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Critical processing parameters for foamed bead manufacturing in a lab-scale autoclave system

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HIGHLIGHTS

- ▸ A lab-scale autoclave system was developed for study of foamed bead manufacturing.
- ▸ Foaming experiments were conducted with PP ter-polymer and CO_2 at various conditions.
- ▸ Beads foamed at higher saturation pressure possessed lower crystallinity, $X_{c\ high}$.
- ▸ Longer die length promoted molecule alignment and increased crystallinity, $X_{c\ high}$.
- ▸ Crystallnity, $X_{c\ high}$, had a strong effect on the expansion ratio of foamed beads.

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ABSTRACT

In recent years, bead foaming technology has been of great interest to researchers because it represents a breakthrough in the production of low density plastic foamed components that have a complex geometrical structure. This helps to expand the market for plastic foams by broadening their applications. Despite earlier, valuable studies on the characterization and manufacture of bead foams, there has been little investigation of the critical parameters in the foamed bead manufacturing process. To provide an insight into the mechanism behind bead foaming technology, a lab-scale autoclave system for foamed bead manufacturing is developed and the critical processing parameters were studied. Foamed beads were obtained under various processing conditions with this lab-scale system while using carbon dioxide as the blowing agent. The cellular morphology and melting/crystallization behaviours of the beads are examined and discussed.

1. Introduction

Plastic foams are widely used throughout the world in daily life. For years, foam extrusion and foam injection molding were the two predominant technologies for manufacturing of recyclable thermoplastic foam. Extrusion foaming is essentially a cost-effective process for manufacturing two-dimensional, simple geometric foam products with various foam densities and cell sizes. By varying the processing parameters, material compositions, and die profiles, foam parts with volume expansion ratios up to 100 can be manufactured for various applications [1]. On the other hand, foam injection molding is known as a promising method by which to produce foams with complex, three-dimensional shapes, and high dimensional stability [2,3]. Foams manufactured using this technology usually possesses a relatively high density because of the high resistance to the flow and a high pressure in the cavity [4], and a unique sandwich structure with a foamed core inside an unfoamed skin layer is formed. This makes them suitable for structural and load-bearing applications. Despite the wide range of foam products being manufactured, the production of foam parts with complex three-dimensional geometry and high expansion ratios remains difficult using these two technologies.

In contrast to foam extrusion and injection molding, bead foaming technology produces plastic foamed products through the molding and sintering of tiny foamed plastic beads. This process is capable of producing three-dimensionally-shaped foam products in a variety of densities. This aspect of bead foaming technology is considered a highly viable technique in the production of foamed products with the foam expansion and dimensional complexity of both extrusion foaming and injection foam molding [5,6]. Examples of foamed products manufactured by this technique include

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