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Mechanical Properties of Textile Reinforced LLDPE in Rotational Molding

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Abstract

Rotational molding has increasingly become an important process for hollow products in industry because of its thicker walls, low sound transfer, high stiffness and good thermal insulation. The objectives of this article are to assess the rotomoldability of the textile insert reinforcement and to investigate how to improve some mechanical properties, the final product quality and develop the process of rotational molding by using the difference of textile types. However, the textile reinforcement of rotational molding has not been well studied. The materials used in this work mainly focus on the local market. Rotational molding experiments were carried out in a laboratory scale biaxial machine capable of controlling temperature and time in the oven. Mechanical property tests, as well as thickness distribution and density measurements, were performed on the rotationally molded parts.

Keywords: Rotational molding, Textile reinforcement

1. Introduction

Rotational molding is a mainly technique for the making of hollow plastic parts. More recently, the rotational molding of high-density polyethylene has gained considerable importance, due to its proven advantages in the making of hollow plastic products. There have been only a few technological developments in rotational molding and the knowledge of the process has essentially been based on trial and error. Not many studies have been carried out to understand the underlying principles that govern this process [1–5]. In that sense, powder processing of metals and ceramics has been the subject of more detailed studies and several models have been proposed to explain the different types of sintering processes that occur in industrial operations. In the polymer field, however, there is still discussion whether sintering or coalescence is the governing processes in the rotational molding technique. Moreover, no consistent models have been produced to explain the processes of multi-component or multiphase sintering with polymers.

The presented in this work is part of a research project that studies how to make a textile reinforced thermoplastic composites by the rotational molding process. It studies the characterization of reinforced and unreinforced polymer samples produced with the rotational molding technique. PE nets have been used in the past as a reinforcing material for LLDPE powder. In recent years, attention has been paid to their use as a reinforcing material for thermoplastics in other thermoplastic processes such as Injcetion molding, Plastics casting and/or Compression molding. In particular, the automotive industries have shown interest in the advantages that this type of reinforced system can provide [5].

2. Methodology

The rotational molding process, briefly, a two-part steel mould (Fig. 1) is loaded with LLDPE powder (M 3204RUP) supplied by Thai Polyethylene Co., Ltd. with MFI 4 g/10mins (190°C/2.16Kg). Then the mould is rotated in two axes at relatively low speeds (5-7 rpm) while being heated for 10min at 240°C in the oven, so that particle consolidation can take part. Then the mould is cooled down and the product is extracted from it. Before loading the polymer or polymer composite, a demolding agent is applied to the internal surface of the mould. Heating was achieved in a chamber by means of a hot air blower. Rotation in the first axis was achieved with an electric AC motor, so that speed could

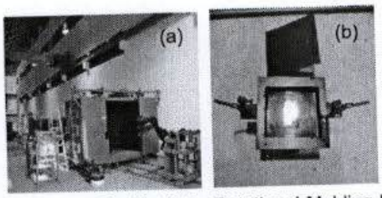

Fig.1 shows a Shuttle Style Rotational Molding M/C and (b) a two-part steel mould

vary over the processing range. Rotation in the second axis was achieved by means of a light weight gear box that transmitted the movement from the first axis with a controlled transmission rate. The mould was cooled down with a fan for 10min. At this stage, the hollow product could be demolded.

3. Results and Discussion

3.1 Tensile strength

This result is in agreement with previous results reported for natural fibre-reinforced composites [1] and for long glass fibre composites [5]. Low mechanical properties at high fibre contents are mostly associated with the presence of fibre clumps and voids. Reinforcing discrete fibres increase the viscosity of the polymer matrix. This phenomenon has been reported for glass fibres as well as for natural fibres. An increased viscosity might also contribute to the formation of clumps during melt processing of natural fibre composites. With an adequate fibre treatment, this problem is reduced in the textile reinforced rotational molding process.

3.2 Drop weight Impact

Textile-reinforced LLDPE absorbs more impact energy than unreinforced LLDPE at the same testing condition. A reduction in the ability to absorb energy is observed for unreinforced LLDPE. Figure 2 (below) shows photographs of sample of reinforced and unreinforced LLDPE at the impact fracture zone. The two different structures are visible here. In the unreinforced LLDPE (a), the morphology of a brittle fracture can be observed. On the other hand, the reinforced LLDPE (b) induce ductile fracture behaviour, as shown in figure below.

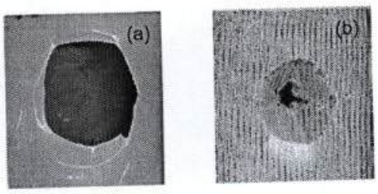

Fig.2 Photographs of (a) reinforced and (b) unreinforced samples.

4. Summary

The mechanical properties of the reinforced and unreinforced rotational molding samples were characterized using several mechanical tests. The mechanical and physical properties of reinforced composites vary considerably with fibre content. Tensile strength results indicated that, depending on the fibre type, there is an optimal fibre content for which textile-reinforced composites show the good properties. Beyond this optimal fibre content, tensile strength decreases due to the increased presence of delamination and voids in the composites.

Impact behavior was influenced by fibre type and content. Textile-reinforced composites showed higher impact strengths than the unreinforced ones. The resulting composite products show less plastic deformation and higher elasticity. At higher fibre contents, lower densities were obtained, mainly due to the formation of more voids and bubbles during the rotomolding process. The testing methodology described here can be used to assess the properties of both reinforced and unreinforced rotomolded products.

Acknowledgments

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