World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:11, No:01, 2017

Study of Influencing Factors on the Flowability of Jute Nonwoven Reinforced Sheet Molding Compound

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Abstract : Due to increasing environmental awareness jute fibers are more often used in fiber reinforced composites. In the Sheet Molding Compound (SMC) process, the mold cavity is filled via material flow allowing more complex component design. But, the difficulty of using jute fibers in this process is the decreased capacity of fiber movement in the mold. A comparative flow study with jute nonwoven reinforced SMC was conducted examining the influence of the fiber volume content, the grammage of the jute nonwoven textile and a mechanical modification of the nonwoven textile on the flowability. The nonwoven textile reinforcement was selected to support homogeneous fiber distribution. Trials were performed using two SMC paste formulations differing only in filler type. Platy-shaped kaolin with a mean particle size of 0.8 μm and ashlar calcium carbonate with a mean particle size of 2.7 μm were selected as fillers. Ensuring comparability of the two SMC paste formulations the filler content was determined to reach equal initial viscosity for both systems. The calcium carbonate filled paste was set as reference. The flow study was conducted using a jute nonwoven textile with 300 g/m² as reference. The manufactured SMC sheets were stacked and centrally placed in a square mold. The mold coverage was varied between 25 and 90% keeping the weight of the stack for comparison constant. Comparing the influence of the two fillers kaolin yielded better results regarding a homogeneous fiber distribution. A mold coverage of about 68% was already sufficient to homogeneously fill the mold cavity whereas for calcium carbonate filled system about 79% mold coverage was necessary. The flow study revealed a strong influence of the fiber volume content on the flowability. A fiber volume content of 12 vol.-% and 25 vol.-% were compared for both SMC formulations. The lower fiber volume content strongly supported fiber transport whereas 25 vol.-% showed insignificant influence. The results indicate a limiting fiber volume content for the flowability. The influence of the nonwoven textile grammage was determined using nonwoven jute material with 500 g/m² and a fiber volume content of 20 vol.-%. The 500 g/m² reinforcement material showed inferior results with regard to fiber movement. A mold coverage of about 90 % was required to prevent the destruction of the nonwoven structure. Below this mold coverage the 500 g/m² nonwoven material was ripped and torn apart. Low mold coverages led to damage of the textile reinforcement. Due to the ripped nonwoven structure the textile was modified with cuts in order to facilitate fiber movement in the mold. Parallel cuts of about 20 mm length and 20 mm distance to each other were applied to the textile and stacked with varying orientations prior to molding. Stacks with unidirectional orientated cuts over stacks with cuts in various directions e.g. (0°, 45°, 90°, -45°) were investigated. The mechanical modification supported tearing of the textile without achieving benefit for the flowability.

Keywords : filler, flowability, jute fiber, nonwoven, sheet molding compound
Conference Title : ICCM 2017 : International Conference on Composite Materials
Conference Location : Paris, France
Conference Dates : January 23-24, 2017