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Processing and Characterization of thin wall and biodegradable injected pots

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Abstract

Currently, the industry of molds seeks new markets with diversified products and added value. The concept associated with the production by injection of biodegradable pots is therefore of particular significance. Furthermore, environmental factors are increasingly decisive in choosing a product by the consumer, either because of imposed legislation or by the growth of a global awareness of the harmful effects than conventional polymers induce in our quality of life present and future. The general goal of this work was the design, the development and characterization of a thin walled pot for germination of plants made of biodegradable material. In this paper the processing and characterization of the bioplastic selected, the Bioplast GS 2189, is presented. Experimental results confirmed that the biodegradable material undergoes changes during its processing, which is attested by the QIS difference as well as in the reduction of the glass transition temperature, which in the post-processed (injected pot) is lower than the pre-processed material (Bioplast GS 2189). From these results it can be concluded that the injection processing of the Bioplast GS 2189 material affects its properties inducing its degradation process. This behavior can be due to the shear forces and thermal variations to which the material is submitted during the injection process. It was demonstrated that the development of future products in very thin-walled and biodegradable materials obtained by thermoplastic injection process is a competitive and effective solution for molds industries.

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Keywords: Thin walled injected parts; Biodegradable polymers; Bioplastic; Injection molding; Pots plants.

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1. Introduction

The rising price of oil in recent years has led to the intensification of research projects, in order to obtaining alternative products to conventional plastics. Currently, biodegradable polymers begun to be produced for industrial and commercial use, leaving be just used for research purposes. Shen and coauthors [1] estimated the global production of bioplastics in 2020, they pointed out that from the most optimistic point of view an increase in worldwide production capacity of bioplastics from 0.36 million tons (in 2007) to 4.40 million tons (in 2020) is expectable. But even for a worst scenario, the world bioplastics production in 2020 will be 1.47 million tons. The most important products in terms of production volumes in 2007 were starch plastics (0.15 million tons) and polylactic acid (PLA) (0.15 million tons). In 2020 the most common bioplastics will be starch plastic (1.3 million tons), PLA (0.8 million tons), bio-based polyethylene (PE) (0.6 million tons) and polyhydroxyalkanoate (PHA) (0. 4 million tons).

The selling price of bioplastics is still the main obstacle to the penetration of these materials on the market, in average the price of granulate biodegradable plastic is 50% higher than conventional plastic such as polypropylene (PP), PE or Polyethylene terephthalate (PET). However, between 1990 and 2002 there was a great increase in bioplastics consumption as reported by [2, 3] due, in part, to higher oil prices, lower production costs and environmental policies.

Pots used in plant germination are currently produced in polyolefins such as PP. This is a low cost container in which the amount of material used is reduced to the maximum in order to reduce the production cost and an attempt to minimize the environmental impact. Nevertheless, to minimize the risk of plant roots damage containers are placed in the soil. Nowadays hundreds of thousands of these containers are used contributing to global pollution. Common thermoplastics, e.g. PP, are resistant to chemical and biological attack in order to delay and prevent attack by fungi, bacteria and other living organisms that is great for the plants germination and growth. These properties together with the good mechanical properties that characterize this kind of polymers represent advantages for most applications, but in the case of plant pots these properties represent a significant environmental problem. There is still a large-scale production of this type of formulations because the accessibility to proper selection of biodegradable polymers is not common, since they have to be selected and adapted to each case and biological environment. Biodegradable polymers are, in general, comprised of a synthetic polymer, such as polyester, and a natural polymer such as starch.

The general goal of this research aims to solve the ecologic problem related with the use of common thermoplastics to produce potted plants. The strategy involves an integrated solution for the injection of thin walled pots, manufactured using biodegradable materials, for plants germination. This integrated solution was divided basically into four phases as represented in the flowchart of Figure 1 and includes the design and manufacture processes of the mold as well as to find the optimum values for the injection parameters in order to become the process effective and competitive. The Phase I was dedicated to the pot design and rheological simulations and the Phase II devoted to the project and mold manufacturing. The Phase III corresponding to the selection and characterization of the pre-processed biodegradable material (bioplastic, synthetic/starch polymer) for the pot conception. Among the biodegradable thermoplastics commercially available the Bioplast GS 2189 of European origin from BIOTEC was chosen to produce the injected thin walled pots because it is particularly suited to inject food products and nonfood fully biodegradables. The Bioplast GS 2189 is classified as a mixture of PLA with starch and presents a stiffness comparable to those exhibited by the polystyrene (PS). Finally, the Phase IV, presented in this work, regards to the processing and characterization of the processed pots. After obtaining the mold, the pots were injected and their chemical and thermal characterization performed to check the possible influence of parameters processing on the material properties changes.

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