Processing of fibre suspensions at ultra-high consistencies

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Typically the paper physicist considers pulp suspensions greater than 0.5% consistency as high consistency. In our research on cellulose fibre-reinforced engineering plastics we have had to develop a two-step method for the processing of fibers suspensions at ultra-high consistencies (consistencies greater than 30%).

1) The first step involves the pelletizing of moist pulp fibres (solids content ca. 60%) into a pellet form suitable for further processing in conventional plastics processing equipment. The consolidation of the pulp-fibres into pellets of suitable mechanical properties requires the addition of polymeric rheology-modifiers and de-bonding agents. A rheology-modifier (like carboxy-methyl-cellulose) is used to facilitate consolidation rather than dewatering, while the debonding agent avoids the problems of hornification on subsequent drying.
2) Dry cellulose fibre-pellets are then used in the second high-consistency processing operation. In this step the cellulose fibres are intimately dispersed in a polymeric matrix. Typically fibre consistencies greater than 30% are required but now, instead of water, the fluid component is a molten commodity thermoplastic like polyethylene (or polypropylene) or a molten engineering thermoplastics like polyamide-6 (or polyamide-6,6). Processing these viscous suspensions requires the use of polymer-processing equipment like twin-screw extruders. Especially in processing with high-melting thermoplastics, whose melting points are close to the thermal decomposition temperature of cellulose, the shear-heating of the highly viscous suspension is problematic. Special processing procedures have been developed to utilize the viscous shear-heating of the high-consistency fibre/polymer suspension to maintain fluidity during composite compounding, while utilizing the cooling-capacity of the screw-compounder to avoid overheating and charring. This unique procedure for utilizing viscosity-shear-heating enables the processing of high-melting composites in a "cool-to-the-touch" twin-screw extruder.

Mechanical properties and morphology of the resulting cellulose-fibre reinforced plastics are compared with similar glass-fibre composites, whose processing is not complicated by the problems of viscosity-shear-heating. The remaining technical obstacles impeding commercial applications of the described two-step process are discussed. Also discussed are the fundamentals of the rheological and processing differences between high-consistency fibre/water suspensions and high-consistency fibre/polymer-melt suspensions.

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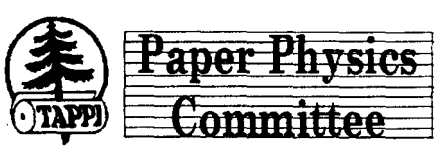

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