



COMPARATIVE PROCESS OF DEPOLYMERIZATION OF POLYETHYLENE TEREPHTHALATE (PET): CONTINUOUS (EXTRUSION) AND BATCH PROCESSES (HAAKR MIXER)

F. Costa^{*1}, A.V. Machado¹, J. Maia²

¹ IPC – Institute for Polymers and Composites, University of Minho, Campus de Azurém, 4800-058 Guimarães, Portugal

² Case Western Reserve University, CLiPS- Center for Layered Polymeric Systems, Kent Hale Smith Bilg, 2100 Adelbert Rd., Cleveland, OH 44106-7202, USA

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Abstract

Glycolitic depolymerisation of polyethylene terephthalate (PET) is investigated in batch (Haake mixer) and continuous (co-rotating twin screw extruder) using ethylene glycol (EG) as depolymerising agent. The influence of EG/PET, reaction time, screw speeds and feed rates were investigated. The solid products mainly composed by oligomers, dimmers and trimers were analyzed by rheometry, intrinsic viscosity, FTIR (Fourier transform Infrared Spectroscopy) and GPC (Gas Performance Chromatography). It was found that the degree of PET depolymerisation was seriously influenced by the ratio of EG/PET. Moreover, the reaction takes place instantaneously after EG addition. Even with small amounts of EG, it was possible to have depolymerisation of PET.

Introduction

It is well known that the consumption of poly(ethylene terephthalate) (PET) is widely increasing and it is crucial to develop an efficient and economical process to recycle PET. The recycling of PET has been studied for many years. These studies have been made mostly in batch and it is possible to depolymerize PET with different types of agents, such as, ethylene glycol (EG) and methanol (MeOH) (Chen *et al.*, 1999). Some works had been performed using a continuous process by extrusion (Dannoux *et al.*, 2002; Yalçinyuva *et al.*, 2000). The studies that are made in batch occurred using catalysts (Ghaemy *et al.*, 2005; Baliga *et al.*, 1989). Bu_2SnO as catalyst was also used during extrusion using (Dannoux *et al.*, 2002). To obtain depolymerisation using these methods required to work in extreme conditions and

probably, the most important, the costs that were involved did not justify the effort. Depolymerization of PET by a glycolysis reaction is the most common (Colomines *et al.*, 2005), in which in the presence of EG, the monomer bis(hydroxyethyl)terephthalate (BHET) and a mix of oligomers like dimmers and trimers are obtained. These compounds have low molecular weight and its possible to use them for repolymerization. This work, aims to compare two processes of PET depolymerization: batch and extrusion via glycolysis using EG as depolymerizer agent. No other catalyst was used and the temperature used was near the melting point of PET. In addition, the effects of the ratio of EG relatively to PET and equipment conditions, such as the speed of screw (for the extruder) and rotor (for the mixer) were studied.

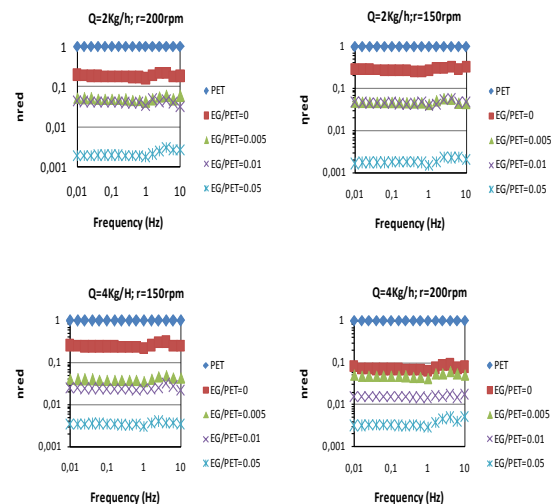


Figure 1: Reduced viscosity of the depolymerized PET via extrusion.

Figure 1 shows the reduced viscosity of PET after depolymerisation in an extruder using different amounts

of EG. The decrease of viscosity is associated with an increase of the depolymerisation of PET. Depolymerisation of PET occurs when a very small amount of EG is added and increases as the amount of EG increases. For all experiments it was observed that the depolymerisation occurred after the addition of EG.

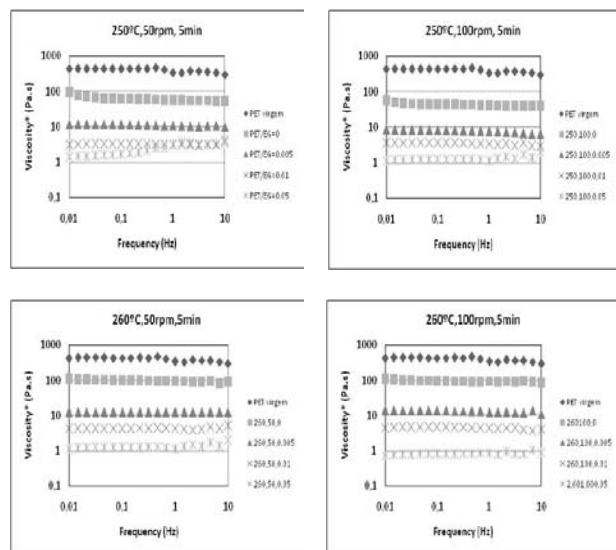


Figure 2: Complex viscosity of the collected samples in the Haake mixer after 5 minutes of reaction.

The results obtained, when the reaction took place in the batch mixer, are similar to the ones obtained during extrusion, *i.e.*, the depolymerisation increases as the amount of EG increases. However, the depolymerisation reaction is more efficient in an extruder.

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Curriculum Vitae

Filomena Costa has a degree in Applied Chemistry, Quality Control in Plastic Materials from the University of Minho; and a master in Chemistry from the same University. Currently, she is doing her PhD in the Department of Polymer Engineering from the University of Minho.