

Reduced fibre breakage in a glass-fibre reinforced thermoplastic through foaming

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Abstract

The processing of a glass fibre-reinforced polypropylene in the presence of a chemical blowing agent was found to dramatically reduce the occurrence of fibre breakage during processing within an injection molding machine. As the concentration of chemical blowing agent was increased from 0 to 5 wt%, the fibre length distribution of the reinforcing agent more closely resembled the original distribution found in the virgin resin. An in-line rheometer was used on the injection molding machine to characterize the melt rheology of the polypropylene composite with and without the blowing agent. The results showed that the plasticizing effect of the dissolved gas affected both the magnitude of the shear viscosity as well as the pseudoplasticity of the material. It was revealed that the greater non-Newtonian flow behaviour of the polymer as the blowing agent concentration was increased, reduced the quantity of glass fibres exposed to shear flow. The reduction in fibre rotation as a result of the decreased shear region present within the flow field, decreased the occurrence of fibre breakage due to buckling and tensile fracture.

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1. Introduction

Injection molding is generally the one of the most economical approaches for producing formed thermoplastic parts within the plastics industries. Particularly within the automotive industry, which has become more reliant on light-weight composites to replace heavier materials within their fleet of vehicles, one sees increased usage of reinforced thermoplastic composites for their molded parts. Increased design flexibility, reduced tooling costs, and improved recyclability have all been key aspects quoted for this growth [1]. These thermoplastic composites incorporate discontinuous glass fibres, either long (1–25 mm) or short (<1 mm), to provide improved stiffness and strength in the molded part. The mechani-

cal properties exhibited by a composite is influenced by the volume fraction and aspect ratio of the fibre [2,3], and the fibre orientation [4–6]; all factors determining the surface area available for transmission of stresses under an applied load. In the processing of these reinforced composite materials through an injection molding machine [7–11] or extrusion equipment [12–14], degradation of mechanical properties often results due to damage of the fibres. This paper examines a relatively inexpensive method for preserving the original fibres during processing by plasticizing the matrix through the addition of a gas (i.e., foam processing).

Several investigators have studied the damage to glass fibres that results from processing, though the majority of these studies have involved extrusion compounding [12–15] rather than injection molding [7–11]. In the case of an injection molding machine, both Gupta et al. [8] and von Turkovich and Erwin [10] have shown that from processing, fibre degradation evolved along the

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