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Research area: Process aims

Paper and paperboard production // Papermaking

Key words:

Spunlace, wet laid, fiber reinforced materials

TITLE:

Development of new paper and wet-laid nonwoven materials by inclined wire technology and integrated spunlace treatment for innovative uses in fibre composite materials

Background/Problem area

Fibre-plastic composites for high performance applications are among the most advanced materials with a dynamically growing market potential. Due to their low weight, fibre-plastic composites are also increasingly used for lightweight solutions in other industries such as rail vehicle, machine and apparatus manufacturing or plant engineering and construction. The necessary breakthrough for mass application is currently hampered by the low level of automation in their production and resulting high costs. Currently, fibre-reinforced plastics are produced by different process technologies which are characterized by long processing and cycle times and therefore of only limited suitability for mass production. For the production of high-performance and especially high-strength components, thermosetting systems continue to be most widely used materials.

Objectives/Research results

The project aim is to determine if or to what extent it is possible to produce reasonably priced nonwovens meeting the specific requirements of fibre materials for fibre-reinforced composites by combining wet-laid nonwoven production with a two layer inclined wire paper machine and spunlace treatment. For this purpose, the following three aspects are to be investigated: - Relationships between fibre properties (surface roughness, fibre flexibility, fibre length, bonding properties, fibrillation) and the web properties achievable by single and two-layer web forming on an inclined wire machine - Identification of relationships between the geometrical and material parameters of dewatering wires and achievable web properties - Determination of technological fundamentals for the control of web properties (stress-strain behaviour, impregnation, porosity) by fibre re-orientation in z-direction through spunlace treatment.

It will be investigated to what extent the structural characteristics of wet-laid nonwovens produced with an existing inclined wire machine can be modified by subsequent spunlace treatment. The influences of different pulps, functional additives and paper-technological parameters as well as of the spunlace treatment on the structural properties and impregnation behaviour of wet-laid nonwoven materials will be evaluated.

The two-dimensional fibre-based materials will be processed to multilayer composite components (demonstrators) and subjected to customary physical tests. Based on these results, concepts for using the composites in products will be developed. The impregnation behaviour of wet-laid nonwovens was investigated in WP 4, evaluating also a test method that makes it possible to assess the resin absorption of paper. Papers with and without spunlace treatment were impregnated by means of the same method, and their resin absorption was assessed.

In the further course of the project, the industrial users showed a heightened interest in thermoplastic materials. The latter make it possible to dispense with time-consuming additional impregnation steps. Because thermoplastics melt under heat, the wet-laid nonwovens could directly be pressed into semi-finished fibrous parts. For this reason, nonwovens made from matrix and reinforcement fibres (e.g.a basalt-polyamide (PA) 6- combination) were included in the study by way of example.

Semi-finished parts were selected and used to identify the characteristics relevant to fibre composites. The semi-finished parts were processed into multi-layer composite components whose characteristics were then determined to identify corresponding material properties. The interactions between wet-laid nonwovens and matrix materials were evaluated, and the effect of spunlace treatment was identified.

The variation of raw materials and technological parameters for the production of spunlace-treated wet-laid nonwovens, their processing into semi-finished parts for fibre-based composite components and the identification of corresponding characteristics of semi-finished parts and structural components had paved the way for the development of product concepts. These product concepts were developed and evaluated in interdisciplinary cooperation with mechanical, materials and textile engineering specialists. The properties of nonwovens obtained in WPs AP 2-5 were then used to identify three typical product areas for the use of spunlace-treated wet-laid nonwovens jointly with relevant institutions or companies.

Final project step was the overall assessment and cost analysis of results, estimating the specific cost of fibre-reinforced components made from semi-finished parts based on spunlace-treated wet-laid nonwovens to identify potential savings in comparison to similar components made by means of conventional reinforcement pulps.

Application/Economic benefits

Due to the high cycle times of their production processes, applications based on thermosetting matrix systems have been limited to small series so far. Developments in the field of lightweight construction were therefore almost exclusively focused on thermoplastic material systems. Research is needed to develop possibilities for reducing the cost of fibre-based reinforcement elements. In view of the required higher level of automation, work in this area should focus on endless components which can be used in continuous processes. Papermaking pulps are significantly cheaper than the carbon, synthetic or regenerated fibres currently used for reinforcement.

Period of time: 01.04.2015 – 31.03.2017

Remarks

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