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Research area: Product aims
Paper, paperboard and board // Graphic papers

Key words:
Nanocellulose, microfibrillated cellulose, fibril, filler, calcium carbonate, titanium dioxide

Title:

Filling papers with nanoscale cellulose-based fibre-filler compound particles

Background/Problem area

In papermaking, raw material costs can be saved and energy demand decreased by replacing pulp fibres by mineral fillers. With regard to paper quality, such replacement is only possible if paper strength, high filler retention and equal filler distribution in the fibre matrix are ensured. This will also guarantee the runnability of the paper machine without further loading of the water circuit.

The small particle size of mineral fillers, resulting in a large surface area, and their high refractive index are the reasons for their excellent optical properties. The larger the interface between air and particle and the higher the refractive index, the greater will be the light scattering ability, resulting in high brightness and opacity of the filled paper. Particles tend to aggregate which in turn decreases the optical properties of the filler. If agglomeration can be avoided, e.g. by suitable spacers, no loss in optical properties would occur.

Last but not least, mineral particles are detrimental to paper strength since they cover some of the fibre surface, thus reducing the fibre-fibre contact area.

Objectives/Research results

The aim of the research project is the more efficient use of fillers in paper resulting in better optical properties, higher strength and reduced production costs of high filled paper grades. A suitable compound of cellulosic fibrils (“nanocellulose”) and filler particles must therefore be generated and introduced into the paper. This compound(s) should meet the following requirements:

- stability: assembly of a stable compound/flocs, insensitive to the shear forces in the wet end of the paper machine
- marginal aggregation of filler particles by the use of cellulosic spacers, thus avoiding losses in optical properties
- less detrimental effects on paper strength by masking filler particles in the cellulosic compound

The network of cellulosic fibrils around the filler particles will not only enhance the dry strength of the paper, it will also increase its initial wet web strength.

The coupling between filler particles and cellulosic fibrils and/or whiskers is evaluated among other things by scanning electron microscopy (SEM) and dynamic mechanical analysis (DMA). A dynamic mechanical analyzer from Mettler-Toledo was put into operation within the scope of the project.

The coupling is strongly influenced by

- the charge of the cellulosic fibrils, their state of swelling, their shape and particle size distribution,
- the charge of the filler, its shape and particle size distribution,
- the chemical character, charge density and molecular weight of the polymer used for coupling and
- the coupling conditions, e.g. shear forces and pH.

The effects of filler-fines-flocculation at low consistency led to somewhat higher filler amount in model paper systems. Compounds of fillers (calcium carbonate, clay, titanium dioxide) and different cellulosic fines were also prepared at higher solid content levels which are typical for filler slurries (e.g. 300g/kg). These compounds led to a significantly higher tensile strength (5-8%) for the same filler content compared to non-compounded filler/fines. The introduction of cellulosic fines particles and cationic polymers into typical filler slurries had no strong detrimental effect on slurries viscosities.

Application/Economic benefits

The results of the project will be used by papermakers in producing paper that already has high filler contents, e.g. graphic paper for copying and printing or decorative paper. The project is intended to assist in providing even greater filler content for enhanced product quality, for more efficient use of fillers and for cutting raw material costs.

Period of time: 01.02.2010 – 30.07.2012

Remarks

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