[AMT03] Lumen Loading : The effects of beating process on tensile index

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Introduction

Lumen-loaded technology has been studied for many years especially by researchers in Pulp and Paper Research Institute of Canada (PAPRICAN) such as Green (1982, 1985), Middleton and Scallan (1985, 1989, 1991) and Van de Van (1994). In 1992, Rioux et. al and Marchessault have proved the suitability of magnetic particles such Fe_2O_3 and Fe_3O_4 to use in lumen-loaded process. This study relates to the effects of beating process on tensile index.

Magnetite as filler is the most widely used magnetic pigment in the production of magnetic recording and information storage media. Lumen loading allows filler particles to be introduced exclusively into the lumens of the fibers while leaving the external surfaces free of filler. The cell wall protects the filler from dislodgement during the future process such as papermaking. Furthermore, the filler particles do not interfere with inter-fiber bonding, thus increasing paper strength. Cationic polyelectrolyte such as polyethylenimine has been used for many years as retention aid to improve filler retention.

Materials and methods

Materials

Unbleached Kraft never-dried pulp was used to produce fibers lumen-loaded with (Fe_3O_4) powder (<5 micron, 98%). Forest Research Institute Malaysia (FRIM) prepared the pulp from kenaf (Hibiscus cannabinus) with active alkali 14%. Aluminium sulphate ($Al_2(SO_4)_3.18H_20$) and polyethylenimine with mass-average molecular weight Mw=750,000 were used as retention aids.

Beating Process

This process carried-out by PFI Mill at FRIM. Kenaf pulps weighted 24g (oven dry) were mixture with distilled water at 10% consistency. Then, the pulps were beaten for 4 different degrees of rpm, 2000, 4000, 6000 and 8000.

Lumen-loading Procedure

Filler suspension was prepared by dispersing 30 g of pigment in 250 ml of distilled water containing 0.1g/L alum with a laboratory mechanical stirrer. Separately, 15 g dry weight of pulp was fiberized in 1250 ml of distilled water containing 0.1-g/L alum. Fiberization as carried out for 30 minutes in another laboratory mechanical stirrer operating at the standard rotor speed of 1000 rpm. After 30 minutes, filler suspension was poured into the latter laboratory mechanical stirrer, which contains the pulp, i.e. pulp consistency of 1%. Subsequently, the mixture of pigment and the pulp was stirred at the standard rotor speed of 1000 rpm for 30-60 minutes. At this impregnation stage, the magnetic pigment entered the lumen of the fibers at the same time become attached to the surfaces. Polyethylenimine (PEI) was used after the lumen-loading process. This inter-stage treatment with PEI (0-4% w/w polymer on pulp) was slow stirred (600 rpm) for 4 hours. After treatment, the pigment on the fiber surface was removed by washing with tap water in a self-designed fiber classifier containing a filter screen (45um) for 60 minutes. Scanning electron microscopy (SEM) was used to examine the attachment of the pigments to the lumen surfaces.

Tensile Strength

Horizontal Tensile, Butcher V.O Korput was used to determine the tensile strength. Eight samples were used for each testing set. One sample was used to measure cross head speed that needed. After that, the other 7 samples were used for tensile strength and each reading was recorded and average values were measured.

Tensile index = tensile strength / basis weight

Results and Discussions

Figure 1 shows that the scanning electron microscopy of cross section of an unbleached kraft pulp lumen-loaded with Fe_3O_4 adhering to the lumen surface. This micrograph exhibited acicular pigment particles located in the lumen of the fiber. It was proven that lumen-loaded with beating pulps has been successfully produced. However, the degrees of beating are significant factors that will affect the structure of lumen of pulps.

Meanwhile, Figure 2 shows the tensile index of beaten pulps with certain criteria and conditions that mentioned. It can be seen that the tensile index increase by the increasing of beating process. However, the tensile index of samples were reduced when the beating degree increase. This is due to fiber structures were collapsed and disturbed the fiber to fiber bond.

An absence of magnetic particles will decrease the tensile index of samples. It depends on how much of magnetic fillers can deposit into the lumen of fibers. Normally, tensile index decrease with the increasing of magnetic particles. Although, lumen-loaded technology can minimize the reducing of tensile index of loaded pulps. This is due to fiber to fiber bond was not disturbed by fillers because the filler is located inside the fibers.

In this research PEI was employed as retention aids. Actually, PEI can strengthen the attachment of fillers inside the lumen surfaces. While washing process less of fillers dislodgement from lumen of fibers. As a result, the tensile index degraded compared with the untreated samples. Meanwhile, PEI can be more effective with existence of alum. This is due to PEI is suitable under acid condition.

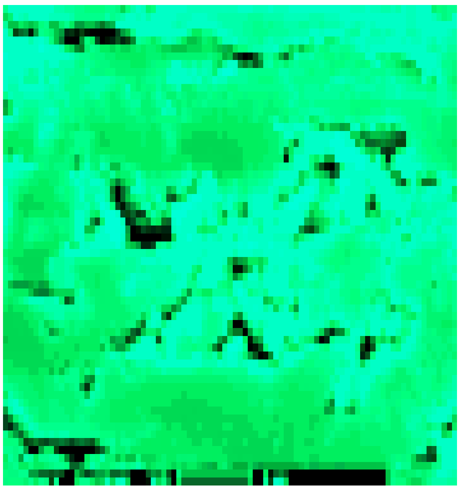

FIGURE 1 Scanning electron microscopy of cross section of unbleached never-dried kraft pulp loaded with Fe_3O_4.

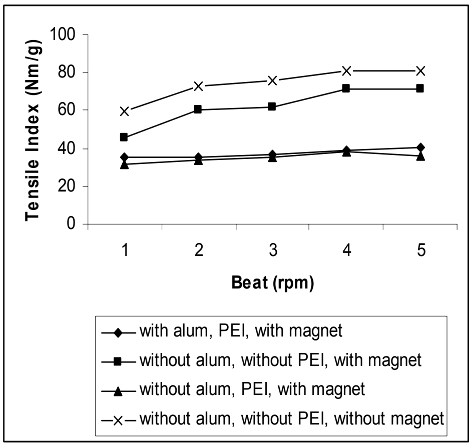

FIGURE 2 Tensile index of beaten pulps at different rpm, 2000, 4000, 6000 and 8000.

Conclusion

The beating process can assist the improvement of tensile index values in certain degree of rotation. Meanwhile, lumen loading technology has been found beneficial to increase tensile index value due to fiber to fiber bond factor. Eventually, the combination of beating process and lumen-loaded technology can enhance tensile strength of magnetic paper that produced.

Acknowledgements

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References

Alince, B, Petlicki, J, Van de Ven, T.G.M. (1991). *Collids and Surfaces*, 59:265-277.

Green, H.V., Fox, T.J., Scallan, A.M. (1982). *Pulp and Paper Canada,* 83(7):203-207.

Kamiti, M. and Van de Ven T.G.M. (1994). *Journal of Pulp and Paper Science*, 20(7):199-205.

Marchessault, R.H., Rioux, P., Raymond, L. (1992) *Polymer*, 33:4024-4028.

Middleton, S.R. and Scallan, A.M. (1989). *Journal of Pulp and Paper Science*, 15(6):229-235.

Petlicki, J. and Van de Ven, T.G.M. (1994). *Journal of Pulp and Paper Science*, 20(12):375-382.

Petlicki, J. and Van de Ven, T.G.M. (1994). *Colloids and Surfaces*, 83:9-23.

Ricard, S. and Marchessault, R.H. (1990). *Materials Research Soc. Symp. Proc.,* 197:319-324, Pittsburgh, PA.

Rioux, P., Ricard, S. and Marchessault, R.H. (1992). *Journal of Pulp and Paper Science*, 18(1):39-43.