ABSTRACT

A Study On The Recycling Of Polyethylene Terephthalate (PET)

With A Caribbean Perspective

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The disposal of Polyethylene Terephthalate (PET) water/soft drink bottles (some 1.4 million per day in Trinidad alone) represents a major environmental challenge to the region. The issue of PET bottle disposal and recycling, from both a Caribbean and an international perspective was examined. The relevance of the various PET recycling methods—primary, secondary, tertiary and quaternary—which are available were examined in a regional context.

In order to broaden the knowledge available in the area of bottle-to-bottle recycling, extrusion studies were carried out on PET samples at various temperatures, screw speeds and throughputs. The extrudate was analysed to determine product parameters including intrinsic viscosity (IV), melt flow index (MFI) and molecular weights—via the Mark-Houwink-Sakurada (MHS) equation and via gel permeation chromatography (GPC). A qualitative assessment has been made on the effect of extruder parameters on the product parameters and it has been found that a higher temperature and a lower screw speed results in greater degradation of the PET samples. The data has been applied to kinetic models developed to relate change in molecular weight to residence time for the thermal degradation of polymers by random scission as would be occurring in the extruder. Values of the activation energy for the process have been determined and have been found to be in the range of 48 to 66 kJ mol^{-1}, values which compare favourably with what are found in the literature.

In order to provide information needed for the modelling of PET pyrolysis, experimental thermogravimetric analysis (TGA) work was carried out on samples of virgin PET and the data analysed with the use of MATLAB to determine values of the kinetic triplet at various heating rates. The results, with values of the activation energy in the range of 320 kJ mol^{-1}, compared favourably with a more restrictive set of results quoted in the literature. Evolved gas analysis (EGA) was conducted in conjunction with TGA to determine the products of pyrolysis at the TGA conditions and it was found that only oligomers of PET were formed.

Using partial glycolysis to convert waste PET into polyester polyols (which could then be utilized in the manufacture of polyurethanes (PURs)), was identified as a technically viable recycling route for PET, with potential for the Caribbean. A study was made of the PUR industry and its current state in the Caribbean. The economic viability of such a recycling option for the Caribbean requires further investigation.

Keywords: Jeffrey Victor Smith, polyethylene terephthalate (PET), polymer recycling, bottle-to-bottle, extrusion studies, kinetic modelling, polyester polyols