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STUDY OF BURST STRENGTH AND DEINKING EFFICIENCY OF RECYCLED PULP BY USING ENZYMATIC DEINKING METHOD

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ABSTRACT
In recent times waste paper recycling has increased significantly, and will continue to do so in the future. The objective of the present study was to find the effect of pH on burst strength and deinking efficiency of recycled pulp by using enzymes. Since the burst strength ("burst") is one of the oldest tests developed for paper and board and is a general indicator of strength characteristics. Burst strength is used widely as a measure of strength in many kinds of papers. The potential of using enzymes in deinking of wastepaper has been investigated and proven successful using xylanase enzymes. The scope of this work is to give economic and pollution control process with increased burst strength of waste paper. The enzymatic deinking process also reduces the amount of chemicals added it also reduces the BOD and COD in the waste water. This study focuses on burst strength of a recycled pulp. The effect of pH on burst strength of a paper was studied for different enzyme dosages concentrations. In our study the raw materials used were the papers of Note book (NB), White record (WRD) NO.1 quality, and Export quality. Map printing (MP), Map litho (ML), Cream wove (SCW) , White writing (WW) and White printing(WP) these are some of the industrial grade qualities in which we tried enzymatic Deinking method to increase the bursting strength of the paper in an economical manner. The enzyme dosage of 0.5% and 1% were selected. There was no significant difference in deinking efficiency with the enzyme concentration in the range of 0.5%. For 1% concentration of enzyme there is decrease in burst strength. The enzyme dosage was carried out after pulping stage the various qualities of paper were tested at various pH levels. At pH 9 the result shows that there is maximum burst strength compared to chemical and conventional deinking process but there is no significant difference on results.

Keywords: burst strength, burst index, recycled pulp, Enzymatic deinking

INTRODUCTION

Pulp and paper manufacturing is one of the largest global industries with very high capital investments. The process of making paper, paperboard, and tissues today is highly cost-sensitive.

The necessity for increasing productivity and quality, combined with environmental regulatory pressures, has resulted in an increased demand for pulp and paper chemical additives.

The deinking is a process for the removal of contaminants from reusable paper fibres. Basically, is carried out in two major phases: the

disintegration of printed paper and the separation of ink particles and contaminants from the fibrous suspension by washing or flotation [11].

The enzymatic deinking technology will be helpful for small scale industries to compete with the brightness of waste paper recycling in large scale industries. This method also improves the quality of the product in an effective manner. This enzymatic deinking method will result in the minimal amount of BOD and COD content in the effluent water compared to conventional chemical deinking. The various advantages of enzymatic deinking methods include decreasing availability of conventional raw materials, lower energy requirements, decrease the average ink particle size and destroy fiber-toner concentration, improving ink removal effectiveness, improved technology for reuse of secondary fibers and to obtain better quality products. Some paper grades, e.g., newspapers printed with oil-based inks can be deinked with relative ease. Even so, the best deinking processes remove only about half the ink (12). Nonimpact printed papers are more difficult to deink (13), and the quantity of such papers continues to grow as a proportion of total waste paper volume. Enzymatic deinking may provide a means to meet these needs. Useful enzymes, e.g., cellulases, are now available in larger quantities and at lower cost than in the past (14).Producing specific enzymes in quantities sufficient for commercial use involves cosily purification.Increased usage and advances in fermentation and purification technology are expected to lower production costs. Alternatively, genetic engineering techniques can be used to identify the gene for a specific enzyme, and transfer it to another organism, e.g., Escherichia coli, that normally does not produce the enzyme. This approach was used by Paice et al. to move a 13-xylosidase gene from Bacillus subtilisto E. coli (15-17).

Experience from textile manufacturing and pulp bleaching provides valuable lessons for researchon enzymatic deinking. Operating environments are critical to success, and manifold variablesmust be optimized. These include, among others' temperature, pH, enzyme activity and dosage, reaction time, pulp consistency, and mechanical action (18,19).

J. Behin et al., studied the effect of alkyl chain in alcohol deinking of recycled fibers by flotation process. In which combination of chemical and mechanical forces was done to remove the ink particles from the fibers. The mechanical force is usually supplied by a pulper where the paper is beaten into its constituent fibers. C.K. Lee et al. used the enzymatic deinking of laser printed office waste papers. The protocol for the enzymatic deinking of laser printed waste papers on a laboratory scale using cellulase (C) and hemicellulase (H) of Aspergillusniger (Amano) was developed as an effective method for paper recycling. A maximum deinking efficiency of almost 73% by the enzyme combination of C:H was obtained using the deinking conditions of pulping consistency of 1.0% (w/v) with the pulping time of 1.0 min, temperature of 50 °C, pH 3.5.

Performance of enzymes at alkaline conditions showed their suitability for paper industries.. This deinking approach also improved the various physical properties.

The bursting strength of paper or paperboard is a composite strength property that is affected by various other properties of the sheet, principally tensile strength and stretch. Generally, bursting strength depends upon the kind, proportion, and amount of fibers present in the sheet, their method of preparation, their degree of beating and refining, upon sheet formation, and the use of additives (TAPPI T 403, "Bursting Strength of Paper").

Materials and Methods

From the literature survey, among the various methods of deinking process, the enzymatic deinking methods have been chosen because of their future scope in the improvement of bursting strength. A xylanase enzymes producing bacterial strain was purchased from (MTCC), Institute of Microbial Technology (IMTECH), Chandigarh. The microorganisms purchased were enterobacteraerogenes(MTCC111), enterobactergergoviae(MTCC621), enterobacter cloacae (MTCC509) [20]. Xylan, were purchased from sigma chemicals. All other chemicals used

were of commercial grade. Bursting strength is measured by means of a Mullen tester. Bursting strength is measured by means of a Mullen tester. The test specimen, held between annular clamps, is subjected to an increasing pressure by a rubber diaphragm, which is expanded by hydraulic pressure at a controlled rate, until the test specimen ruptures. The pressure reading at the instant of rupture is recorded as the bursting strength. Burst index is calculated from the following formula;

$$\text{Burst index}=\frac{Bursting\ strength(Kpa)}{grammage,g/m2}$$

Results and Discussion

In the present work, the bursting strength of different paper pulps is evaluated. In the laboratory, the burst is determined by holding the paper sample between two small circular clamps. The sample is subjected to increasing pressure via a rubber diaphragm, expanded by hydraulic pressure, at a controlled rate, until the paper ruptures. The instrument used measures the peak pressure to rupture, usually in kilopascals.The tested pulps are representative of different printing methods. The selection of the optimal enzyme concentration is important since excessive enzymes may be corrosive to the fibers and thus affected the strength of the paper and its quality. There was no significant difference in deinking efficiency with the enzyme concentration in the range of 0.5%. For 1% concentration of enzyme there is decrease in burst strength. The results clearly indicated that since the pulp was an insoluble substrate, the rate of reaction would, therefore, not be directly proportional to the enzyme amount or concentration.

Effect of pH on burst strength of pulp (enzyme dosage 0.5%)

The effect of variations in bursting strength of different grade of pulp was studied with various ranges of pH values. Result shows that for 0.5% enzyme dosage, there is an increase of burst index compared to chemical and conventional deinking process, but there is no significant difference on results. Time taken for enzymatic reaction is 1 hr, but compared to chemicals used this process is effective. Result reveals that the burst index is high at pH of 9.0 for all grades of pulp.

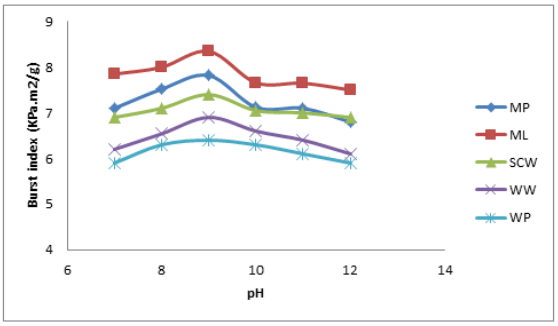

Figure 1: pH Vs burst strength for various pulp with 0.5 % enzyme concentration

Effect of pH on burst strength of pulp (enzyme dosage 1 %)

The effect of variations in bursting strength of different grade of papers was studied with various ranges of pH values. Result shows that for 1% enzyme dosage, there is decrease in burst index compared to 0.5%, but there is no significant difference on results. Time taken for enzymatic reaction is 1 hr, but compared to chemicals used this process is effective. Result reveals that the burst index is high at pH of 9.0 for all grades.

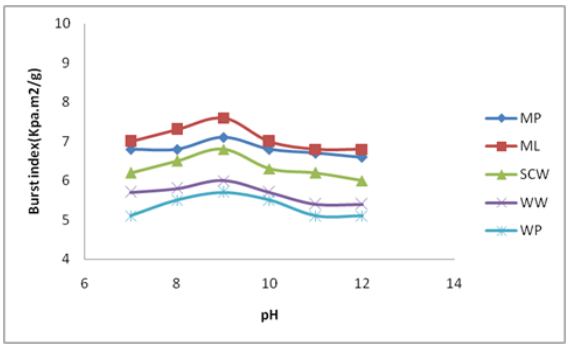

Figure 1: pH Vs burst strength for various pulp with 1 % enzyme concentration

Conclusion

According to this study, the use of enzymes is a possible and competitive strategy to deink recycled pulps. However, a thorough enzyme selection and the optimization of the process are needed in order to accomplish a good quality final product [20]. Different pulps may react differently to similar deinking protocols, either enzymatic or chemical. The enzymatic process effectiveness depends more critically on the furnish characteristics than the chemical one. Considering

the wide variability on the industrial wastepaper supplies, this is probably the most important disadvantage of this methodology. The enzyme effectiveness was obtained at pH level 9, although enzymes favour ink removal, their action significantly affects the paper strength properties. The effect of COD and BOD also been decreased on enzymatic deinking. The highest deinking efficiency was observed with Map litho quality at 0.5% concentration of enzyme dosage, but the lowest efficiency was obtained with white writing quality. In all the quality 1% concentration of enzyme dosage gives reduced brightness because of its reversible reaction. However, the enzymatic process resulted in both positive and deleterious effects on the mechanical properties of deinked paper [10]. Microbial enzymes enhance the release of toners from office waste papers. Enzymatic ally deinked pulp also displays improved drainage, superior physical properties, higher brightness and lower residual ink than chemically deinked ink. Enzymes for deinking are commercially available and at lower cost than in the past. Bursting strength is used widely as a measure of strength in many kinds of papers, primarily as an indication of the suitability of certain fibers and the extent of beating and refining. The enzymatic deinking process the BOD, COD in the effluent water gives a pollution control process.

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