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Research area: Process aims
Paper- and paperboard production // papermaking

Key words:
BCTMP, high yield pulp, stiffness, volume

Title: Systematic adjustment of specific volume and stiffness in choosing an ideal pulp-additive composition

Background/ Problem area

In addition to optical properties, paper stiffness and specific volume, both of which significantly influence the processability and surface feel of a paper, are the most important reasons for consumer acceptance. Strength and specific volume are paper properties that have contrary development trends. High apparent density and rising strength usually result in decreasing stiffness. In point of fact, an increase in tensile stiffness (modulus of elasticity) is normally nullified by a decline in paper thickness or by an increase in apparent density. In particular, increasing the content of extender and fines and decreasing the mass per unit area result in less strength, stiffness and specific volume. The properties of the papers produced strongly depend on the mixing ratio of the pulps used. This holds especially true for writing, printing and reprographic paper, beverage carton, wallpaper and several speciality papers. The impact of the selection of particular pulp types on paper properties, such as strength, specific volume or stiffness, is well known. Stiff fibres with a high lignin content, hornified fibres or recycled pulps usually increase the specific volume and paper stiffness. However, the strength development of these materials is limited. Flexible fibres make many fibre-fibre-bonds possible, thus increasing the strength properties whilst decreasing specific volume and stiffness. Low priced BCTMP (bleached chemical thermomechanical pulp), made especially of hardwood trees and systematically processed for greater volume or paper strength, has been available for quite some time. However, as BCTMP was rarely used in the past, its application-technological properties, possibilities and impacts, e.g. during substitution of conventional pulps, are unknown in most cases. It is not known for example how to combine recycled, wood-containing and wood-free pulps in the best possible way. In addition, there is no experience regarding the combination of BCTMP and paper additives, especially at low mass per unit areas. The impact of production processes on the specific volume and stiffness of BCTMP papers, especially during wet- and dry extrusion, is unknown, particularly when combined with additives.

Objectives/Research results

The aim of the project was to reduce or to replace the cost-intensive bleached eucalyptus kraft pulp (BEKP) using BCTMP or deinked pulp (DIP) combined with paper additives and processed to increase volume or paper stiffness. A decrease in strength properties should be compensated for by additives. However, volume or stiffness should not be affected. In addition, high quality production standards and a low-cost manufacture had to be observed. Moreover, light-induced yellowing of BCTMP paper was to be analysed. The research results were intended to describe the interrelationships of different pulps, additives and process properties on paper volume and stiffness. Using these results, recommendations were to be derived to support the capability and competitiveness of small and medium enterprises (SMEs) within the “paper manufacturer – processing – end customer” supply chain. Once a tool has been designed and created, the results should help SMEs in particular to generate high-quality but low-priced paper and board.

Compared to conventional pulp, BCTMP exhibits greater surface charge and total charge as well as a thicker fibre wall. Hence, it is possible to produce greater specific volume, an adequate number of fibre-fibre-bonds and high strength values. Compared to conventional pulps, BCTMP processed for greater paper volume, increased the volume of handsheets by 10-20 %. However, paper stiffness remained unchanged. Handsheets made of BCTMP, processed for greater paper strength, exhibited tensile strength properties comparable to those of conventional hardwood pulps. However, no increase in volume was detectable. The stiffness of the handsheets was comparable to those with made from conventional pulps. As was expected, it was possible to increase the stiffness by 20 % by grinding the fibres. Furthermore, BCTMP handsheets showed a fast, significant decrease in the degree of whiteness irrespective of the type of BCTMP or additive used for inhibition. Papers produced on a pilot scale and mixed with extender showed, as was expected, a significant decrease in volume and stiffness. However, volume increased significantly when a combination of Expancel and Polyacrylamide or cationic starch was used. An increase in stiffness properties was not detectable. It was also demonstrated that wet extrusion did not influence paper strength. An effect of the calender could only be verified in the system with guar or starch. Using BCTMP, guar or starch led to an increase in volume. Here the impact of wet extrusion on the paper volume was detectable. Nevertheless, the calender was the determining factor for volume. The interrelationship between bending stiffness, volume and single fibre properties as a function of process parameters of stock preparation and sheet formation could be derived using multi-scale modelling. Mathematical relationships and models allowed recommendations for processing to be derived. The results were confirmed on the pilot scale by a trial at a paper manufacturer.

Application/Economic benefits

The tools developed offer the possibility for a detailed consultancy of enterprises during the substitution of short fibre pulps by a BCTMP-additive combination. Costs and risks are minimised during substitution. Thus, the results significantly contribute to the competitiveness of SMEs. The simulations showed that 40 % of the production costs can be saved, with bending stiffness increasing by 20 % and the tensile index remaining constant. The highest cost savings of 12.76 EUR/t were determined for a combination of 60 % short fibre/ 10 % long fibre/ 30 % BCTMP/ 0.5 % starch. 7.3 % short fibre pulp could have been saved resulting in a reduction of 12.37 EUR/t.

Project period: 01.07.2007 – 30.06.2009

Remarks

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