

ABSTRACT

Project S.P.O.R.T. -
(Sustainable Polymers to Olefins Recycling Technology)
THE DEVELOPMENT AND OPTIMIZATION OF A NOVEL
UWI/BP/STRATA POLYMER CRACKING REACTOR TO STUDY
THERMAL DEGRADATION OF POLYETHYLENES AND
POLYPROPYLENE

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The use of plastics is omnipresent in modern society. There are many problems associated with the waste management of plastics due to the fact that most are non-degradable. Waste plastics can be turned into chemicals and fuels via thermal degradation. In this thesis, a novel UWI/BP/Strata (S.P.O.R.T.) polymer cracking rig was developed and optimized to investigate thermal degradation of polyethylenes and polypropylene. The S.P.O.R.T. reactor is a combination of a semi-batch and a continuous flow reactor connected in series. The influence of pyrolysis temperature and stirring rate on the yield and composition of the derived products were investigated in the semi-batch reactor over a range of 320 to 400 °C and 1.0 to 10.0 Hz respectively. The influence of pyrolysis temperature on the composition of the derived products was investigated in the continuous flow reactor over a range of 500 to 700 °C.

Pyrolysis temperature was found to be the most important variable in influencing product formation with higher temperatures producing greater amounts of condensable vapour product and consequential reduction in wax products. In the continuous flow reactor, there was a significant increase in non-condensable products as the reactor temperature increased. The products, product distribution, physical and thermal properties of products were obtained using FT-IR, GC, GPC/SEC, TGA/DSC, MALDI TOF MS, NMR and Melt flow analysis techniques. Analysis of the recovered products showed that thermal degradation of LDPE and PP in the S.P.O.R.T. reactor consisted mainly of aliphatic alkenes, with lesser amounts of alkanes and alkadienes. Chain-end scission products were favoured to random chain scission products as the production of volatiles increased. Mass effects may have led to the favouring of chain-end scission products and their formation at temperatures lower than reported in literature. The recovered products have great potential to be used in the petrochemical industry as reactants for making new plastics and production of fuels.

Keywords: Jason Shezard Toney; Thermal degradation; UWI/BP/Strata reactor; polyethylene; polypropylene; batch reactor and fluidized bed reactor.