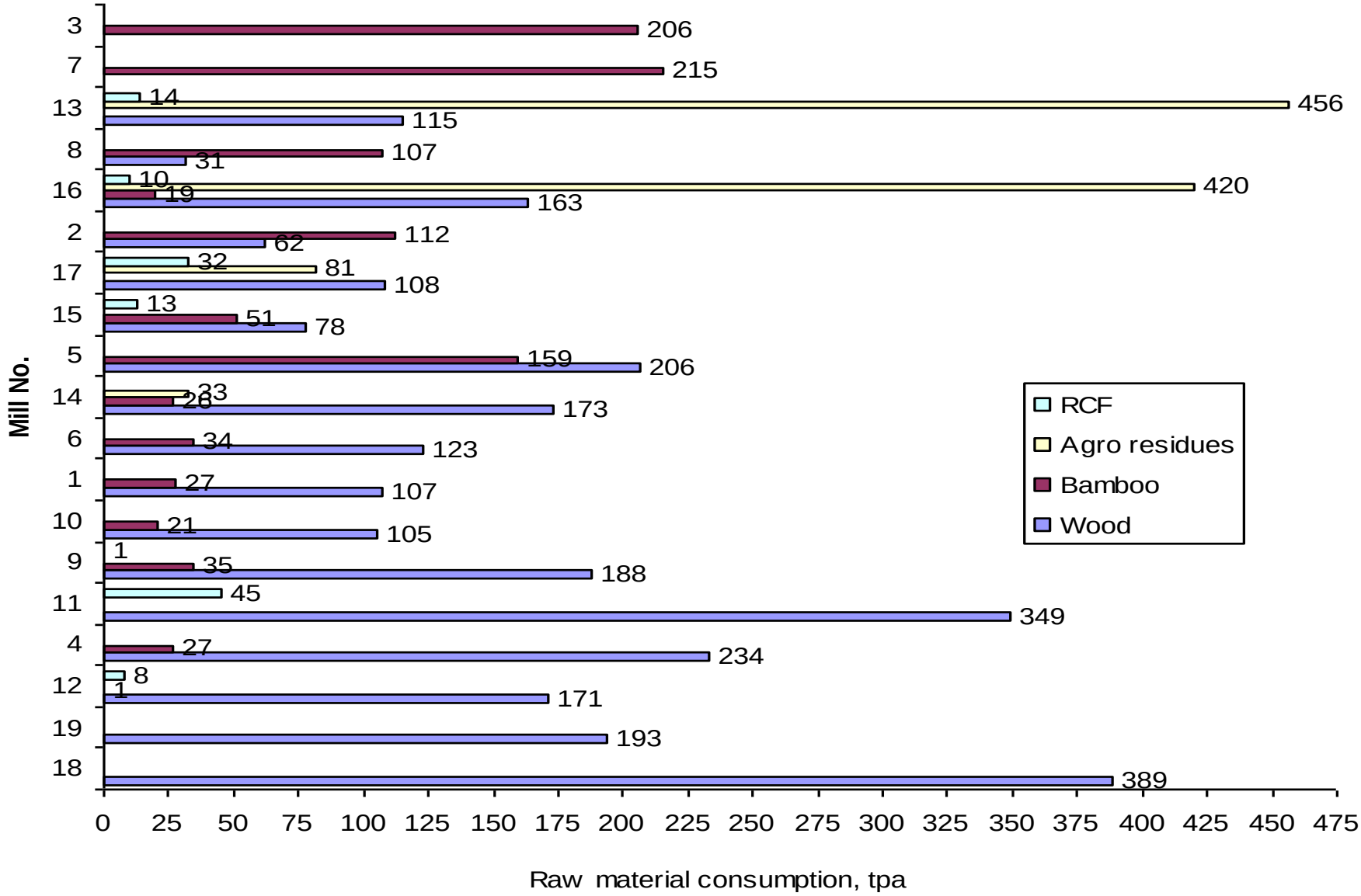
Only two mills use 100% hardwoods, whereas 8 mills use wood and bamboo to produce writing printing and unbleached varieties of paper.

6 mills use RCF along with wood/ bamboo fiber in the furnish. 2 mills use agro residue fiber in their furnish. There are only 2 mills based on 100% bamboo.

Details of % raw material consumption of various wood based mills is given below.



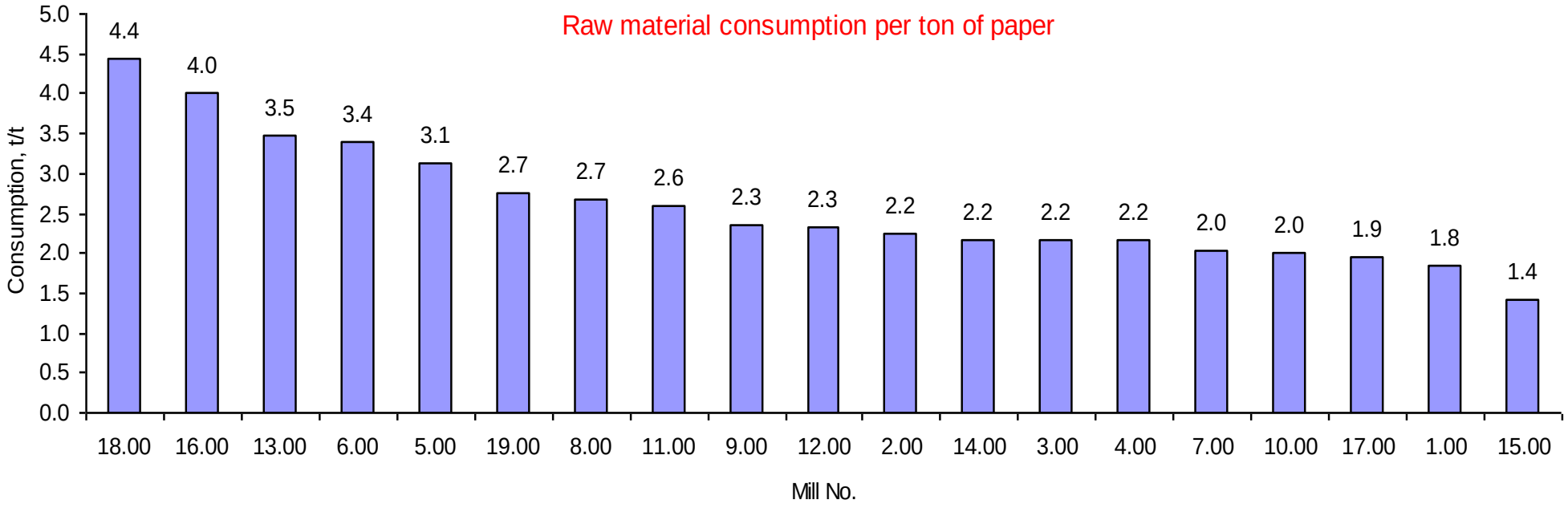
Raw material…….. Consumption by major producers



Raw material…….. Consumption per tonne of paper

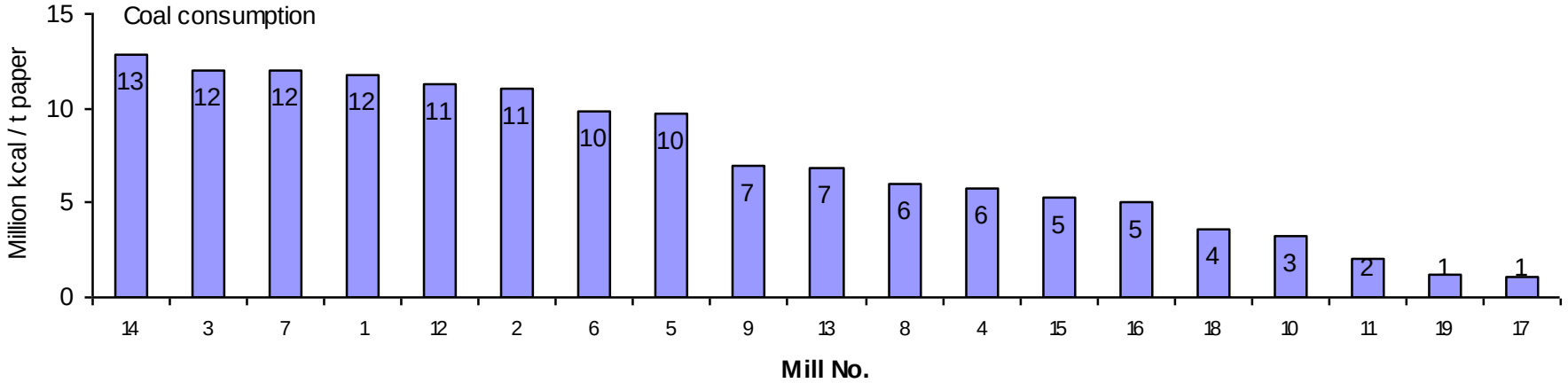
Raw material consumption pattern per tonne of paper varies significantly from mill to mill. This is mainly due to raw materials availability.

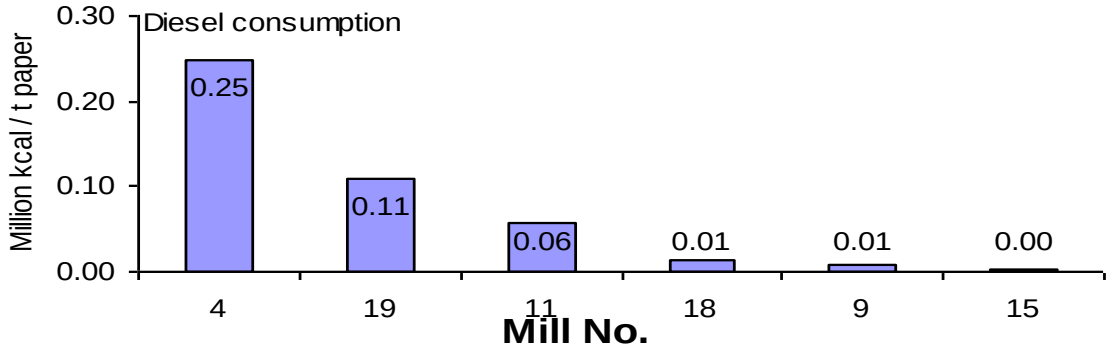
- For writing and printing paper the average raw material consumption varies between 2-2.5 t/t paper with exception of a few mills close to 3 t/ t paper.
- The raw material consumption per tonne is high for rayon grade pulp i.e. 4.5 t/ t paper.
- The consumption of raw materials is also high in case of mills using wood & agro residues. (3.5 to 4.0 t/ t paper).



Coal, Oil & other Fuel Consumption

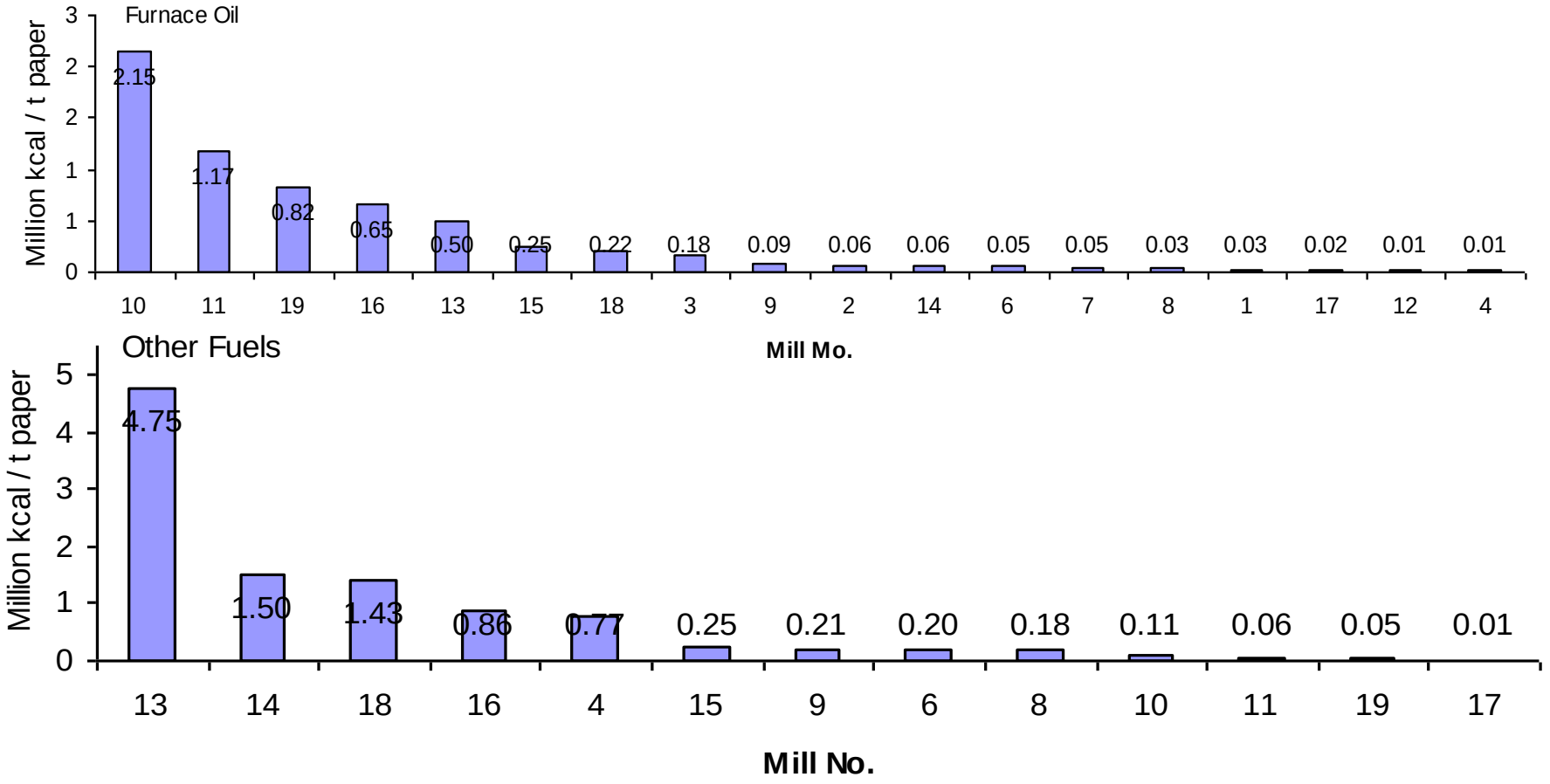
Wood based paper mills use coal, lignite & various agro residues as fuel in the power boilers for generation of steam. Many mills use imported coal also as it has high calorific value compared to the Indian coal which has high ash content. Lignite is also used as fuel in some of the mills which are in close proximity of the lignite belt. In northern part of the country rice husk is a predominant fuel. Many mills in the states where sugarcane is the main agricultural crop, use pith as a fuel in the boilers. In some of the mills groundnut shell, coconut shell and many other agricultural biomass is also utilized as fuel.





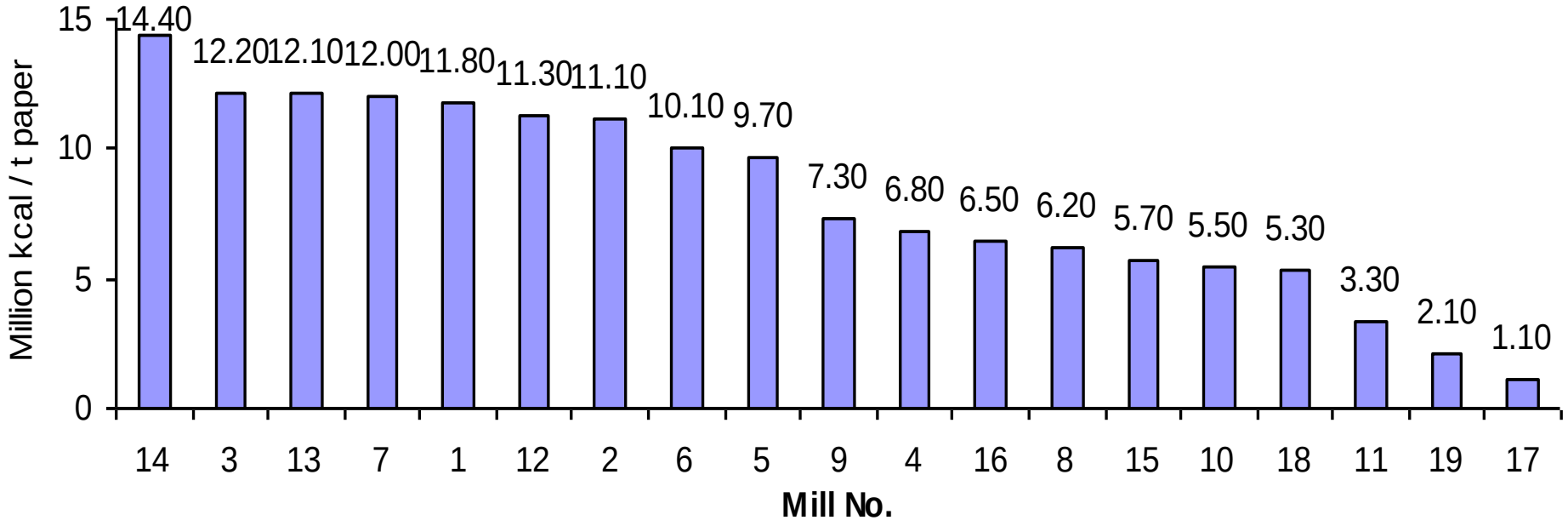
Coal, Oil & other Fuel Consumption

Furnace oil is used in recovery boilers and lime kilns for combustion of black liquor and reburning of lime sludge. Many mills also use high speed diesel / furnace oil in the DG sets for captive power generation. The status of coal, oil & other fuel consumption in wood based mills is shown below;



Fuels ..... Overall Purchased Energy Consumption

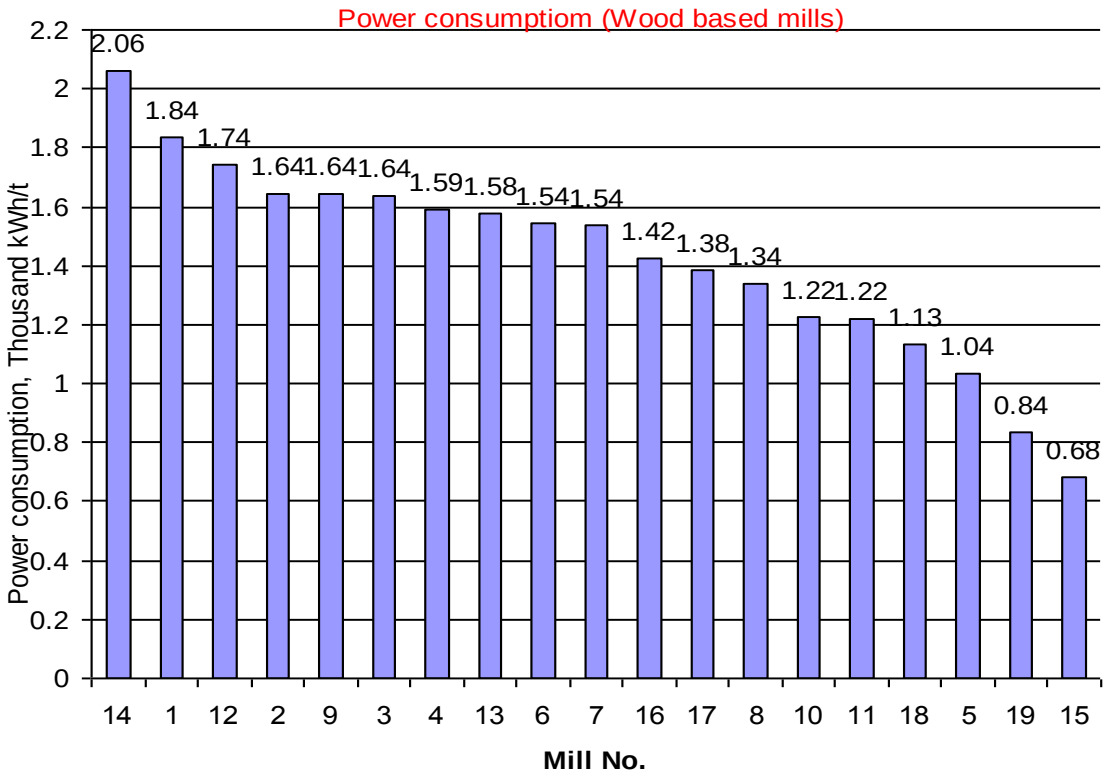
The highest purchased energy consumption figure among the wood based mills is 14.4 Million kcal/t of finished paper. The analysis of purchased power consumption shows 3 distinct classes of wood based industries. The difference between best mill and the highest consumption is more than 10 times. The best 3 mills have purchased energy consumption ranging from 1.1 to 3.3 Million kcal/t. The average figure of consumption is between 5.3 to 7.3 million kcal/t which is achieved by 7 mills.



Electricity Consumption ……Overall consumption

An analysis of electricity consumption in wood based mills shows variation from 680 to 2063 kWh/t for production of different varieties of products. Most of the mills produce different varieties of products and the power consumption figures given by the mills are based on total production.

- The consumption for mills producing only bleached varieties ranges between 1300 to 1856 kWh/t.
- For mills producing bleached and unbleached varieties, it varies between 1223 to 1774 kWh/t.
- The power consumption in rayon grade mills is 889 to 1074 kWh/t. However, the average power consumption of mills producing bleached varieties of paper and rayon grade pulp is 1424 kWh/t.

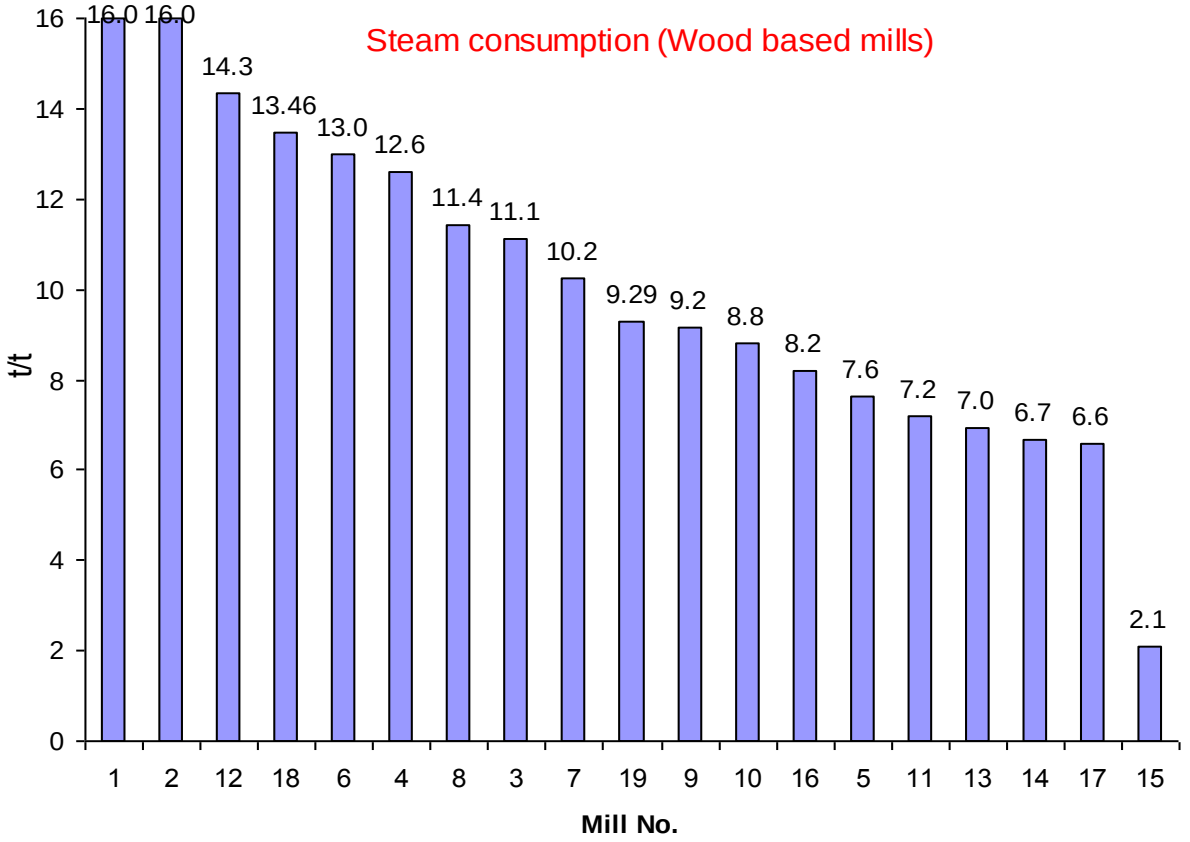


- For mill producing writing printing paper and newsprint average power consumption is 1580 kWh/t, whereas it is 2063 kWh/t for newsprint from hard wood/bamboo and 680 kWh/t for newsprint from recycled fiber

Steam Consumption .....Overall consumption

An analysis of steam consumption in wood based mills shows variation from 6.6 to 16.3 t steam / t of paper for different varieties of products. The steam consumption figures reported are average figures based on total production.

- The consumption for mills producing only bleached varieties ranges between 10.4 to 17.3 t steam/t paper, however, for mills producing bleached and unbleached varieties, it varies between 8.8 to 16.3 t steam /t paper.
- The steam consumption in rayon grade mills is 9.18 t steam/t pulp and for the mills producing bleached varieties of paper along with rayon grade pulp is 14.23 t steam/t paper.
- For mills producing writing printing paper and newsprint, the average steam consumption is 7.7 t steam /t paper, whereas it is 8.47 t steam/t for newsprint from hard wood/bamboo and 5.0 t steam/t for newsprint from recycled fiber.



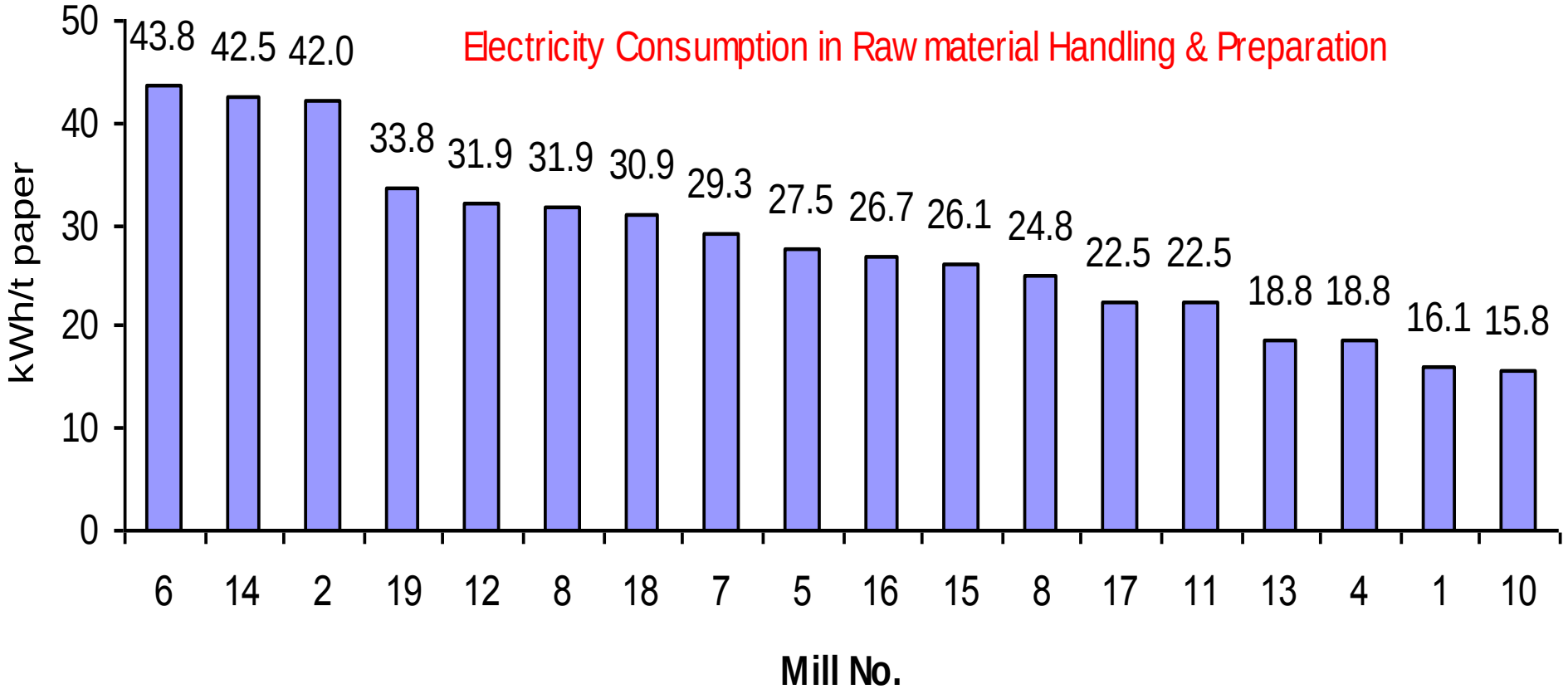
Electricity & Steam Consumption …..Section wise analysis

An analysis of electricity and steam consumption in major sections of pulping, paper making, utilities chemical recovery etc. is given in the next few pages for following sections.

- Raw material preparation
- Pulp mill (Digesters/ Washing/ Screening/ Centricleaning)
- Bleaching
- Stock preparation (Refining & chemical additives preparation)
- Paper machine
- Recovery section (Evaporators, Recovery boiler, Causticization)
- Power house (Power boilers, Turbines0
- Utilities (DM Plant, Raw water treatment, effluent treatment, lighting etc.)

Raw Material Preparation …Power Consumption Pattern

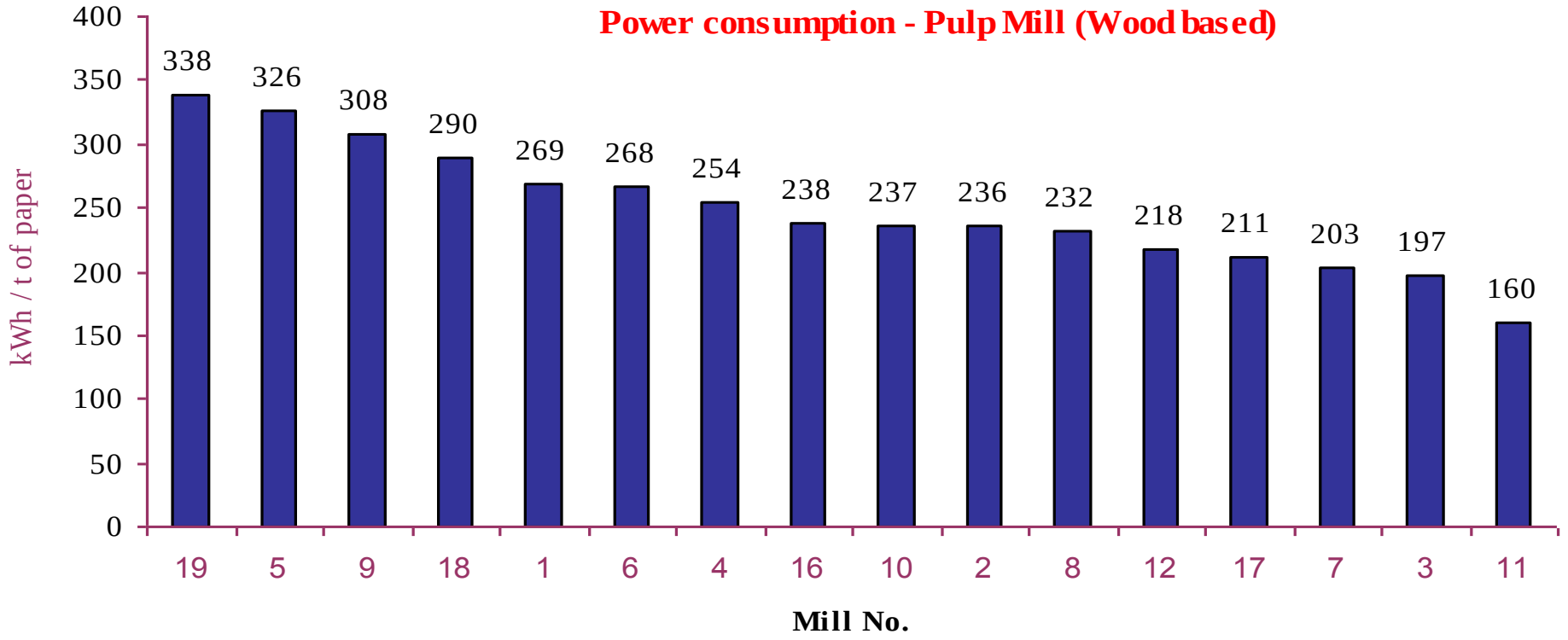
The mills show a wide variation in electrical energy consumption in the raw material preparation section. This ranges from 16 to 44 kWh/t paper, however majority of mills consume power in the range of 25 - 30 t/t paper, which is much higher when compared with developed countries. This is mainly due to variety of raw materials used, and old technology / equipment.



Pulp Mill…….. Power Consumption Pattern

The mills show a large variation in power consumption in the pulp mill. This ranges from 160 to 308 kWh/ t paper. However the average mills consume 220 to 260 kWh/ t paper. This is higher in comparison to the average consumption figures in pulp mills in developed countries despite low kappa pulp production.

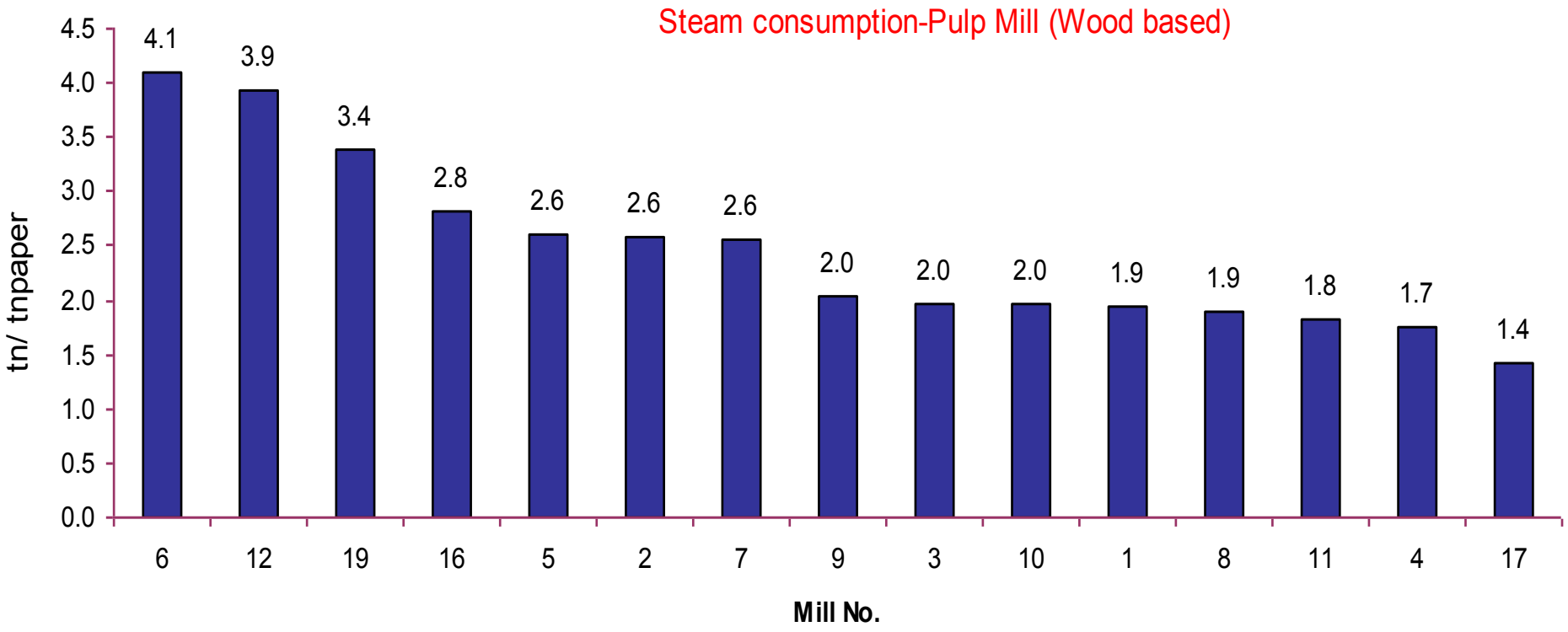
The large variation is mainly due to use of variety of raw materials, inadequate process controls in most of the mills for process monitoring & optimization, and lack of modern pulping, washing, screening & centricleaning technologies and equipment.



Pulp Mill..... Steam Consumption Pattern

Steam consumption analysis in pulp mill by wood based sector indicates large variation. The steam consumption ranges between 1.7 to 4.1 t/t paper. Average pulp mill steam consumption ranges between 2.0 – 2.6 t/t paper.

The steam consumption pattern shows that there is ample scope for improvement by process integration and optimization in pulp mill operation. This can provide significant savings apart from modernization of pulp mill and use of process control systems.



Pulp Mill.....Bleaching

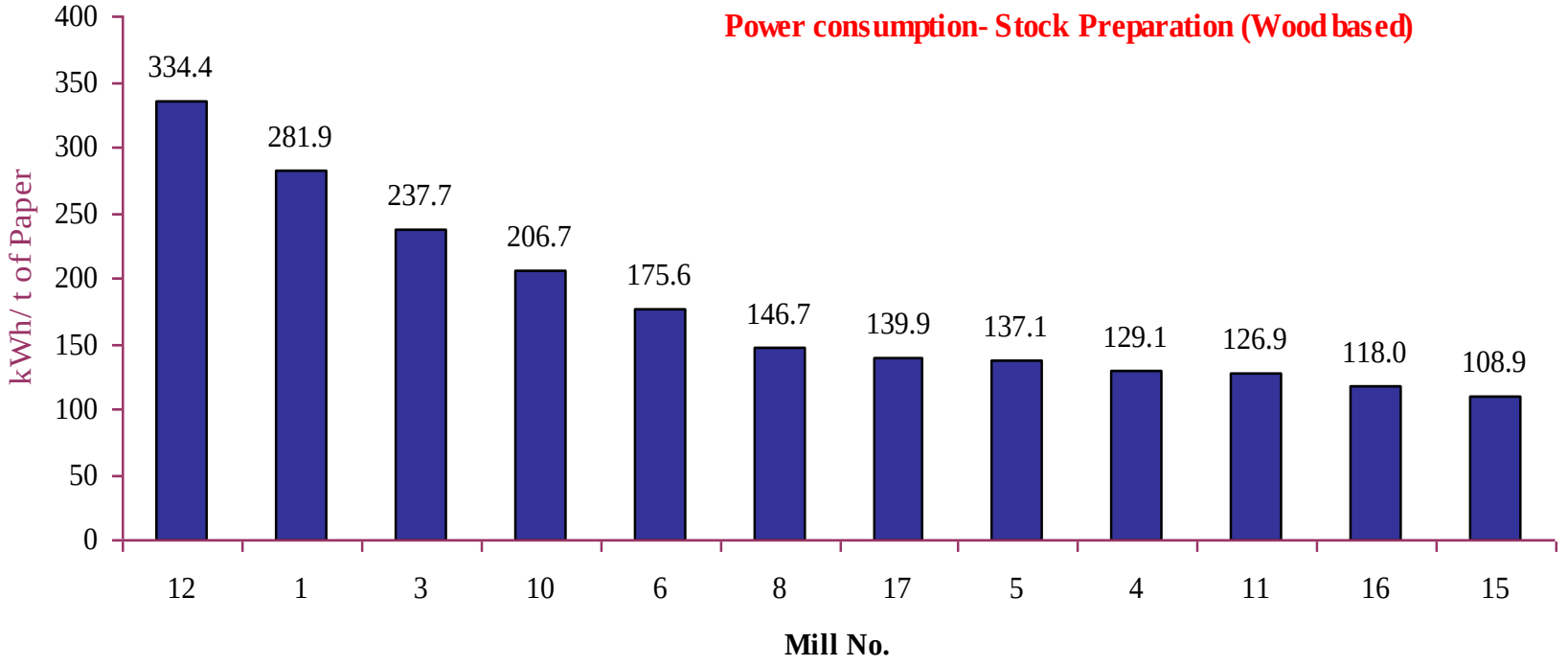
The steam and electricity consumption pattern by various mills using different bleaching sequences is shown here. The steam consumption is above 1.0 t/t pulp in most of the cases, which is high in comparison to average steam requirement for bleaching under optimized conditions. Electrical energy consumption reported shows large variation from 92 to 170 kWh/ t pulp on account of different bleaching sequences and brightness level of pulps for the mills.

Mill No.	Bleaching Sequence	Brightness, %ISO	Bleached pulp yield, %	Bleaching loss , %	Steam Consumption, %	Electrical Cons., %	Water Cons., %
9	C-EP-H-H & C/D-Eop_D-E-D-SO_2	80/86	40	12	0.6/0.5	120/110	26.6/25.92
6	C-EP-H-H-D	88	41.5	10	1.6	93.6	48
18	C/D-Eop-H-D-Ep	88-89	-	10	N.A.	126	52
17	CEpHH	80-82	41	7-10	N.A.	N.A.	N.A.
8	CEpHH	81-82	42.35	10	0.7	127	85
10	C-Ep-H-H	82-83	43-44	9-10	NA	160	N.A.
2	C-Ep-H-D	82-87	37-38	9-11	N.A.	N.A.	N.A.
15	P / C-Ep	64 / 68	80 / 45	3 / 10	0.25 / 0.6	120 / 160	12 / 30
3	C-Ep-H-E-D	85-86	45	10	1-1.5	125-140	60
4	C/D -EO P -D	89	40	6.5-7.0	0.5	95	10
7	C-EP-H-E-D	85-86	44-45	10	1.5-1.8	N.A.	N.A.
12	CEpHH	82	36	15	N.A.	N.A.	120
11	C/D, E/D, H, D	88	42	7	1.1	170	70
14	CE/P-H-H	80+	40	10	0.4	130	45
16	CEHHD	85	42	3	N.A.	92.5	N.A.
1	C/DEoD1D2	88.5-89	44-44.5	10	0.9	150	45
5	CD EOP HHD	88.5	45	10	0.78	144.84	N.A.
13	CEpHH	80-83	45	10	1.6	117	66
19	C-E/Oo-H-E-D-SO_2	95.5	33	5	0.56-0.6	182.4	65.6

Stock Preparation……Electricity Consumption

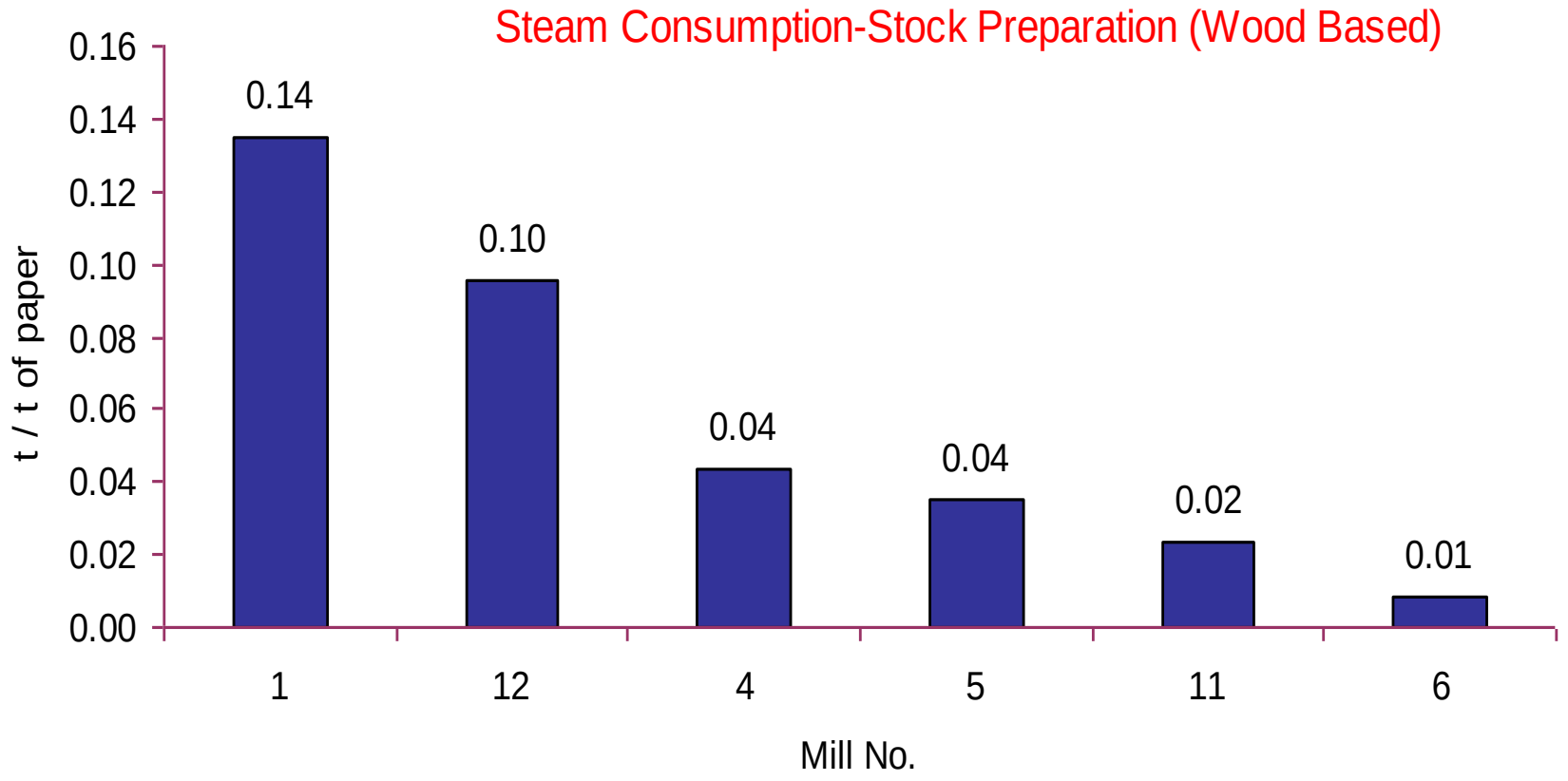
Electrical energy consumption during stock preparation depends mainly on type of pulp fiber morphology, degree of refining required, type of equipment and operating conditions. The analysis of electrical energy consumption for various mills shows a wide variation in electricity consumption by mills ranging from 118 to 334 kWh/ t paper.

Most of these mill use modern energy efficient refiners. However the variations observed are due to variation in raw materials, degree of refining depending on the requirement of paper and to some extent the operating conditions & layout of refiners in the mills.



Stock Preparation…Steam Consumption in Chemical Additives Preparation

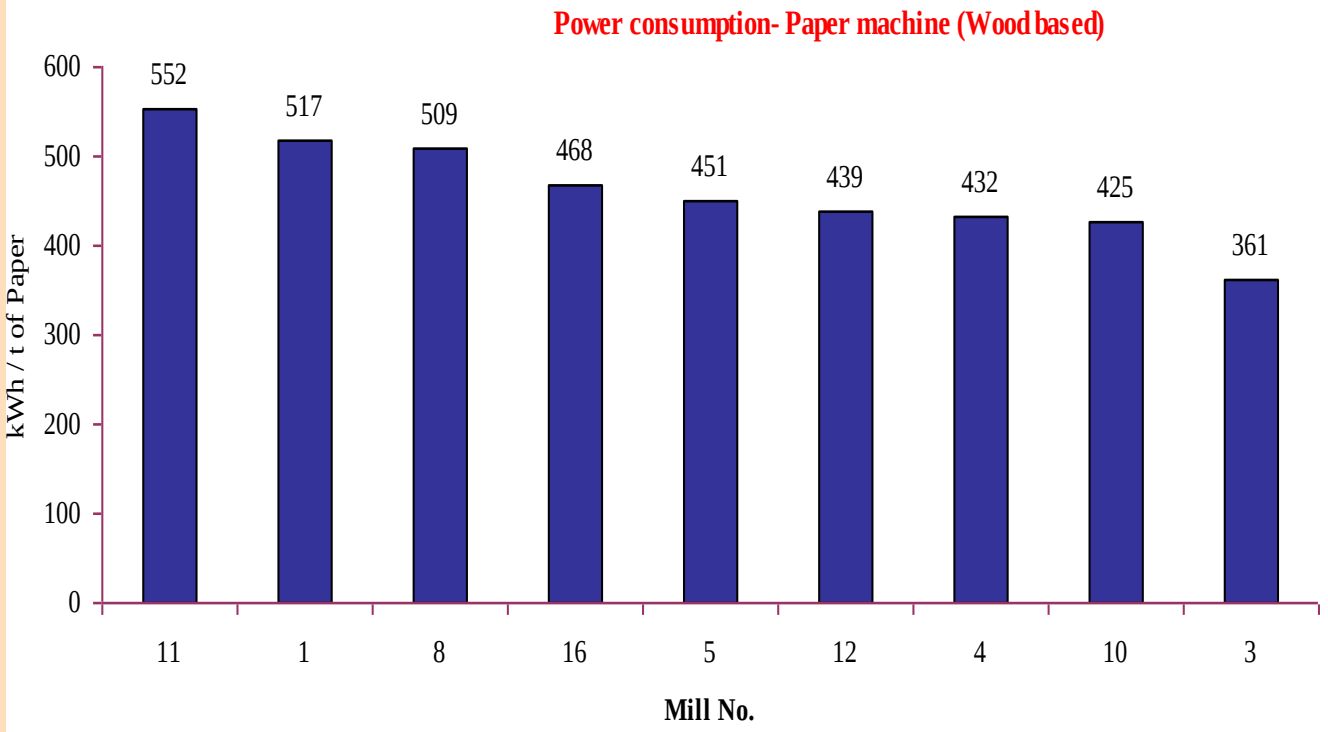
Some mills producing coated and paper utilize steam for chemical additives preparation. Depending upon the type of product, the steam requirement for chemical additive preparation varies. The highest amount of steam, i.e 0.24 t/t paper is used by mills producing coated paper varieties. The steam is used for cooking starch for coating in its starch cookers.



Paper Machine ……Electricity Consumption

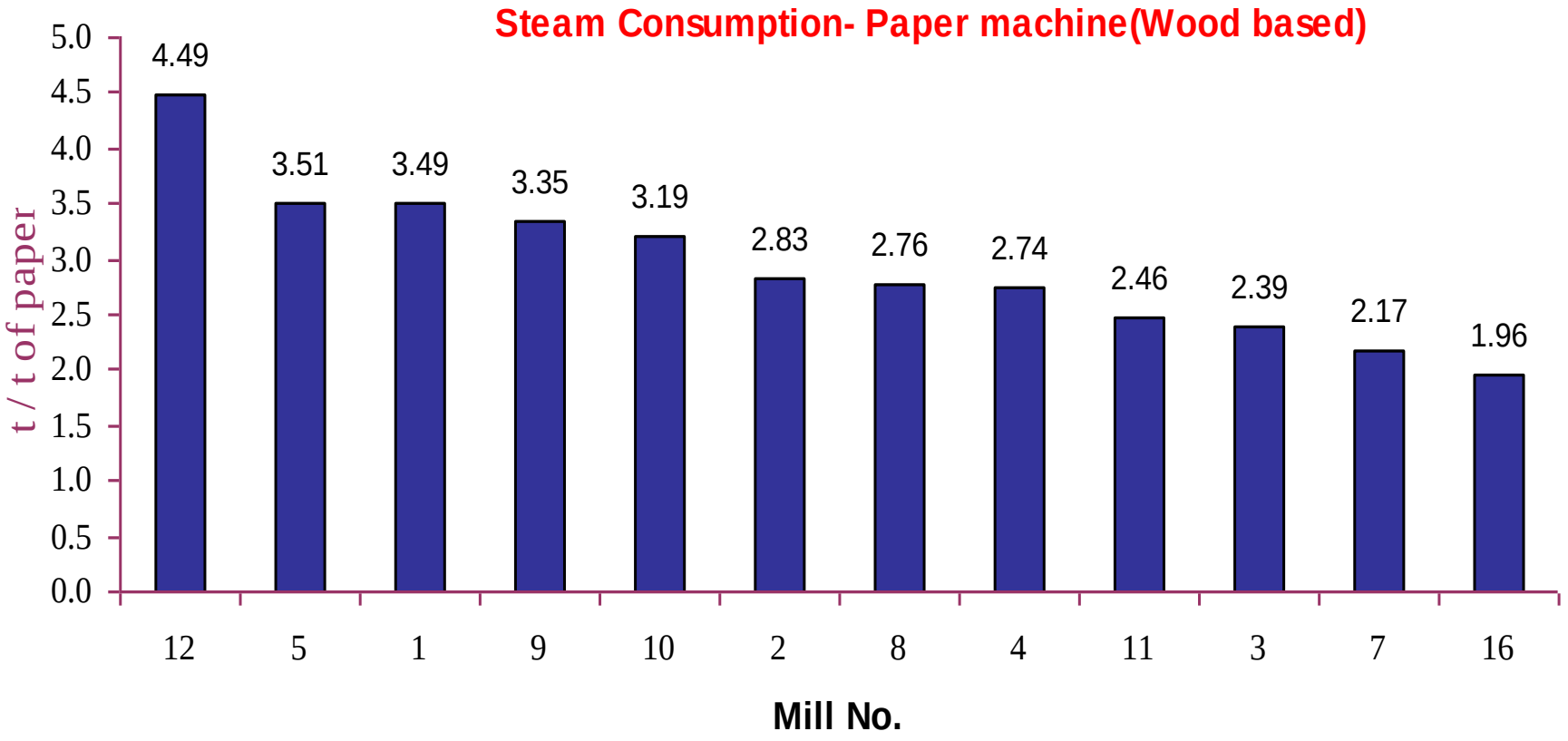
Most of the wood based mills use fourdrinier paper machines with or without size press between the dryers. The electrical consumption pattern in paper machines shows a wide variation in paper machines from 361 kWh/ t to 552 kWh/t paper. The large variation is due to different varieties of papers produced on different size of paper machines using different technologies.

The average mill consumption ranges between 425 to 468 kWh/t which is higher as compared with the paper machines producing similar grades in developed countries. In India the average paper machine size is smaller in comparison to mills abroad and results in higher power consumption on account of low productivity. Rebuilds and old paper machines in mills are the main reason for the large variation.



Paper Machine ……Steam Consumption Pattern

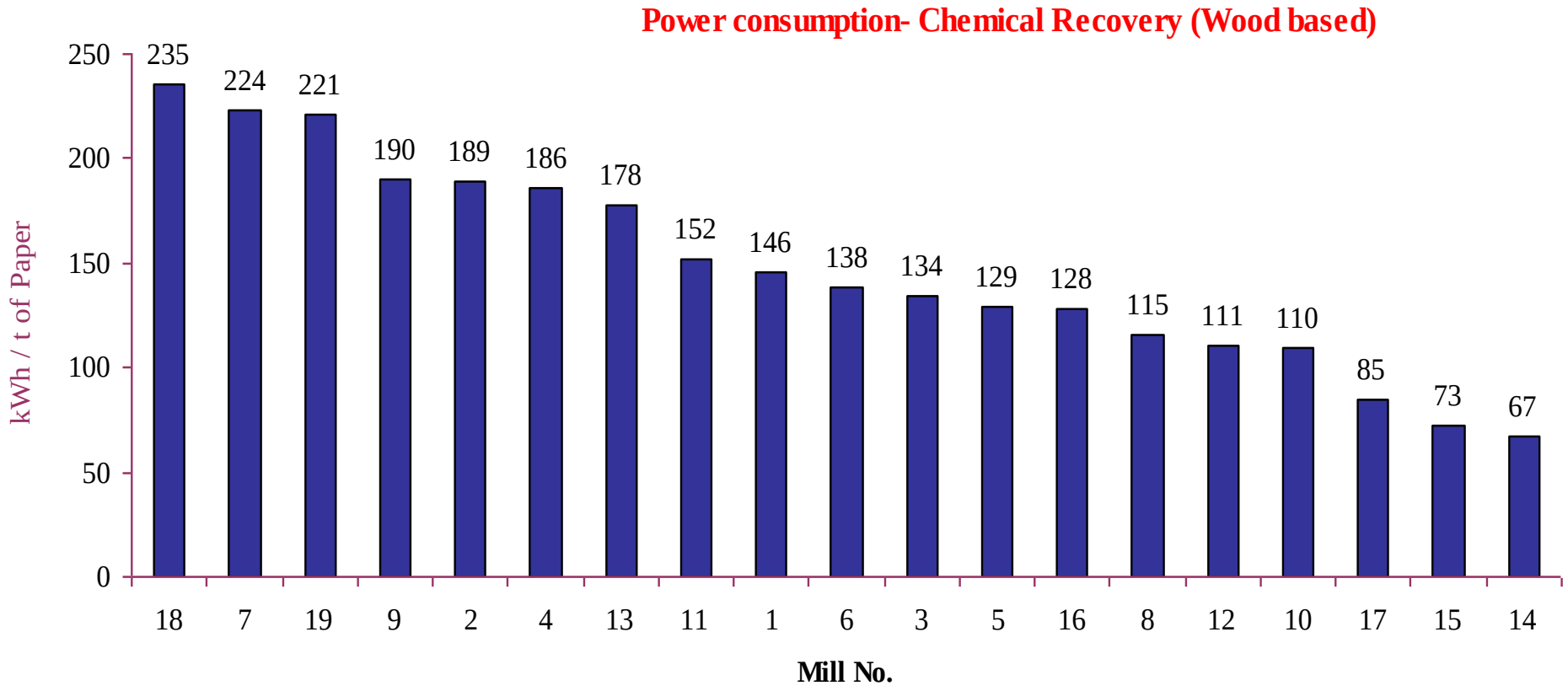
The steam consumption in paper machine dryers shows a wide variation ranging from 2 t/ t paper to 4.5 t/ t paper. The high steam consumption is in case of specialty products. The average steam consumption in these mills ranges between 2.75 to 3.50 t/t and is fairly in range with international competitive machines.



Chemical Recovery ……Electricity Consumption Pattern

Chemical recovery section includes evaporators, recovery boiler and re-causticization section. The limekiln is not installed by all the mills therefore data on chemical recovery is compared excluding the limekiln. The electrical energy consumption for wood based mills shows variation from 67 to 235 kWh/ t paper.

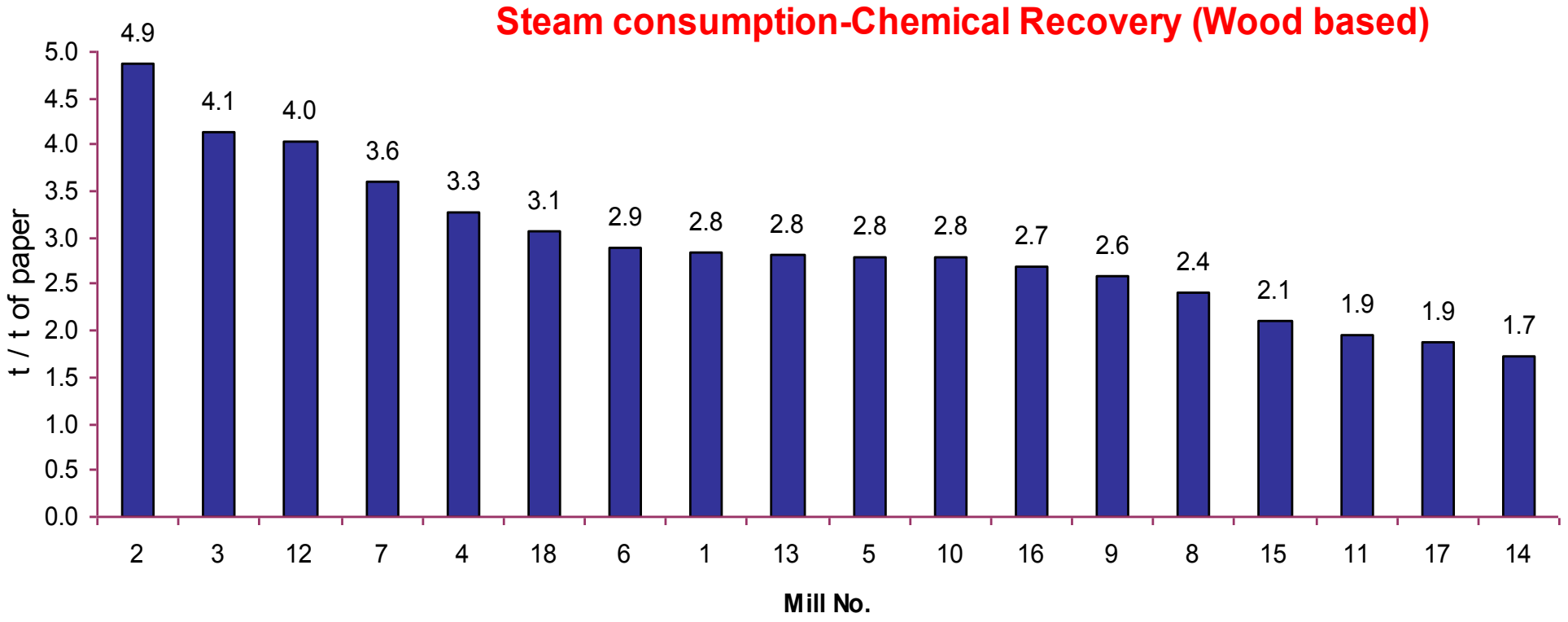
The average mills fall between the range of 110 to 152 kWh/ t which are fairly in line with the international consumption ranges.



Chemical Recovery ……Steam Consumption Pattern

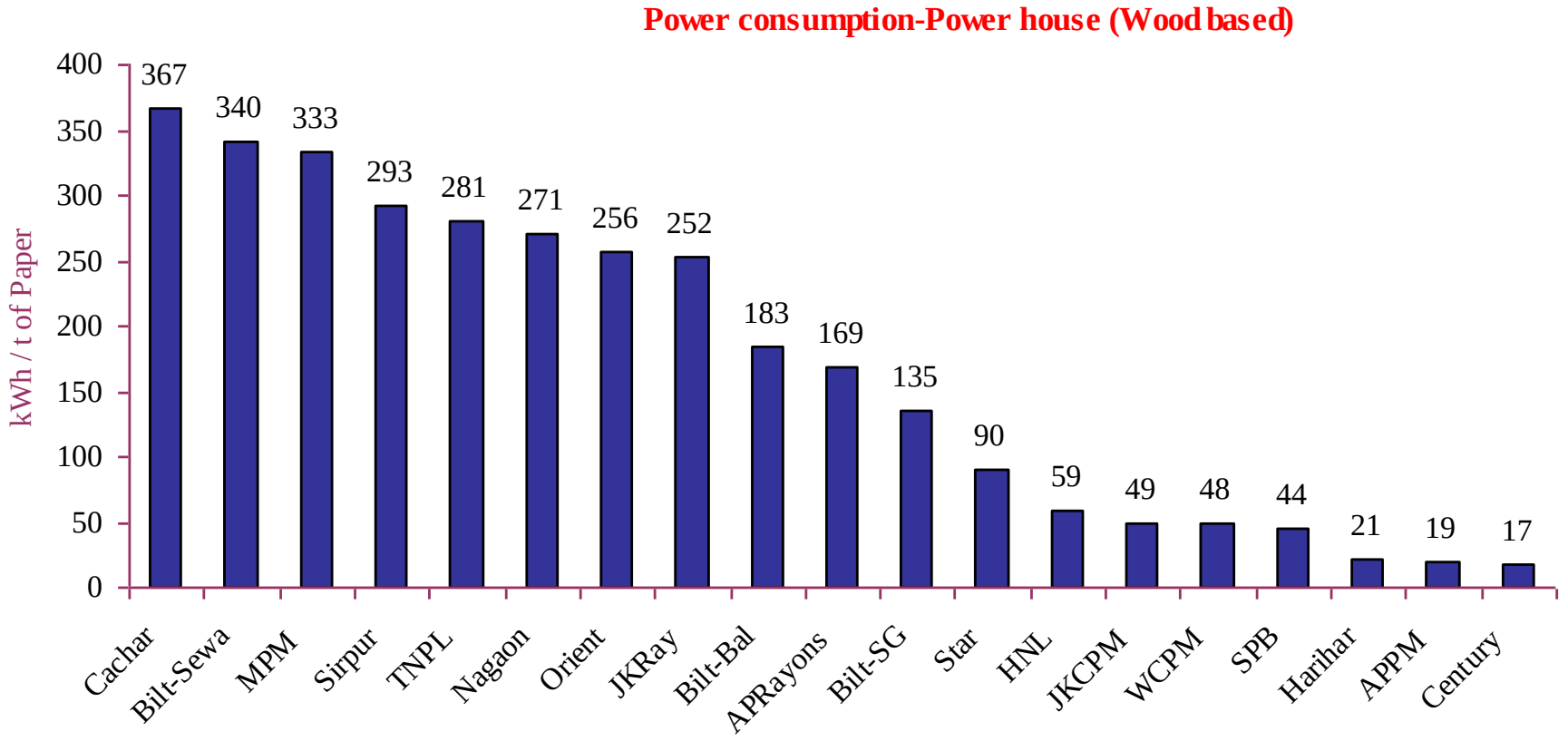
Steam consumption pattern in chemical recovery section shows wide variation from 1.7 t/ t to 4.9 t/ t paper.

Average steam consumption is in the range of 2.42 to 3.3 t/ t paper which is consumed mainly in the evaporators. Most of the mills use 5 LTV evaporators with direct contact evaporators. The steam economy is 4.0-4.5.



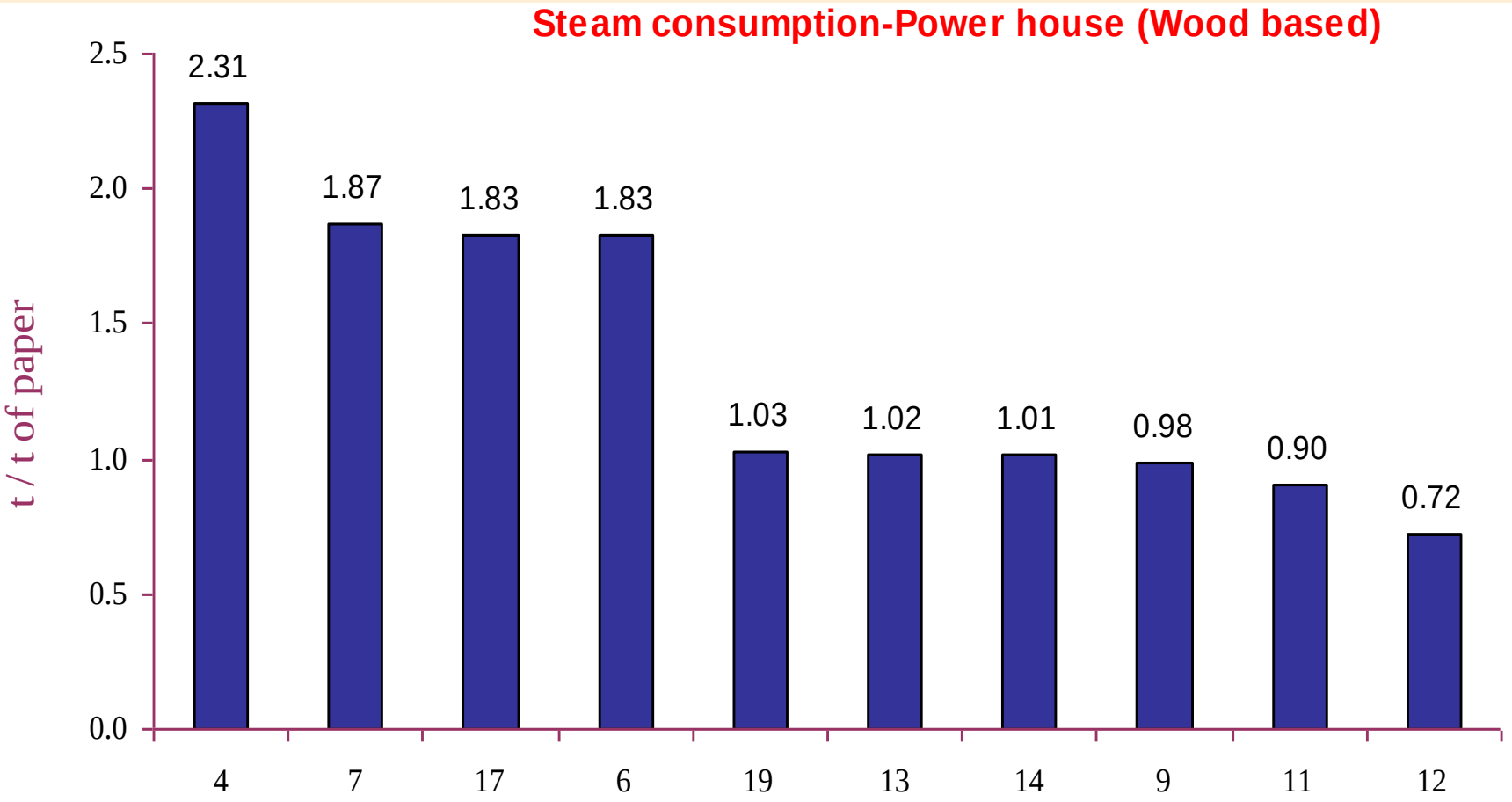
Power House ……Electricity Consumption Pattern

The power consumption in power house, as reported by mills, shows a wide variation from 76 to 367 kWh/ t paper. The large variation shown by these mill is due to accounting of power from sections/ processes other than power house. For example, many mills have included recovery boiler and other utilities in power house due to no separate meter for recording. The average power consumption figure in the mills should range between 76 – 180 kWh/ t paper.



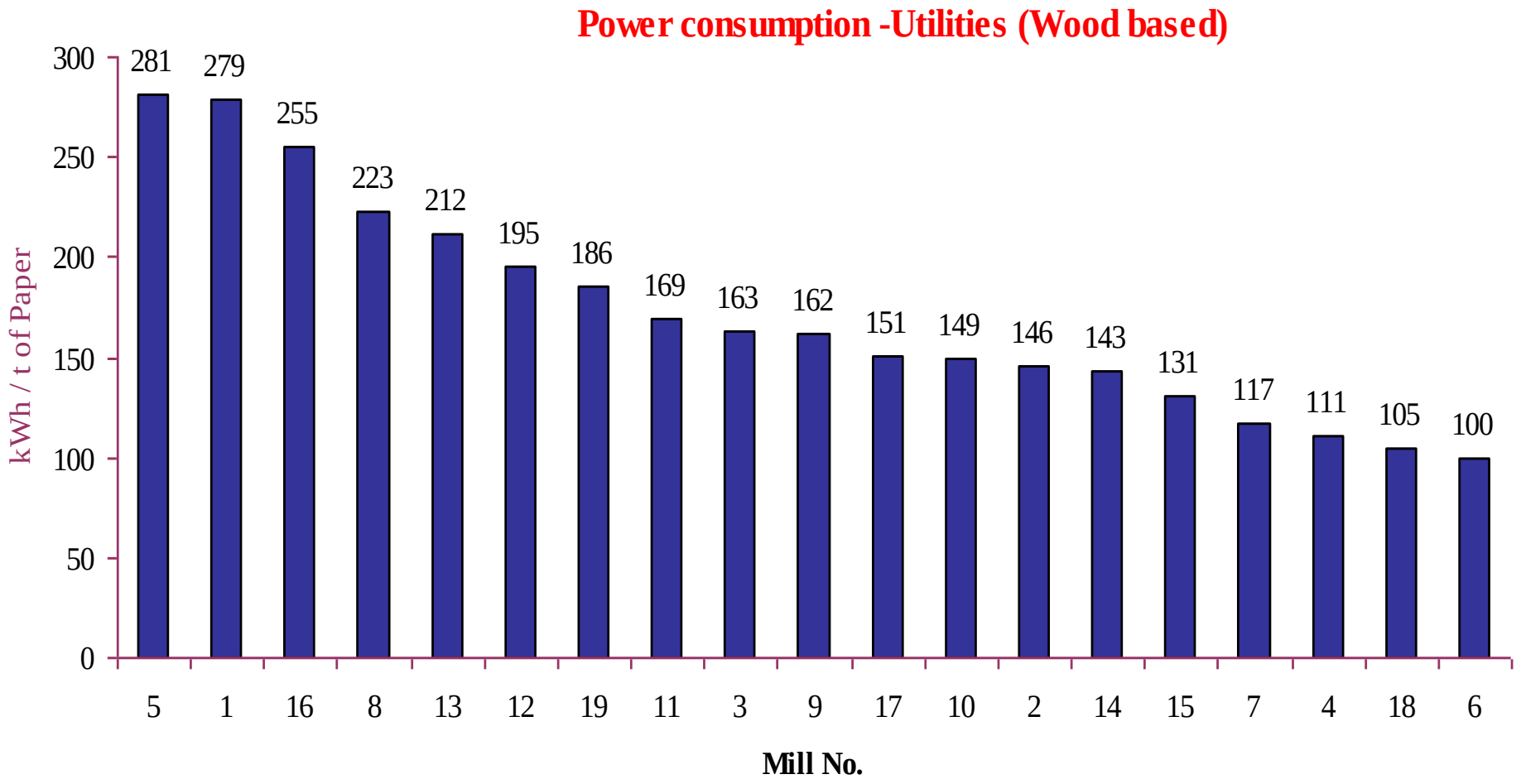
Power House ……Steam Consumption Pattern

The figures provided by large No. of mills on steam consumption in power house were not relevant as some of the mills have reported very high figures. The range of steam consumption in power house is from 0.72 to 3 t/t paper. The average figure are within 1.5 to 3.0 t/ t which is high in comparison to international mills.



Utilities (DMP,RWP,ETP,Lighting etc) ….Electricity Consumption

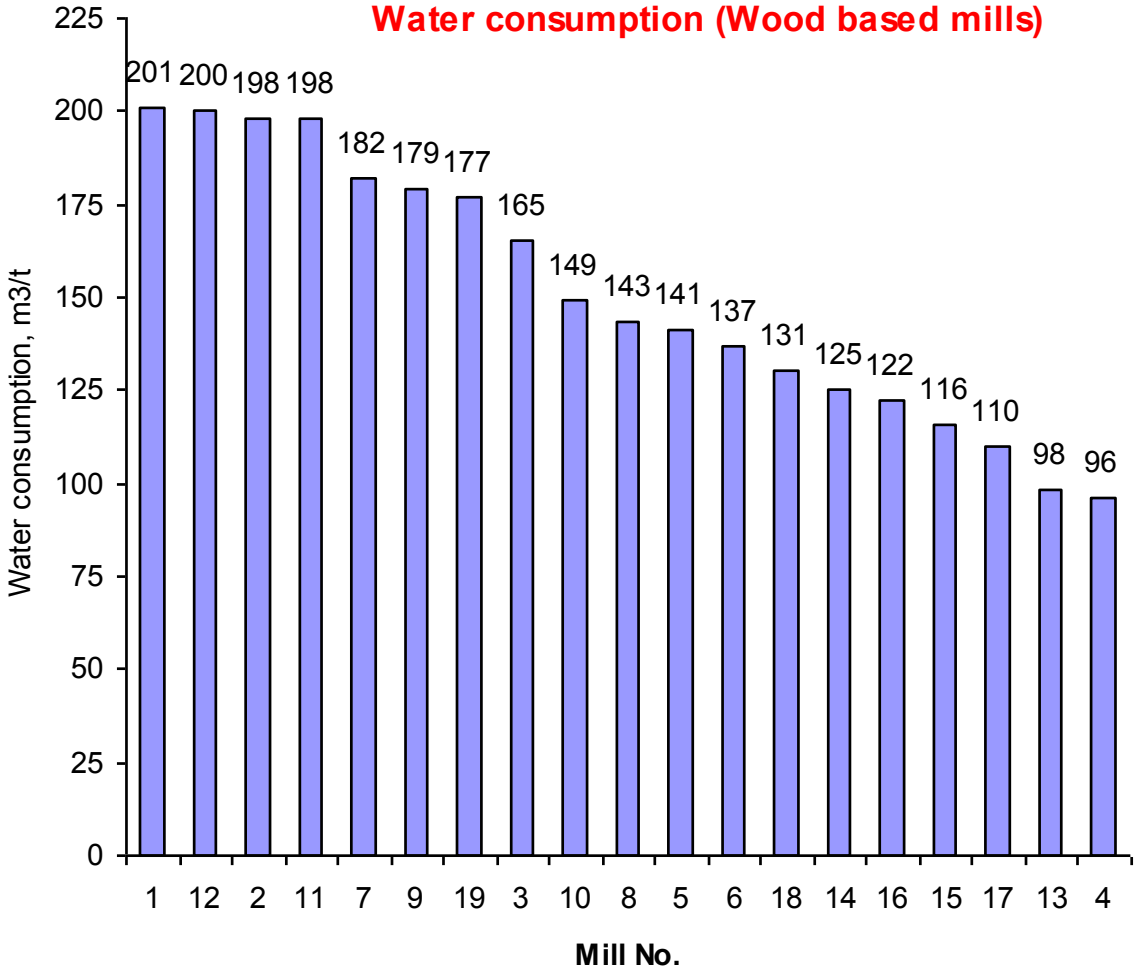
The power consumption figures in De-mineral plant, raw water treatment plant, effluent treatment plant & lighting also shows a wide variation from 100-281 kWh/t paper. Average figures lie between 117 to 169, which is on higher side.



Water Consumption ……Overall consumption

The water consumption in wood based mills for production of writing printing paper, packaging paper , newsprint and rayon grade pulp varies between 96 to 200 m^3/t. Only two mills have consumption below 100 m^3/t, 7 mills range between 100-150 m^3/t, 6 mills between 150-200 m^3/t and only one mills above 200 m^3/t.

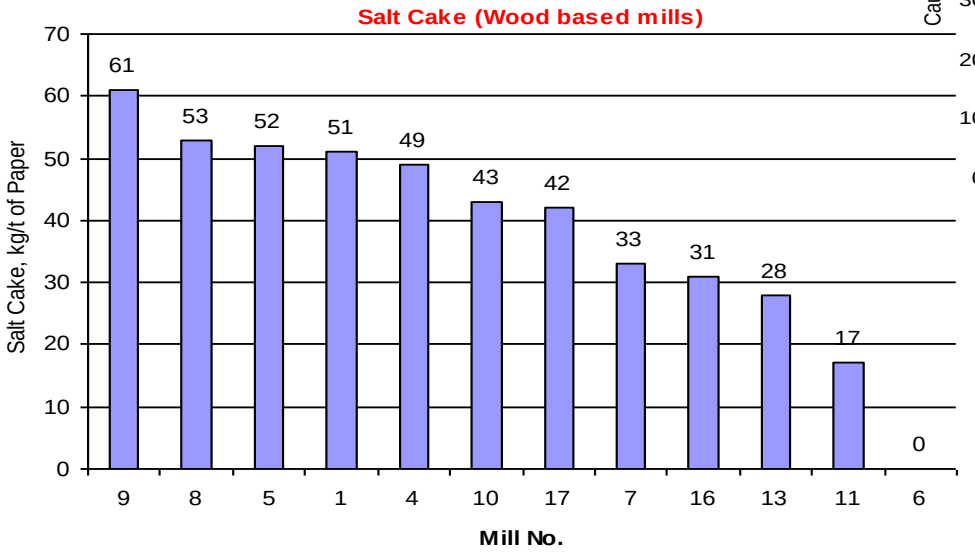
- Mills are striving for achieving the targeted consumption as per CREP directives.
- There has been significant reduction in consumption over last 2 years and this has been achieved mainly due to increased recycling and reuse of water in the mills..
- Mills need to closely monitor the build-up pattern of non-process elements in the water recycles as slowly they try to achieve the CREP directives.

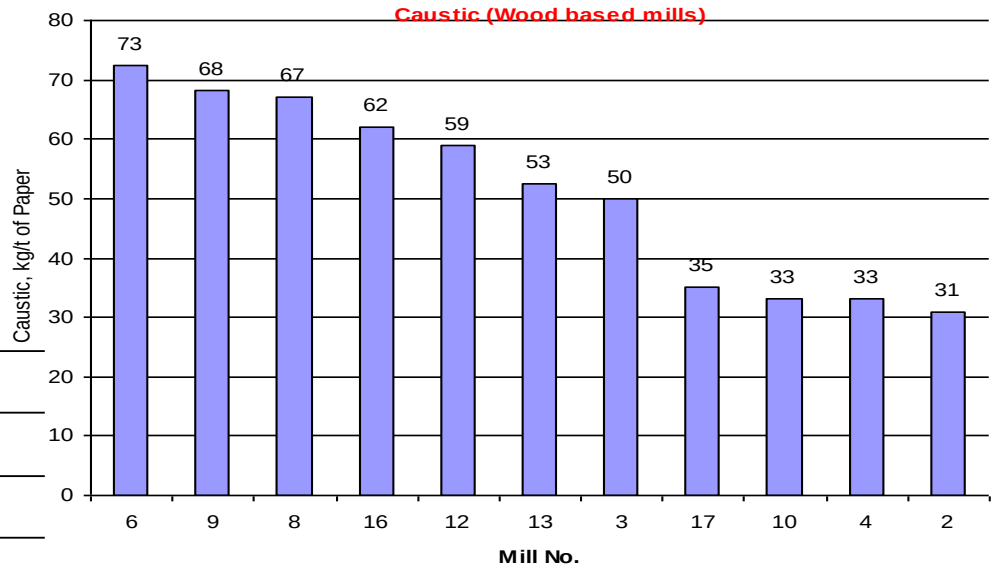


Chemical Consumption ……Pulping chemicals

The major chemicals used by wood based large mills for pulping are caustic soda (NaOH) and Sodium Sulphide (Na_2S). All of the wood based large mills recover these chemicals by conventional recovery systems. The recovery efficiency is about 90-98%. The losses are met by addition of sodium sulphate in the recovery cycle before incineration in the recovery boilers.

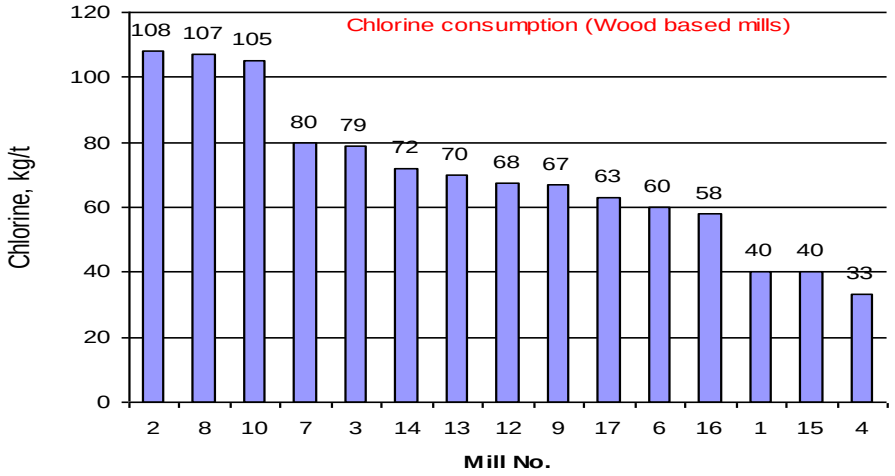
- Mills use purchased caustic as pulping chemicals. The consumption ranges between 14 to 44 kg/t paper.
- The average figures of consumption of salt cake is from 17 to 61 kg/t paper.

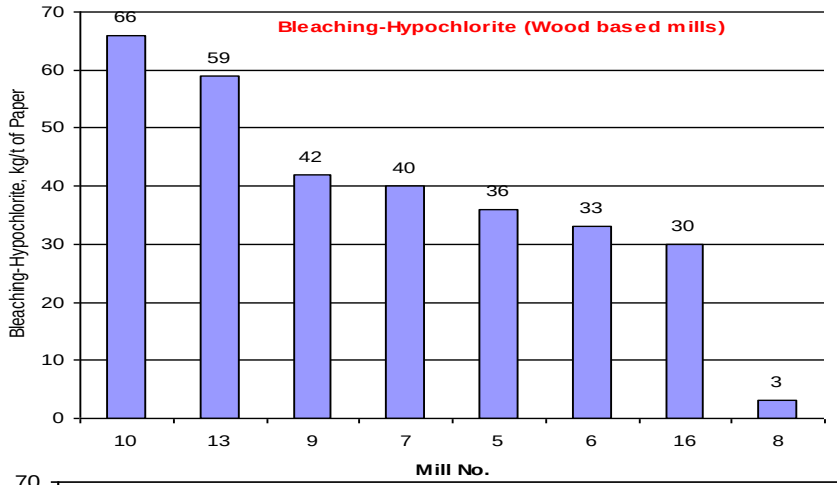


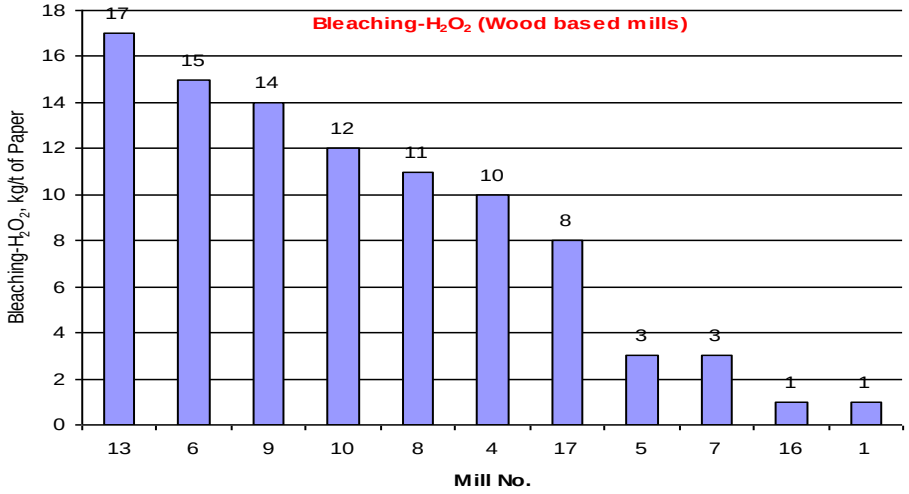


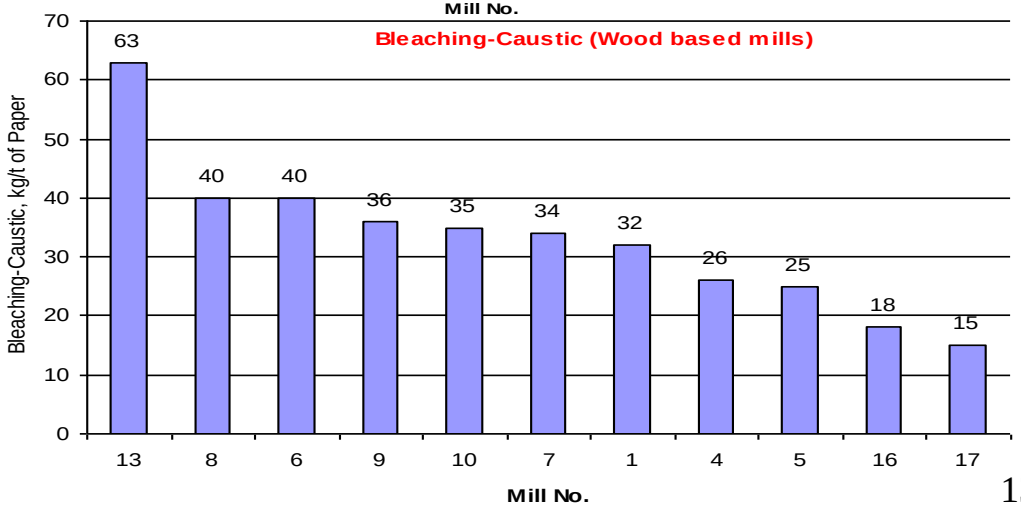
Chemical Consumption ……Bleaching chemicals

Chlorine is one of the predominantly used bleaching chemical in Indian mills. CEHH is the most commonly used sequence in the mills, however due to quality and strict environmental requirements, mills are adopting peroxide, dioxide and oxygen in the sequences. The status of consumption of different chemicals in bleaching is shown below;



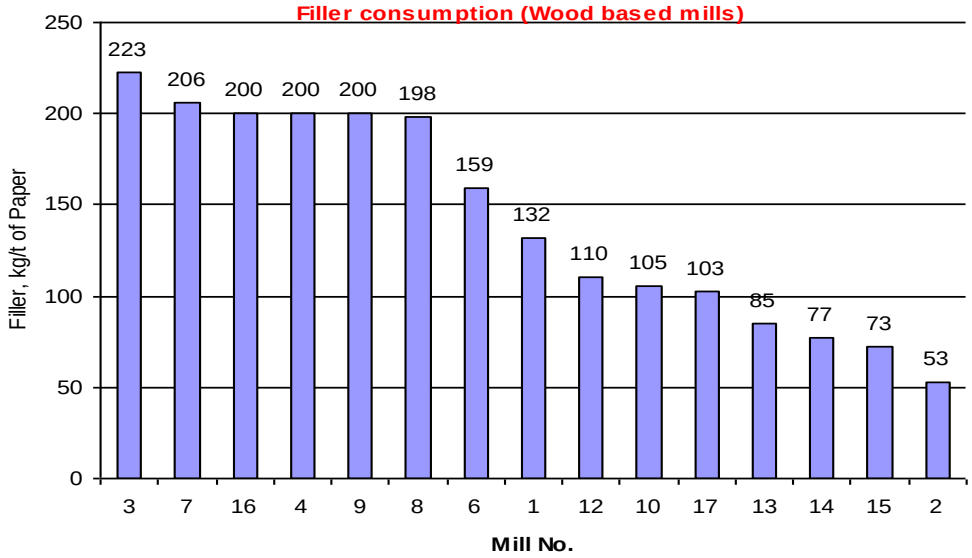


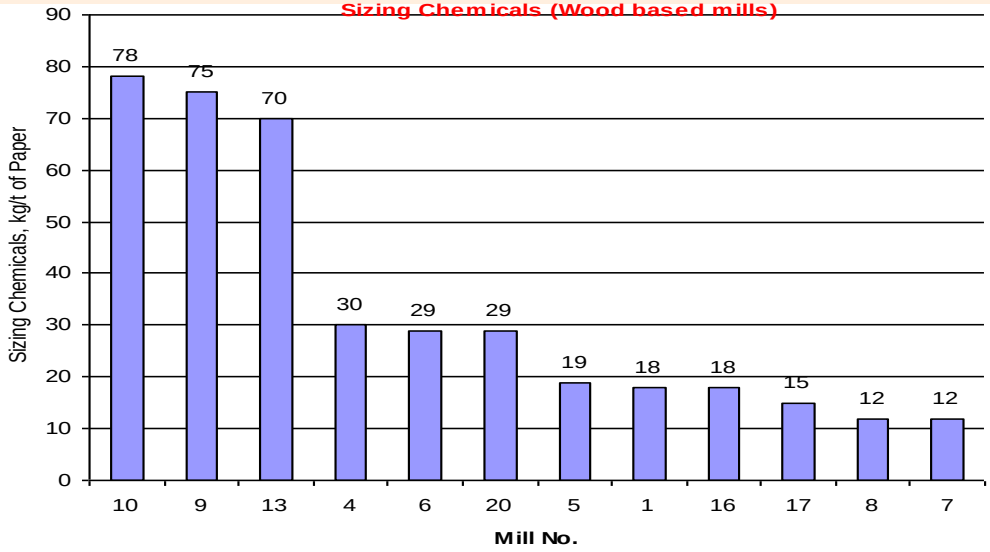


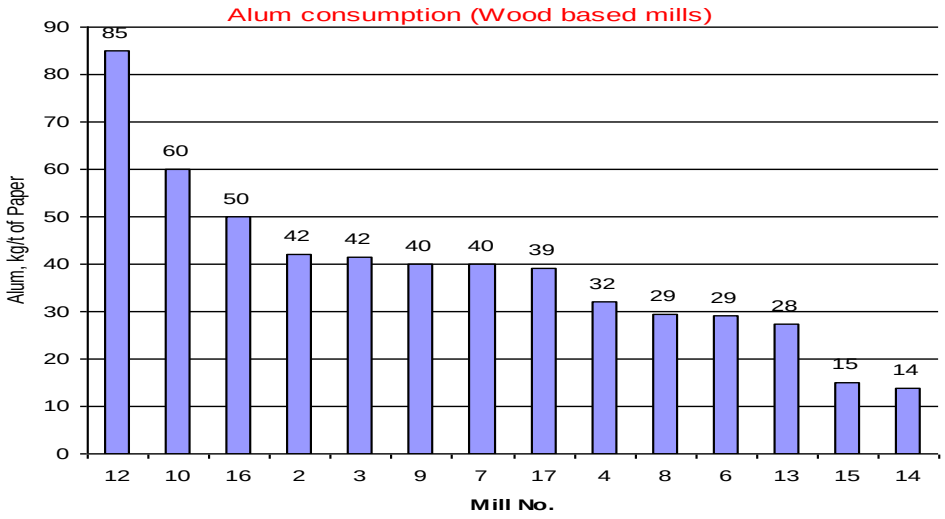


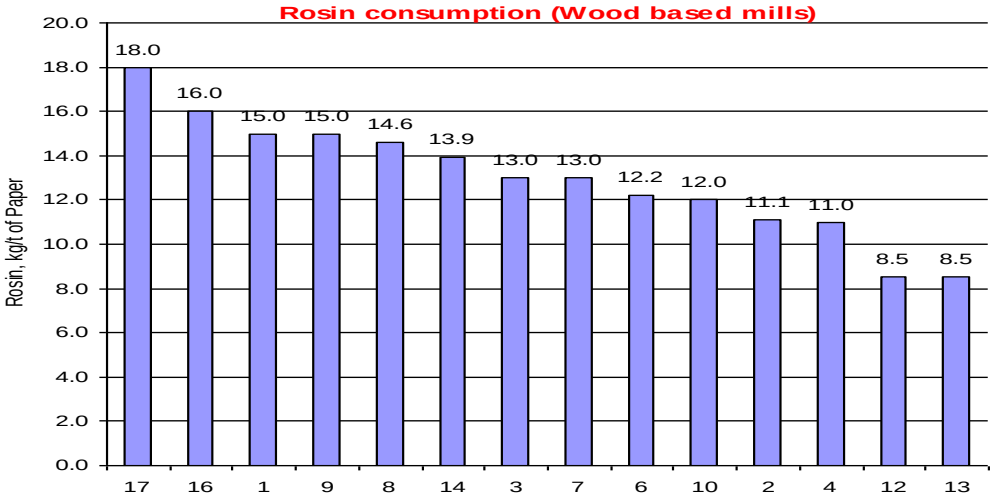
Chemical Consumption ……Chemical additives

The mills used various chemical additives in papermaking. Status of chemicals used in papermaking is shown below.





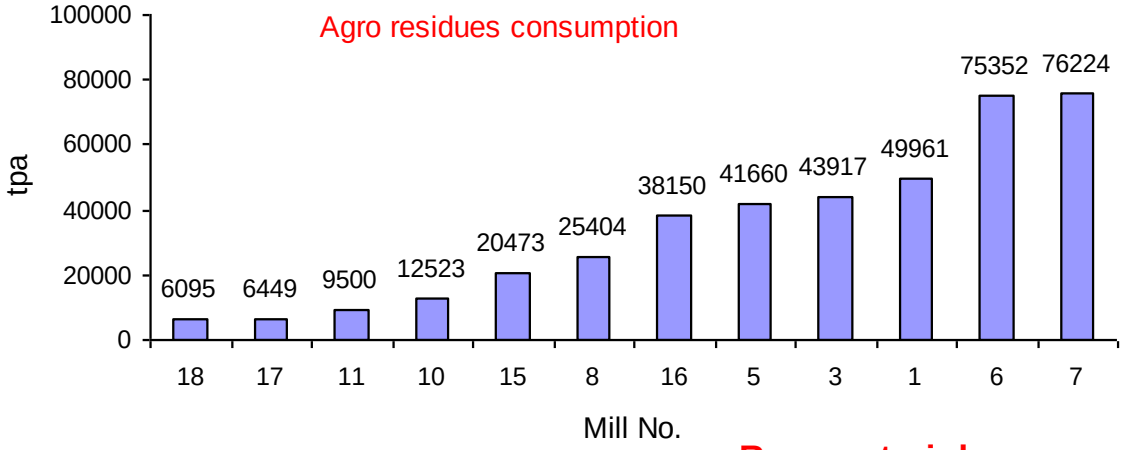


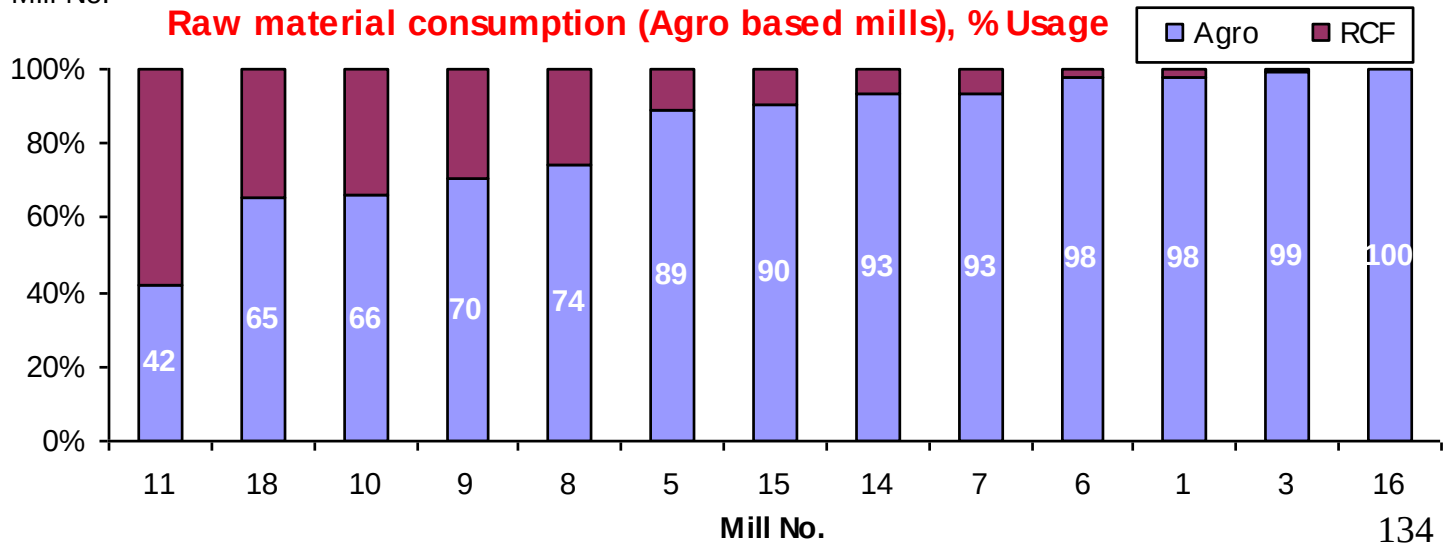


CONSUMPTION PATTERN IN AGRO BASED MILLS

Raw Material Consumption

The study shows a large variation in Raw material consumption pattern of these mills. The variation in comparison of raw materials is very wide and ranges in this group of mills between 6095 to 76224 tpa. Only a few mills use 100% agro residue pulp for production of paper. Most of the mills utilize RCF in the furnish and it varies from 1 to 40% depending upon the type of product.





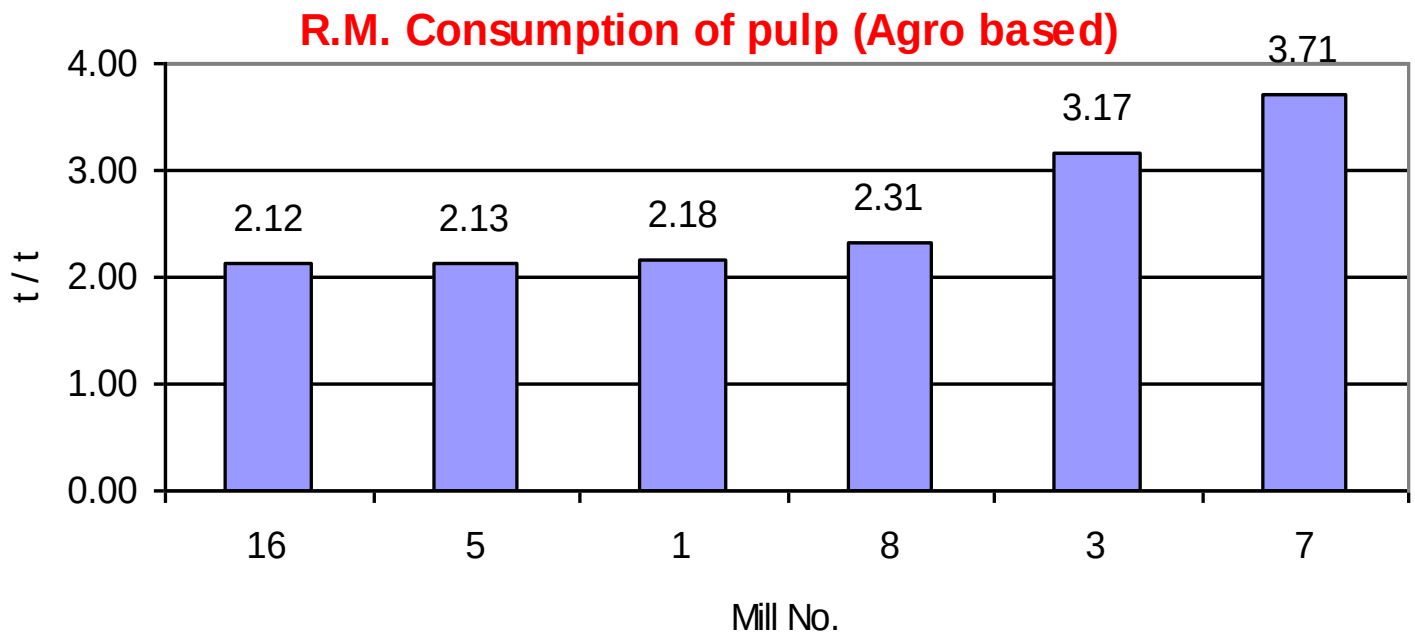
Raw Material Consumption

There is a wide variation in consumption of Raw materials per tonne of paper in the agro based mills. The variation is due to the variety of paper produced. It is low in mills producing unbleached grades. Also a lower consumption in mills is due to higher proportion of RCF used in the furnish.

For bleached variety it ranges between 3.17 to 3.71 t/t

For unbleached products the range of raw material consumption is 2.1 to 2.3

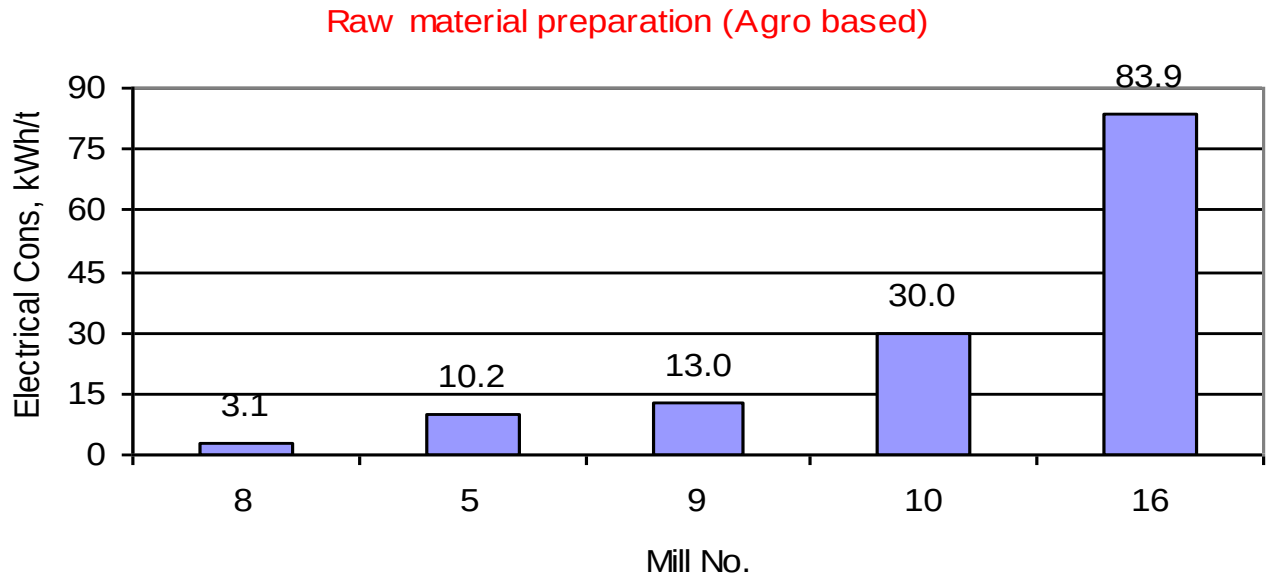
For mills producing both bleached & unbleached varieties, the range is from 2.13 to 2.18



Raw Material Preparation …… Power consumption

Only a few mills have power metering for raw material preparation section. Also the data reported by mills for power consumption in the raw material preparation section is not reliable as seen by the wide variation. It ranges from 3.1 kWh/t to 83.9 kWh/t.

The agro residues being bulky is different to storage and handle and generally requires power consumption from 20-30 kWh/t paper. The power consumption varies due to shortage of raw material used and the treatment given to it. Bagasse requires to be depith before pulping and needs relatively higher consumption of power. Type of depithing is also very important for power consumption. Based on the quality of the product cleaning is also required and it also increases the power consumption dramatically. In case of straws, cleaning consumes very large amount of power. Cutting is relatively simpler & less power intensive.

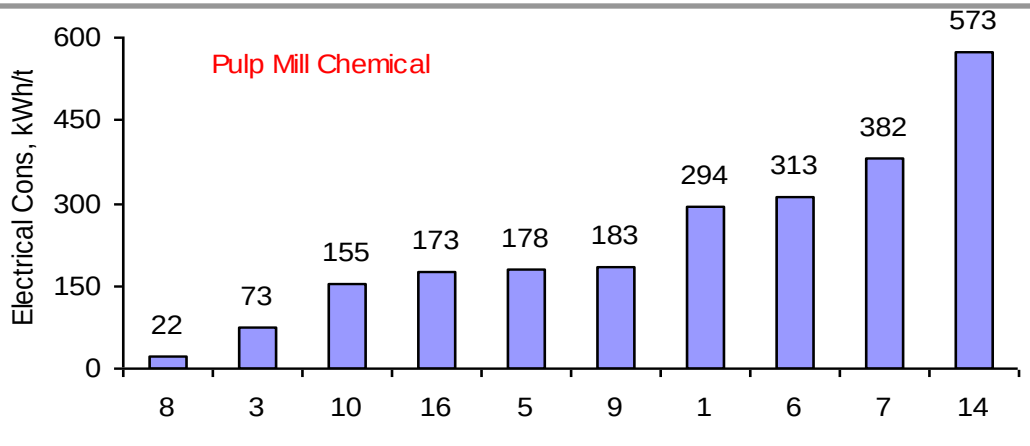


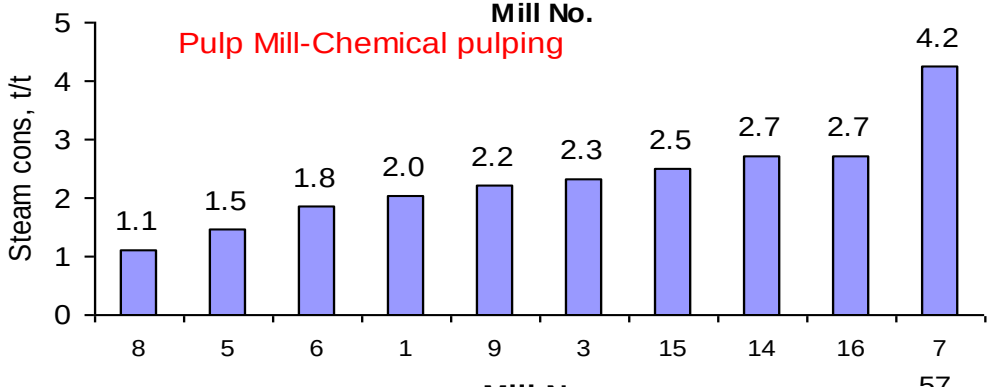
Pulp Mill .....Digesters & Pulper

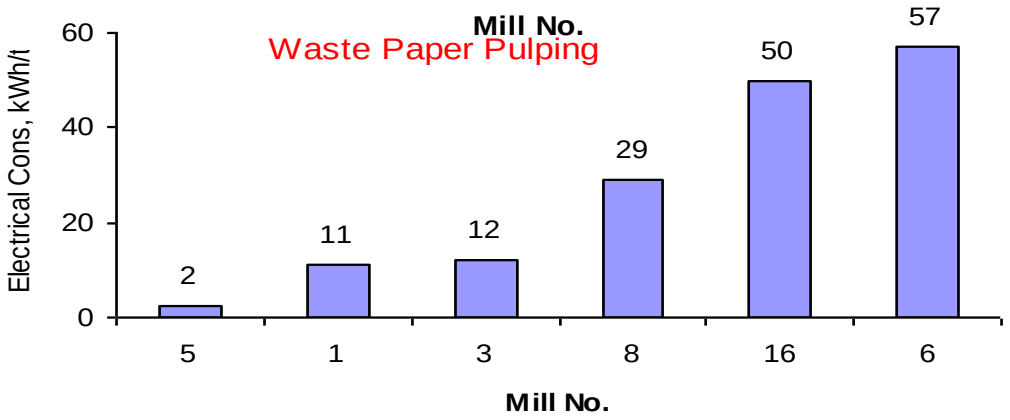
Power & steam consumption in pulp mill varies widely in agro based mills. This variation is mainly due to a large number of factors. These mills are also using more RCF in furnish.

The Unbleached mills produce pulp of high kappa number (above 40) using very small amount of chemical charge. This requires less power & steam. Mills providing bleached grades use higher chemical charge and pulp produced is of Kappa number in the range of 30. The power & steam consumption is relatively high for these mills.

The agro based mills also use Recycled fibre in their furnish. Depending on the quantity of RCF, power consumption in pulpers for pulping of recycled fibres varies.

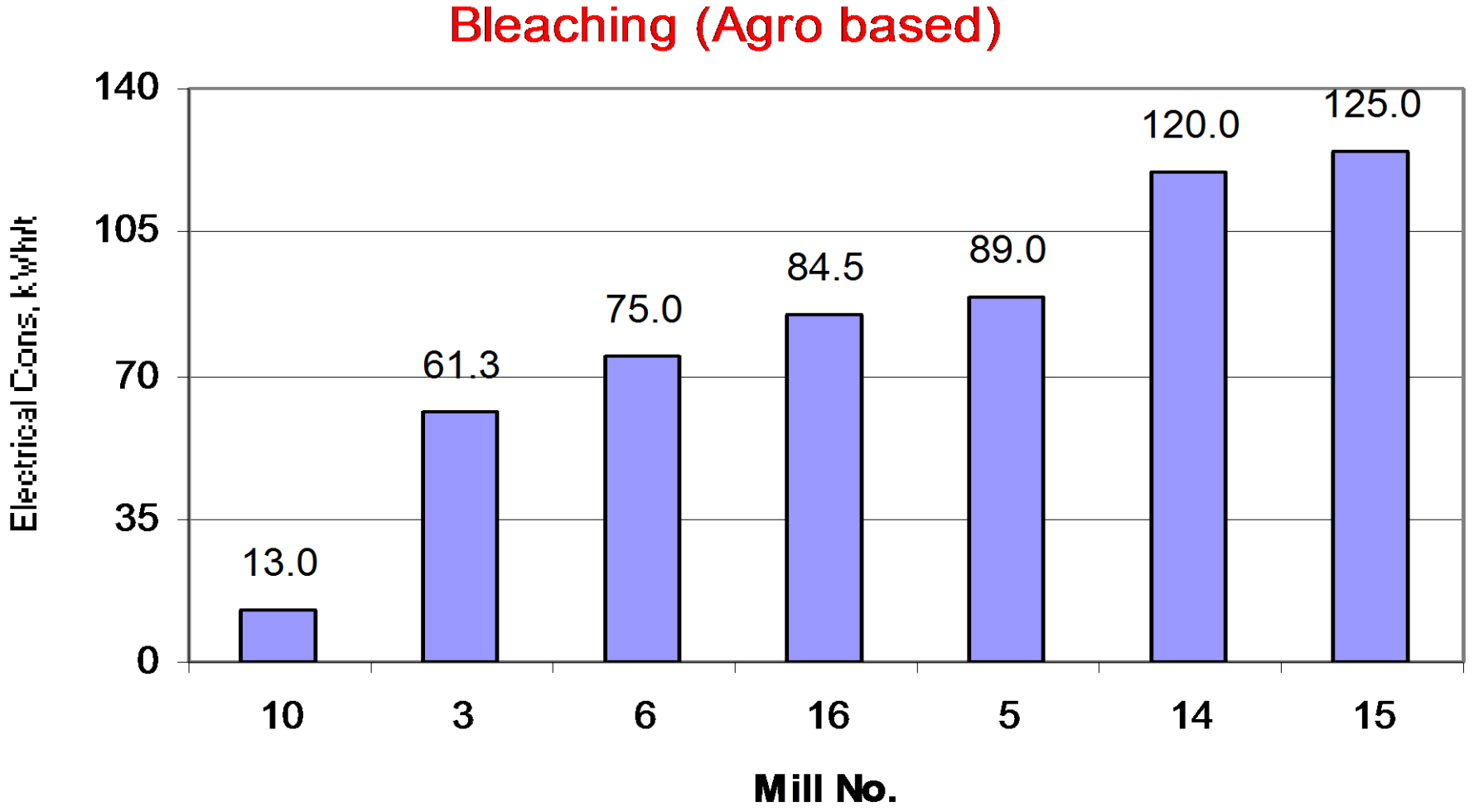






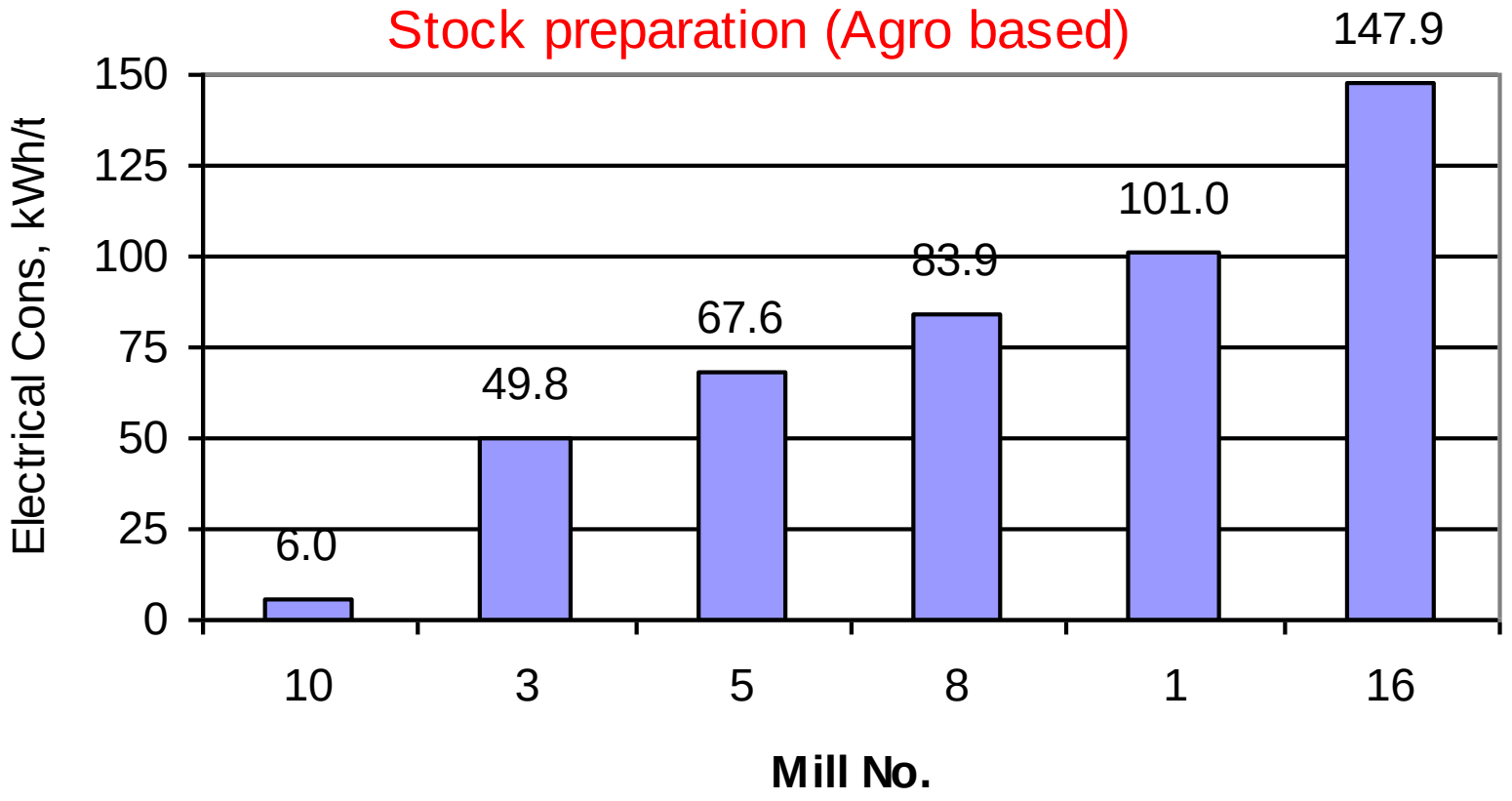
Pulp Mill..... Bleaching

A large variation is observed in power consumption of agro based mills in bleaching section. This is mainly due to improper metering of the power. The average consumption figures are within 85 – 125 kWh / t of paper. Steam consumption figures are within a range of 0.6 – 1.0 t / t of paper.



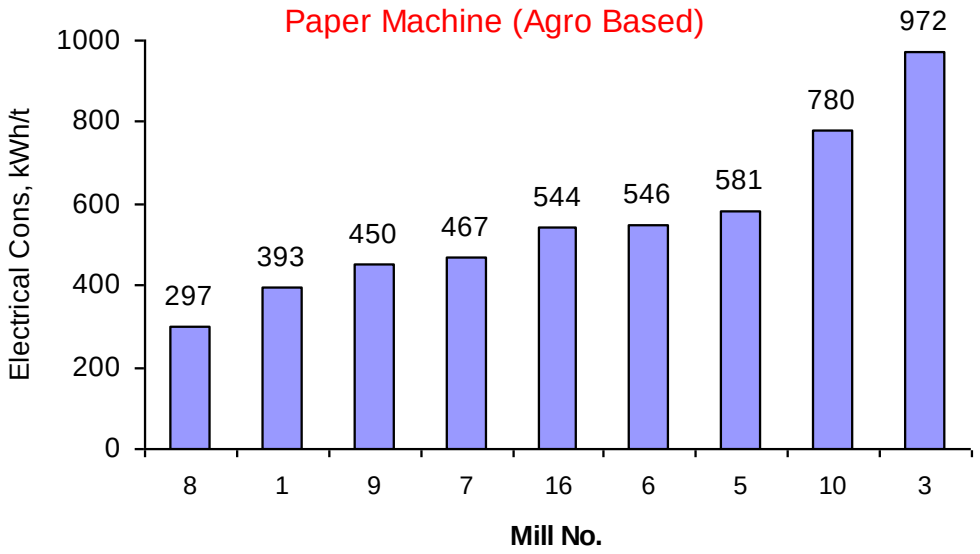
Stock Preparation

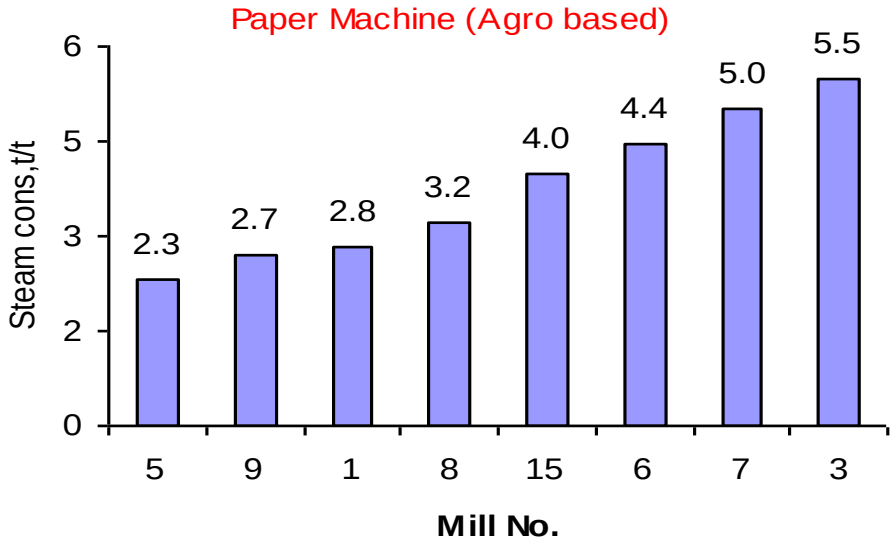
Non-wood pulps require gentle refining treatment compared to wood based pulps. The figures are lower incase of bagasse pulp which is easier to refine and slightly higher in case of straw pulps. The figures reported by the mills are varying between 50 – 150 kWh/ t of paper which is mainly due to non-wood fiber and varying amount of RCF in their furnish.



Paper Machine……Steam & Power consumption

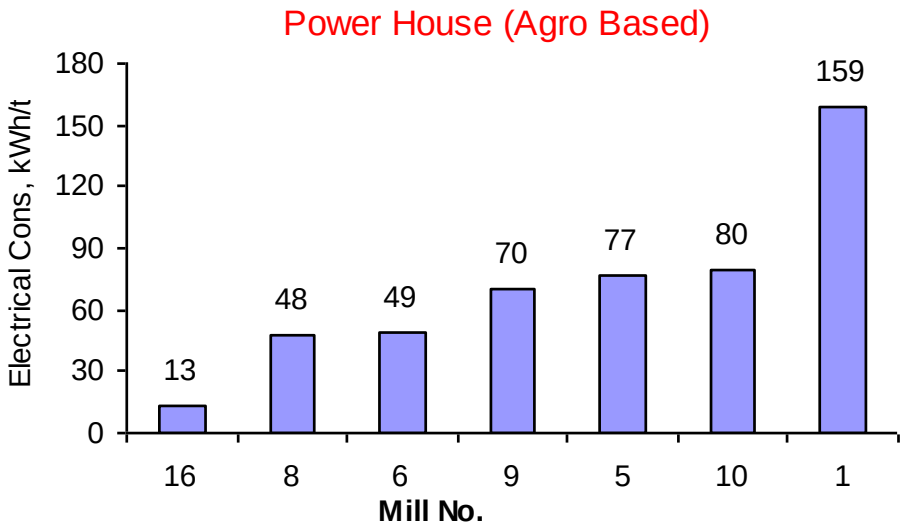
A large variation is also observed in power & steam consumption in paper machines in agro based mills. This is mainly due to variation in their furnish and old / obsolete technology used by these mills. Mills producing unbleached varieties have reported lower consumption figures due to easy drainability and drying of unbleached fibres. Mills producing bleached grades consume higher amount of power & steam. Average consumption figures are reported by mills producing bleached & unbleached grades of paper. Abnormally high power & steam consumption is also reported by some mills which is mainly due to their product quality variation among these sector of mills. The overall consumption of power and steam is very high looking into the product quality and simple equipment layout in these mills. Instrumentation and operation in paper machine and stock preparation section of these mills need to be reviewed seriously.

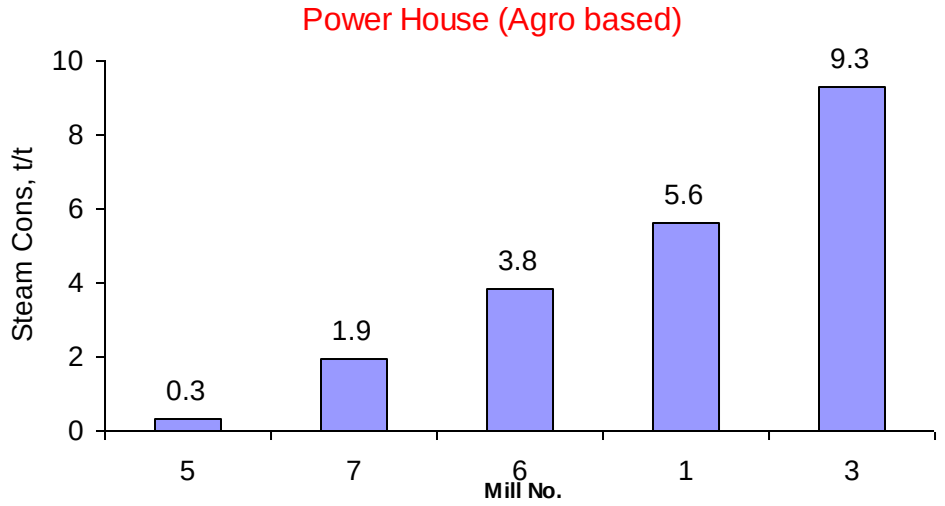




Power House

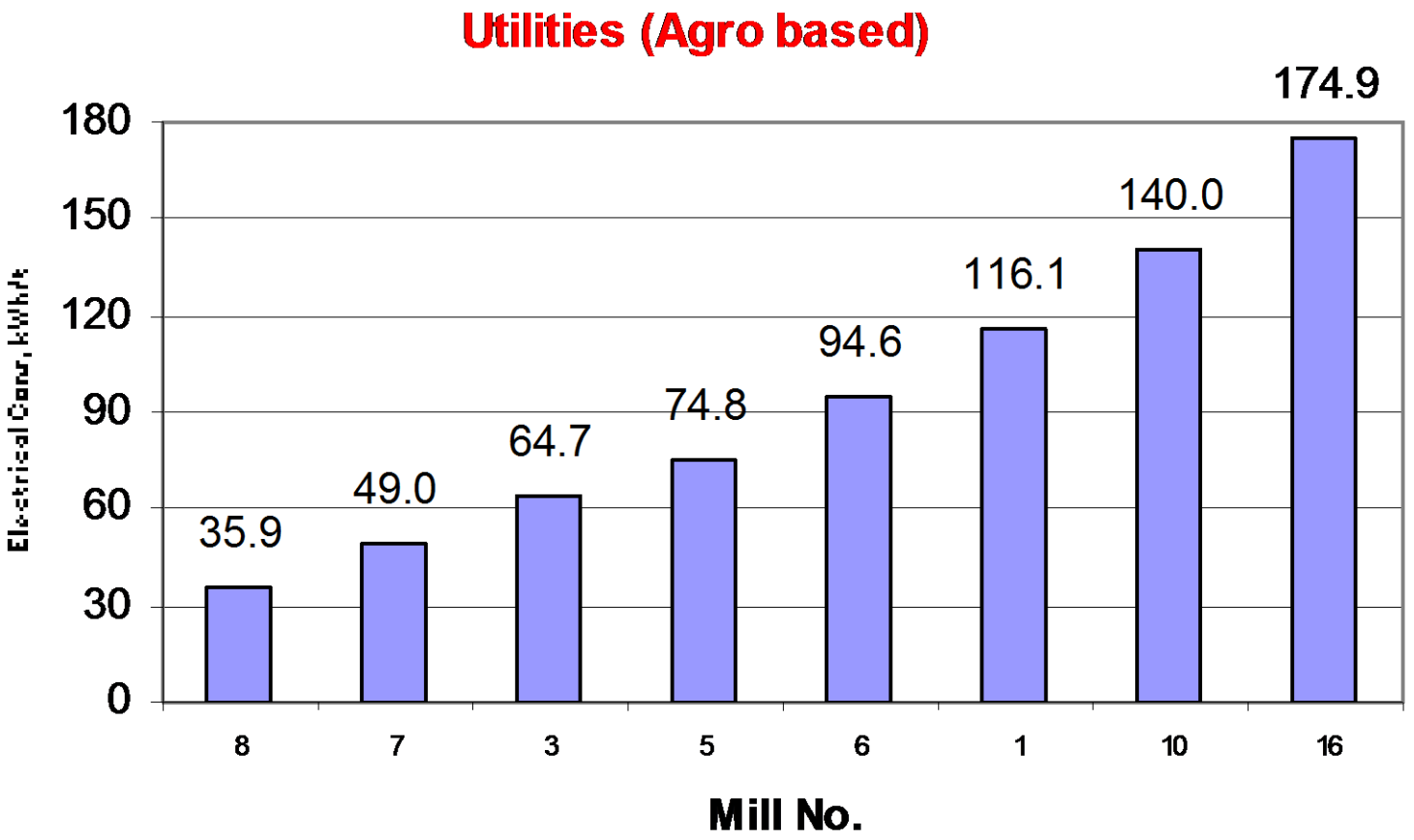
Only a few mills have reported power & steam consumption in the Power house in this category which shows a large variation. The mills produce low pressure steam in old boilers. These boilers require lower limit of blowing. Only a few mills have co-generation system and produce steam above 20 kg/cm^2 pressure. Average range of power consumption is between 70 – 150 kWh / t paper and steam consumption between 2 – 3.8 t / t of paper.





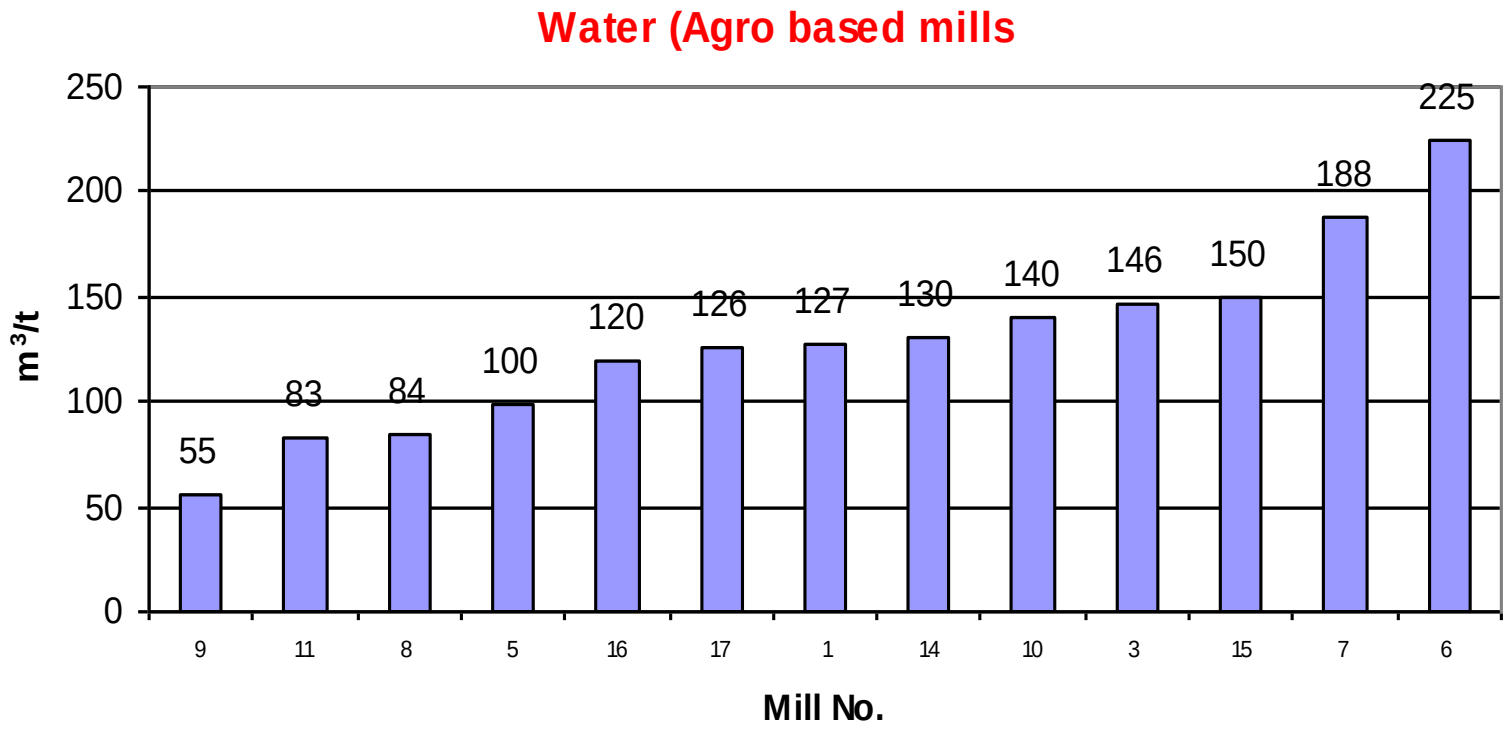
Utilities (Water Intake & ETP)

Many mills have included power consumption of power house in utilities section and therefore the consumption figures are high for some mills. The figures range between 36 to 175 kWh / t paper for mills producing different varieties of products. The consumption is higher in case of bleached varieties due to higher power input in ETP.



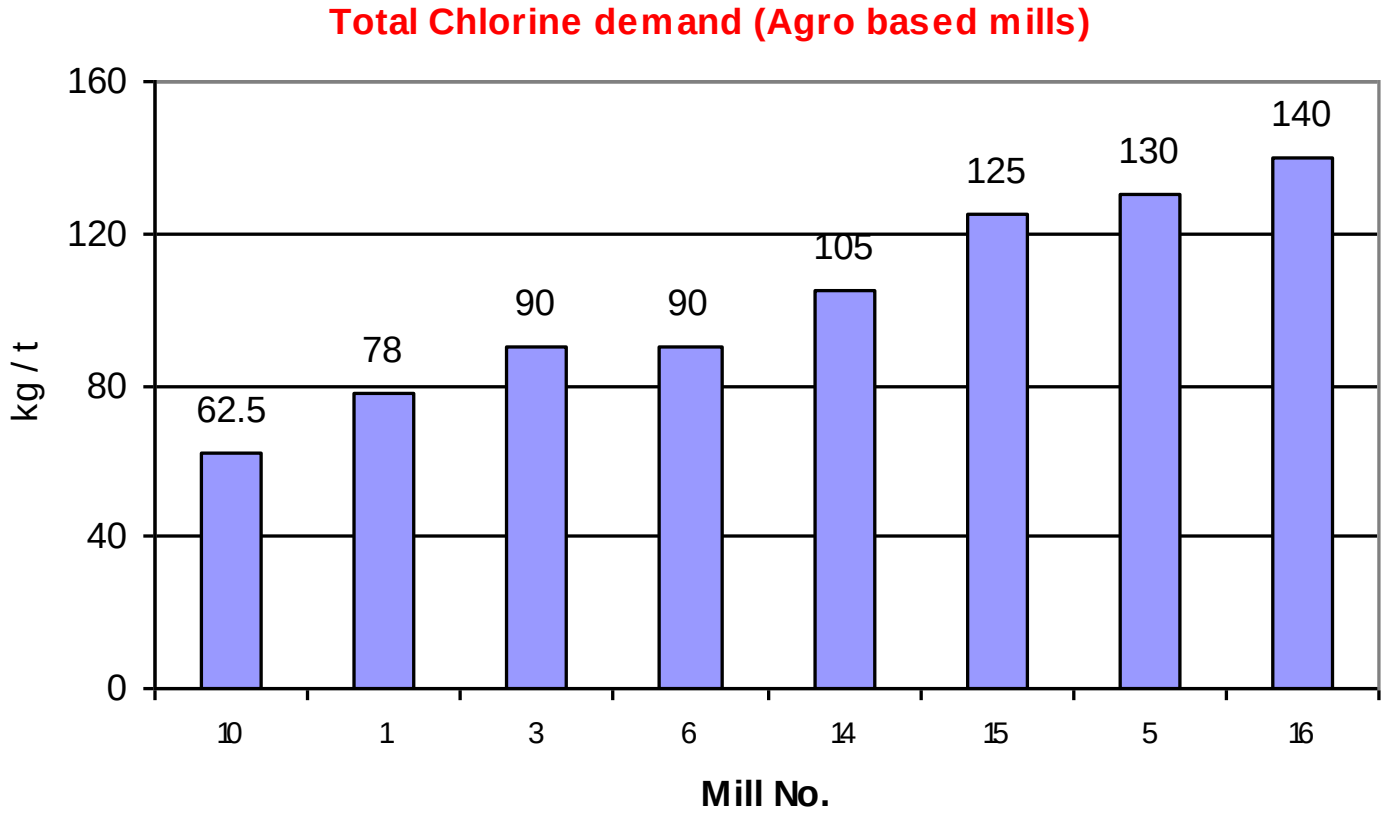
Water Consumption

Overall consumption figures are on higher side and range between 55 to 225 m3/t of paper. The water consumption is lower in mills producing unbleached grades, whereas for mills producing bleached grades the consumption is very high. It varies from 55 to 84 m3/t of paper for mills producing unbleached grades and 100 to 225 m3/t of paper for mills producing bleached and unbleached grades. Water consumption for mills producing both bleached & unbleached grades varies significantly depending upon the finished production of both the varieties.



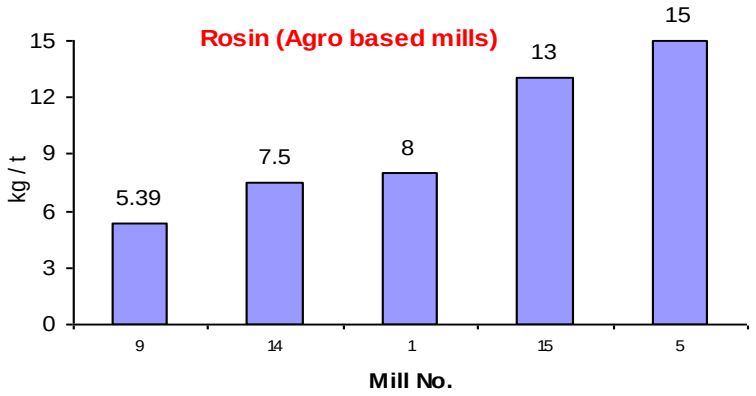
Chemicals .....Bleaching chemical consumption

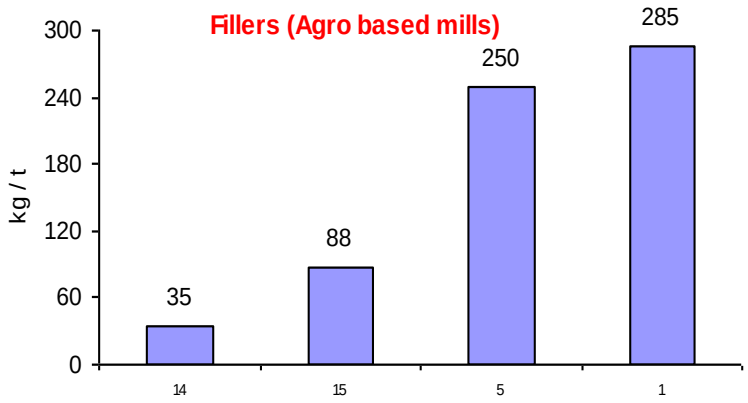
Wide variation in chlorine consumption is observed in the agro based mills. The consumption of chlorine varies in these mills depending upon the quality of product and proportion of bleached variety in the production. This is also due to liberal use of chlorine to delignify the high kappa pulp in the bleaching stage. The consumption varies between 62.5 to 140 kg/t of paper and can be easily brought down by proper control of pulping process to produce low kappa pulp and optimize the bleaching using the sequences suitable for non woody fibres. This would significantly reduce the bleaching losses also.

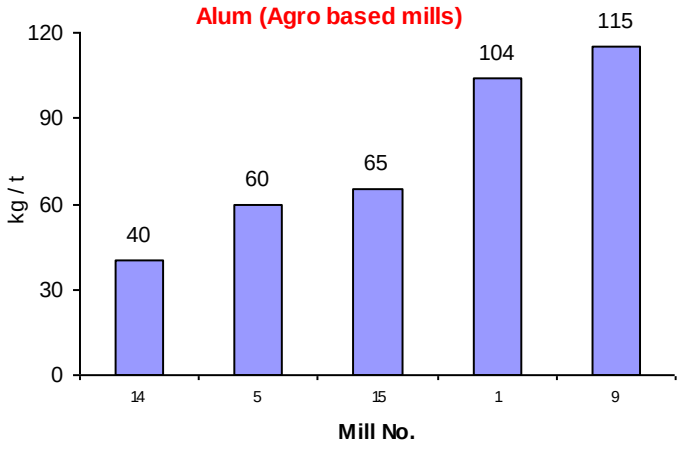


Chemicals ……Additives in Paper Making

Filler loading is dependent upon the fiber furnish and mills show a variation from 35 kg / t to 285 kg/t. Very high filler loading is possible with straw pulps. Accordingly rosin & alum consumption also varies with filler loading.





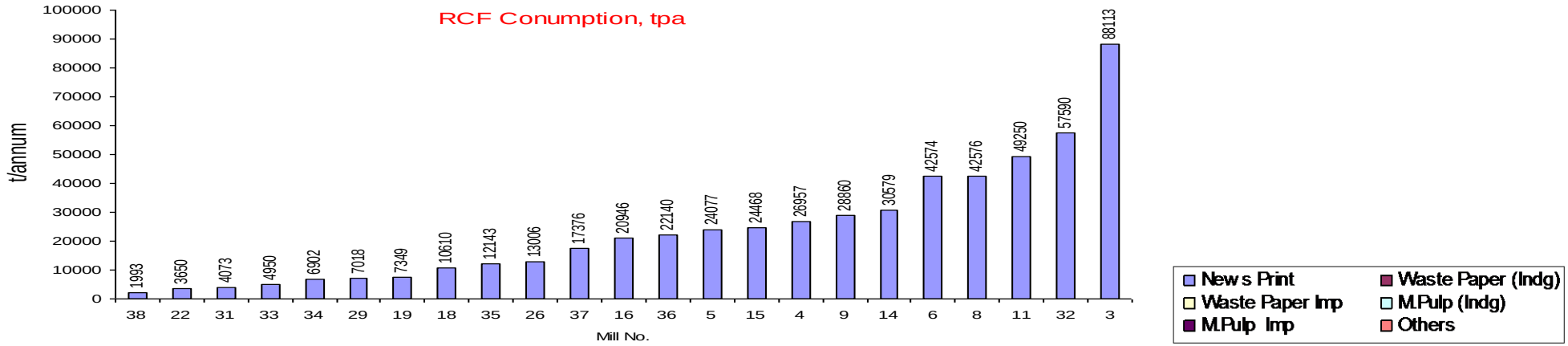


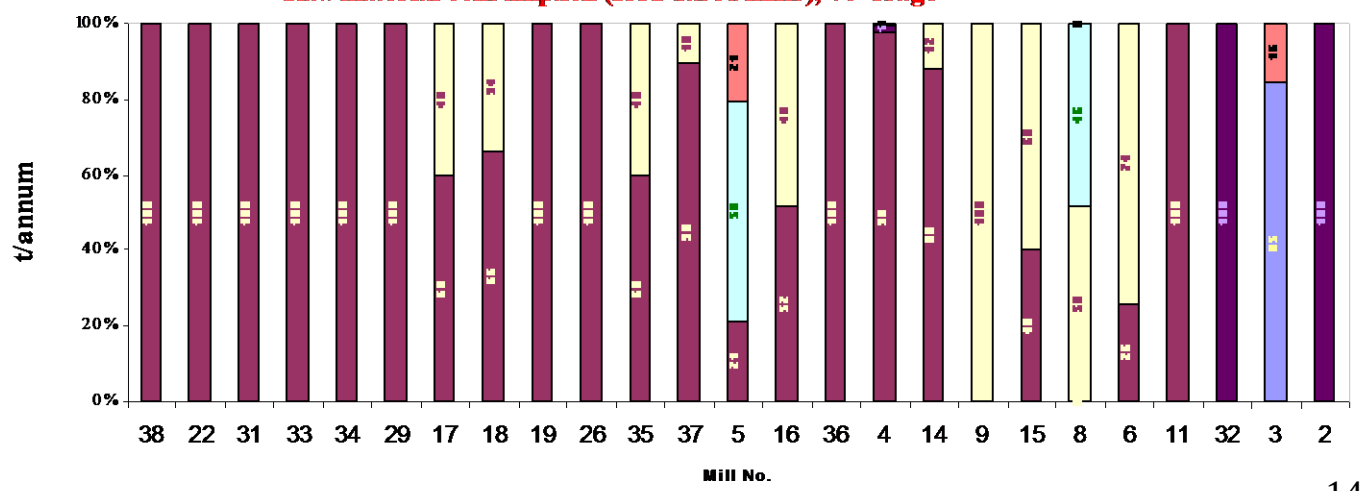
WASTE PAPER (RCF)

BASED MILLS

Raw material consumption

The waste paper consumption pattern in RCF mills producing different varieties of product depends upon raw material and the end product. The varieties used are Newsprint, indigenous & imported mixed waste paper, indigenous & imported market pulp. The variation in capacities of these mills is shown here along with the percentage usage of the raw materials.





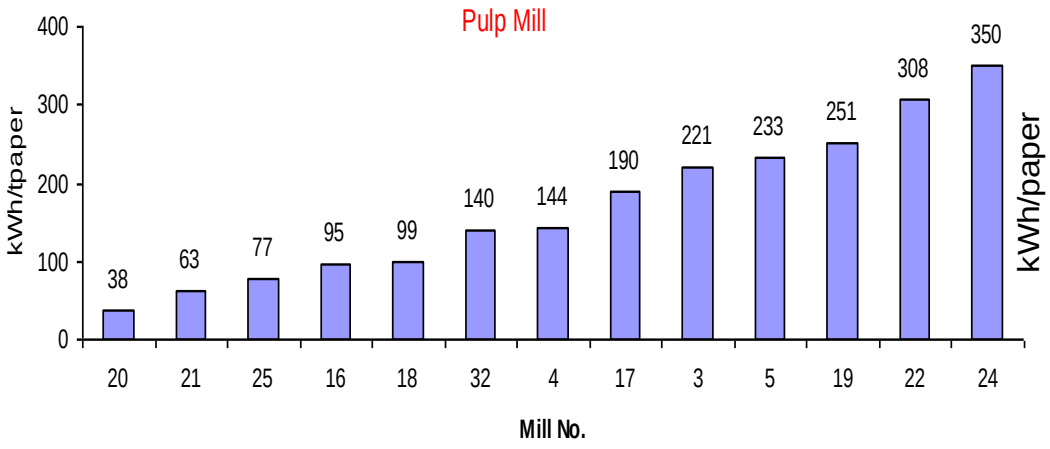
Pulp Mill & Refiners

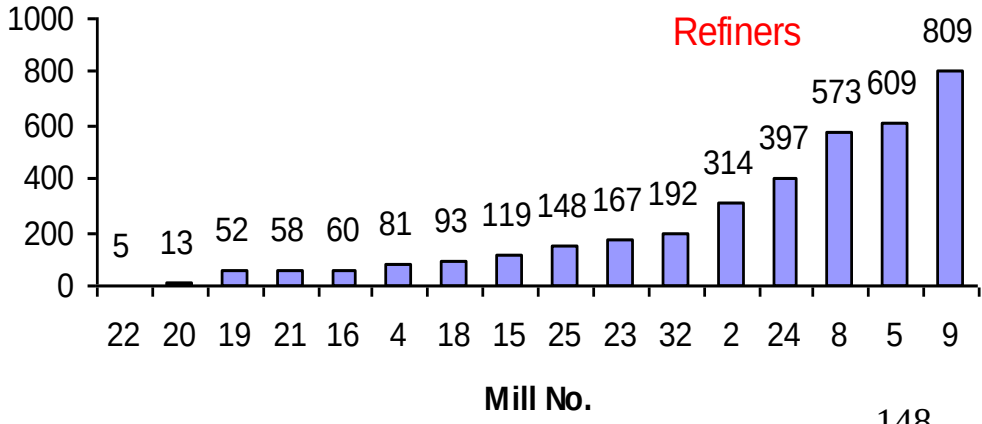
A wide variation in pulp mill power consumption is observed which ranges from 38 to 350kWh/t of paper. The reporting of consumption is not proper by these mills and some mills have included the refiner load in pulp mill also. The power consumption is high in mills practicing deinking. For mills without deinking the consumption falls between 38 to 144 kWh / t of paper whereas for mills using deinking the consumption ranges between 190 to 250 kWh/t of paper. Refining is the major power consuming equipment in stock preparation.

Refining:-

Refining power varies depending upon the type of products. The figures are high in case of BILT-Graphics, Good Will, APR Packaging, Pudumjee and Khatema Fibres as they are producing high quality paper from the Recycled fiber.

Some mills refine fiber to simplify disintegrate them for formation and use minimum power in refining. A large number of mills use mixed waste papers and refining varies based on their fiber furnishes.

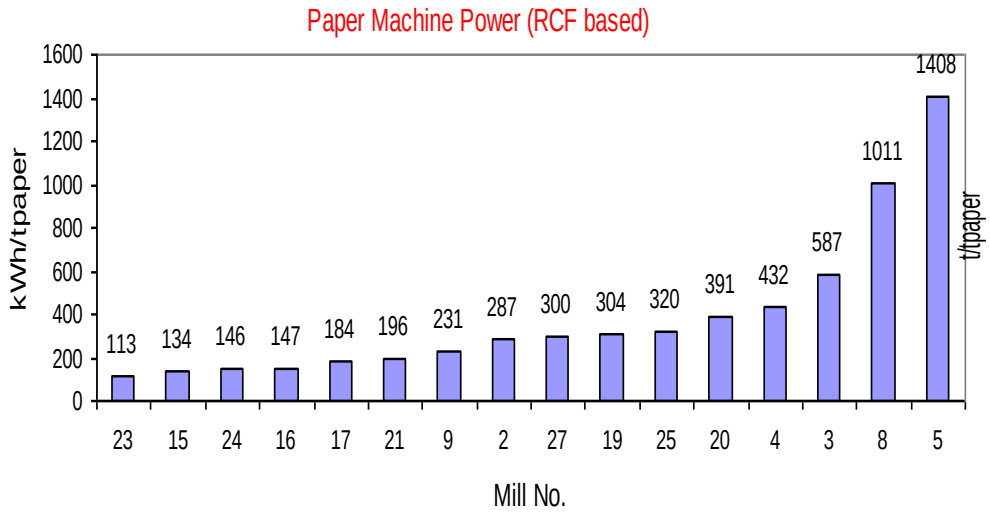


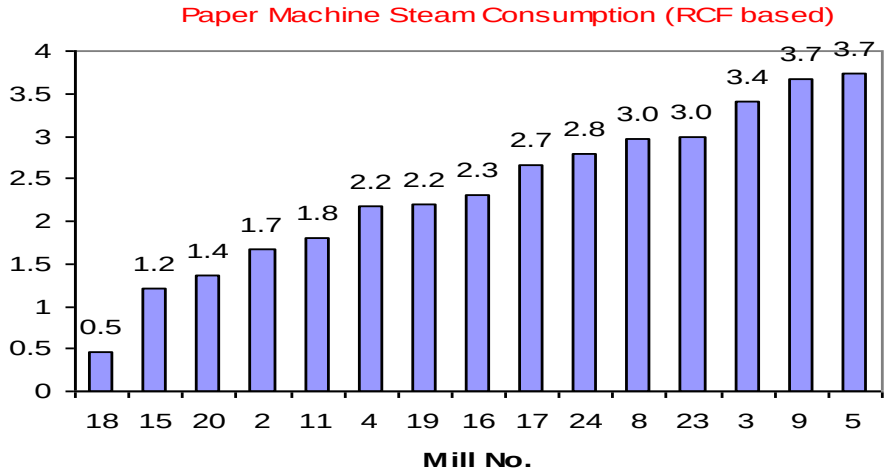


Paper Machine ..... Power & Steam consumption

Power and steam consumption shows a large variation in these mills depending on the quality of product. A very high power consumption is reported by Rama Newsprint, APR packaging & Pudumjee which produce Newsprint & specialty papers. In case of Khatema, BILT Graphics and BIPCO the power consumption is fairly low inspite of their good quality products.

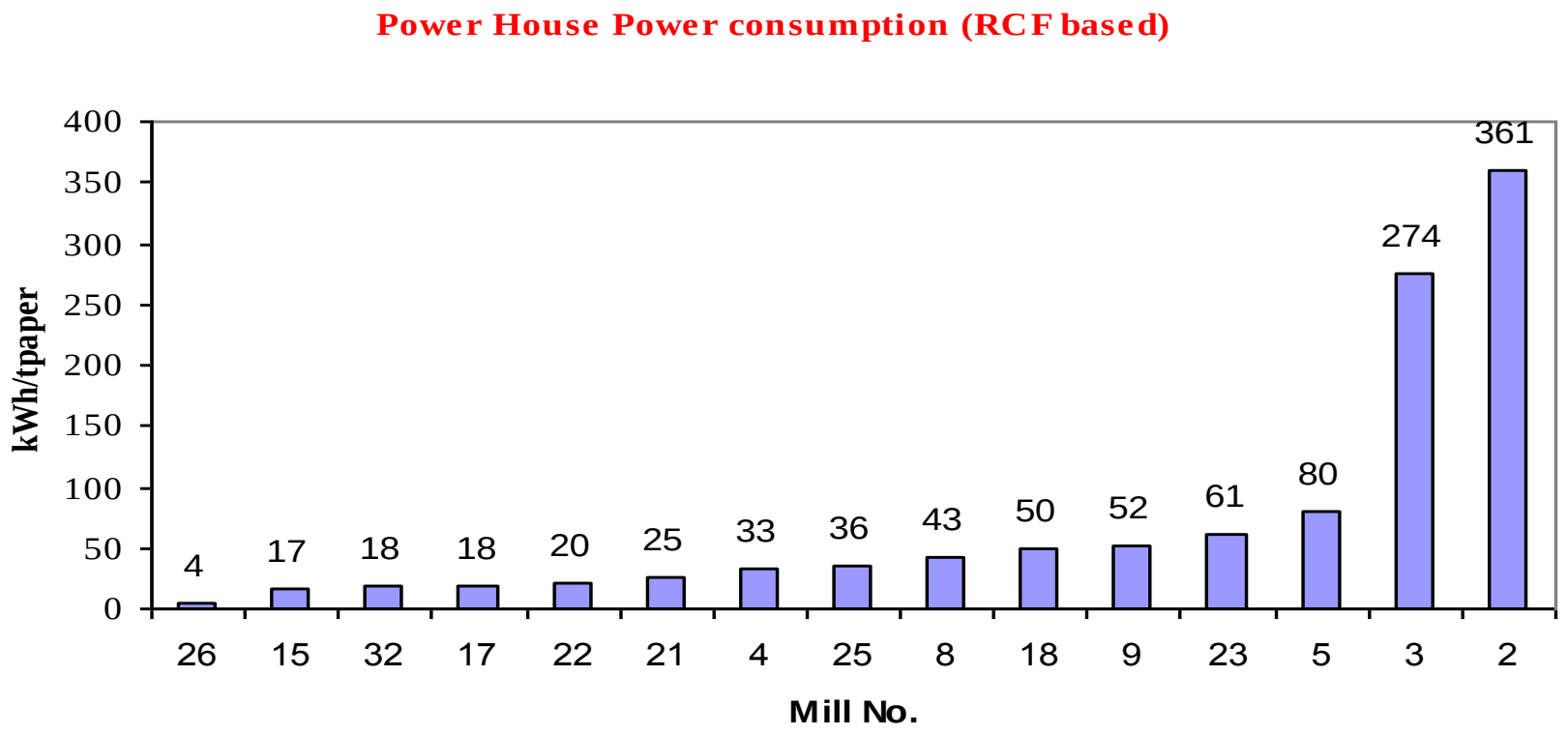
Steam consumption also varies depending upon the quality of paper and raw material furnish.. Status of power & steam consumption in Paper Machines in recycled fibre mills is shown below.





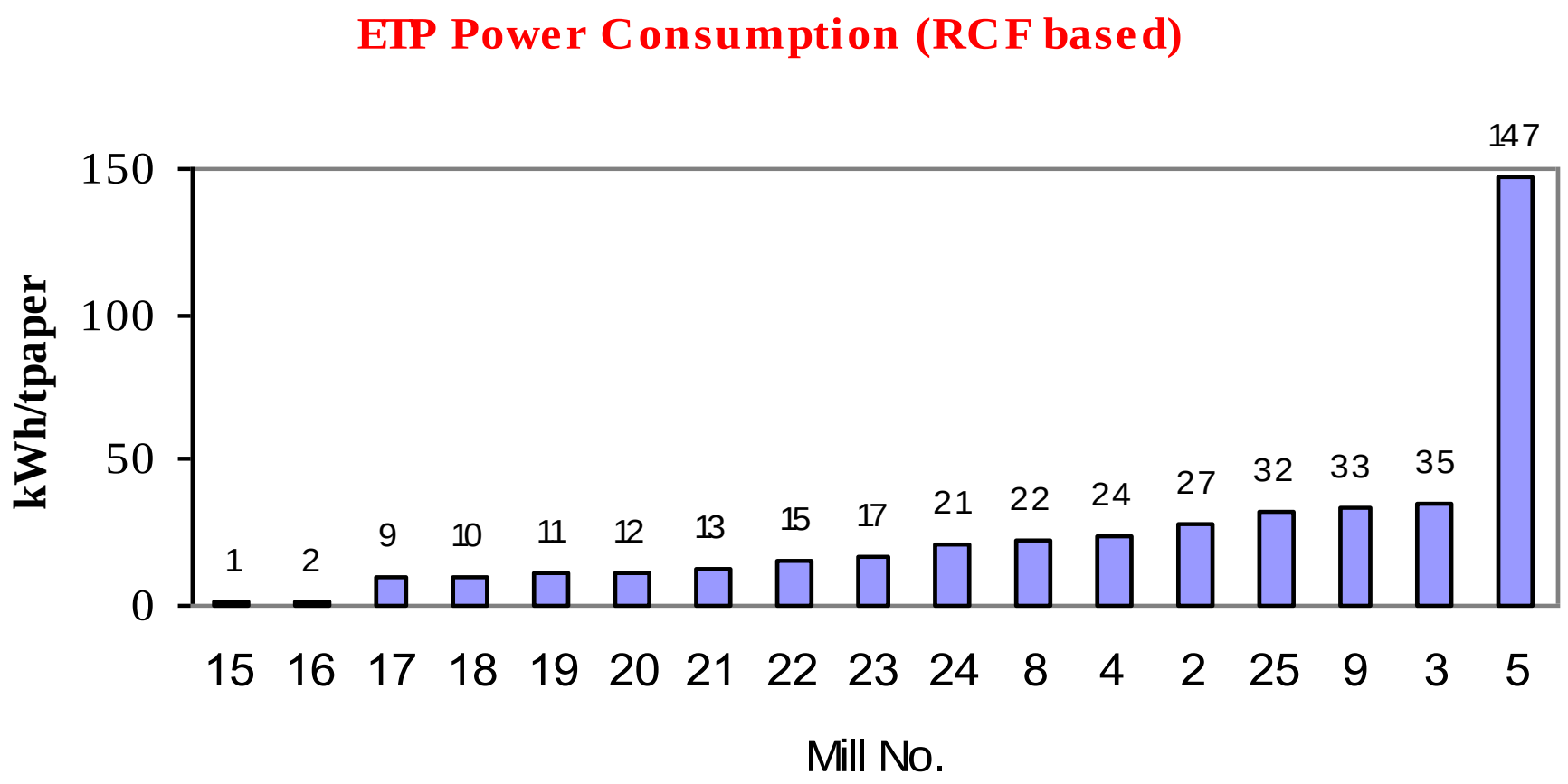
Power House

Majority of mills have old, low pressure boilers. Only a few mills generate high pressure steam and co-generate power. The power consumption is high in case of Rama Newsprint & BILT Graphics due to their Co-generation capability. Status of power consumption in Power house in recycled fibre mills is shown below.



ETP

The power consumption in ETP is fairly low in all the mills except Pudumjee Pulp & Paper. Status of power consumption in Effluent Treatment Plant in recycled fibre mills is shown below.



This page is kept intentionally blank

Chapter - 5

Benchmarking / Input Norms for various categories of mills

Benchmarking ..... Introduction

The study for Benchmarking and Input Norms of the Paper Industry has been performed using analysis of results of input consumption pattern within different categories of mills. In this chapter the Benchmarking have been derived with the identification of best performance mill in its class of the industry. A performance rating exercise has been conducted to identify the best mill among a class of mills which can be taken up as the benchmark for a category of mills.

Input Norms have been derived based on the analysis of consumption of basic inputs in different segments of the industry considering their technological level and process optimization. The chapter has been divided into two parts. First part deals with Benchmarking and performance rating of the industry. Second section deals with proposed input consumption norms.

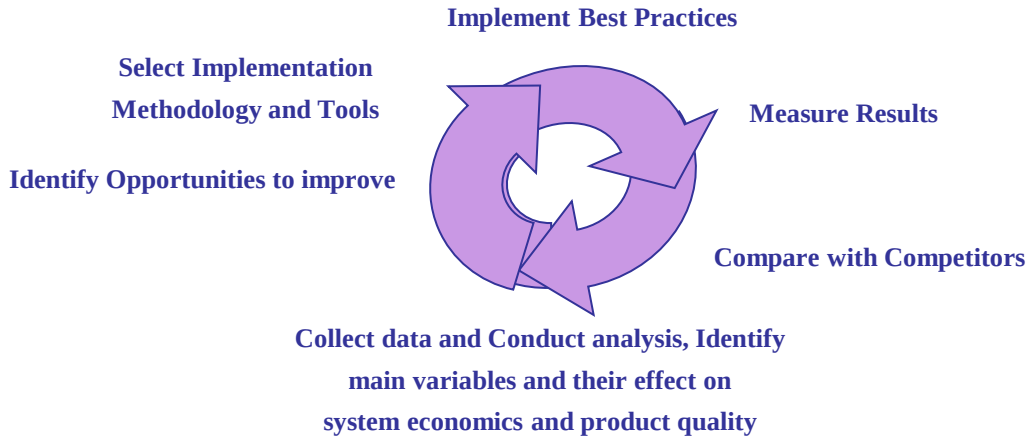
Benchmarking ..... The concept

Benchmarking is fundamental to competitive analysis and is undertaken to compare production costs, mill uptime, energy consumption or other critical parameters. Benchmarking is always conducted within mills of a similar type, producing essentially the same products. Gap analysis then reveals the differences within mills of the same age class, technology status and design layouts etc.

Benchmarking is very useful for energy efficiency studies and helps to provide directions in the search for energy conservation opportunities. For an effective benchmarking exercise, it is important that the studies be carried out at section wise/ process level by energy type, e.g. steam, electricity or fuel used. The consumption analysis carried out as a part of benchmarking study also reveals many areas of process improvement and optimization.

Benchmarking is

1. A continuous process for improvement.
2. A measure of best in class performance that has been achieved in reality.
3. A powerful tool to spot weaknesses and establish improvement goals.



Benchmarking - A continuous improvement tool for Manufacturing Processes

Benchmarking ..... Definition & benefits

Benchmarking is defined as a “systematic and logical method of improving performance by continuously identifying, understanding and adopting outstanding practices and processes found both inside and outside any organization.”

Benchmarking has been successfully applied in the pulp & paper industry in developed countries for;

- Financial performance.
- Cost competitiveness.
- Resource utilisation & energy consumption
- Discharge requirements.
- Strength & weakness of an industry

Benchmarking helps to

- identify best achievable practice
- Measure true productivity / cost effectiveness.
- Establish targets and goals
- Increase performance that is comparable to the best in Industry.

Input Norms Vs Benchmarks…… Concept & limitations

Norms represent the average results for large, representative category based data and it can provide a useful reference point from which results may be compared between different categories. A shortcoming of the averages relates to the goals of a energy efficiency and quality improvement initiative. Thus improvements to an average performance level might be an important preliminary goal, but ultimately benchmarking system should aspire the organizations to excellence. Norms and averages provide little guidance on where excellence lies on the performance continuum.

Benchmarking, a statistical process provides numerical goals reflecting excellent yet achievable performance. Benchmarks reflect results of the highest performing organization in an industry. These results can be used by other organizations to interpret their own performance and develop numerical standards for energy efficiency and quality improvement. Organizations that use industry averages as performance goals may be reinforcing a status quo, whereas benchmarks can help an organization to aim for the best possible results.

The application of statistical benchmarking has been practiced by defining the benchmarks operationally as the performance achieved by the top 10 percent for a sample of data within a category and adjusted for the other numbers. This approach is objective, reproducible and accounts for small sample sizes that can otherwise skew the results. Since measurement based energy & quality assessment and improvement is at an early stage of development in pulp and paper sector in India, and we have collected data from the mills, still we believe that with an emergence of better measurement and control practices in future the reliability of analysis results would improve.

Strengths & Limitations of quality measurement approaches

	Strengths	Limitations
Standards	Set numerical expectations for performance Can reflect expert judgement Do not require extensive data	Can lack empirical foundation Can set expectations that ar either unrealistic or too easily achieved
Means	Available from previous applications of measures Provides a basis for preliminary comparisons Multiple samples may increase utility	May reflect unique characteristics of the populations studied Case mix adjustment is often lacking
Norms	Provides a useful reference point for assessing treatment for large, diverse populations Can be developed for specific sub-populations	Available for few measures Comparison with average results does not encourage excellence.
Statistical Benchmarks	Represents excellent yet achievable results Derived by using objective, reproducible methods.	Limited application to energy efficiency and quality measures in pulp & paper sector. Stratification to other form of case mix adjustment may still be needed.

Benchmarking & Input Norms…….. Methodology

Planning
- Categorization of mills
- Selection of variables
- Selection of mills for study

Collection of data
- Preparation of questionnaire
- Submission of questionnaire
- Mill visits

Data Analysis
- Grouping of mills into different categories
- Relative performance Rating
- Identify best Performance
- Identification of reasons for gaps.

Report Preparation
- Specific Energy Consumption norms
- Recommendations & Targets to be achieved

Benchmarking – Performance Rating and Norms setting of the Mills

Benchmarking & Input Norms…….. Categorization

The industry represents a complex scenario of raw material mix, product ranges varying capacities ranging from 10 to 600 tpd, technological status, amalgamation of aged equipment and obsolete processes along with state of the art machinery and process technologies in the same plant. No two plants have similar outlay of processes & equipment making the industry complex with a complicated structure and highly unorganized state of operation.

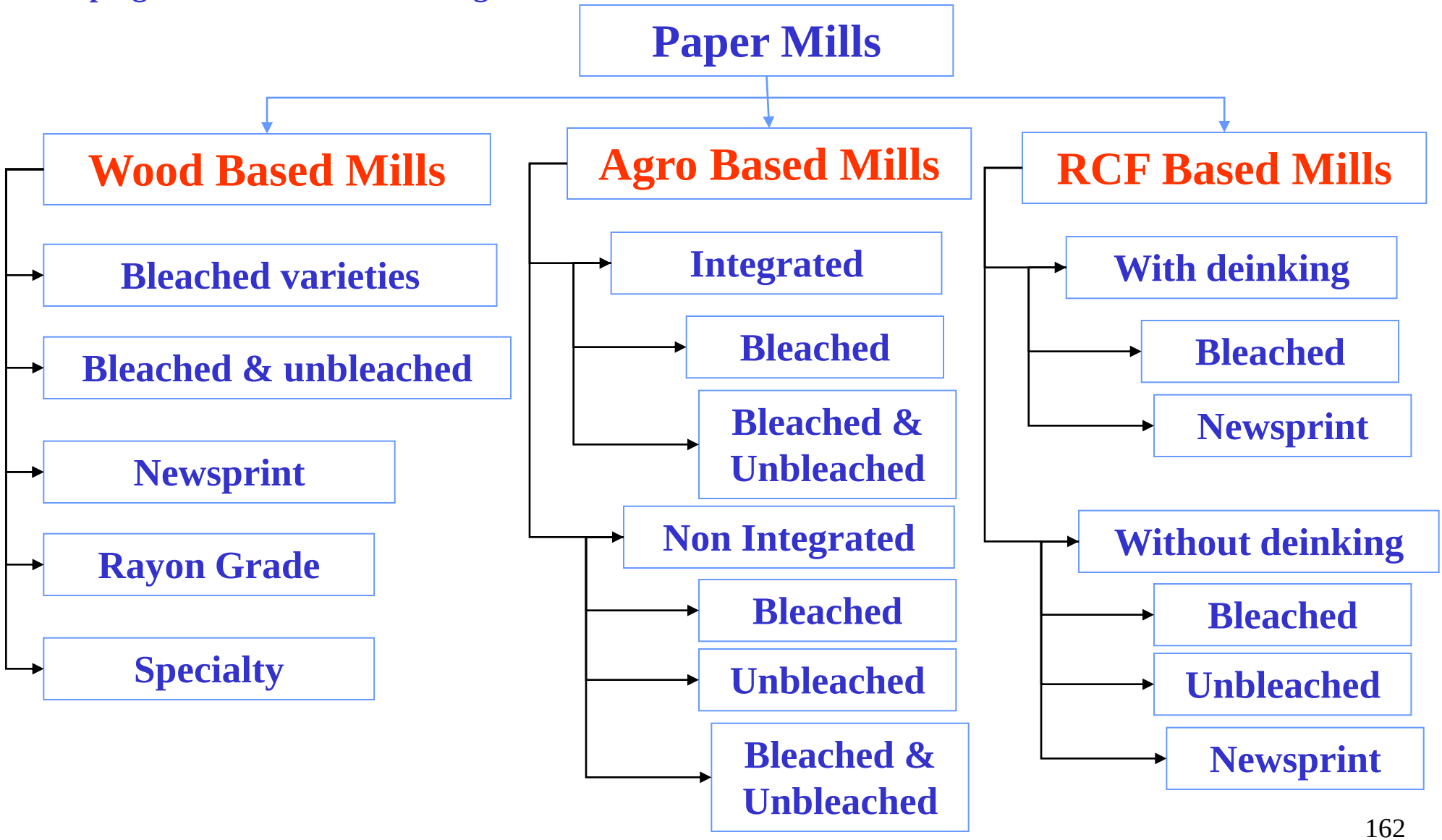
The situation becomes even more difficult when we try to derive benchmarks and Norms for this type of setup, particularly when most of the mills have very small matching among themselves. In other words it is very difficult to compare apples with oranges which are class apart. In an attempt to setup some similarities between these mills, it is necessary to group them into all possible clusters of groups of mills with a matching of similarities among themselves. These groups of mills, among different segments of the industry, would be then compared and analysed for their performance as well as to study the input consumption pattern.

The mills were grouped into three major categories based on the type of raw material. These major categories were further classified into other sub groups considering their similarities in the products.

Clusters of mills in different categories are shown in the categorization chart given in next page. Based on these groupings the Benchmarks (Performance ratings) and input norms have been suggested.

Indian Paper Industry ..... Categorization

Grouping of Mills in different categories



Benchmarking …….. Performance rating of the mills

Benchmarking defines the best practice within a category of mills which can be followed as a guideline for other mills to reach the highest achievable levels. The project study aims to benchmark the pulp & paper industry and to setup some norms of basic input consumption as reference point to assess the efficiency of processes. Following major steps were taken up for performance rating of the mills (Benchmark).

1. As a first step to benchmark the mills, proper categorization was made of the industry in which mills have been grouped representing a cluster of closely matching mills with respect to raw material usage, products, capacity of the mills etc.

2. The data collected from various mills was analyzed and a statistical data base of the mills prepared to observe the variance in inputs and outputs variables in different categories of mills.

3. A performance scoring system was formulated to find out the best performance among a group of mills. This includes

    a. Performance scoring of basic input consumptions among the mills such as
        i. Raw material consumption, t/t paper
        ii. Energy consumption including power & steam used in various processes.
        iii. Chemicals & additives consumption in various sections such as pulping, bleaching, paper making, chemical recovery & utilities etc.
        iv. Water consumption by the mills

    b. Performance scoring of the mills based on the Technological status existing in respective units. This includes
        i. Pulp mill – Digesters
            - Type of digesters, for example batch or continuous
            - Use of latest technology in pulping such as RDH pulping, extended delignification etc.

- Level of automation
- Waste heat utilization eg. Level of blow heat recovery etc.

ii. Washing & screening – Technology used for washing & screening etc.

iii. Bleaching – sequences used with particular emphasis on use of elemental chlorine free bleaching.

iv. Stock preparation & paper machine including technological level of equipments & their speeds.

v. Chemical recovery

- Type of evaporators & boiler
- Steam production and reduction efficiency in boiler
- Lime reburning etc.

vi. Power house

c. Process operation & optimization practiced in the mills. This includes combination of various scoring system for the process variables & their control by the representative mills.

d. Environmental Performance Rating of Industrial sectors considering impact on environment.

An effort was made to study the specific energy consumption and other details of Process & Technology by the whole mill and also section wise details were analyzed. However as the mills could not submit the section wise details of all the inputs, therefore during analysis some of these details were omitted. A complete energy consumption analysis was performed for the mills. Wood based large industries supplied fairly good data and their evaluation was more systematic. The other sectors of the industry such as Agro & RCF mills could not furnish the details in required format therefore, we have considered only few relevant points for scoring.

Since this exercise is being conducted in the pulp & paper sector for the first time, therefore there may be some erroneous reporting of the input by mills and data may not be representative. Therefore CPPRI has taken due to care to include only the relevant information for benchmarking to assess the level of performance of mills.

Benchmarking …….. Performance rating of the mills

4. The performance rating of the mills has been presented showing the best practices in the industry. A Star Rating system has been devised for the mills based on their performance rating.

The best performance mills are those which score above 75% of the scores for best practices mills. These mills are given the 5 star rating.

Other mills have been given star ratings based on their performance scoring on a overall basis. The star rating is given below.

Rating	Performance Level
5 Star Rating	75 % and above
4 Star Rating	65 to 75 %
3 Star Rating	60 to 65 %
2 Star Rating	50 to 60 %
1 Star Rating	below 50 %

The study has been useful to provide an in-depth analysis of the sector and highlight the areas of weakness within the mills which are revealed in the scoring card for a mill. A study of the rating highlights the gray areas which require special attention for improvements and to take up adequate steps to enhance their efficiency levels.

We hope this exercise will initiate a systematic and comparative study of performance evaluation in the pulp & paper sector and in our future endeavor we will have more realistic results with active participation of the industry.

This page is kept intentionally blank

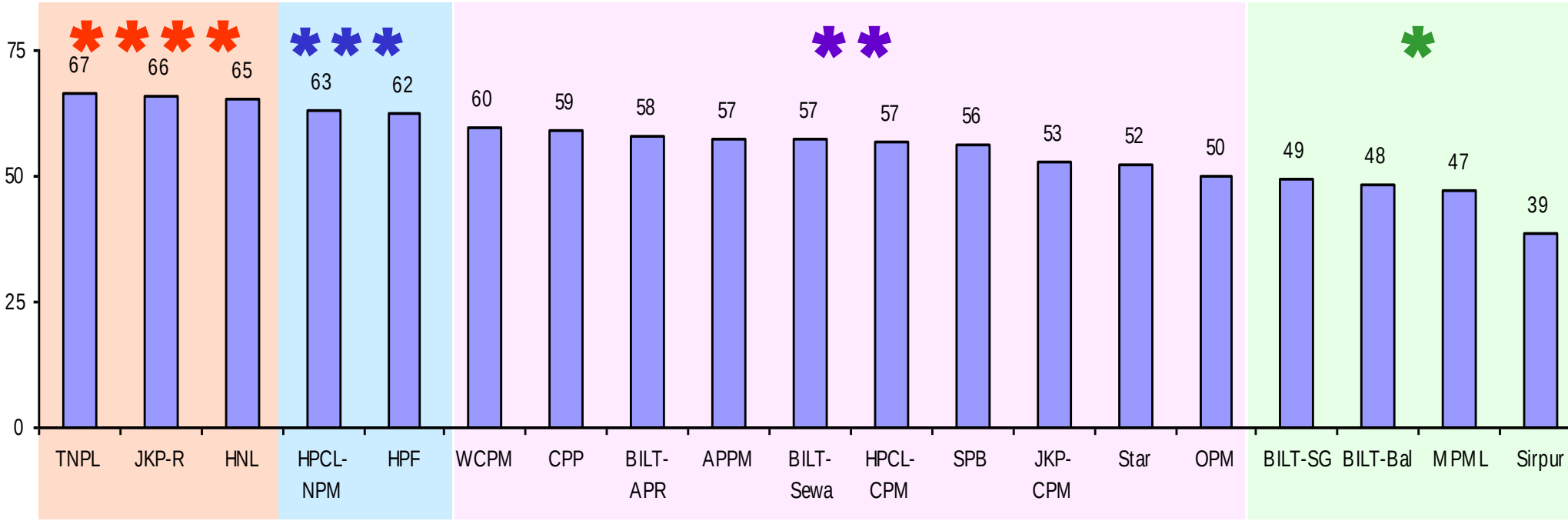
Performance Rating of

Wood based Mills

Wood Based Mills ..... Overall Ranking

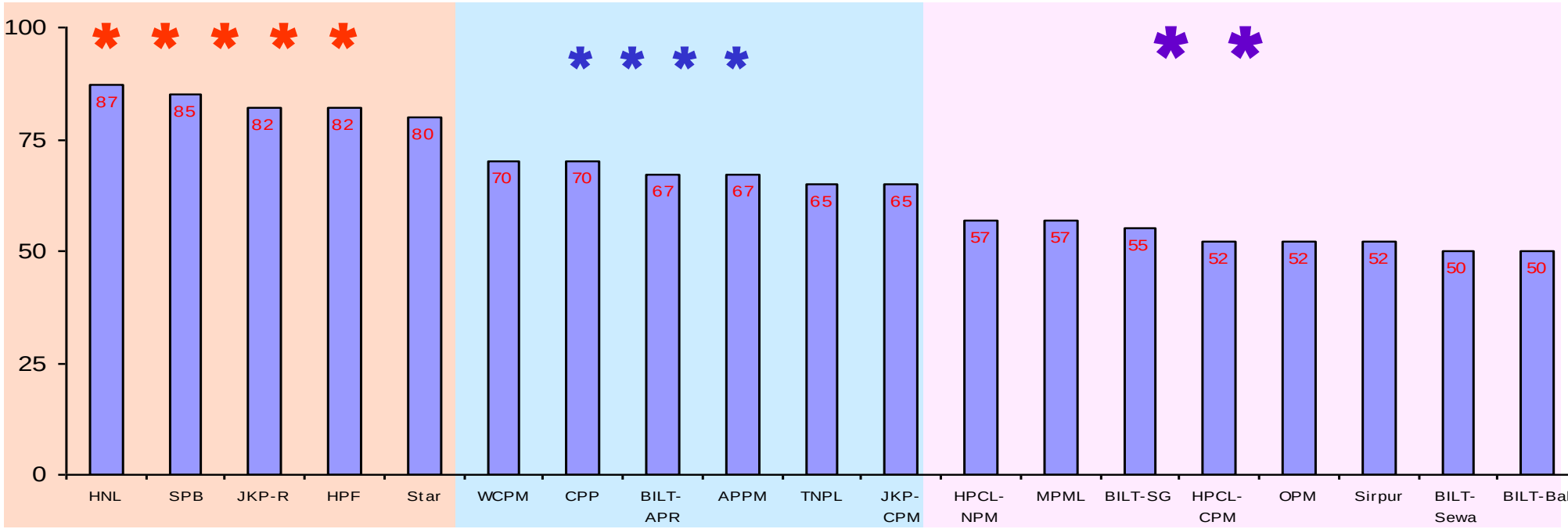
The overall ranking of the mills has been provided by cumulative assessment of performance of the mill in basic input consumption, Technological performance, process operation, optimisation and environmental performance. The overall score of an industry depicts its level of performance and mill performing the highest level can be taken up as the benchmark mill among the industry. The study conducted for all the wood based mills shows that out of the 19 mills which submitted information for the study, none of the mill comes under the 5 star rating. 3 mills have performance level in the 4 star range and have been considered as the best performers on overall basis. Only 2 mills are in the 3 star level, where as performance rating of largest number of mills is in 2 star range. 4 mills have scored single star level and need to review their performance seriously.

A close look on the overall rating is made by comparing them within their category of mills.



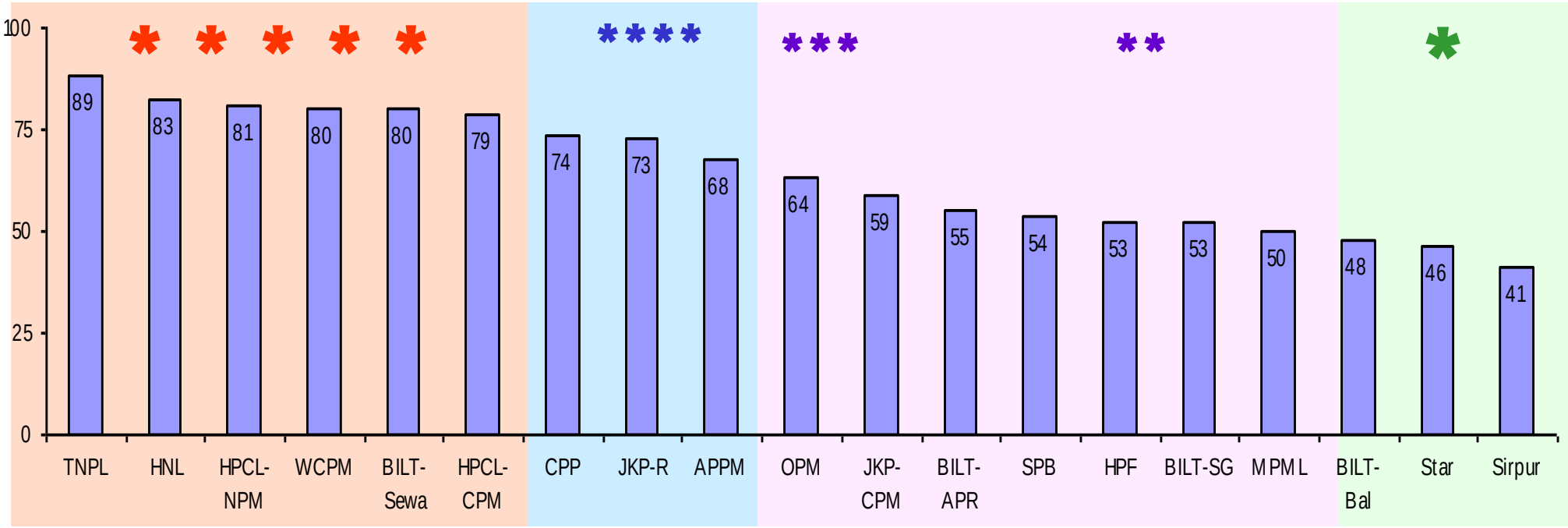
Wood Based Mills ……..Overall Ranking- Input Consumption

An analysis of basic input consumption within the wood based mills indicated that performance of 5 mills is under 5 star rating, 6 mills fall under 4 star rating and 8 mills come under 2 star rating. The input consumption level of the highest ranking mill under a group indicates the best practice in its class of mills. A large number of mills (2 & 3 star mills) have their consumption levels higher than the acceptable range and need to evolve it on individual basis. These mills are suggested to closely monitor their consumption levels and make necessary modifications in their process operations.



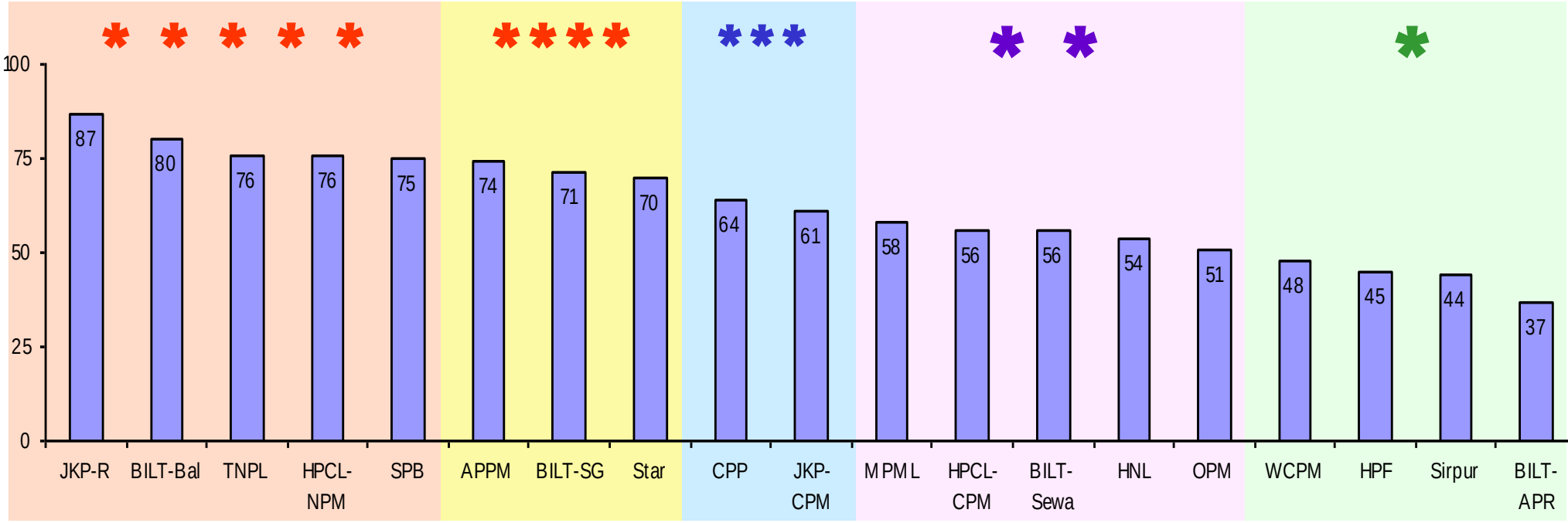
Wood Based Mills ..... Overall Ranking-Technology

The analysis shows that 6 mills have 5 star rating, 3 mills 4 star rating, 1 mill 3 star rating, 6 mills 2 star rating and 3 mills have 1 star rating. The 5 star rating mills show the best technology available in the industry and are considered as benchmarks in their categories of mills. Most of the mills have planned large modifications in their process technologies over the years. Other mills need to upgrade their equipment, process technologies. Many mills are already under technology upgradation process and within a few years the situation may improve. As a result the technology gap would be reduced and overall performance scenario would be totally changed within a short period of time.



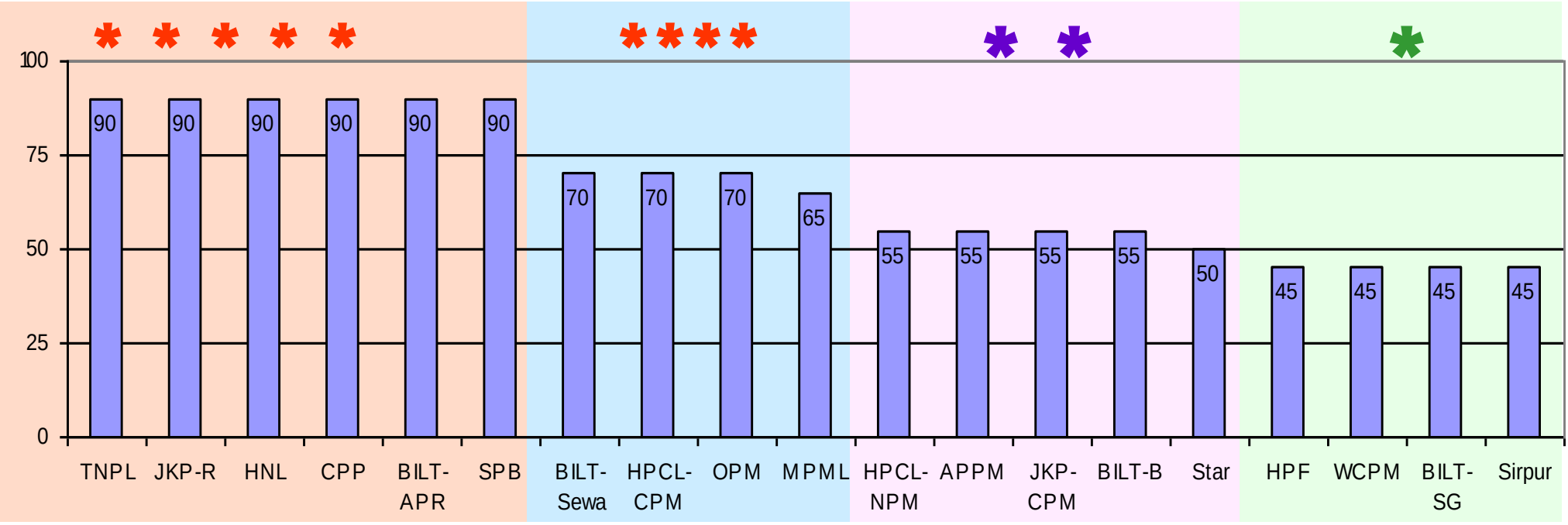
Wood Based Mills .Overall Ranking-Process Control and Optimization

Process control & optimization within the group of mills was also evaluated on overall ranking basis. The results show that 5 mills have 5 star rating indicating state of the art process control and optimization of the processes. These mills form a guideline for other mills to follow. Very close to these mills are three mills coming under the 4 star rating. Rest of the mills need a close look on their process control systems and take adequate steps to optimize their processes. Mills are required to devise their in house programs and monitoring systems to address this issue. Services of external agencies may also be beneficial to take-up the process optimization. HRD initiatives need to be taken up very seriously to train the staff for better control of the processes. Strength of an organization rests on its manpower assets and better controls and optimization are possible through human intervention only.



Wood Based Mills ……. Overall Ranking- Environment

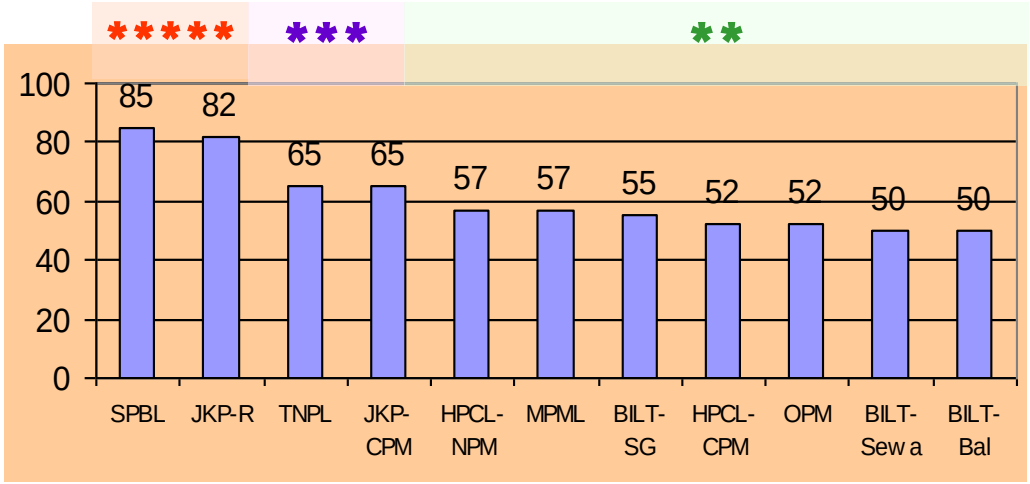
Environmental performance of the mill on a rating scale was performed to identify the best mill on environmental performance basis. 6 mills have been rated as 5 star in terms of their environmental performance and are considered as the best practice.



Wood Based Mills …….. Category wise Ranking of Basic Input

The performance rating of the mills have been assessed among the group of mills producing different types of products. This analysis shows performance of the mills within their groups and indicates best performance among competitors. The category wise ranking of the mills is depicted considering the basic input consumption by the mills for producing the same type of product.

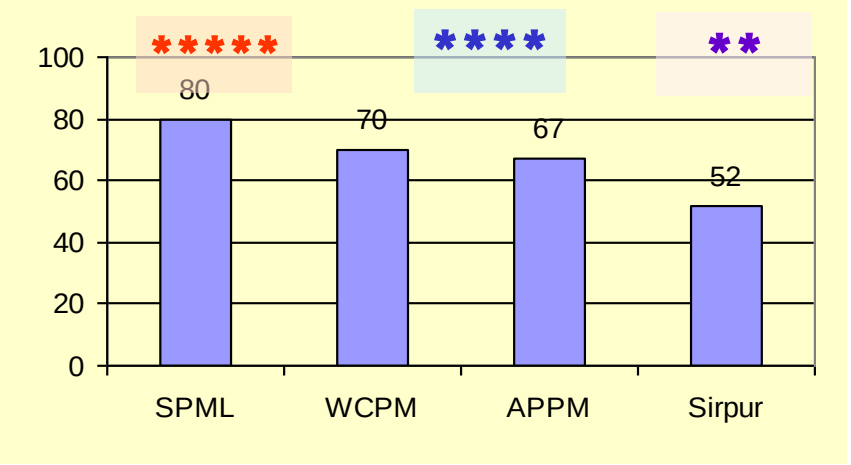
Bleached Varieties



Among the category of mills producing bleached varieties (writing printing) 2 mills have shown 5 star rating. 2 mills are within 3 star rating. The 5 star rating mills have been considered for setting up the norms.

Among the mills producing bleached & unbleached varieties (writing printing & kraft), 1 mill has shown 5 star rating. 2 mills are within 4 star rating. 1 mill has 2 star rating.

Bleached & Unbleached Variety



Wood Based Mills …….. Ranking – Basic Input consumption

Newsprint

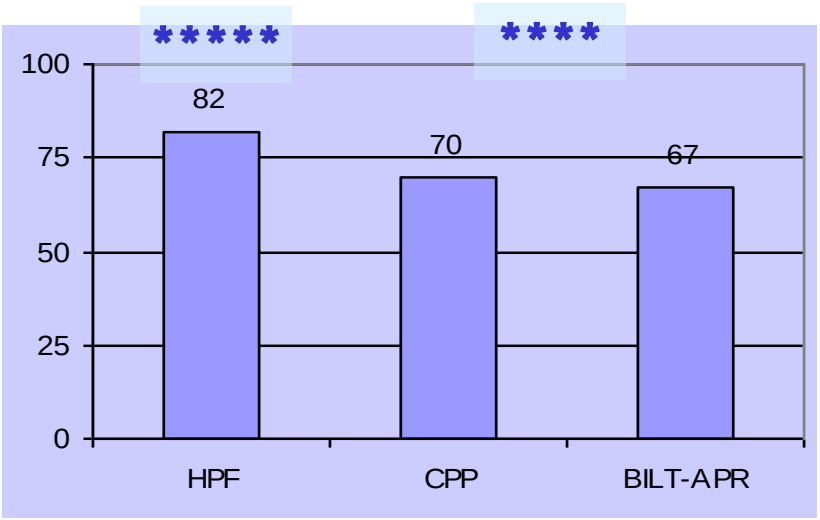
HNL is the only mill producing newsprint as major product. Other mills (MPM & TNPL) have major share of writing printing paper and therefore are grouped among the mills producing bleached varieties.

Hindustan Newsprint Ltd.	87	*****

Miscellaneous

This category includes mills providing Rayon grade and other bleached varieties. The ranking of these mills is shown below

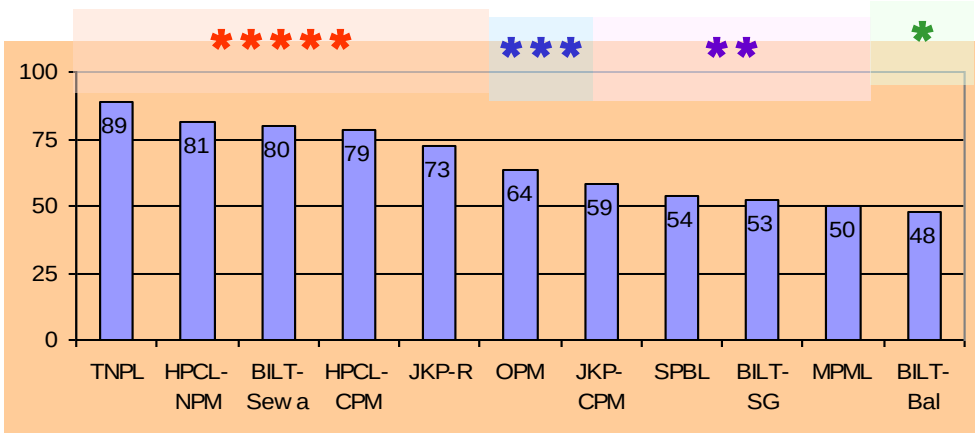
Harihar Polyfibers	82	*****
Century Pulp & Paper	70	****
Ballarpur Industries Ltd., Unit AP Rayon	67	****



Wood Based Mills …… Ranking – Technology

Technological inputs in the wood based mills have been compared among different groups of mills to highlight the best performer within a group of mills.

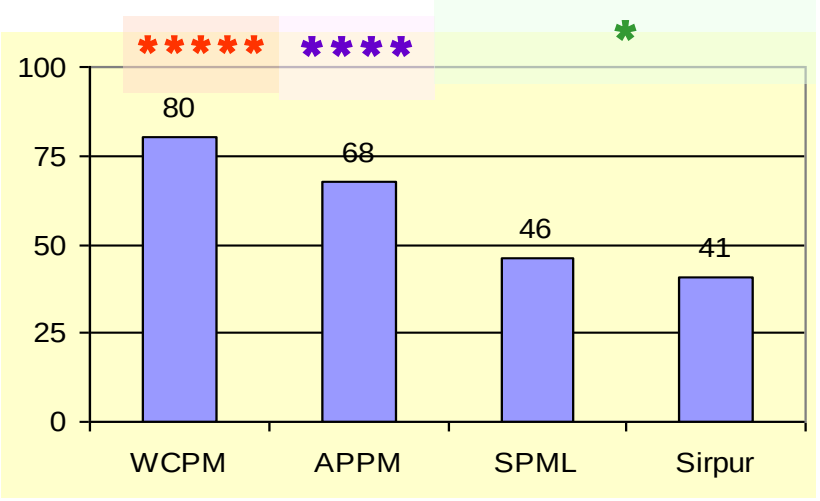
BLEACHED MILLS



4 mills among the bleached varieties (writing printing) producers have shown 5 star rating. 1 mill is within 4 & 3 star rating.

BLEACHED & UNBLEACHED MILLS

Only 1 mill producing bleached & unbleached varieties has shown 5 star rating. 1 mill is within 4 star rating and 2 mills qualify for 1 star rating



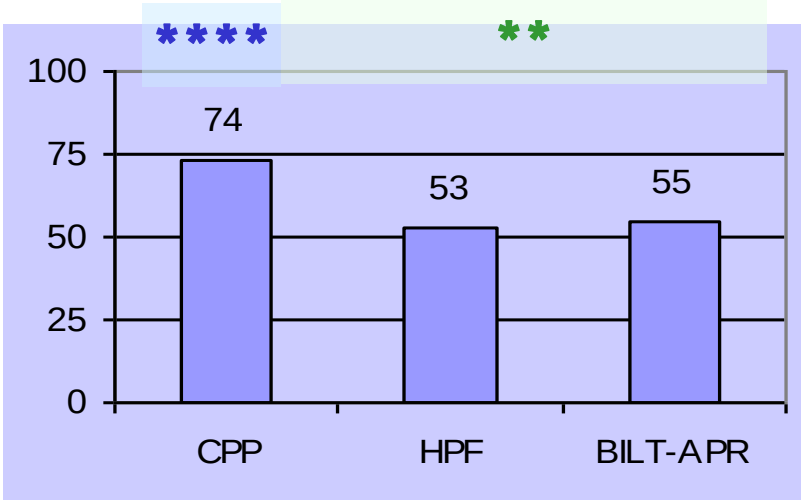
Wood Based Mills …….. Ranking – Technology

Newsprint

Hindustan Newsprint Ltd.	82.5	*****

Miscellaneous

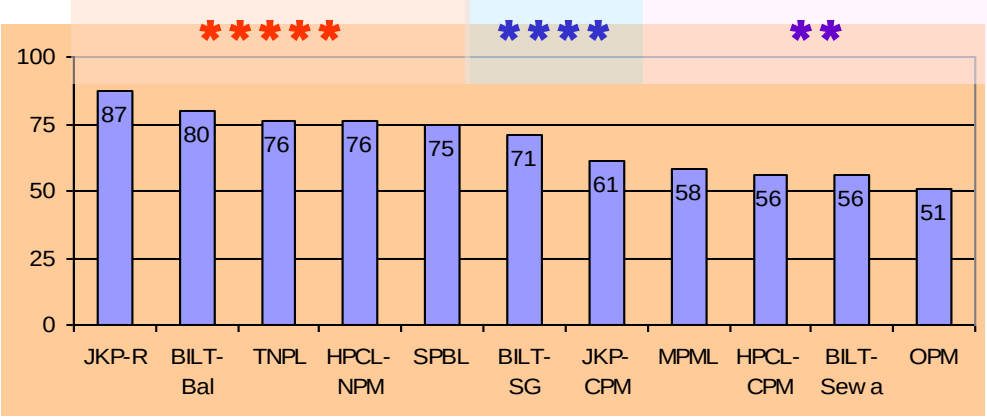
Harihar Polyfibers	72.5	****
Century Pulp & Paper	53.5	**
Ballarpur Industries Ltd.,Unit AP Rayon	55.0	**



Wood Based Mills …….. Ranking – Process Operation

The process control operation and optimization when compared among the group of mills producing similar products also delineated the best performer in cluster of producers.

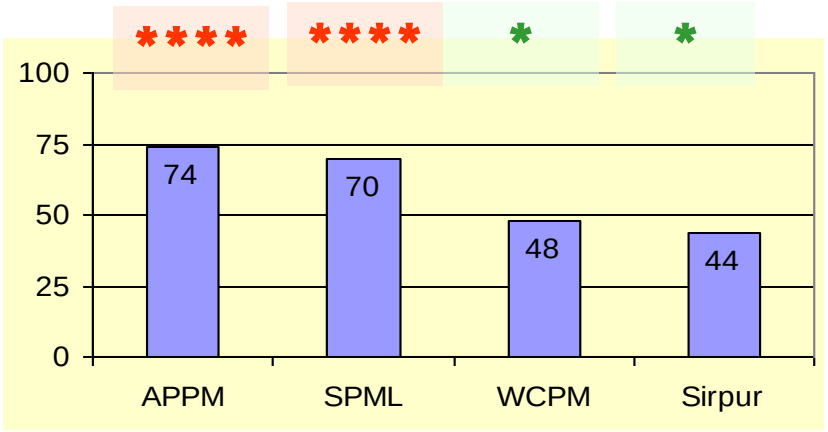
BLEACHED MILLS



The rating of the process operations among a group of mills producing bleached varieties has shown fairly a good process operations by these mills. 5 mills among the bleached varieties (writing printing) producers have 5 star rating. 1 mill is within 4 star rating and 4 mills are within 2star rating.

BLEACHED & UNBLEACHED MILLS

2 mills among the bleached & unbleached varieties have 4 star rating. And 2 mills are within 1 star rating.



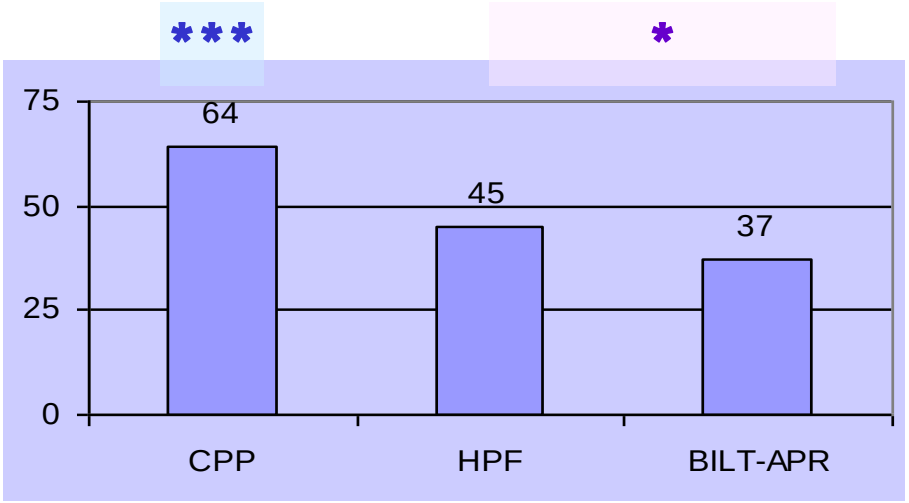
Wood Based Mills …….. Ranking – Process Operation

Newsprint

Hindustan Newsprint Ltd.	54	**

Miscellaneous

Century Pulp & Paper	64	***
Harihar Polyfibers	45	*
Ballarpur Industries Ltd.,Unit AP Rayon	37	*



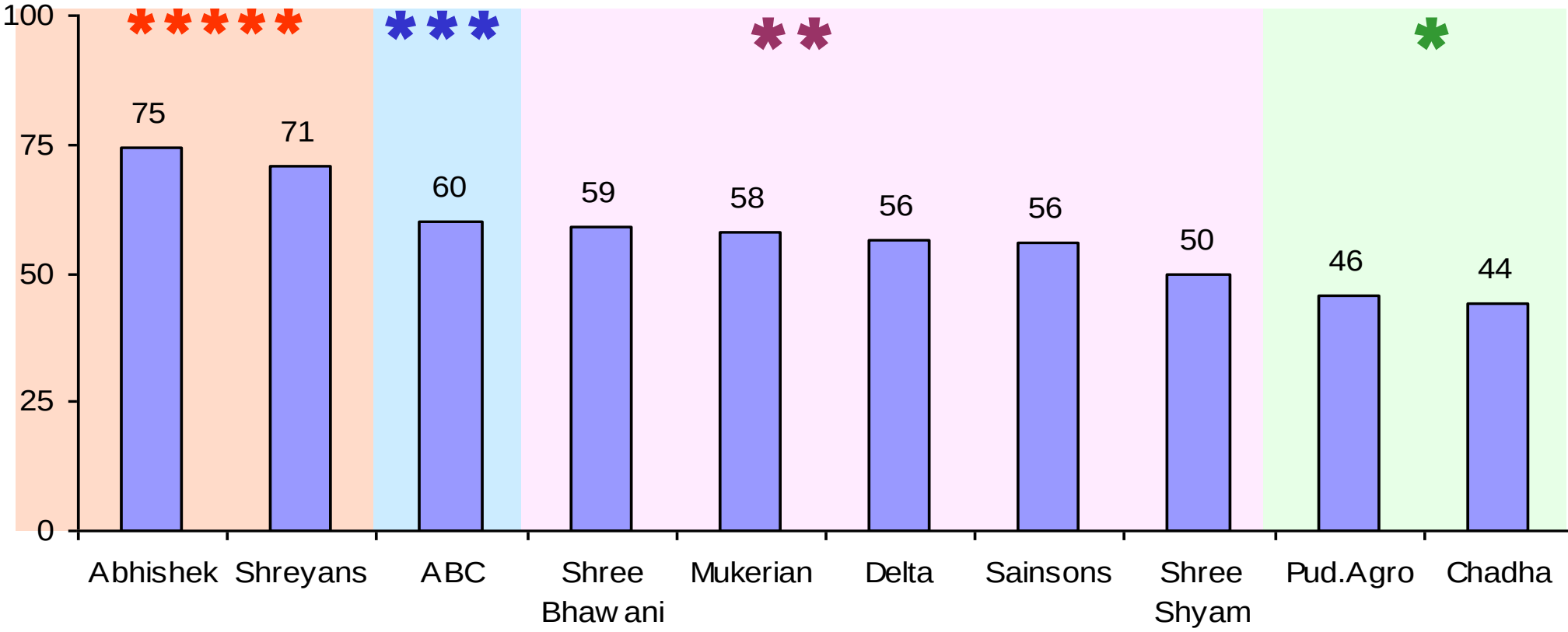
This page is kept intentionally blank

Performance Rating of Agro based Mills

Agro Based Mills ..... Ranking - Overall

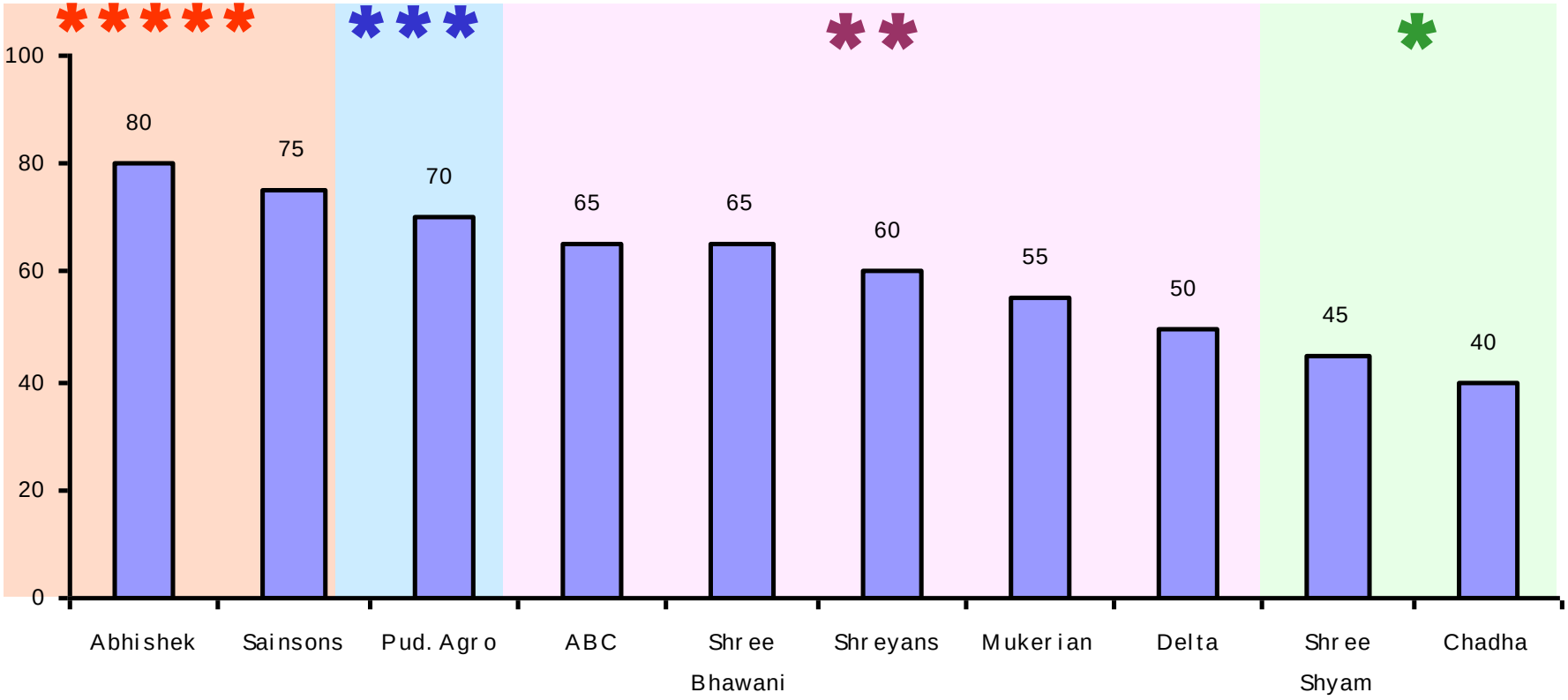
Out of the 10 mills which submitted information for the study, 2 mills come under the 5 star rating. 1 mill has performance level in the 3 star range. The 5 star rating mills have been considered as the best performers on overall basis. 5 mills are in the 2 star level. The performance rating indicates that largest number of mills are in 2 star range. 2 mills have scored single star level and need to review their performance seriously.

A close look on the overall rating is made by comparing them within their category of mills.



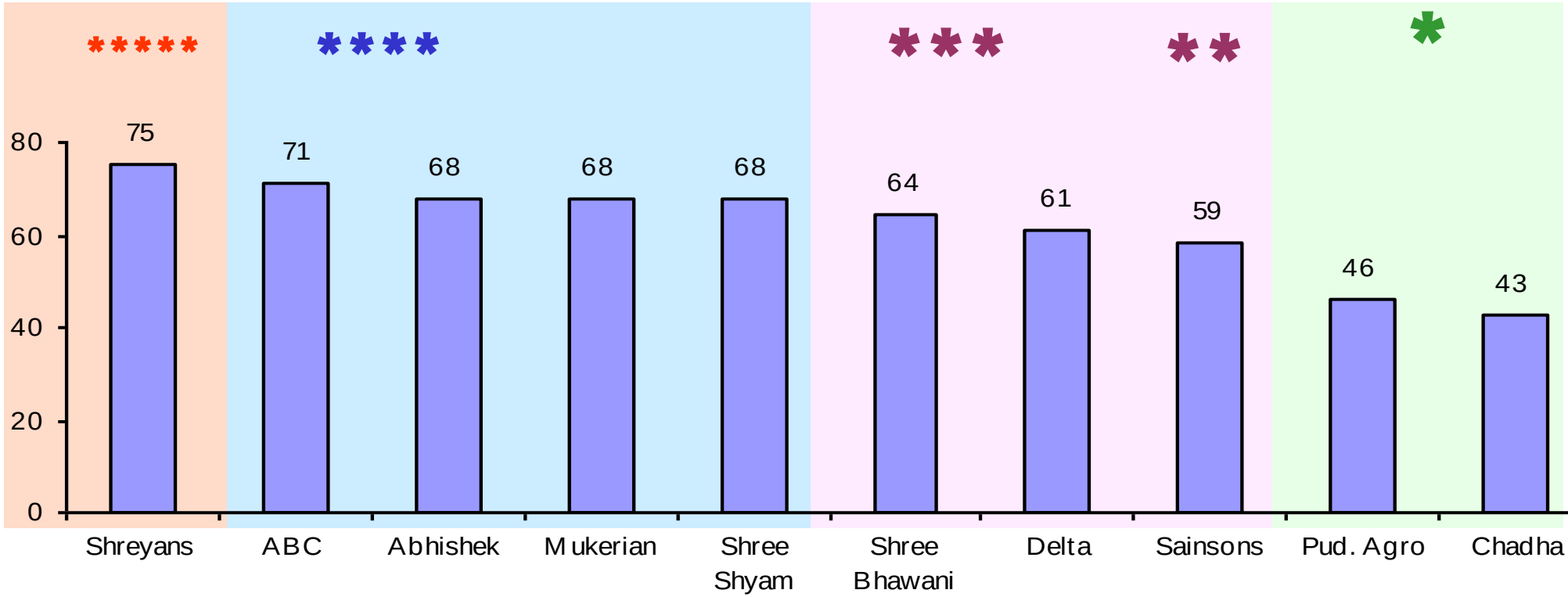
Agro Based Mills ..... Ranking – Basic Input

Out of the 10 mills, 2 mills come under the 5 star rating. 1 mill has performance level in the 3 star range. The 5 star rating mills have been considered as the best performers for basic input consumption. 5 mills are in the 2 star level and as performance rating indicate that largest number of mills are in 2 star range. 2 mills have scored single star level. The 2 & 1 star ranking mills need to evaluate their input consumption on individual basis and make necessary up-gradations in process technologies, equipments and operations to improve the basic input consumption levels.



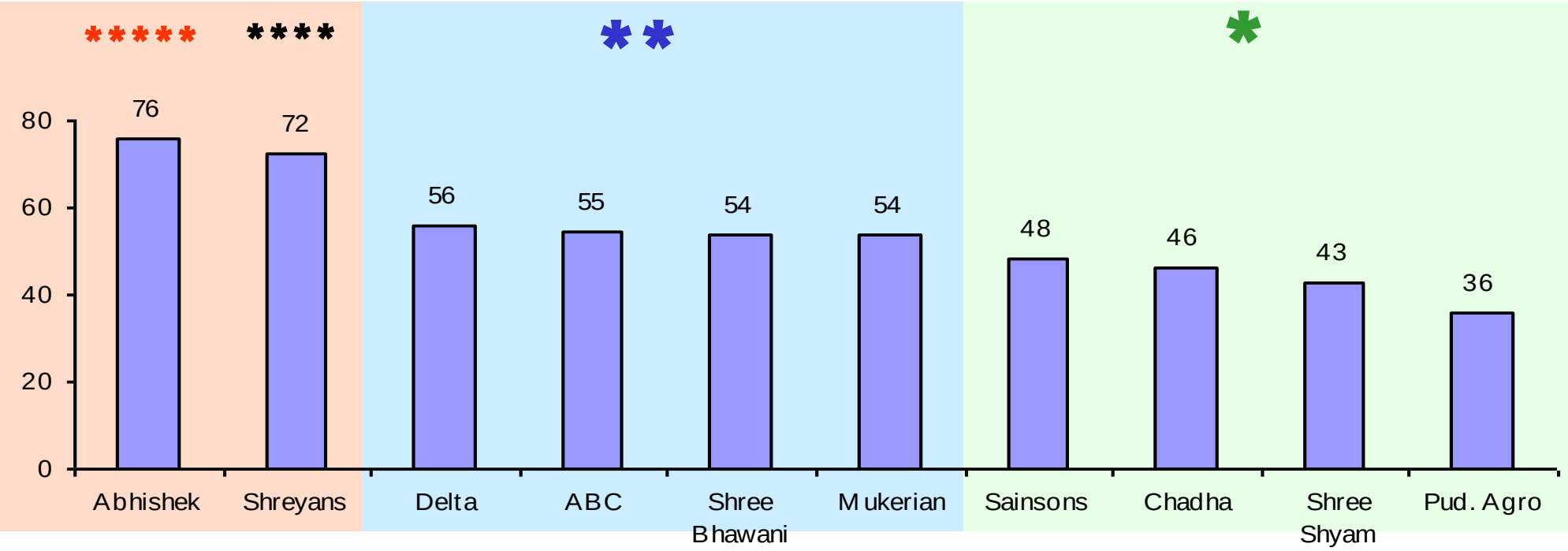
Agro Based Mills ..... Ranking – Process Optimization

Out of all the mills, 1 mill comes under the 5 star rating. 4 mills have performance level in the 4 star range. The 5 & 4 star rating mills have been considered as the best performers for process control & process optimization basis. 2 mills are in the 3 star level, 1 mill is in 2 star level. 2 mills have scored single star level and need to review their performance seriously.



Agro Based Mills …….. Ranking – Technology

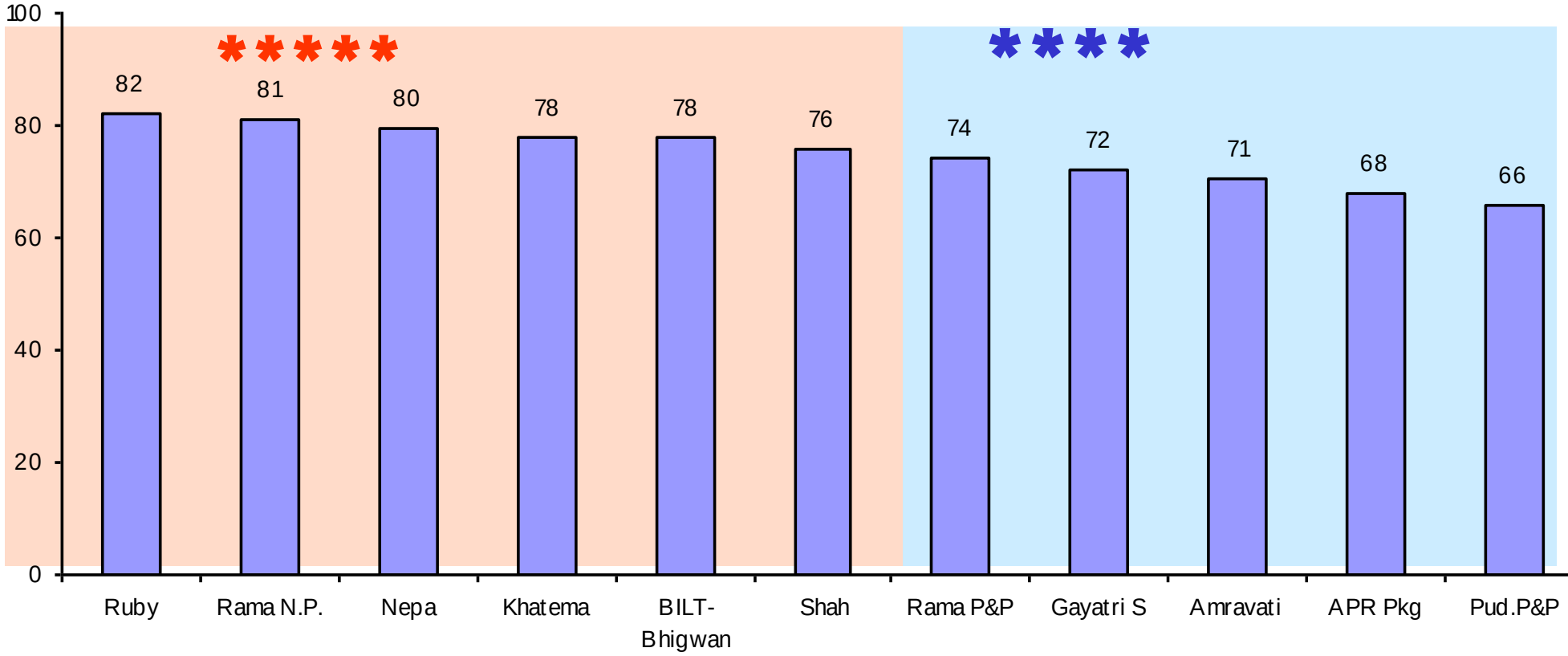
The technology performance analysis indicates that 1 mill in this category is under the 5 & 4 star rating. These mills have been considered as the best performers considering the technological inputs. 4 mills are in the 2 star level. 4 mills have scored single star level. The analysis shows low technology inputs in above sectors which has seriously affected their overall performance and would adversely affect their cost competitiveness.



Performance Rating of Recycled Fibre based Mills

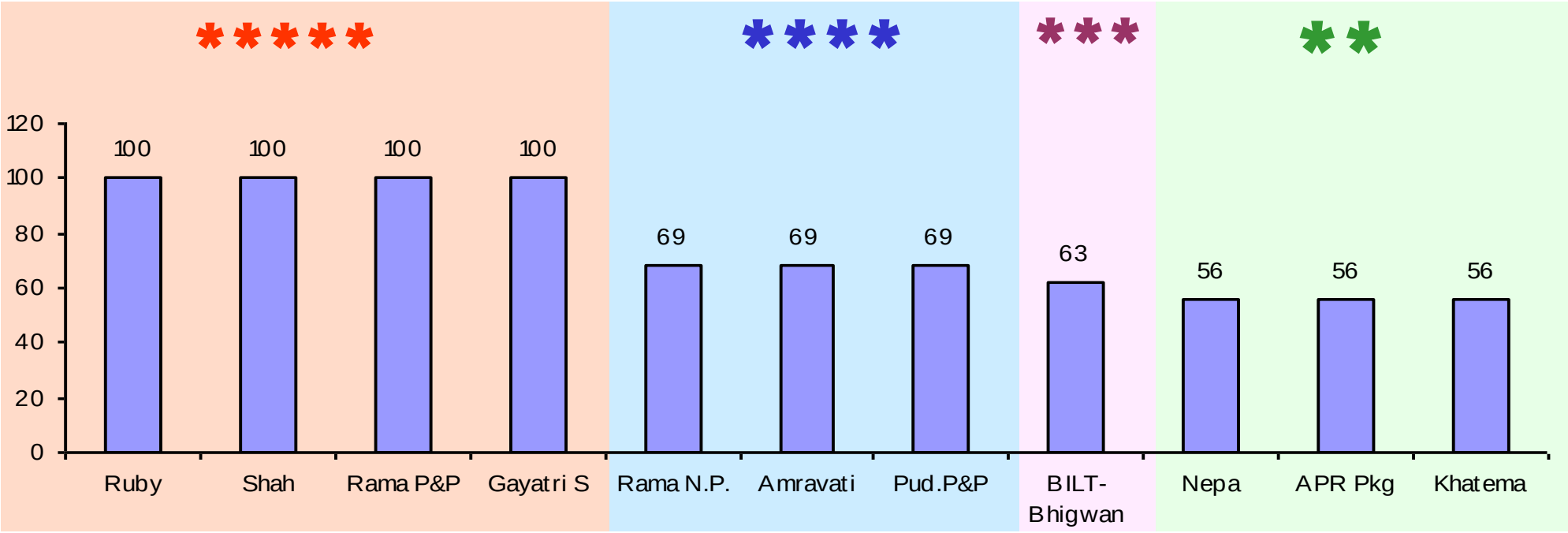
Recycled Fibre Based Mills ……. Ranking - Overall

11 mills submitted information for the study and performance rating has revealed that 6 mills are in the 5 star rating. These mills have been considered as the best performers on overall basis. 4 mill have performance level in the 4 star range. A large number of mills are in 5 & 4 star range.



Recycled Fibre Based Mills ……. Ranking – Basic Input

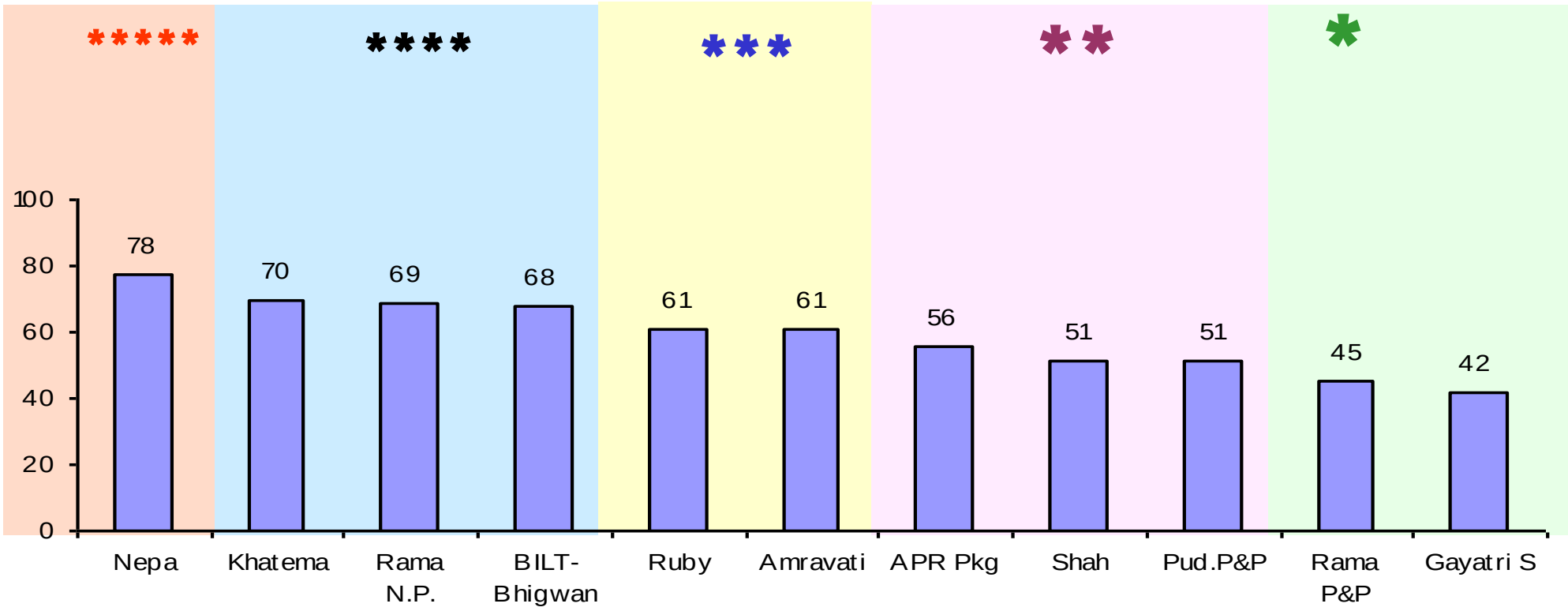
The basic input consumption performance analysis for recycle fiber based mills indicate that 4 mills have consumption levels in the range of 5 star rating. 3 mills have performance level in the 4 star range. This indicates that fairly good consumption pattern in this sector of the paper industry. The 5 star rating mills have been considered as the best performers on basic input consumption basis. The mills in 3 & 2 star category are low in scoring on account of high quality product manufacturing.



Recycled Fibre Based Mills ……. Ranking – Technology

The technology status of RCF mills shows very poor technological input in this sector. Only 1 mill has qualified 5 star rating, 3 mills has qualified 4 star rating. 2 mills have performance level in the 3 star range and 3 mills under 2 star rating. The 5 star rating mills has been considered as the best performer on technological basis.

Due to poor status of technology none of the mills has submitted process details as requested in the questionnaire. Therefore no ranking on the basis of process control & optimization has been prepared.



This page is kept intentionally blank

Input Norms

for

Paper Industry

Input Norms ……Setting up of Basic Input Norms

The setting up of basic input norms for different categories of mills based on the study of average consumption pattern of various input such as raw material, chemicals, purchased energy, steam & power consumption among a category of mills, has been attempted in the study. For setting up of norms the consumption pattern of steam & power has been studied and the average figures out of the best practice for different categories of mills have been presented as norms. For arriving at the norms the due consideration has been given to various factors such as status of processes, technological status prevailing in the industry and optimization of the process variables.

The norms would provide the industry guidelines to track and monitor their energy consumption levels and help to perform sensitivity analysis of the process variables to achieve the best performance. The input consumption norms derived for various categories of mills are presented in this section.

The categories of mills and types of paper for which the norms are proposed are as follows

a. Wood pulp based integrated mills:-
- **Bleached varieties**
- **Bleached & Unbleached varieties**
- **Newsprint**
- **Speciality / Rayon grade pulp**

b. Agro & RCF pulp based mills
- **Bleached varieties**
- **Bleached & Unbleached varieties**
- **Unbleached varieties**

c. RCF mills

i. with deinking
- **Bleached varieties**
- **Newsprint**

ii. RCF mills without deinking
- **Bleached varieties**
- **Unbleached varieties**
- **Newsprint**

Input Norms ……Wood Pulp Based mills-Bleached Varieties

The overall input consumption norms, best practice & range of consumption of 8 mills is given below:
Raw Material :- 100% Hardwood; Process:- Chemical Kraft; Product:- Bleached 100%
Varieties :- Writing & Printing

		Norms	Best Practice	Range of consumption Minimum	Maximum
Raw material	t/t of paper	2.05	2.01	2.01	2.35
Chemical - Pulping					
• Active Alkali charge as Na_2O	%	13	11.2	11.2	16.9
• Kappa No.	No.	16	14	14	23
Chemical - Bleaching					
• Chlorine (Cl_2 +ClO_2 as Cl_2)	kg/t	91	87(75+12)	87(75+12)	126(110+16)
• Sequence • ISO Brightness	 %		(CEpHED) 85-86		
• NaOH	kg/t	29	27	27	49
• H_2O_2	kg/t	3.3	2	2	17
Chemical - Stock Preparation					
• Fillers	kg/t	210	223	53	223
• Rosin	kg/t	11.5	11.0	11.0	15.0
• Alum	kg/t	30	29	29	32
Energy					
• Purchased energy	kcal/t x 10^6	7.7	6.0	6.0	12.0
• Steam	t/ t of finished paper	9	10.23	10.23	18.35
• Power	kWh/ t of finished paper	1300	1300	1300	1773
• Water	m^3/ t of finished paper	120	85.2	85.2	198

Input Norms ……Wood Pulp Based mills-Bleached Varieties

Specific Steam Consumption :-

The Norm 9.0 t/t does not include the steam used in power generation through steam turbines.

	t/t of finished paper
Pulp Mill	1.3
Bleach Plant	0.3
Evaporators	1.2
Soda Recovery Plant	1.4
Paper Machine	2.5
Boilers	1.2
Others	1.1
Total	**9.0**

Specific Power Consumption :-

1.The Norm 1300 kWh/t does not include the power consumption for condensing steam turbine auxiliaries.

2.The above consumption is for surface sized paper produced on paper machines with sizing press in between the pre & post dryers. This does not include power for production of coated paper, which may be additional 80-100 kWh/t in a typical case.

3. The figure of 80 kWh/t for bleach plant is for CEpHH sequence. It may vary from 80-100 kWh/t for others sequences. The power consumption in chemical plant is not included in overall consumption.

	kWh/t of finished paper
Chippers	20
Digestors	40
Washing & Screening	110
Bleach Plant	80
Stock Preparation	150
Paper Machine	450
Boilers	125
Recovery Section	125
Water system	50
Effluent Treatment	40
Others	110
Total	**1300**

Input Norms ……Wood Pulp Based mills-Unbleached Varieties

The overall input consumption norms, best practice & range of consumption of 4 mills is given below:
Raw Material :- Hardwood, RCF and Market Pulp; Process:- Chemical Kraft;
Product:- Bleached & Unbleached; Varieties :- Writing , Printing and Kraft

		Norms	Best Practice	Range of consumption Minimum	Maximum
Raw material	t/t of paper	2.14	2.0	2.0	2.3
Chemical - Pulping					
• Active Alkali charge as Na_2O	%	13.4	12.7	12.7	14.5
• Kappa No.	No.	18.5	17	17	23
Energy					
• Purchased energy	kcal/t x 10^6	5.6			
• Steam	t/ t of finished paper	7.0			
• Power	kWh/ t of finished paper	1150			
• Water	m^3/ t of finished paper	120			

Input Norms ……Wood Pulp Based mills-Unbleached Varieties

Specific Steam Consumption :-

1.The Norm 7.0 t/t does not include the steam used in power generation through steam turbines.

2. The Norms for unbleached varieties are based on integrated mills producing Writing & Printing and Kraft varieties. The energy consumption for bleaching and additional systems by these mills has not been included in this case.

	t/t of finished paper
Pulp Mill	1.0
Evaporators	1.2
Soda Recovery Plant	1.2
Paper Machine	2.2
Boilers	1.2
Utilities & others	0.2
Total	**7.0**

Specific Power Consumption :-

1. The Norm 1150 kWh/t does not include the power consumption for condensing steam turbine auxiliaries.

	kWh/t of finished paper
Chippers	20
Digestors	40
Washing & Screening	110
Stock Preparation	150
Paper Machine	400
Boilers	125
Recovery Section	125
Water system	50
Effluent Treatment	40
Others	90
Total	**1150**

Input Norms ……Wood Pulp Based mills-Newsprint Varieties

The overall input consumption norms, best practice & range of consumption of 1 mill is given below:
Raw Material :- Hardwood, Agro residues, RCF and Market Pulp; Product:- Bleached;
Process:- Chemical Kraft & Chemi-Mechanical; Varieties :- Newsprint

		Norms
Raw material	t/t of paper	1.41
Chemical - Pulping		
• Active Alkali charge as Na_2O	%	17
• Kappa No.	No.	18
Chemical - Bleaching		
• Cl_2	kg/t	41
• Sequence • ISO Brightness	 %	CEp 68
• NaOH	kg/t	20
• H_2O_2	kg/t	17
Energy		
• Purchased energy	kcal/t x 10^6	7.0
• Steam	t/ t of finished paper	5.0
• Power	kWh/ t of finished paper	2100
• Water	m^3/ t of finished paper	100

Input Norms ……Wood Pulp Based mills-Newsprint Varieties

Specific Steam Consumption :-

1.The Norm 5.0 t/t does not include the steam used in power generation through steam turbines.

	t/t of finished paper
Pulp Mill (Chemical Plant)	0.4
CMP Plant	0.2
Soda Recovery (including Evaporators)	1.5
Paper Machine	2.2
Boilers	0.6
Others	0.1
Total	**5.0**

Specific Power Consumption :-

1. The Norm 2100 kWh/t does not include the power consumption for condensing steam turbine auxiliaries.

	kWh/t of finished paper
Chippers	20
Digestor, Washing & Screening and bleach plant	80
CMP	1050
Stock Preparation & Paper Machine	600
Boilers	125
Recovery & Evaporators	100
Water system	45
Effluent Treatment	40
Others	40
Total	**2100**

Input Norms ……Wood Pulp Based mills-Rayon grade Varieties

The overall input consumption norms, best practice & range of consumption of 2 mills is given below:
Raw Material :- Wood – 100%; Product:- Bleached & Unbleached
Process:- Chemical Kraft ; Varieties :- Rayon grade pulp

		Norms	Best Practice	Range of consumption Minimum	Maximum
Raw material	t/t of paper	2.82	2.74	2.74	2.89
Chemical - Pulping					
• Active Alkali charge as Na_2O	%	13	13	13	13
• Kappa No.	No.	9.15	9.0	9.0	9.3
Chemical - Bleaching					
• Chlorine (Cl_2 +ClO_2 as Cl_2)	kg/t	45	38(29+9)	38(29+9)	76(55+21)
• Sequence • ISO Brightness	% 		CEOoHEDSO2 95.5		
• NaOH	kg/t	20	16	16	45
• H_2O_2	kg/t	13	13	13	13
Energy					
• Purchased energy	kcal/t x 10^6	3.0	2.15	2.15	5.37
• Steam	t/ t of finished paper	8.0	9.2	9.2	13.46
• Power	kWh/ t of finished paper	800	889	889	1074
• Water	m^3/ t of finished paper	120	138	138	176

Input Norms ……Wood Pulp Based mills-Rayon grade Varieties

Specific Steam Consumption :-

1.The Norm 8.0 t/t does not include the steam used in power generation through steam turbines.

	t/t of RG Pulp
Pulp Mill (Chemical Plant)	1.3
Bleach Plant	0.3
Evaporators	1.2
Soda Recovery Plant	1.4
Pulp drying machine	1.3
Boilers	1.2
Others	1.3
Total	**8.0**

Specific Power Consumption :-

1. The Norm 800 kWh/t does not include the power consumption for condensing steam turbine auxiliaries.

	kWh/t of finished paper
Chippers	20
Digestor	60
Washing & Screening	110
Bleach plant	100
Pulp drying	120
Boilers	100
Recovery Section	100
Water system	50
Effluent Treatment	40
Others	100
Total	**800**

Input Norms .....Agro Based mills-Bleached Varieties

The overall input consumption norms, best practice & range of consumption of 4 mills is given below:
Raw Material :- Agro residue, RCF & Market Pulp; Product:- Bleached Process:- Chemical Soda; Varieties :- Writing & Printing

		Norms	Best Practice	Range of consumption Minimum	Maximum
Raw material	t/t of paper	1.86	1.47	1.47	2.44
Chemical - Pulping					
• Active Alkali charge as NaOH	Rice Straw, %	7	--	--	--
	Wheat Straw, %	15	--	--	--
	Bagasse, %	15	--	--	--
• Kappa No.	Rice Straw	13.5	--	--	--
	Wheat Straw	13.5	13.5	13.5	22.5
	Bagasse	13.5	13.5	13.5	22.5
Chemical - Bleaching					
• Cl_2	kg/t	100	90	90	130
• Sequence • ISO Brightness	 %		CEH 75		
• NaOH	kg/t	30	15	15	50
• H_2O_2	kg/t	10	10	10	10

Input Norms .....Agro Based mills-Bleached Varieties

		Norms	Best Practice	Range of consumption Minimum	Maximum
Chemical - Stock Preparation					
• Fillers	kg/t	175	--	--	--
• Rosin	kg/t	8.0	--	--	--
• Alum	kg/t	50	--	--	--
Energy					
• Purchased energy	kcal/t x 10^6	6.7	5.0	5.0	8.0
• Steam	t/ t of finished paper	7.5	4.1	4.1	8.94
• Power	kWh/ t of finished paper	1050	1141	1141	1215
• Water	m^3/ t of finished paper	150	67	67	146

Input Norms ……Agro Based mills-Bleached Varieties

Specific Steam Consumption :-

1.The Norm 7.5 t/t does not include the steam used in power generation through steam turbines.

Section	t/t of finished paper
Pulp Mill	1.2
Bleach Plant	0.3
Evaporators	1.2
Soda Recovery Plant	1.4
Paper Machine	2.5
Deareator	0.6
Others	0.3
Total	**7.5**

Specific Power Consumption :-

1. The Norm 1050 kWh/t does not include the power consumption for condensing steam turbine auxiliaries.
2. The Norm for mills without Recovery System

•Power Consumption = Norm - 125 kWh/ t

•Steam Consumption = Norm – 2.6 t/t

Section	kWh/t of finished paper
Raw material Preparation, Pulping and Bleach plant	200
Stock Preparation & Paper Machine	550
Boiler House	85
Recovery Section	125
Water System	50
ETP	40
Others	--
Total	1050

Input Norms .....Agro Based mills-UnBleached Varieties

The overall input consumption norms, best practice & range of consumption of 2 mills is given below:
Raw Material :- Agro residue, RCF & Market Pulp; Product:- Bleached & Unbleached Process:- Chemical Soda; Varieties:- Writing & Printing, Tissue and Kraft

		Norms	Best Practice	Range of consumption Minimum	Maximum
Raw material	t/t of paper	1.55	1.4	1.4	1.69
Chemical - Pulping					
• Active Alkali charge as NaOH	Rice Straw, %	13.9	--	--	--
	Wheat Straw, %	13.9	--	--	--
	Bagasse, %	12.2	--	--	--
• Kappa No.	Rice Straw	13	--	--	--
	Wheat Straw	13	--	--	--
	Bagasse	13	--	--	--
Energy					
• Purchased energy	kcal/t x 10^6	5.0	6	6	11
• Steam	t/ t of finished paper	3.3	4	4	6.6
• Power	kWh/ t of finished paper	500	1034	1034	1204
• Water	m^3/ t of finished paper	150	80	80	145

Input Norms .....Agro Based mills-UnBleached Varieties

Specific Steam Consumption :-

1.The Norm 3.3 t/t does not include the steam used in power generation through steam turbines.

Section	t/t of finished paper
Pulp Mill	1.0
Paper Machine	2.0
Boiler House	0.2
Others	0.1
Total	3.3

Specific Power Consumption :-

1. The Norm 500 kWh/t does not include the power consumption for condensing steam turbine auxiliaries.
2. The Norms for Mills with Recovery System

- Power consumption = Norm + 125 kWh/t
- Steam Consumption = Norm + 2.6 t/t

Section	kWh/t of finished paper
Raw material Preparation & Pulping	100
Stock Preparation & paper Machine	325
Boiler	35
Water System	25
ETP	15
Others	-
Total	500

Input Norms ……Recycled Fibre Based mills-Writing & Printing

The overall input consumption norms, best practice & range of consumption of 1 mill is given below:
Raw Material :- 100% RCF ; Process:- Defibration with deinking; Product:- Bleached 100% ; Varieties :- Paper

		Norms
Raw material	t/t of paper	1.5
Energy		
• Purchased energy	kcal/t x 10^6	4.0
• Steam	t/ t of finished paper	3.2
• Power	kWh/ t of finished paper	800
• Water	m^3/ t of finished paper	50

Input Norms .....Recycled Fibre Based mills-Writing & Printing

Specific Steam Consumption :-

1.The Norm 3.2 t/t does not include the steam used in power generation through steam turbines.

Section	t/t of finished paper
Pulper	0.2
Paper Machine	2.5
Deinking	0.3
Boiler House	0.2
Others	-
Total	3.2

Specific Power Consumption :-

1. The Norm 800 kWh/t does not include the power consumption for condensing steam turbine auxiliaries.

Section	kWh/t of finished paper
Pulper	100
Stock Preparation & paper Machine	450
Boiler House	50
Deinking	150
Water System	20
ETP	30
Others	-
Total	800

Input Norms ……Recycled Fibre Based mills-Newsprint

The overall input consumption norms, best practice & range of consumption of 3 mills is given below:
Raw Material :- RCF and Market Pulp ; Process:- Defibration with deinking;
Product:- Bleached ; Varieties:- Newsprint, Writing Printing & Speciality

		Norms	Best Practice	Range of consumption Minimum	Maximum
Raw material	t/t of paper	1.27	--	--	--
Energy					
• Purchased energy	kcal/t x 10^6	6.0	6.4	6.4	12.8
• Steam	t/ t of finished paper	3.0	2.27	2.27	8.6
• Power	kWh/ t of finished paper	750	873	873	1125
• Water	m^3/ t of finished paper	50	31	31	82

Input Norms ……Recycled Fibre Based mills-Newsprint

Specific Steam Consumption :-

1.The Norm 3.0 t/t does not include the steam used in power generation through steam turbines.

Section	t/t of finished paper
Pulper	-
Stock Preparation & Paper Machine	2.5
Deinking	0.3
Boiler House	0.2
Others	-
Total	3.0

Specific Power Consumption :-

1. The Norm 750 kWh/t does not include the power consumption for condensing steam turbine auxiliaries.

Section	kWh/t of finished paper
Pulper	75
Stock Preparation & Paper Machine	425
Boiler House	50
Deinking	150
Water System	20
ETP	30
Others	--
Total	750

Input Norms ……Recycled Fibre Based mills-Kraft

The overall input consumption norms, best practice & range of consumption of mills is given below:
Raw Material :- RCF and Market Pulp ; Process:- Defibration without deinking;
Product:- UnBleached ; Varieties:- Kraft packaging, etc.

		Norms	Best Practice	Range of consumption Minimum	Maximum
Raw material	t/t of paper	1.14	1.12	1.12	1.18
Energy					
• Purchased energy	kcal/t x 10^6	3.0	--	--	--
• Steam	t/ t of finished paper	2.2	2.5	2.5	4.0
• Power	kWh/ t of finished paper	450	480	480	1067
• Water	m^3/ t of finished paper	50	NA	NA	NA

Input Norms ……Recycled Fibre Based mills-Kraft

Specific Steam Consumption :-

1.The Norm 2.2 t/t does not include the steam used in power generation through steam turbines.

Section	t/t of finished paper
Pulper	-
Paper Machine	2.0
Boiler House	0.2
Others	-
Total	2.2

Specific Power Consumption :-

1. The Norm 450 kWh/t does not include the power consumption for condensing steam turbine auxiliaries.

Section	kWh/t of finished paper
Pulper	50
Stock Preparation & Paper Machine	300
Boiler House	50
Water System	20
ETP	30
Others	-
Total	450

Input Norms ……Recycled Fibre Based mills-Board

The overall input consumption norms, best practice & range of consumption of 2 mills is given below:
Raw Material :- RCF and Market Pulp ; Process:- Defibration without deinking;
Product:- Unbleached ; Varieties:- Kraft packaging, etc.

		Norms	Best Practice	Range of consumption Minimum	Maximum
Raw material	t/t of paper	NA	--	--	--
Energy					
• Purchased energy	kcal/t x 10^6	4.0	2.0	2.0	7.0
• Steam	t/ t of finished paper	2.0	2.0	2.0	2.0
• Power	kWh/ t of finished paper	400	450	450	462
• Water	m^3/ t of finished paper	50	NA	NA	NA

Input Norms ……Recycled Fibre Based mills-Board

Specific Steam Consumption :-

1.The Norm 2.0 t/t does not include the steam used in power generation through steam turbines.

Section	t/t of finished paper
Pulper	-
Paper Machine	2.0
Boiler House	--
Others	-
Total	2.0

Specific Power Consumption :-

1. The Norm 400 kWh/t does not include the power consumption for condensing steam turbine auxiliaries.

Section	kWh/t of finished paper
Pulper	50
Stock Preparation	100
Paper Machine	200
Boiler House	25
Water System	10
ETP	15
Others	-
Total	400

Chapter - 6

International Benchmarks, reasons for gap and suggested initiatives

The Model Kraft Paper Mill in Developed Countries

The model kraft market pulp mill in developed country produces fully bleached market pulp from wood chips transported from local sawmills. It utilizes the most energy-efficient unit operations that have been proven technically feasible. The power boiler uses hog fuel, and condensing-extracting steam turbines are used to produce electricity. The total liquid effluent from the mill would be approximately 35 m^3/air dried tonne (ADt).

The energy consumption, energy production and the purchased energy consumption for the model mill is shown below.

Steam and Electricity Consumption

Section	Steam, GJ/t	Electricity, kWh/t
Chip conveying	0.0	20
Digester	1.7	40
Washing and screening	0.0	30
Oxygen delignification	0.5	75
Bleaching	2.3	100
Paper machine	3.3	253
Black liquor evaporators	3.1	30
Power plant	2.3	60
Kiln and recausticizing	0.0	50
Hot water supply	0.0	32
Waste-water treatment	0.0	30
Miscellaneous	0.0	30
Total Consumption	13.2	750

Steam and Electricity Generation

	Steam GJ/ADt	Electricity kWh/ADt
Recovery boiler	15.8	655
Total Generation	15.8	655

Purchased Energy Required

	Steam GJ/ADt	Electricity kWh/ADt	Natural Gas GJ/ADt
Amount purchased (excess)	0.0	(17)	1.2

The Model Kraft Paper Mill in Developed Countries

In this section we have outline the model mills in developed countries which indicate the difference in technological level of Indian & International mills. The main purpose of this exercise is to identify the areas of gap in which Indian Mills have to improve and adopt latest technologies. Data's for paper mills producing bleached varieties and Newsprint was available and has been compared with Indian Mills..

Bleached

Section	Steam, t/t	
Paper Mills	**International**	**Indian**
Chip Conveying	0.0	1.3
Digestor	0.61	
Washing & Screening	0.0	
Oxygen delignification	0.18	
Bleaching	0.83	0.3
Paper Machine	1.19	2.5
Soda Recovery	1.12	2.6
Power Plant	0.83	1.2
Miscellaneous	0.0	1.1
Total Consumption	**4.76**	**9.0**

The Model Kraft Paper Mill in Developed Countries

Bleached Varieties

Section	Electricity, kWh/t	
Paper Mills	**International**	**Indian**
Chip Conveying	20	20
Digestor	40	40
Washing & Screening	30	110
Oxygen delignification	75	--
Bleaching	100	80
Paper Machine	253	600
Soda Recovery	30	125
Power Plant	60	125
Kiln & recausticising	50	--
Hot water supply	32	50
Waste water treatment	30	40
Miscellaneous	30	110
Total Consumption	**750**	**1300**

The Model Newsprint Mill in Developed Countries

Newsprint

	TMP (International)		CTMP (Indian)		DIP (International)		DIP (Indian)	
Section	Steam	Electricity	Steam	Electricity	Steam	Electricity	Steam	Electricity
	t/t	kWh/t	t/t	kWh/t	t/t	kWh/t	t/t	kWh/t
TMP	--	2450	2.1	1375	--	--	--	--
DIP	--	--	--	--	0.29	400	0.3	225
Paper Machine	1.58	330	2.2	600	1.58	330	2.5	425
ETP	--	60	--	40	--	60	--	30
Others	--	--	0.7	85	--	--	0.2	70
Total Consumption	**1.58**	**2840**	**5.0**	**2100**	**1.87**	**790**	**3.0**	**750**

The Model Kraft Paper Mill in Developed Countries

The process design for the model mill is described in details below.

Conveying Chips

The chips are purchased from sawmill operations. Belt conveyers are used to transfer the wood chips from the chip piles to the pre-steaming vessel. Heat from black liquor flash tanks is used to preheat chips in the pre-steaming vessel; thus, no live steam is required. The electricity requirement for the conveying operations is estimated at 20 kWh/Adt.

Digester

The cooking process in a modern kraft mill is by modified continuous cooking (MCC) in a Kamyr digester. The target Kappa number (for softwood) would be 30 to preserve wood yield. Live steam requirement for this process is 1.7 GJ/ADt, and the total electricity demand is 40 kWh/ADt.

Washing and Screening

High-efficiency washers, such as pressure filters, are employed for brownstock washing. Inlet consistencies for these washers is about 4 percent, more than double that of a conventional vacuum drum washer, which reduces the amount of vat dilution to be pumped. However, the blower required to pressurize the washer consumes the electrical energy savings. The net result is better washing for approximately the same energy requirement. The screen room is closed, and screening is done at 5 percent consistency. The higher consistency reduces pumping requirements. Condensate from the mill's, black liquor evaporators is used as wash water. No live steam is required for washing and screening. The electricity requirement is estimated to be 30 kWh/ADt.

Oxygen Delignification

Oxygen delignification is used to further delignify the pulp prior to bleaching. Approximately 60 percent delignification is achieved in two stages. Two stages of post-oxygen washing are required; twin roll presses are used. The live steam required to heat the oxygen stages is 0.5 GJ/ADt, and the electricity required for this is 75 kWh/ADt.

The Model Kraft Paper Mill in Developed Countries

Bleaching

A modern mill is able to achieve fully bleached pulp from a four-stage elemental chlorine free (ECF) bleach plant. A D0EoDND bleaching sequence is used. High-efficiency pressure filters are used for washing between bleaching stages. All stages are medium consistency to reduce pumping requirements. The D0 stage is at 60ºC and uses 0.96 percent ClO2 on pulp. The Eo stage is at 90ºC and uses 1.50 percent NaOH on pulp. The DN stage is at 70ºC and uses 0.75 percent ClO2 on pulp. The D stage is at 70ºC and uses 0.20 percent ClO2 on pulp.

All the ClO2 is generated on-site from sodium chlorate using the R10 process. NaOH is purchased. The steam requirement for ClO2 generation is 0.2 GJ/ADt. The steam requirement for heating throughout the rest of the bleach plant is about 2.1 GJ/ADt. The electricity requirement for the bleach plant would be 100 kWh/ADt.

Paper Machine

A twin-wire former is used before a trinip press. The web achieves 50 percent consistency into the dryer section of the machine. The steam consumption is 3.3 GJ/Adt. Electricity consumption was reported at 253 kWh/ADt.

Black Liquor Evaporation

Weak black liquor is produced at 15 percent solids, which is then evaporated to 78 percent solids using a seven-effect multiple-effect evaporation system with an integrated super concentrator. Steam economy is estimated at 6.0 kg water/kg steam for such an arrangement. The black liquor contains 1.6 kg solids/kg pulp. The steam requirement for the evaporators is calculated to be 3.1 GJ/ADt. The electricity requirement is 30.0 GJ/ADt.

Lime Kiln and Recausticizing

The kiln utilizes flash drying and product coolers to minimize energy consumption. Natural gas is used to provide the 1.2 GJ/ADt of heat energy required. Pressure filters are used for solids separation from process liquors. Electricity requirements is 50 kWh/ADt.

The Model Kraft Paper Mill in Developed Countries

Power Plant

The mill uses a high solids recovery boiler that achieves a 75 percent heat-to-steam efficiency. Heating value of black liquor is approximately 6250 Btu/lb. solids (21.0 GJ/ADt pulp). The boiler air is heated to 150ºC using steam, and minimal use of soot blowers is employed, consuming 0.9 GJ/ADt of steam. The mill recovers 70 percent of steam condensate, and the resulting energy use in the deaerator is 1.0 GJ/ ADt. Condensing-extracting steam turbines are used to produce electricity with a power-to-heat ratio of 100 kWh/GJ. The mill's power boiler uses hog fuel and achieves a heat-to-steam efficiency of 70 percent. The mill generates 15.8 GJ/ADt in the recovery boiler to satisfy the heat requirements of the process and electricity generation needs. A backpressure steam turbine generates 520 kWh/ADt of electricity, while excess high-pressure steam generates another 135 kWh/ADt through a steam-condensing turbine. Therefore, the total electricity generation by the mill is 655 kWh/ADt. The power plant has a parasitic electricity need of about 60 kWh/ADt.

Hot Water System

Warm water (50ºC) is produced through heat recovery in the evaporator condensers. Hot water (70ºC) is produced through heat recovery from the digester surface condenser, cold blow liquor cooling and black liquor cooling. Hot water for use on the pulp machine will be generated using heat recovery from the dryer section. Electricity requirements are 32 kWh/ADt.

Waste-Water Treatment

Mill effluent is treated in a primary clarifier and secondary activated sludge basin. Total mill effluent is 35 m^3/ADt. A cooling tower is required to remove process heat. Electricity requirements are 30 kWh/ADt for aeration and pumping.

Miscellaneous

This includes HVAC, lighting, office use, etc. No live steam is required. The electricity requirement is approximately 30 kWh/ADt.

Technology Status …….. Competence of Indian Mills

The benchmarking/ input norms study has pointed out various areas which require serious attention for achieving competitiveness of the sector. These are;

Comparison with the competitiveness of Indian Sector with the same in selected countries:- As compared to USA, Europe, the paper industry in India is far below the quality standards of the products. Paper industry in India even is not as competitive as in other Asian countries such as; Japan, Indonesia, Thailand, Malaysia & China.

Comparison with the competitiveness of Sector with the similar sectors in India:-The paper industry in India is less competitive as compared to similar sectors such as; cement and capital goods.

Possible reasons for being less competitive as compared to same sector in other countries and similar sectors in India:- Two possible reasons which makes paper industry less competitive compared to other similar sectors are – (i)availability of good fibrous raw materials; & (ii)level of technology. Similar industries are characterized by good quality of raw materials and good quality of finished products.

TECHNOLOGICAL COMPETENCE/ INFRASTRUCTURE STRENGTH

Brief description of technology being used and associated problems:- Major portion of the Indian paper industry continues to operate on obsolete technology. According to a study, technology in a modern paper mill in India is 30 years behind. The main associated problems are: -

- Diverse and mixed raw materials
- Low scale of operation &
- Lack of initiatives taken by the industry to keep pace with technological developments

Technology Status …….. Competence of Indian Mills

Best technology available and the reasons for not being able to adopt the same:- Mills seriously lack the BAT's. Low scale of operation and non-availability of uniform quality of fibrous raw materials and other inputs is the main reason for not being able to adopt the best technology.

The main reasons for the lack of desired infrastructure and the name and role of possible agencies for creating the desired infrastructure:- The paper industry does not have the required infrastructure such as; roads transports, railways, communications and sustained power supply. The main reason for lack of availability of desired infrastructure is that the location of paper mills is scattered and the availability of fibrous raw material was the main criteria for selection of the site rather than the basic infrastructure. Ministry of Urban Development, Ministry of Transport, Ministry of Shipping & Ministry of Power should create the desired infrastructure for industrial development.

Details of upgrading technology and skill content of the experts:- The major segment of the paper industry requires the infrastructure & technology upgradation. The technology upgradation selected should reduce the environmental problems while producing the cost effective & quality products. Skilled manpower in the sector is low which requires regular upgradation of their skills by conducting training programmes and workshops at each level.

Technology …….. Gap

The industry requires technology inputs at various process/ operational levels. The study has shown some of the areas which require immediate attention in different segment of the industry. These are;

For Paper Industry

The installed capacity of mills in developed countries is very large, i.e. more than 1000 tpd with high speed machines. Therefore they have the advantage of absorbing state of art & new technologies and are cost effective. In India the average size of large mills is 250 tpd, medium mills are below 100 tpd and small mills below 50tpd. The state of art & modern technologies are financially viable for big size mills i.e. more than 500 tpd. Following technological upgradations are required in Indian industry.

Pulping:- Continuous digester for pulping (at present only in two mills), **Cold blow system, Super batch system**

Brown stock washing:- The use of ultra filter like **belt filter, double wire belt washer & twin roll washer** for washing with minimum dilution factor & chemical losses & maximum washing efficiency.

Bleaching:- Oxygen delignification, Total chlorine free (TCF), **Elemental Chlorine free (ECF)** bleaching (except few mills)

Chemical Recovery :- Evaporation by full street of **falling film evaporators** (except a couple of mills, none has it in India), **Single drum recovery boiler**, **Lime kiln** to reburn lime sludge (only ten mills have it).

Process control:- DCS control & on line instrumentation to monitor and control various process parameters.

Technology …….. Gap

Stock Preparation & Paper Machine:-

- DCS control with automatic metering.
- Very high speed M/c with **modern head boxes**, high speed M/c with **wider deckle** equipped with **closed head box** with **automatic CD profile control system**, **twin wire former bi nip/ tri nip presses closed hood** with efficient **condensate removal system** combination of **soft nip & hard nip calendars.**

Environment:-

- Efficient dewatering of secondary sludge by screw press.
- NCG control system.

For Newsprint Industry

India is unable to adopt the world wide best technology available mainly due to type of raw material available and size of the mill. The ground wood and thermo mechanical pulping to produce mechanical pulp is not possible, which are suitable for soft wood pulps.

Mechanical pulping:- Thermo mechanical pulping and ground wood pulping.

Recycle fibre pulping :-

- Gradation of waste paper.
- Efficient deinking, screening & cleaning with adoption of appropriate system configuration and proper contaminant removal equipments to obtain clean pulp stock using two loop combination system having pre & post flotation stage with disperger. In India only 17 mills has deinking that also with single loop system.

Technology ..... Barriers

Introduction of best available technologies in the pulp and paper industry, with in the existing setup, and a serious evaluation of various factors which inhibit the growth of the industry is need of the hour. Some of the important factors which need to be looked at before planning a technological upgradation drive in the mill are

For Paper Industry

- **Size of the mills**:-Average size of mill in world is **42,000 tpa** where as average size of mill in India is **14,000 tpa**. Larger paper machine capacity in world is **6,00,000 tpa** where as in India it is **90,000 tpa**.
- In developed countries technical persons employed are **4 per ton of paper** produced where as in India it is **2**.
- **Low standard** of converting industry, lack of infrastructure and transportation.
- Shortage of **good quality** virgin wood fibre.
- **Non-availability** of good quality indigenous **pigments, fillers** and paper making **chemicals**.
- **Non- availability of single raw material** at one place in bulk quantity due to which mixed raw material has to be used.
- **High cost of raw material** as compared to neighboring countries and world.
- **High energy cost** from grid as well as high energy cost due to **low quality coal** available.
- **High cost of financing** and time of processing of loans is very long compared to single window system in the other countries.
- **Lack of indigenous capability** for design and development of equipments, machineries and process control systems.
- Impact of **high local taxes** on inputs of paper.

Technology ..... Barriers

- **Low inputs** into mill level R & D.
- **Supply chain management** integrated with forward and backward linkages is not existing.
- The size of small and medium mills is the biggest barrier to integrate these with economically feasible chemical system and have efficient effluent treatment system.

For Newsprint Industry

The biggest barrier is raw material for mechanical pulping like eucalyptus, reed, bagasse, which are not suitable for thermo-mechanical pulping (TMP), the most cost effective technology, whereas, in developed countries softwood is used, which is suitable for newsprint. Due to this opacity problem is prevalent & also GSM for newsprint can not be brought down below 50 GSM.

- Raw material & energy cost are higher.
- It is not possible to have very high speed paper machine, i.e. >1500 mpm for type of raw material available in India.
- It is important to use new papermaking technology which can improve bulk, porosity and evenness of paper but limitation for this is size & quality of raw material available.

The study has indicated various options for performance improvements in the pulp and paper industry with which the competitive position of the industry can be improved. Converting an existing mill to the desired level and to meet the benchmark / norms would be capital intensive and may not be economically feasible when the basic inputs reductions are the only advantage. However, there is considerable potential for improvement in basic input consumptions by performing a case to case study of the mills which requires a detailed examination of the best practices and provides a set of directives for planning a systematic approach towards achieving these best practices in existing pulp and paper mills.

An integrated approach for modernization and up gradation of the industry is required to be adopted. Some of the initiatives to take up an efficiency drive in the pulp and paper sector are presented here.

Management Overview

The implementation of an optimization and efficiency improvement program requires a change in the work culture of the mill, which must start with senior management. They must be committed to the growth & improvement, develop a sound plan of action, provide the leadership and secure the resources. The benefits of the efficiency improvement plan can be large, but they will generally be derived from a large number of smaller gains. Thus, continuous effort is required to retain the benefits long after the projects are implemented. Benchmarking is one of the first steps a mill should undertake. Benchmarking enables senior management to compare the relative performance of their mills with similar mills or with a model mill representing the current best practice. It provides the motivation for looking at efficiency improvement opportunities in their mill operations. The program should be led by a mill management with sufficient resources allocated for the task, assisted by a team of mill staff, outside consultants and other experts drawn from all areas of mill operations. This cross-functional team will attend to the details of implementing the program.

Process Analysis and Optimization

No process technologies or equipment can yield the best results if not operated under optimized conditions. Process monitoring forms the basis of process optimization and mills need to install, upgrade and maintain all the measuring equipment. The process that is monitored can be easily controlled. Process control equipments are required to be installed to eliminate the human error. Optimization of the processes can be taken up based on monitoring and would result in substantial savings. A systems engineering approach is essential to ensure that any efficiency project reduces the energy use of the mill, and doesn't merely shift the energy use to another department or mill area. Process integration tools, such as pinch analysis, identify the minimum theoretical energy consumption level of a process and provide guidelines for the modifications required to reach that minimum level. Pinch analysis is a powerful tool, which must nonetheless be applied with care, as there may be good process reasons why a particular heat recovery project cannot be implemented. As well, the minimum energy consumption levels may require large capital expenditures, and not all heat recovery projects will be economically feasible at a given price for energy. Nonetheless, awareness of the theoretical minimum energy consumption level is a powerful motivator for improving efficiency and reducing waste.

Continuous Performance Monitoring and Improvement

Once capital budgets have been allocated and the projects implemented, it is important to be able to show that the savings continue to be reaped, year after year. As well, it is important to treat efficiency as a continuous improvement process: once a set of projects has been implemented, it is important to start planning the next iteration in the efficiency program. For these reasons, a continuous monitoring and improvement system must be put in place. A mix of hardware, software and management practices, these systems ensure that once a steam line is shut, it remains shut, that once a process has been adjusted, it remains adjusted, and that the economic benefits continue to accumulate.

Technology ..... Suggested Initiatives

Identification of suitable process technologies and Process Equipment

Each process area in a mill should be compared with the industry average, and with the model mill, to see how it compares with best practices and where it can be improved. Industry has to initiate an active participation with the technology suppliers to identify most suitable processes technologies and equipment for their operations. R&D institutes and consultants can act as inter phase between the supplier and the mill.

Setting-up of Internal Benchmarks

Industry should develop their own benchmarks/norms to achieve the targeted levels. Setting of benchmarks/ norms for section wise consumption would motivate the mill management for achieving the benchmarks/norms. Mills should regularly evaluate their process efficiencies by conducting energy and process audits. This would indicate the variation from the targeted norms. Assistance of external agencies would be helpful to pin point the areas requiring attention for improvement.

Information dissemination of technology demonstration

Research institutes should disseminate information through frequent interactive meetings with the industry, workshops & seminar and also through its web site and should take up projects for demonstration of technology available elsewhere, but suitable for Indian conditions and also for technology developed by it. CPPRI is already engaged in this activity.

Technology ..... Suggested Initiatives

Easy finance availability

The government may take steps for making finance available on easy terms from banks & financial institutions for upgradation of those technologies, which may result in increase of productivity, improvement in quality and reduction in energy, pollution load & cost of production.

HRD initiatives

Training programmes should be held zone-wise on site in the mill and also at the R&D institutes for the mill personnel at various levels to create awareness among them about new technologies available and means for improving productivity, improved quality, reduced energy consumption & pollution load and at the same time to make production cost effective by way of short term and long term courses by inviting national/international experts in various fields of pulp & papermaking, energy & environment management.

Creation of common infrastructure

The small mills which do not have chemical recovery and cannot have it because of economic feasibility (being capital intensive) can have a common chemical recovery and effluent treatment plant.

Technology …….. Perceived Benefits

PERCEIVED BENEFITS OF TECHNOLOGY UPGRADATION- Paper Industry

Reduction in cost of production:- By upgrading the raw material preparation, pulping & washing sections, there will be a lot of saving in the steam consumption, water consumption and chemical consumption and by increase in speed of machine & by upgradation of chemical recovery, i.e. evaporators, recovery boilers & also retrofitting of boilers, the capacity of the machine will increase and thus will result in reduced production cost.

Quality Improvement:- The upgradation of bleaching system from CEH to ECF bleaching and upgradation of recycled fibre processing system, i.e. addition of deinking & efficient screening units will improve the paper quality very much and higher grades of paper can be produced from the same units after upgradation, which will be value addition to the product.

Market expansion due to design aesthetics and variety of products:- The technology upgradation of pulping, stock preparation & paper machine will result in good formation, improved brightness and higher strength of paper, which will make it possible to make a variety of products, which in turn will help to reduce the import of specialty paper, and open market for export.

Productivity improvement and capacity expansion:- The upgradation of pulp & paper industry in different areas will result in automatic and DCS control system with online controls, which will result in uniform and improved quality, improved energy & environmental management and decrease in manpower requirement and cost reduction, which will all add up to the productivity improvement and capacity expansion of the pulp & paper mills.

Environmental preparedness:- The upgradation of washing & bleaching system, chemical recovery system will result in decreasing pollution loads, which in turn will help the paper industry to meet the pollution norms fixed by the regulatory authority like water consumption, AOX, etc. and also norms which may come up in future.

Employees and workers safety:- Due to automation & DCS control & adoption of cleaner production technology, the manual functions & impact on environment will decrease very much and thus will result in the safety of employees & workers.

Technology ..... Perceived Benefits

PERCEIVED BENEFITS OF TECHNOLOGY UPGRADATION- Newsprint Industry

Reduction in cost of production:- By upgrading the recycled fibre processing system, i.e. efficient screening & de-inking and also by increasing speed of machine, production cost will decrease due to increase in capacity and return will be more due to improved quality.

Quality Improvement:- The addition of de-inking and efficient screening unit will improve the newsprint quality very much matching with the international standard.

Market expansion due to design aesthetics and variety of products:- The technology upgradation in paper machine and soft calendaring will result in good formation and improved quality.

Productivity improvement and capacity expansion:- The upgradation in recycled paper processing and also automatic DCS control system with online control will result in uniform & improved quality product and capacity expansion of newsprint mills.

Environmental preparedness:- The upgradation of ATP system will help the newsprint industry to solve the problem of colour of effluent and also de-inking sludge disposal.

Employees and workers safety:- Due to automation & DCS control & adoption of cleaner production technology, the manual functions & impact on environment will decrease very much and thus will result in the safety of employees & workers.

This page is kept intentionally blank

Annexure - I

TECHNOLOGY

Technology.. Listing Of Technologies Used In India For Paper Industry

Raw Material Preparation

-Chipping of wood & bamboo – Use of Disc/drum chippers.
-Cutting of agro residues – Straw Cutters are used.
-Depithing of bagasse – Both Dry and wet Depithing is practiced.

Pulping

-Pulping of agro residues – Spherical Rotary Digesters and Continuous Pandia Digesters are being used using soda process pulping of straws and bagasse.
-Pulping of wood & bamboo – Sulfate process is being used using –
-Stationary batch digesters.
-Continuous Kamyr digesters in two running mills & one closed mill
-RDH pulping in one mill.

Brown Stock Washing

-Countercurrent washing using rotary drum vacuum filters.
-Chemi- washers existing in two mills.
-Poacher washers are being used in small mills based on agricultural residues.

Bleaching

-Hypo chlorite bleaching in some of the small mills (H-H).
-Conventional bleaching in medium & large mills are CEH, CEHH, CEoHH (C-Chlorine, E-Extraction, H-Hypochlorite, Eo-Oxidative Extraction)
-Chlorine dioxide bleaching existing in 5 mills.

Chemical Recovery:-

- In evaporation street most of the large mills have Long Tube Verticle (LTV) (Fig-8) type of evaporators with exception of 2 mills which still have short tube vertical (STV) evaporators, followed by Direct Contact Evaporator (DCE) which are environmentally incompatible as well as it is difficult to achieve high solids concentration with DCE'S.
- Some of the mills have incorporated falling film (FF) type Finisher effects. Eliminating DCE'S two mills have completely changed the LTV street with Falling Film (Tube Type) Evaporators.
- In the area of Recovery boiler the mills are equipped with Tomlinson boilers with double drum technology. The problem of silica in black liquor is one of the major problems in the area of chemical recovery and none to the mill has so far adopted black liquor desilication.
- In the area of Lime sludge Reburning only 6 mills have lime-kilns out of which only 2 mills have pre coat filters for efficient lime mud filtration.

Paper Machine:- Slow speed having deckle of lesser width

(i) Paper machine components

Head Box

- Normally open head box with rectifier rolls
- No automatic CD profile control system

Wire section

- Normally Fourdrinier with dandy roll
- Some machines have no suction pick up arrangement
- Few twin wire machines

Technology ..... Used in India - List

Press section

- Plain/suction presses
- No extended nip presses
- Open draw after I & II nip
- Low linear load

Dryer section

- Open hood
- Unsupported web
- Uneven CD moisture profile
- No online web moisture measurement in many cases
- Poor condensate removal system
- No steam/condensate cascading system

(ii) Calenders

- Normally hard nip calenders

(iii) Coating

- Blade/air knife coaters having smaller width
- Coaters & super calenders are often OFF-machine
- Low automation

(iv) Rewinders

- Almost totally manual without any automation
- Reels of smaller diameter are generally produced

(v) Sheeting & Packaging

- Finishing houses are not air conditioned
- Little automation in finishing areas

Technology …….. Used in India - List

Environment:-

Large Scale Paper Mills:-

The large paper mills are having a full-fledged facilities for management of wastes particularly wastewaters which involves mainly primary clarifier, activated sludge process, secondary clarifier, sludge dewatering press, etc.

Small Medium Scale Paper Mills:-

- These mills have effluent treatment plant consisting of sedimentation tank/clarifier aerated pond, secondary clarifier & anaerobic lagoon for treatment of black liquor.
- Some mills have installed full-scale bio-methanation plant for treatment of black liquor.
- The anaerobically treated black liquor along with other waste water streams is further treated in subsequent conventional effluent treatment plant.

Technology ..... Used in India - List

LISTING OF TECHNOLOGIES USED IN INDIA FOR NEWSPRINT INDUSTRY

Type of pulp used for Newsprint Manufacture:- Both Chemi-Mechanical Pulp (CMP) obtained from chemi-mechanical pulping of hardwood/bagasse and deinked pulp from recycled paper is used for Newsprint production.

Pulping Technology

-Chemi-Mechanical Pulping (CMP) / Chemi-Thermo-Mechanical Pulping (CTMP) is being practiced in three number of mills for newsprint production.

-Majority of the mills producing Newsprint from RCF using ONP/OMG furnish have low consistency pulper for slushing and do not have flotation cells for efficient ink removal and slot screening system with disperger for contaminant removal which are essential for producing deinked pulp stock.

-About 17 mills have flotation cells for deinking, out of which only 2-3 mills have pre and post floatation stage with disperger and post bleaching stage.

-The proportion of ONP/OMG furnish ratio is not fixed.

Paper machine

- Slow speed, short deckle
- Some mills have Fourdrinier machine
- Some have twin wire formers

Paper quality:- Paper has relatively lower brightness, opacity & formation index

QUALITY STANDARDS

Details of the national and international quality standards followed in the sector:- The quality standards in other countries are maintained as per customer preferences, whereas in India we still go by BIS norms which are much below the international standards particularly with respect to surface properties, optical properties & mechanical properties.

General perceptions (through public survey or international or national organizations) about the quality of the products being produced in the sector:- General perception about the quality of products produced in India is poor. The paper going for printing of schoolbooks & notebooks, generally there is a complaint by the customer. As far as Printing papers such as; art paper, coated paper etc. are generally the customer prefers imported paper, and the Newspaper segment also by & large gives preference to the imported Newsprints.

Possible reasons for the poor quality of the products and what needs to be done to improve the quality are :-

- Lack of availability of good fibrous raw materials
- Absence of modern technology
- Low Scale of operation &
- Lack of adequate process control systems and skilled manpower

Management Practices ……. Best Available in the world

The best management practices in different areas such as raw material and forest management, marketing management, quality management, R&D management, Inventory management, Financial management, HRD, etc. are being practiced in the world for both Pa per as well as Newsprint Industry.

Practice area	Gaps
Raw Material & Forest Management	There is a need to develop industrial forest reserves to meet pulp & paper industry's raw material requirement.
Marketing Management	Experienced export managers are needed when exports start to grow.
Quality management	Quality variations are still one of the main problems of most mills. Raw material, technology and machinery must be improved. There should be DCS system & online monitoring & control
R&D Management	Calibration of measurements needs to be improved. R&D costs should be about 1% of turnover. Both industry and company wise R&D is needed.
Inventory Management	Just-in-time system difficult to apply in India due to infrastructure.
Financial Management	Importance of financial management will drastically increase in line with the industry growth, mill size expansion, modernization of technology and entry to WTO.
HRD	Growth of industry will increase the need for qualified personnel at all organization levels and in all functions.

Technology ..... Status in Indian Mills

STATUS OF TECHNOLOGY :- The agro-residue based segment is using agro-residues such as bagasse, straws as its main raw material. In this segment, there are only a few mills complying with quality & environmental requirements, whereas large number of units does not have proper technology to produce quality products at a competitive price. This segment is also having serious environmental pollution problems due to lack of chemical recovery system. Major portion of this segment requires modernization and upgradation in order to become competitive.

The third segment, i.e. based on recycled fibre also has a number of small pulp & paper mills, which are based on obsolete technology. One of the major concern of these mills is lack of adequate equipment for processing of recycled fibres and as a consequence, the quality of paper products produced from these mills are not conforming to anywhere, even nearer to the national standards. The competitiveness of this segment without modernization and upgradation would be difficult.

Technology …… Areas Requiring Technology Upgradation

Generally, papermaking process involves a number of complex unit operations and unit processes and the proposal for technology upgradation are prepared in order of priority so that the following four objectives/ deliverables are met –

(1) Cost effective production;

(2) Improved quality standards;

(3) Environmental compliance; and

(4) Enhanced productivity.

The technology upgradation proposal should cover the following areas –

- Modernization of paper machine
- Modernization of stock preparation section of paper machine;
- Upgradation of chemical recovery installations;
- Upgradation of pulp mill operation, particularly, pulp washing, bleaching section.

The present technology upgradation proposal does not cover the areas such as raw material preparation and other auxiliary departments.

Technology …….. Best Available technologies in the world

FOR PULP & PAPER INDUSTRY

The mills in developed countries have capacity normally higher than 1000 tpd.

Raw material preparation- De-barking of the raw material is practiced.

Pulping – By continuous digesters, energy efficient Super batch digesters and RDH pulping using sulphate process, sulfide process. **For newsprint:-** Ground-wood pulping process; TMP process;CTMP process.

Bleaching – TCF process & ECF process.

Chemical Recovery:- In the area of chemical recovery the state of art is –
-Inclusion of **7 effect plate type FF evaporators** and **Vapour Compression Evaporation** for higher steam economy and low steam consumption.
-Inclusion of **Thermal treatment** in the evaporator street to achieve higher solids concentration.
-Adoption of large capacity **single drum boiler** with continuous blow down.
-Rotary **lime Kilns** with **pre coat filter** for mud filtration.

Paper machine – Very high speed machine with twine wire former fully automatic and computerized with all on-line measurements and control systems. The deckle is much wider. High speed (Avg. speed of the best paper machine in world is double in comparison to best paper machine in India).
The advantages of the above techniques are higher production rate
(i) Paper Machine components
Head box:- Closed head box with automatic CD profile control system
Wire section:- Mainly formers (blade & roll type), twin wire machines
The advantages of the above techniques are- Better formation, Retention, Drainage, Orientation, MD/CD profile.

Technology …….. Best Available technologies in the world

Press section:- Bi nip/ tri nip presses with extended nip, viz, Optipress and high linear load.
The advantages of the above techniques are-More sheet dryness, More energy saving, Better runnability, Better retention

Dryer section
-Closed hood with efficient heat recovery system
-Web supported with dryer screens
-Uniform CD moisture profile
-Online web moisture measurement in most cases
-Efficient condensate removal system
-Cascading of steam & condensate
The advantages of the above techniques are High machine runnability, Better surface properties, Better steam economy

(i**i) Calenders:-** Soft nip & hard nip calenders
The advantages of the above techniques are better smoothness & bulk

(iii) Coating:- Film/non contact type, blade type coaters with larger width, Coaters & super calenders are often ON-machine, High automation
The advantages of the above techniques are-Better coated surface having better printability & Better production

(iv) Rewinders:- Totally automatic rewinders with high speed, Handle low GSM & light weight coated papers easily, Equipped with soft roll for coated & newsprint grades rewinded
The advantages of the above techniques are-High speed, Higher production, Better reel quality

(v) Sheeting & Packaging:- Fully air conditioned finishing houses, Fully automated
The advantages of the above techniques are Better papers for printers without dimensional stability problem, Low finishing losses

Technology …….. Best Available technologies in the world

Environment:- For treatment of wastewater, the mills have adopted best available technologies (BAT), which include activated sludge process, high rate biomethanation technologies, tertiary treatment system, etc.

The reduction in pollution due to adoption of these environmental friendly technologies, best effluent treatment practices have led to increase reuse/recycling of treated effluent back into the process (system closure), thus reducing the water consumption of the mills to as low as 25 m^3/ton of paper.

Technology …….. Best Available technologies in the world

FOR NEWPRINT INDUSTRY

- The state of art technology available for Newsprint production from recycled fibre (RCF) is a two loop combination having alkaline loop first followed by neutral loop with disperger between pre and post floatation stage and slot screening both in processing line and machine approach flow system with forward cleaners ahead of slot screens including post bleaching stage.
- The furnish used is 70/30 or 50/50 ONP/OMG mix.
- The brightness gain is high with such configuration.

Type of pulp:- Softwood TMP/other mechanical pulp/ deinked pulps are used
The advantages/quality differences of the above techniques are TMP process is technically not feasible to be adopted in India due to lack of availability of suitable softwood

Paper machine:-
-High speed (World class machine are of double speed and 50% wider than best Indian machine)
-Mainly twin wire formers
The advantages/quality differences of the above techniques are More production and Better formation & less two sidedness.

Paper quality:- Paper has better brightness, opacity & formation index
The advantage/quality difference of the above technique is Improved quality will help in curtailing in the import of newsprint in India.

This page is kept intentionally blank

Annexure - II

FORMAT FOR PERFORMANCE RATING / BENCHMARKING

Performance Score board…….. Wood based

A	Basic Inputs	Max	Scores		
I	Raw material Consumption, t/t	100	1.5-2	2-2.5	2.5 & above
	Marks	10	10	7	5
II	Capacity Utilization, %		90-100	80-90	Below 80
	Marks	10	10	7	5
	Chemicals				
	Elemental Chlorine, kg/t		30-50	50-60	60- above
	Marks	20	20	10	5
III	Energy Consumption				
	Energy				
	Steam, t/t		7-9	9-12	12-15 & 15 above
	Marks	20	20	15	10 & 5
	Power, kWh/t		below 1400	1400-1600	above 1600
	Marks	20	20	15	10
IV	Water Consumption, m^3/t		98-120	120-150	150-above
	Marks	20	20	15	10

Performance Score board…….. Wood based

B	Technological Status	Max	Scores		
I	**Pulp Mill**				
b	Digesters	**100**			
	Batch	5	**5**		
	Continuous (New kymar//old kymar/ Baggase Con)	25	**25/15/10**		
	Indirect Heating	5	**5**		
	Heat Integration (RDH)	20	**20**		
	Blow Heat Recovery	5	**5**		
	Extended Delignification (O2 Delignification)	15	**15**		
b	Washing and Screening				
	Rotary Drum Washer /Chemi washer	5	0/5		
c	Bleaching				
	Bleaching Sequence used				
	Elemental bleaching / ClO_2 1 Stage / ClO_2 2 Stage	20	**5/15/20**		
II	**Stock Preparation and Paper Machine**				
	Paper Machine	**100**			
	Number of Machines		**1-2**	**2-3**	**3 above**
	Marks	45	**45**	**30**	**15**
	Speed (avg)		**850-500**	**500-300**	**300-below**
	Marks	45	**45**	**30**	**15**
	Coating	10	**online/10**	**Ofline/5**	
III	**Chemical Recovery**	**100**			
	Marks Avg (STV/LTV/FF)	20	5/10/20		
	Number of Recovery Boilers	20	>3/10	2/15	1/20
	Steam production kg / t BLDS				
	Marks	40	less 2.5/10	2.5-3.5/20	above 3.5/40
	Lime Kiln	10			
IV	**Power House**				
	Type of Boilers	10	FBC-10	Grate -7	O-5 or Non 5

Performance Score board…….. Wood based

C	Process Operation and Optimization	100	Scores		
	Pulping				
	kappa Number		9-13	13-16	16-18 & 18 above
	Marks	10	10	7	5 & 2
	Yield		52-49	49-45	45-below
	Marks	30	30	20	10
	Soda Losses in washing, kg/t		8-10	10-15	15-above
	Marks	10	10	7	5
	Dilution Factor		1.5-2	2.5-3	3-above
	Marks	10	10	5	0
	Bleaching				
	Bleaching Losses, %		6-9	9-11	11-above
	Marks	10	10	7	5
	Paper Machine				
	Dryness at end of pressing		Below 40	40-45	45 - above
	Marks	10	5	7	10
	% condensate recovery		100-90	90-60	60-below
	Marks	10	10	7	5
	Dryness of Paper		97.4-95	95-below	
	Marks	10	10	5	

Performance Score board…….. Agro based

A	Basic Inputs	Scores			Max
I	Raw material Consumption, t/t	1.5-2	2-2.5	2.5- above	100
	Marks	100	75	50	
II	Chemicals				
	Elemental Chlorine, kg/t	30-50	50-75	75 - above	100
	Marks	100	75	50	
	Enzyme	25			
III	Energy Consumption				
	Steam, t/t				100
	Bleached Alkaline- without Recovery	Below 4 (100)	4-6 (75)	above 6 (50)	
	Bleached Soda with Recovery	Below 8 (100)	8-10 (75)	above 10 (50)	
	Bleached Soda without Recovery	Below 6 (100)	6-8 (75)	above 8 (50)	
	Miscellaneous (bleached, unbleached & Kraft)	Below 3.5 (100)	3.5-5.5 (75)	above 5.5 (50)	
	Power, kWh/t				100
	Bleached Alkaline	below 800 (100)	800-1000 (75)	above 1000 (50)	
	Bleached Soda with Recovery	below 1050 (100)	1050-1200 (75)	above 1200 (50)	
	Bleached Soda without Recovery	below 800 (100)	800-1000 (75)	above 1000 (50)	
	Miscellaneous	below 800 (100)	800-1000 (75)	above 1000 (50)	
IV	Water Consumption, m^3/t	below 70	70-100	100 above	100
	Marks	100	50	25	

Performance Score board…….. Agro based

B	Technological Status	Scores			Max
I	**Pulp Mill**				
b	Digesters				
	Batch	**25**			25
	Continuous (Kynmar/Baggase Con)	**100/50**			100
	Indirect Heating	**25**			25
	Blow Heat Recovery	**25**			25
b	Washing and Screening				
	Potcher - Rotary Drum Washer/ Chemi washer	**75/100**			100
c	Bleaching				
	Bleaching Sequence used				
	Elemental bleaching / ClO_2 1 Stage / ClO_2 2 Stage	**50/75/100**			100
II	**Stock Preparation and Paper Machine**				
	Paper Machine				
	Number of Machines	**1-2**	**2-4**	**4 above**	**100**
	Marks	**100**	**50**	**25**	
	Speed (avg)	**850-500**	**500-300**	**300-below**	**100**
	Marks	**100**	**75**	**50**	
	Type of Head Box (Open/Closed/Pressurised)	**Open-50**	**Closed-75**	**Pressurised-100**	**100**
	Sheet Forming (Fourdrinier/Twin wire)	**Ttwin Wire -100**	**Fourdrinier -75**		**100**
	Pressing				
	Marks Avg				100
	P/M Drive				
	Marks Avg (LS/DC/AC)	50/75/100			100
III	**Chemical Recovery**				
	Marks Avg (STV/LTV/FF)	50/75/100			100
	Soda Recovery System				
	Marks	50			100
	Lime Kiln	Y-100			
IV	**Power House**				
	Type of Boilers	FBC-100	Grate -75	O-50	100
	Cogeneration	Y-100			100

Performance Score board…….. Agro based

C	Process Operation and Optimization	Scores			Max
	Pulping				
	kappa Number	9-13	13-16	16-18 & 18 above	100
	Marks	100	75	50 & 25	
	Yield (Screened)	above-49	49-45	45-below	100
	Marks	100	75	50	
	Soda Losses in washing, kg/t	8-10	10-15	15-above	100
	Marks	100	75	50	
	Bleaching				
	Bleaching Losses, %	6-9	9-11	11-above	100
	Marks	100	75	50	
	Paper Machine				
	Dryness at end of pressing	Below 40	40-45	45 - above	100
	Marks	50	75	100	
	% condensate recovery	100-90	90-60	60-below	100
	Marks	100	75	50	
	Dryness of Paper	97.4-95	95-below		100
	Marks	100	50		

Performance Score board…….. Recycle Fibre based

A	Basic Inputs	Scores			Max
I	Raw material Consumption, t/t	1.5-2	2-2.5	2.5- above	100
	Marks	100	75	50	
II	Energy Consumption				
	Steam, t/t				100
	Bleach& Unbleach with deinking	below 5 (100)	5-8 (75)	8 above (50)	
	Bleach& Unbleach without deinking	below 4 (100)	4-7 (75)	6 above (50)	
	Unbleach without deinking	below 3 (100)	3-4 (75)	4 above (50)	
	Bleach with deinking	below 4 (100)	4-5 (75)	5above (50)	
	Speciality	below 6 (100)	6-8 (75)	8above (50)	
	Power, kWh/t				100
	Bleach& Unbleach with deinking	below 800 (100)	800-1000 (75)	above 1000 (50)	
	Bleach& Unbleach without deinking	below 700 (100)	700-900 (75)	above 900 (50)	
	Unbleach without deinking	below 600 (100)	600-800 (75)	above 800 (50)	
	Bleach with deinking	below 850 (100)	850-1150 (75)	above 1150 (50)	
	Speciality	below 1000 (100)	1000-1300 (75)	above 1300 (50)	
IV	Water Consumption m^3/t	20	20-50	50-above	100
	Marks	100	50	25	

Performance Score board…….. Recycle Fibre based

B	Technological Status				
I	**Stock Preparation and Paper Machine**				
	Paper Machine				
	Number of Machines	**1-2**	**2-4**	**4 above**	**100**
	Marks	**100**	**50**	**25**	
	Speed (avg)	**850-500**	**500-300**	**300-below**	**100**
	Marks	**100**	**75**	**50**	
	Type of Head Box (Open/Closed/Pressurised)	**Open-50**	**Closed-75**	**Pressurised -100**	**100**
	Sheet Forming (Fourdrinier/Twin wire)	**Twin Wire -100**	**Fourdrinier-75**		**100**
	Pressing				
	Marks Avg				100
	P/M Drive				
	Marks Avg (LS/DC/AC)	50/75/100			100
IV	**Power House**				
	Type of Boilers	FBC-100	Grate -75	O-50	100
	Cogeneration	Y-100			100

C	Process Operation and Optimization				
	Paper Machine				
	Dryness at end of pressing				
	Marks	**Bleow 40/50**	**40-45/75**	**45 - above/100**	**100**
	% condensate recovery				
	Marks	**100-90/100**	**90-60/75**	**60-below/50**	**100**
	Dryness of Paper				
	Marks	**97.4-95/100**	**95-below/50**		**100**

Annexure - III

BASIS FOR NORMS

Basis for Norms…….. Wood based (Bleached Varieties)

Overall Norms

Sl. No	Particulars	Norms	Units – 1	Units – 2	Units –3
1	Purchased Energy M kcal/t	7.0	12.12	6.2	7.05
2	Steam, t/t of finished paper	9.0	10.23	11.43	10.41
3	Power, kWh/t of finished paper	1300	1594	1300	1383
4	Water, m^3/t of finished paper	120	170	140	85.17

Breakup of Specific Steam consumption (t/t of finished paper):

Sl. No	Section	Norms	Units – 1	Units – 2	Units –3
1	Pulp Mill & Bleach Plant	1.6	2.6	1.90	1.74
2	Paper Machine	2.5	2.2	2.76	2.74
3	Evaporators & Soda Recovery	2.6	3.6	2.42	3.33
4	Boiler House	2.0	1.8	3.07	2.31
5	Others	0.3	--	1.28	0.29
	Total	9.0	10.2	11.43	10.41

Basis for Norms…….. Wood based (Bleached Varieties)

Breakup of Specific Power consumption (kWh/t of finished paper):

Sl. No	Section	Norms	Units – 1	Units – 2	Units –3
1	Raw material preparation, Pulping &Bleach plant	230	232	232.23	273.2
2	Stock Preparation & Paper Machine	600	750	655.9	561.6
3	Boiler House	125	271.5	48.8	252.3
4	Recovery Section (without lime kiln)	125	223.5	115.3	185.9
5	Water System	50	27	43.1	43
6	ETP	40	47	42.8	32.4
7	Utilities & Others	130	43	161.87	34.6
	Total	1300	1594	1300	1383

Breakup of Specific Water consumption (m3/t of finished paper):

Sl. No	Section	Norms	Units – 1	Units – 2	Units –3
1	Pulp Mill	40	72	75	18
2	Paper Machine	30	72	38	38
3	Boiler incl. water treatment & cooling tower	20	25	27	22
4	Chemical Recovery & others	30	1	N.A.	7.17
	Total	120	170	140	85.17

Basis for Norms…….. Wood based (Unbleached Varieties)

Overall Norms

S.No	Particulars	Norms	Units – 1	Units – 2	Units –3
1	Purchased Energy, M kcal/t	5.6	5.57	7.61	3.5
2	Steam, t/t of finished paper	7.0	8.82	9.7	7.80
3	Power, kWh/t of finished paper	1150	1233	1627	1272
4	Water, m^3/t of finished paper	120	149	177	198

Breakup of Specific Steam consumption (t/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2	Units –3
1	Pulp Mill	1.0	1.96	3.6	1.93
2	Paper Machine	2.2	3.19	3.4	2.49
3	Evaporators & Soda Recovery	2.4	2.79	2.6	1.5
4	Boiler House	1.2	N.A.	N.A.	1.55
5	Others	0.2	0.88	0.1	0.33
	Total	7.0	8.82	9.7	7.80

Basis for Norms…….. Wood based (Unbleached Varieties)

Breakup of Specific Power consumption (kWh/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2	Units –3
1	Raw material preparation & Pulping	170	252.6	289.1	179.6
2	Stock Preparation & Paper Machine	550	632.2	699.4	700.6
3	Boiler House	125	90.3	180.1	83.2
4	Recovery Section	125	120.2	190.0	127.6
5	Water System	80	49.6	103.3	40
6	ETP	40	23.6	46.4	43.4
7	Utilities & Others	50	64.5	118.7	97.6
	Total	1150	1233	1627	1272

Breakup of Specific Water consumption (m3/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2	Units –3
1	Pulp Mill	40	N.A.	62	N.A.
2	Paper Machine	30	N.A.	53	N.A.
3	Boilers including water treatment & Cooling tower	20	N.A.	51	N.A.
4	Chemical Recovery & others	30	N.A.	11	N.A.
	Total	120	149	177	198

Basis for Norms…… Wood based (Newsprint)

Overall Norms

S.No	Particulars	Norms	Units – 1	Units – 2	Units – 3
1	Purchased Energy, M kcal/t	7.00	12.13	14.77	14.77
2	Steam, t/t of finished paper	5.0	7.68	12.14	8.47
3	Power, kWh/t of finished paper	2100	1756	2153	2049
4	Water, m^3/t of finished paper	100	109	123	102

Breakup of Specific Steam consumption (t/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2	Units – 3
1	Pulp Mill	0.6	1.79	0.94	1.08
2	Paper Machine	2.2	2.04	2.38	2.12
3	Evaporators & Soda Recovery	1.5	2.82	1.82	2.10
4	Boiler House	0.6	0.69	6.31	3.17
5	Others	0.1	0.34	0.69	N.A.
	Total	5.0	7.68	12.14	8.47

Basis for Norms…… Wood based (Newsprint)

Breakup of Specific Power consumption (kWh/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2	Units – 3
1	Raw material Preparation, Pulping & Bleach plant	1150	376	706.5	1020
2	Stock Preparation & Paper Machine	600	723	850.5	739
3	Boiler House	125	281	280.7	59
4	Recovery Section	100	176	69	73
5	Water System	45	59	86.6	53
6	ETP	40	66	69.0	36
7	Utilities & Others	40	75	90.7	69
	Total	2100	1756	2153	2049

Breakup of Specific Water consumption (m3/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2	Units – 3
1	Pulp Mill	40	60	54	27
2	Paper Machine	30	22	40	22
3	Boilers including water treatment & Cooling tower	20	14	14	25
4	Chemical Recovery & others	30	13	15	28
	Total	120	109	123	102

Basis for Norms…….. Wood based (Rayon Grade)

Overall Norms

S.No	Particulars	Norms	Units – 1	Units – 2
1	Purchased Energy, M kcal/t	3.00	2.15	5.37
2	Steam, t/t of finished paper	8.00	9.2	13.46
3	Power, kWh/t of finished paper	800	889	1074
4	Water, m^3/t of finished paper	120	176	138

Breakup of Specific Steam consumption (t/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2
1	Pulp Mill & Bleach Plant	1.6	3.3	N.A.
2	Pulp drying	1.3	--	N.A.
3	Evaporators & Soda Recovery	2.6	4.6	N.A.
4	Boiler House	1.2	1.3	N.A.
5	Others	1.3	--	N.A.
	Total	8.0	9.2	13.46

Basis for Norms…….. Wood based (Rayon Grade)

Breakup of Specific Power consumption (kWh/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2
1	Raw material Preparation, Pulping and Bleach plant	290	240	290
2	Pulp drying	120	80	128
3	Boiler House	100	160	169
4	Recovery Section	100	210	235
5	Water System	50	120	68
6	ETP	40	79	27
7	Utilities & Others	100	--	157
	Total	800	889	1074

Breakup of Specific Water consumption (m3/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2
1	Pulp Mill	70	134	N.A.
2	Boilers including water treatment & Cooling tower	20	31	N.A.
3	Others	30	11	N.A.
	Total	120	176	138

Basis for Norms…….. Agro based (Bleached varieties)

Overall Norms – With Chemical Recovery

S.No	Particulars	Norms	Units – 1	Units – 2	Units –3
1	Purchased Energy, M kcal/t	7	5	5	8
2	Steam, t/t of finished paper	7.5	5.0	6.9	8.94
3	Power, kWh/t of finished paper	1050	1097	1215	1141
4	Water, m^3/t of finished paper	150	123	140	67

Breakup of Specific Steam consumption (t/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2	Units –3
1	Pulp Mill & Bleach Plant	1.5	1.54	N.A	1.81
2	Paper Machine	2.5	2.9	N.A	2.90
3	Evaporators & Soda Recovery	2.6	0	N.A	2.64
4	Boiler House	0.6	0.30	N.A	1.59
5	Others	0.3	0.26	6.9	0
	Total	7.5	5.0	6.9	8.94

Specific Energy Consumption Norms for Mills without Chemical Recovery

Power Consumption = Norm - 125

Steam Consumption = Norm - 2.6

Basis for Norms…….. Agro based (Bleached varieties)

Breakup of Specific Power consumption (kWh/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2	Units –3
1	Raw material Preparation, Pulping and Bleach plant	200	290	272	184
2	Stock Preparation & paper Machine	550	648	494	474
3	Boiler House	85	74	159	151
4	Recovery Section	125	N.A	140	169
5	Water System	50	12	59	59
6	ETP	40	73	56	54
7	Others	--	N.A	35	50
	Total	1050	1097	1215	1141

x

Basis for Norms…….. Agro based (Unbleached varieties)

Overall Norms Without Chemical Recovery

S.No	Particulars	Norms	Units – 1	Units – 2
1	Purchased Energy, M kcal/t	5	6	11
2	Steam, t/t of finished paper	3.3	6.60	4.0
3	Power, kWh/t of finished paper	500	1204	1034
4	Water, m^3/t of finished paper	150	145	80

Breakup of Specific Steam consumption (t/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2
1	Pulp Mill	1.0	N.A	N.A
2	Paper Machine	2.0	N.A	N.A
4	Boiler House	0.2	N.A	N.A
5	Others	0.1	N.A	N.A
	Total	3.3	6.60	4.0

Basis for Norms…….. Agro based (Unbleached varieties)

Breakup of Specific Power consumption (kWh/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2
1	Raw material Preparation & Pulping	100	N.A	N.A
2	Stock Preparation & paper Machine	325	N.A	N.A
3	Boiler House	35	N.A	N.A
4	Water System	25	N.A	N.A
5	ETP	15	N.A	N.A
6	Others	--	N.A	N.A
	Total	500	6.9	1034

Basis for Norms…….. Recycle Fibre based (Writing & Printing)

Overall Norms With Deinking

S.No	Particulars	Norms	Units – 1	Units – 2
1	Purchased Energy M kcal/t	4.0	--	--
2	Steam, t/t of finished paper	3.2	4	3.7
3	Power, kWh/t of finished paper	800	810	1409
4	Water, m^3/t of finished paper	50	30	96

Breakup of Specific Steam consumption (t/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2
1	Pulper	0.2	N.A	--
2	Paper Machine	2.5	N.A	3.7
3	Deinking	0.3	N.A	--
4	Boiler House	0.2	N.A	--
5	Others	-	N.A	--
	Total	3.2	4.0	3.7

Specific Energy Consumption Norms for Mills without Deinking

Power Consumption = Norms -200

Steam Consumption = Norms –0.3

Basis for Norms…….. Recycle Fibre based (Writing & Printing)

Breakup of Specific Power consumption (kWh/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2
1	Pulper	100	N.A	233
2	Stock Preparation & paper Machine	450	N.A	1029
3	Boiler House	50	N.A	N.A
4	Deinking	150	N.A	N.A
5	Water System	20	N.A	N.A
6	ETP	30	N.A	147
7	Others	-	N.A	N.A
	Total	800	810	1409

Basis for Norms…….. Recycle Fibre based (Newsprint)

Overall Norms With Deinking

S.No	Particulars	Norms	Units – 1	Units – 2
1	Purchased Energy M kcal/t	6	14	6
2	Steam, t/t of finished paper	3.0	4.6	8.6
3	Power, kWh/t of finished paper	750	1641	1125
4	Water, m^3/t of finished paper	50	N.A.	31

Breakup of Specific Steam consumption (t/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2
1	Pulper	--	--	--
2	Paper Machine	2.5	3.7	3.4
3	Deinking	0.3	N.A.	N.A.
4	Boiler House	0.2	0.90	5.2
5	Others	--	N.A.	--
	Total	3.0	4.6	8.6

Specific Energy Consumption Norms for Mills without Deinking

Power Consumption = Norms -200

Steam Consumption = Norms –0.3

Basis for Norms…….. Recycle Fibre based (Newsprint)

Breakup of Specific Power consumption (kWh/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2
1	Pulper	75	45	221
2	Stock Preparation & Paper Machine	425	1217	587
3	Boiler House	50	334	274
4	Deinking	150	N.A.	--
5	Water System	20	--	--
6	ETP	30	36	36
7	Others	--	9	7
	Total	750	1641	1125

Basis for Norms…….. Recycle Fibre based (Kraft)

Overall Norms Without Deinking

S.No	Particulars	Norms	Units – 1	Units – 2	Units – 3
1	Purchased Energy M kcal/t	3	3	3	--
2	Steam, t/t of finished paper	2.2	3.5	4.0	2.5
3	Power, kWh/t of finished paper	450	979	1067	480
4	Water, m^3/t of finished paper	50	N.A.	N.A.	4.0

Breakup of Specific Steam consumption (t/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2	Units – 3
1	Pulper	-	--	N.A.	--
2	Paper Machine	2.0	3.50	4.0	2.5
3	Boiler House	0.2	N.A.	N.A.	--
4	Others	-	N.A.	N.A.	--
	Total	2.2	3.50	4.0	2.5

Basis for Norms…….. Recycle Fibre based (Kraft)

Breakup of Specific Power consumption (kWh/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2	Units – 3
1	Pulper	50	75	N.A	N.A
2	Stock Preparation & Paper Machine	300	541	1002	N.A
3	Boiler House	50	52	43	N.A
4	Water System	20	N.A.	N.A	N.A
5	ETP	30	33	22	N.A
6	Others	-	278	N.A	N.A
	Total	450	979	1067	480

Basis for Norms..... Recycle Fibre based (Board)

Overall Norms Without Deinking

S.No	Particulars	Norms	Units – 1	Units – 2
1	Purchased Energy M kcal/t	4.0	2.0	7.0
2	Steam, t/t of finished paper	2.0	2.0	2.0
3	Power, kWh/t of finished paper	400	450	462
4	Water, m^3/t of finished paper	50	7.5	19.5

Breakup of Specific Steam consumption (t/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2
1	Pulper	--	N.A.	N.A.
2	Paper Machine	2.0	2.0	2.0
3	Boiler House	--	N.A.	N.A.
4	Others	--	N.A.	N.A.
	Total	2.0	2.0	2.0

Basis for Norms…….. Recycle Fibre based (Board)

Breakup of Specific Power consumption (kWh/t of finished paper):

S.No	Section	Norms	Units – 1	Units – 2
1	Pulper	50	56	32.9
2	Stock Preparation	100	350	163
3	Paper Machine	200		180
4	Boiler House	25	24	32
5	Water System	10	10	9.4
6	ETP	15	10	11
7	Others	--		33.7
	Total	400	450	462

xx