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Depolymerization of polyethtlene terephthalate (PET): comparison between two different depolymerizing agents, Ethylene glycol (EG) and Diethylene glycol

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KEYWORDS

Glycolysis, continuous extrusion, batch mixer, PET, recycling.

ABSTRACT

Glycolitic depolymerisation of polyethylene terephthalate (PET) is investigated in batch (Haake mixer) and continuous (co-rotating twin screw extruder) using ethlylene 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

Poly(ethylene terephthatlate) (PET) is a thermoplastic polyester that is produced via policondensation reaction. This polymer is one of the most used in packaging and food industry. That's why is so urgent to recycle PET to re-use as a value-added product. Among the different recycling techniques, the only one acceptable according to the principles of ''Sustainable Development'' is the chemical recycling, since it leads to the formation of the raw materials from which the polymer is made of, as well as of other secondary value-added products. The recycling of PET has been studied for many years. These studies had been made mostly in batch with different depolymerizing agents (Chen *et al*., 1998; Pardal *et al*., 2006; Karayannidis *et al*., 2006). Depolymerization of PET by a glycolysis reaction is the most common, where the EG and DEG are the most used to transform the PET into the monomer bis(hydroxyrthyl)terephthalate (BHET) and a mix of oligomers like dimmers and trimers are obtained (Xi *et al*., 2004; Romão *et al*., 2009). These materials have low molecular weight and its possible to use them for repolimerization. In this work, we aim to compare two process of PET depolymerization: depolimerization via glycolysis using EG and DEG as depolymerizing agents working at temperatures near the melting point of PET.

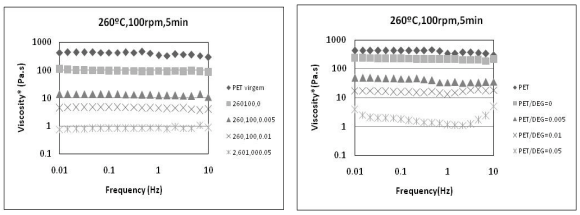

Figure 1: Comparison of depolymerization of PET with two different depolimeryzing agents, EG and DEG.

Figure 1 shows the viscosity of PET before and after depolymerisation in batch using different amounts of EG and DEG. 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 or DEG is added and increases as the amount of depolimeryzing agent increases. For all experiments it was observed that the depolymerisation occurred after the addition of he depolimeryzing agent. It is also possible to see that the results obtained with the EG are quite better than the results obtained with DEG.

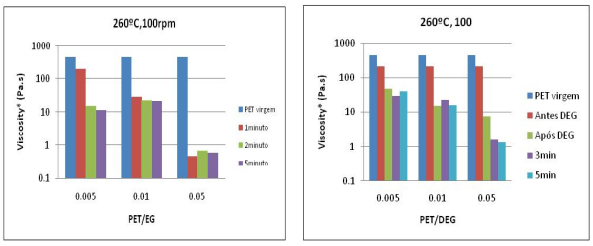

Figure 2: Complex viscosity of the collected samples along the time of the reaction in the Haake mixer.

In figure 2 is possible to see that increasing the amount of depolimeryzing agent, increases the depolymerization of PET because the complex viscosity of the materials decreases. It is also possible to see that the reaction took place just right after addition of EG or DEG. According with the results obtained by rheometry, the depolymerisation reaction is more efficient when the EG is used. It is possible to obtained viscosities below 1 Pa.s. The results are better for EG/PET=0.05.

CONCLUSIONS:

The method was very effective in depolymerising PET to a mix of oligomers. It was also possible to see that the amount of depolimeryzing agent influence the rate of depolymerisation, being the concentration of 0.05 more effective. The EG is more effective than DEG.

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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.