Research Institute:

PTS München
Hess-Str. 134
80797 München

Internet: www.ptspaper.de

Head of the research institute:

Prof. Dr. Frank Miletzky

Project leader:

Dr. Reinhard Grenz
Tel: 089 / 12146-272
Fax: 089 / 12146-36
E-Mail: reinhard.grenz@ptspaper.de

Research area: Product aims

Paper, paperboard and board // Technical speciality papers

Key words:

Highly filled papers, functional papers, convertability

Title:

Use of strength-increasing special components to control the formability of highly filled fibre-based materials

Background/Problem area

Results of previous research projects have proven the importance of the formability of highly filled fibre-based materials. They have shown that functionalized materials suitable for a multitude of application sectors could be developed and produced with the variable, economically priced paper manufacturing process. The use of functionalized composite materials in the practice affords converting to three-dimensional structures to be able to integrate them into the constructions specified by the particular applications. The formability of highly filled functional materials is impaired by the reduction of their structural strength due to their low fibre content, resulting in problems with the necessary converting processes (e. g. corrugation, creasing and folding) by increased numbers of breaks and delaminations. These defects are impairing the market access necessary for a broader application of the novel materials.

Research activities are required therefore to avoid failures of highly filled fibre-based materals during their production and converting processes, to stabilize the materials against delamination caused by tensile stress in z-direction (e. g. during the expansion of honeycomb structures) and to provide a sufficicient stability for the material transport processes in production and converting machines (runability). The developed measures have also to be assessed regarding their economic efficiency (raw material, operating and energy expenses) in a holistic approach.

Objectives/Research results

Aim of the research project is the control of the converting properties of highly filled fibre-based materials by the systematic construction of a fibre framework optimized regarding morphology and bonding properties ("hierarchic fibre network"), imitating naturally occuring fractal structures with optimal strength and surface properties. The measures shall provide functionalized materials which are uncritical during converting processes and which can be manufactured using conventional paper-specific installations, i. e. paper machines and corrugating plants. For the reinforcement of the fibre structure, low amounts of suitable fortification components were used to form additional fibre-fibre-bonds, optimally using the existing fibre framework. Cellulose-based, synthetic and mineral fibres were used in combination with special binding components to construct the "hierarchic fibre network". Basic prerequisite in the development work was the transferability to conventional installations of the paper industry without additional investments.

In the first step of the project, a raw material screening was carried out to assess the potential to improve paper properties by use of strength-increasing components and to verify the hierarchical structure concept. In the trials, the hierarchical structure concept could be verified. Based on the results, further trials were carried out with promising combinations of strength-increasing components in different amounts to assess the transferability of the results and to optimize the paper composition. Systematic laboratory trials were carried out to produce Rapid Köthen laboratory sheets with different amounts of cellulose, various functional fillers (e. g. aluminium hydroxide, calcium carbonate and kaolin for the application area "fireproof lightweight construction", active carbon and diatomaceous earth for the application area "adsorptive filtration") and strength-increasing compounds (polyvinyl alcohol fibres, polyamide fibres, basalt fibres, fibrillated hemp and flax fibres). The papers were characterized regarding their relevant paper properties (e. g. grammage, residue on ignition, strength properties) and their formability using a laboratory corrugator. The paper strength properties and the formability could be significantly improved by the use of the different strenghtening compounds. In the next step, the results could be transferred from the standard round Rapid Köthen sheets to a larger, square format of 30 cm x 30 cm using a modified Rapid Köthen sheet former. In the last step, the results gathered in laboratory scale will be transferred to the continuous papermaking process using the PTS pilot paper machine.

Application/Economic benefits

The project results shall enable the production and converting of cost-efficient functionalized materials with innovative properties on conventional paper machines and corrugating plants, providing them for a broad range of applications, especially in the sectors of lightweight construction materials and adsorptive filtration. Key industrial innovation is the use of cellulose-based fibres together with synthetic binding components hitherto used only in sectors outside the paper industry (e. g. in the production of polymers, concrete or nonwovens).

Small and medium enterprises of the paper industry will be enabled to use their present installations for the manufacture and converting of functionalized speciality materials intended for novel end products. Being able to flexibly manufacture and convert manageable amounts of speciality papers in their relatively small plants, SME can optimally use the potential of the novel functionalized materials after adaptation to their specific installations. New market segments, especially in the sectors of lightweight construction materials and in filtration applications, will be opened for SME from the paper industry, enabling them to expand their product portfolio and to secure their capacity utilization.

Period of time: 01.06.2015 – 30.11.2017

Remarks

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