Licentiate Seminar

Production and application of fine fractions made of chemical pulp for enhanced paperboard strength

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Abstract

For all kinds of paperboard packages, the bending stiffness of the paperboard is a crucial property. In multiply folding boxboard (FBB) grades, this is obtained by placing different stocks in the outer and centre plies of the board. In the outer plies, a stock with a high tensile stiffness is used, typically made from refined kraft pulp fibres. In the middle ply/plies a stock with more bulky properties is placed, typically comprising of a high proportion of CTMP (chemi-thermomechanical pulp). CTMP fibres are stiffer and more inflexible with poor bonding abilities resulting in low strength properties. To increase the bonding strength in the middle ply, broke, containing chemical pulp is added, and sometimes refined chemical kraft pulp as well. Both fibres and fines, i.e. smaller fibre fragments, in a pulp have a significant contribution to the properties of the product. Fines produced during refining of chemical pulp are especially beneficial for increasing the strength.

To achieve pulp fraction with higher fines content the pulp can be fractionated with a micro-perforated screen basket; a fine fraction produced from a screen with very small holes will contain a large proportion of fines. By adding such a fine fraction to a middle ply stock, the bulk properties of the main pulp, for example a CTMP, can be conserved as less refining of this pulp is required to achieve the targeted strength properties. However, a drawback is that the fine fraction usually has a very low mass concentration after the screening process as a lot of water pass through the screen together with the fines and fibre fragments. The excess water must be removed to maintain the water balance of the papermaking process. Further, the larger volumes require extra pumping capacity. A resource-efficient production of a fine fraction must target a high fine fraction mass concentration and a high content of fines and short fibre fragments in order to be implemented industrially.

The focus of the present work was on separation efficiency (i.e. the difference in fibre length distribution caused by screening) and process efficiency (i.e. the concentration of the fine fraction) for production of a fine fraction of chemical pulp by screening, and the utilisation of the fine fraction as strength agent.

Pilot-scale fractionation trials with a pressure screen with different micro-perforated screen baskets were performed in order to evaluate how the separation efficiency and process efficiency were affected by parameters such as feed concentration, pulp type (hardwood or softwood kraft pulp), hole size of the screen, and refining treatment prior to screening. The trials were evaluated using fibre length distributions, flow rates and concentrations of the feed flow and the fractions. Here, two complementary quantitative measures, Proportion in fine fraction (for process efficiency) and Fine fraction enrichment (for separation efficiency), were developed. To evaluate the strength enhancing effect of the obtained fine fraction, a lab scale study was performed where the fine fraction of a highly refined pulp was compared with the highly refined pulp as strength agent for a CTMP. The results of this study were verified in a pilot paper machine trial. In a second pilot paper machine trial, sheets with different CTMP proportions in the middle ply were studied in order to find out if the bulk could be increased while maintaining strength, by using a fine fraction made from refined chemical pulp.

Regarding process efficiency, it was found that the most important parameter to obtain a high fine fraction concentration was a high feed concentration. Further, a higher fine fraction concentration for a given screening process was also obtained when using hardwood pulp and refining the pulp prior to the screening process. A higher feed concentration also had a positive effect on the separation efficiency. Small holes and a smooth surface of the screen basket were also important to improve the separation efficiency.

It was shown that, when used as a strength agent in a CTMP pulp, the fine fraction of highly refined kraft pulp was twice as efficient as the highly refined kraft pulp, when added at equal mass proportion. However, both in the lab and pilot trial the strength increase was accompanied by a decreased bulk. This was expected, and to avoid this the proportion of the bulky CTMP had to be increased. The pilot paper machine trial with an increased CTMP proportion in the middle ply and a fine fraction of refined kraft pulp as strength agent demonstrated that it was possible to produce sheets with an increased bulk and maintained z-strength.

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