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Benchmarking of Pulping, Bleaching and Recovery Operations (Wood & Agro Based Mills)

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Abstract: ***Paper plays a key role in our daily life and papers have been used for many years from now. Papers are made with the pulp of the woods, which is an Eco-friendly product. For that we made pulp and then after the paper. Throughout the processes after pulping, bleaching of the brown pulp is necessary to produce good white paper and to run the pulp mill smoothly chemical recovery is also needed. The increasing need for paper is continuously putting pressure on forests per capita, whereas regional restrictions are being imposed worldwide by local governments to save forests and the environment. So from this century, non-woody raw materials like straws, bamboo, kenaf, hemp etc., got considerable interest as raw material for papermaking to reduce the increasing pressure on forest wood resources. Also with some recycled fibres paper can be made because of recycling paper saves landfill space and reduces the amount of pollution in the air from incineration and the process of recycling protects the environment. Using recycled paper to make new paper reduces the number of trees that are cut down, conserving natural resources. Pulp and paper are made from cellulosic fibres and other plant materials. Paper is made from wood fibres, but rags, flax, cotton linters, and bagasse (sugar cane residues) are also used in some papers. Products such as cellulose acetate, rayon, cellulose esters that are made from cellulose will be used for packaging films; explosives. The pulping process is aimed at removing lignin without losing fibre strength, thereby freeing the fibres and removing impurities that cause discoloration and possible future disintegration of the paper.***

Key words: ***Pulping vision, Technology Comparison, Bleaching Latest Technique, Chemical Recovery.***

Introduction

The Indian paper industry accounts for about 4 % of world production of paper and it is expected to grow from the present production i.e. 19 MT to 23.5 MT (million tons) by 2025. On other hand, in 2019 the total production capacity of bleached hardwood Kraft pulp amounted to around 79.26 million air-dried metric tons (statista.com). In recent years, paper production from wood-based raw material has reduced from 84 % in the 1970's to 25 % and 17 % of total pulp production is from agro-based pulp and paper mills. With India becoming a member of WTO it has become important for the paper industry also to evolve a strategy to become a globally competitive one. This industry in the last few decades has been faced with a number of challenges. Technological obsolescence is one of the major challenges which are required to be addressed in order to make the industry sustainable and globally competitive.

Pulping

For pulping there are number of challenges to be faced or facing by the paper mills to run their organisation. Pulping processes reduce wood or any other fibrous raw material to a fibrous mass. Chemical pulping essentially dissolves the non-cellulosic components in wood, mainly lignin, and thereby liberates the fibres. This process, also known as 'delignification,' centres around the removal of ligneous binding material, but, in the process, certain hemi cellulosic as well as cellulosic components are dissolved.

Chemical Pulping Process

Two major chemical pulping processes are:

- **Sulphite pulping**
- **Kraft pulping.**

Sulphite pulping can be carried out at different pH levels with different bases – calcium at low pH (1–2), magnesium (3–5), and ammonium and sodium over the entire range of pH. Chemical pulping is by far the most common method for pulping wood both in Europe and in the United States. In the United States, it accounts for more than 80% of all pulp produced. Chemical pulps have a low yield (40–55%), but the pulp produced is of very high quality. The most common process, the Kraft process, accounts for more than 80% of all chemical pulp produced both in the United States and in Europe. In this process, the virgin materials are mixed with a chemical solution, called white liquor, in a digester, where they are pressurized and heated to dissolve the lignin from the wood.

Bleaching

Once the pulping process becomes less selective (in the removal of lignin as compared to cellulose and hemicellulose), the process is stopped; further processing of pulp proceeds via extended delignification and bleaching processes. Although the bleaching process is intended to bleach the 'brown' unbleached pulp into bright white pulp, the initial stages in a multistage bleaching process are more aptly called delignification since they essentially contribute to additional and preferential lignin dissolution..

Recovery

After being dissolved, the virgin material is separated into individual fibres and the chemical mixture, now called black liquor, is concentrated in an evaporator. Then, it is burned in a recovery boiler, where the energy is recovered, often cogenerating both steam and electricity, which is then used as process energy.

COMPARISON OF TECHNOLOGIES USED IN INDIAN PAPER INDUSTRY VIS A VIS THOSE USED IN DEVELOPED COUNTRIES.

FOR PULPING, BLEACHING AND RECOVERY OPERATIONS

	Advanced Countries	India
Pulping Chemical	• Continuous Digesters or RDH pulping • Oxygen Delignification	• Mainly batch scale pulping • Only practiced by some mills
Newsprint	• Ground wood pulping, TMP process, CTMP Process	• Generally CRMP
Bleaching	• TCF & ECF bleaching in most of the mills	• Chlorine is still being used in many mills.
	• Extended nip press • Closed draw	• Plain/Suction Press mostly used • Open Draw
	• Closed hood • Supported web • Steam/condensate cascading system	• Many mills have open hoods • Generally unsupported web • Generally absent
Chemical Recovery	• Falling film type evaporators • Equipped with lime burning kilns • Direct contact evaporators still used	• No direct contact evaporators • Generally LTV,STV in some mills • Only some mills have lime kilns

AREA REQUIRING TECHNOLOGY UPGRADATION

Due to complex structure of the Indian paper industry, the technology input varies substantially in each category of mills presumably due to variation in their size and raw material mix. A significant step up from the existing technological level to a substantially higher one for such trailing segment would be imperative.

The paper making process involves a number of complex unit operations & unit processes. Technology upgradation is proposed to achieve the following objectives/ deliverables.

- Cost competitiveness
- Improved quality standards
- Environmental compliance and
- Enhanced productivity

The identified process technologies and machinery in a new unit or in an existing unit by way of replacement of existing process and machinery and /or expansion for all three categories mills hold potential for technology upgradation.

PULPING LATEST VISION

Our paper industries now going for the sustainable pulping rather than the older times they were dependent on kraft, sulphite and now days such as soda pulping.

The vision of the pulp and paper industry is to significantly reduce carbon dioxide emissions while improving energy and resource efficiency. Hence, a European initiative has developed a breakthrough technology for greener pulp production.

Currently, pulping of wood to isolate cellulose fibres for paper production uses energy-intensive technologies developed more than a century ago that require fossil chemicals. There is an overall consensus towards greener processes that require less energy, are more sustainable but at the same time retain the efficiency of high quality pulp production. The pulp and paper industry can make a major contribution towards a resource-efficient world, supporting global efforts towards a low-carbon bio economy.

Chemical Pulping (Kraft)

As noted earlier, the kraft process is the most common chemical pulping process (see Pulping: Chemical Pulping). The chipped wood is introduced into an anaerobic alkaline environment under conditions that result in maximizing the solubilisation and removal of lignin, while minimizing the degradation or removal of cell wall polysaccharides, principally cellulose. The pulping process is usually stopped at a lignin content of 4-5% because further treatment under these conditions results in unacceptable losses in cellulose or degradation of the mechanical properties of the fibres. In recent years, however, ways have been found to extend the kraft pulping process to somewhat lower lignin contents without extensive reduction in pulp strength.

Modified Continuous Cooking (MCC) for continue digesters.

Rapid Displacement Heating (RDH) for batch digesters.

In these systems the alkali concentration in the digester is manipulated so as to reduce the damage to the cellulose and hemicelluloses during pulping. The guiding principle in these systems is creation of a counter current flow of the pulping chemicals and wood chips. Their aim is to keep the concentration of alkali lower and more uniform throughout the cooking process and also to minimize the concentration of dissolved lignin at the end of the cook.

Other Alkaline Pulping Process

While it can no longer be regarded as a recent innovation, the use of Anthra quinone (AQ) as a pulping catalyst has been developed further in recent years. It is usually used to enhance the effectiveness of kraft pulping; in some instances it has also been used with soda pulping,

that is, without sulphur. Recently, it has been shown that octahydro dimethyl-anthraquinone (ODiMAQ) is a much more effective delignification catalyst than is AQ. It is thought that ODiMAQ can be produced for about the same cost per unit weight as AQ. It is anticipated that soda-ODiMAQ) cooking will be more attractive economically than soda-AQ. If oxidative delignification is introduced early in the delignification process, at the level of 8-10% lignin content, it may well be that the soda-ODiMAQ treatment is more effective than soda-AQ. If followed by oxidative delignification, it may become an option for sulphur-free pulping.

BLEACHING WITH LATEST TECHNIQUES

The increased emphasis on reducing the environmental impact of pulp bleaching has led to exploration of the use of enzyme systems. In an effort to achieve this goal, research has increased toward enzymatic treatments. There are two fundamental approaches:

- To enhance the removal of lignin by traditional bleaching chemicals.
- To use enzymes that act directly on lignin.

The application of xylanases in commercial systems is indicative of the promise of this approach. The work here has focused largely on manganese peroxidase- and laccase-mediator systems. There are currently economic limitations to their commercial implementation. Additionally, POMs are being developed as inorganic analogues to enzymes in the direct oxidation of lignin.

Xylanase Treatment

The application of xylanases to fibres between chemical pulping and the bleaching sequence is being rapidly implemented in mills worldwide. This has occurred for many reasons. Xylanase treatments can be implemented successfully with softwood, hardwood, and other lignocellulosic pulps. Reduced chemical loads are required for the bleaching sequence; if chlorine or chlorine dioxide is used; effluent properties, such as aromatic organic halides (AOX), chemical oxygen demand (COD), and colour are reduced. Higher-brightness ceilings can be reached. Implementation of xylanase treatment into current industrial bleaching sequences can be done without extensive capital costs. In general, the xylanase treatment is placed after the pulping and oxygen delignification steps and prior to chlorine, chlorine dioxide, and hydrogen peroxide steps; mills have implemented xylanase before or after ozone bleaching stages. In general, the higher the lignin content is prior to the xylanase application, the greater the reduction on subsequent chemical consumption or brightness gain.

STATUS OF CHEMICAL RECOVERY IN PAPER INDUSTRY

Status of kraft recovery Kraft recovery technology is mature and very capital intensive. Economic factors have driven the industry toward very large scale operations. Most recent developments have been aimed at operating improvements and small gains in efficiency.

There is desire for some means, compatible with the existing process, which would give a 10-20% incremental capacity increase, but no generally accepted process to do this has materialized. Vulnerability issues have become important. Since the vulnerability increases with size, this may serve as a brake on the trend toward larger scales of operation. A major breakthrough that will lead to a simple, cheap, kraft recovery technology seems unlikely. The breakthrough, when it comes, will be a different pulping process combined with a recovery technology.

Soda Recovery

This covers the recovery technology for all sulphur- free, sodium-base alkaline pulping processes including any combination of sodium hydroxide and sodium carbonate along with organic substances, oxygen, etc. The chemistry of soda recovery is straight forward.

- Combustion of the black liquor converts the sodium compounds to sodium carbonate.
- Sodium hydroxide can be produced by causticizing the carbonate solution with lime.

Alternative techniques, to be described later, exist in which the chemistry is slightly more complicated. The major elements of soda recovery are similar to kraft. After being washed from the pulp the liquor is concentrated by evaporation and burned. Causticizing and calcining of the green liquor may follow if caustic is desired. Normally washers and evaporators are similar to those used for kraft but there may be some differences. With high-yield wood pulps or when agricultural residues are used, press washers or other special devices may be needed to effectively remove the liquor from the pulp. Soda liquors can be more prone to scaling (a severe problem with agricultural residues), and this may force the use of evaporator types that are more resistant to scaling or lower the extent to which the liquors can be concentrated. Combustion of soda liquors can take on different forms than that used for kraft. Since sulphide is not needed, there is no need to maintain a local reducing environment in the combustion step.

Soda liquor combustion can be carried out in equipment such as fluidized beds that are not suitable for kraft. Most of the variations in soda recovery technology are connected with the combustion step.

Causticizing and calcining, where practiced, is similar to kraft. High amounts of silica may make lime re-burning impossible, and in that case causticizing is followed by mud disposal.

CONCLUSION

With this study we have concluded that pulping operations in such above kraft mills now being changed to sustainable pulping following that technique environment sustains and also future mankind resources protected. After that bleaching techniques are now being changed to xylanase bleaching, will cause a real change to the current paper industry scenario and also the cost will be effective from this type of technique.

In recovery operations, the production of sodium carbonates content should be sold to the customers who need Na2CO3 for their products manufacture as a raw material. In other words kraft recovery should be less polluted such as now a days in older paper mills recovery section not improves too much as compared to the pulping and bleaching areas. Most of the paper industries now switched to recycle based industries, in that there is no recovery plant so that in agro and wood based mills, less pollution with more production technique should be used.

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