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Research area: General aims

Resource saving // Other

Key words:

Nanotechnology, microfibrillated cellulose, microcrystalline cellulose, modification, strength

Title:
Developing a concept for creating paper strength without refining by nanotechnological fibre modification and the build-up of nanofibre networks

Background/Problem area

To improve competitiveness, papermakers are constantly endeavouring to guarantee or even enhance required paper strength despite the fact that, for reasons of costs, more and more paper is being produced based on lower amounts of fibre, greater amount of recycled fibre or higher filler content. In so doing, it is becoming increasingly obvious that there are limits to strength creation by conventional means such as fibre selection and refining as well as the use of strength-enhancing additives.

Implementing the know-how gained from nanotechnological fibre basic research in future in the creation of new fibre materials, fibre networks and paper with completely new functional properties will actually serve to ensure the continued existence of sites and jobs, although we must not lose sight of the risks this new technology may have on human health and the environment.

Objectives/Research results

The project aims at preparing and developing concepts for developing paper strength by the nanotechnological modification of the fibre surface and the formation of nanofibre networks. In so doing, attempts will be made to replace pulp refining by the selective, nanotechnological modification of unrefined fibres.

This project is designed to study typical pulps used in papermaking on a laboratory and pilot scale which would allow a modification of the fibre surface by means of functional cellulose or hemicellulose derivatives (e.g. xylan or CMC), an alternating multiple coating of the fibre surface with cationic and anionic polyelectrolytes (a polyelectrolyte multilayer – PEM) or the use of microfibrillated or microcrystalline cellulose fragments (MFC/MCC) on a nanoscale as well as combination of these three modification pathways in order to achieve synergies.

To prepare a basis for comparing and evaluating the strength values, the pulps underwent standard refining at the same time, and comparable handsheets were made without dry strength agents and using 0.5 % and 1.5 % cationic starch.

After evaluation of strength enhancement based on charge and PEM modification, selected combinations of charge modification and PEM coating were carried out on selected pulps. Once a suitable application of nanofibrillated cellulose (MFC) had been found, the attachment of MFC to previously modified fibre surfaces were included in the study. It was discovered that the combination of CMC attachment and PEM modification was able to achieve strength increases that approached the results of even intensive refining. The addition of MFC can increase the tensile index of paper from previously modified fibres by yet another 10 %.

Application/Economic benefits

The results of the research project will make possible a quick, more selective choice of the pulps to be modified. By adjusting appropriate pulp blends and defining the modification steps, influence can be brought to bear not only on the desired paper strength but also on the structural paper properties.

If, as is planned, the fibres are no longer refined, they will retain their initial fibre strength and will be well-matched for the reinforcement tasks. Combined with the expected decoupling of paper density and strength, either paper with a greater share of fillers and recycling fibres or paper with lower grammages will be able to be manufactured.

The pulp modification, although aimed primarily at creating or enhancing strength, also affects the fibre charge. This makes it possible to not only achieve selective strength development, but also to achieve better adsorption of functional additives such as wet strength agents to the fibres, thus achieving synergies.

The application of the anticipated effects will be useful and profitable especially in multi-ply products such as folding boxboard. Stiff liners and a well bonded intermediate ply of low density but good fibre bonding will allow pulp to be saved. The pulps which have been modified using different procedures will be especially well suited for the production of dense, low-grammage paper when provided with greater shares of MFC or MCC and well suited for the production of low-density, low-grammage paper after charge modification of the surface.

Project period: 01.01.2008 – 31.12.2009

Remarks

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