

A Review on Advancement of Pulp and Paper Industry

Priyanka Gupta*

Research Scholar, Department of Bioscience and Biotechnology, Banasthali Vidyapith, Rajasthan, 304022, India

Abstract: - The development of Biotechnology for the pulp and paper Industry was started in 1970's. In this paper we reviewed the biotechnology applications in the pulp and paper industry with the help of their processes, applications and their enzymatic action. This paper helps the synthesis of specific information on pulp and paper industry by their biotechnological applications. To enhance the important advance the use of enzymes in this industry to identify the future trends of this technology. The current and future trend is used on the development of enzymes to increase their thermostability and alkalinity strength of finished paper.

IndexTerm - Bio-pulping, Bio-bleaching, Biopapers

1.) Introduction

Pulp for Paper making was produced by mulberry bark. It was first discovered in 2nd century in Han dynasty in China by Cai Lun(Tsein, Tsuen-Husin.,1985).Pulp was also made from bamboo, hibiscus bark, blue sandalwood, straw and cotton(Tsein, Tsuen-Husin.,1985a,b).Wood pulp is a recent innovation to make paper and cardboard which is used in modern time(Hunterdard.,1943). Generally we use timber wood pulp that is called pulpwood because of cellulose fibers in the pulp to make strong paper (Geman,Helytee.,2014).Pulp contains three main components such as cellulose fibres, lignin and hemicellulose. Sometimes we use soft wood trees for paper making such as spruce, pine, fir, larch and hemlock and we use hardwood such as eucalyptus, aspen and birch to provide increase ease of breaking down of lignin(Sixta Herbert, ed.,2006).

2.) Types of Paper

- a) Bond Paper is stronger paper and more durable
- b) Gloss coated paper is coated by a mixture of polymer such as Kaolinite, calcium carbonate, Bentonite and talc that is generally used in packaging industry and magazines(Grades of paper).Starch coated paper is also used in water resistance and wet strength to paper and protect against ultraviolet radiation(Diana Twede.,2007).
- c) Matt coated paper contains high percentage of Calcium carbonate. It is generally used by designers and Graphic artists. This type of paper is perfect for reports, flyers and leaflets.
- d) Recycled paper by which waste paper is turned into new paper products (Paper recycling facts). It is generally used for most documents including reports, forms
- e) Silk coated paper is smooth, but without shine of glass paper. It is generally used in books and catalogues.

- f) Uncoated paper is typically found in printers that are excellent for ink receptivity and absorbency. It is mainly used in letter heads.
- g) Water marked paper always give a feel of luxury and high quality. It is mainly used un documents including exam certificates

3.) Pulp and Paper Manufacturing Processes

The pulp and paper industry play important role in world economy. Mostly cellulosic pulp is produced by pulping of ligno cellulose material due to release of fibers from plant material by chemical and mechanical treatment. About 90% of cellulosic pulp is produced from annual plants and agriculture residues. These residues are straw, sugarcane and bamboo (Sixta. 2006). The major macromolecular components of wood and cellulose is 40-50%, hemicellulose 25-30% and lignin 25-30 % (Sjostorm., 1981).

Three major processes are pulping, Wood bleaching and characteristics of the resultant paper are affected. Pulping process is divided into four main groups:

- a) Mechanical Pulp:- It is done by physical separation of wood fiber by grinding and refining. In refining pulping we use steam pretreatment stage that gives thermo mechanical pulp. This mechanical pulp is yellow in color due to high quantity of lignin content (Joelsson and Gustavsson. 2008).
- b) Short steam treatment:- In this treatment we use chemical reagents to make pulp stronger and enabling the furnish of pulp.
- c) Semi chemical pulp:- This type of pulp is combined with chemical and mechanical process. It has significant amount of lignin content which gives good strength and stiffness of paper.
- d) Chemical pulp:-In this process cellulose fibre is separated from lignin to give high brightness and stability. Generally we use sodium hydroxide and sodium sulfide in this process.

4.) Biopulping

Biopulping is the treatment of wood chips by white rot fungi is a method for saving electrical energy and making a stronger paper product (Akhtar et al., 1998; Shukla et al., 2004). White rot fungi and their enzymes such as Ligninases and xylanases is used for the treatment of wood chips. Ligninases attack the lignin content of wood and xylanases is used to degrade hemicelluloses to make pulp more permeable for the removal of residual lignin. Biopulping process removes lignin and wood extractives to reduce the pitch content and effluent toxicity (Ali and Sreekrishnan. 2001).

In Biopulping chemical constituents are cellulose, hemicellulose and lignin (Malherbe and Cloete. 2002). Cellulose is difficult to hydrolyze under natural conditions. It has cellulose chains ranges from 500 to 25000 (Kuhad et al., 1997; Leschine 1995). Hemicellulose is short branched chains of hexoses such as Xylose units in xylans (Kuhad et al., 1997). Hemicellulose degrade enzymes are endoxylanases

an endomannases (Kulkarni et al., 1999). It helps to create the web bonds by cross linking with lignin to provide structural strength (Ldisch et al., 1983; Lynch., 1992). Lignin is about 100kda to prevent its uptake inside the microbial cell. Lignin degradation is too slow process due to its heterogeneous structure. White rot fungi developed enzymes to break lignin (Kirk and Farrell., 1987). Actinomycete decompose lignin and degrade 20% lignin in wood (Cawford 1987; Basaglia et al., 1992).

4.1 Wood degradation by Fungus

Wood degradation is done by two types of fungus they are white rot and brown rot (Hakala., 2007). Both types of fungus belong to Basidiomycetes group. The brown rot fungi cause more damage to wood than white rot, while white rot fungus mortify the hardwoods (Enoki et al., 1988). But white rot have the ability to disintegrate and mineralize lignin (Hunt et al., 2002). Brown rot fungi has lack of exogenous Endo-1, 4 β glucanase activity (Kirk and Highley., 1973). It helps to degrade hemicellulose and cellulose (Cowling. 1961). In the mechanism of wood decay fungi degrade lignin to a significant extent. The walls of wood decayed by white rot fungi to break down lignin and hemicelluloses (Blanchette et al., 1989).

There are eight white rot fungi: *Coriopsis rigida*, *Coriolus versicolor* var. *antarcticus*, *Peniophora* sp., *Phanerochaete sordida*., *Trametes elegans* and *Trametes villosa* , *Pycnoporus sanguineus*, *Steccherinum* sp. Among these fungus *P. sanguineus* was able to reduce lignin content 11%, but *P.taeda* suffering from structural changes in lignin and hemicellulose decaying of wood (Levin et al ., 2007).

Biopulping process helps to reduced the cooking time, consumption of energy decreases and provide the strength of paper.

5.) Biobleaching

It is the chemical process of wood pulp to lighten the colour and whitens the pulp (Paper on web discussion of brightness and whiteness. 2007). Bleaching Mechanical pulp helps to removal of chromophores so we use hydrogen peroxide used as bleaching agent. EDTA is also used to remove metal ions from the pulp. Magnesium salts and sodium silicate are added to improve bleaching with alkaline peroxide (Pulp bleaching chemicals information. 2007).

Biobleaching is the treatment of pulp by microorganisms such as fungi or their enzymes. Biobleaching is modifying pulps residual lignin to facilitate bleaching with chemicals. The mechanism of enzyme action is to removal of xylan adsorbed on fibres and rupture of lignin carbohydrate complex (Paice and Jurasek., 1984).

To improve biobleaching by Xylanases. Xylanases catalyzes the hydrolysis of α -1, 4-glycosidic bonds in xylan (Jeffries. 1996). It helps to removal of disaggregated microfibrils on fiber surface (Bae et al.,

2008).Biobleaching is also done by oxidative enzymes such as laccase and peroxidases enzymes. These oxidative enzymes are used to increase the paper brightness (Kondo et al., 1994).

6.) Biopapers

In paper making it involves the application of enzymes to improve drainage, beatability and runnability of paper mills (Noe et al., 1986). In paper making biomolecules is used. It consist the paper surface functionalization of enzymes and proteins to detect, capture and disable bacteria and other pathogenic microorganisms. There is the development of inkjet printing technologies used for the deposition of bioactive materials on paper due to the simplicity and compatibility with paper substrates (Risio and Yan. 2007).Glucose oxidase, urease and horse radish peroxidase are the examples of printed enzymes using inkjet technology (Kimura et al., 1988).

7.) Conclusion

In various paper products are renewable resources increased in growing developed society. There are many innovative technologies to improve the pulping and bleaching efficiency is investigated. Biotechnological innovative methods are successfully applied in pulp and paper production. The application of biological system to improve the yield and quality of cellulosic pulp to minimize the energy consumption and improves the yield and quality of cellulosic pulp.

8.) Acknowledgement

The authors acknowledge their profound gratitude to the Banasthali University, Banasthali, Rajasthan for providing the facilities for research work. We are highly indebted to this place.

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