ABSTRACT

THE DEVELOPMENT AND OPTIMIZATION OF A NOVEL UWI/BP/STRATA POLYMER CRACKING REACTOR TO STUDY DEPOLYMERISATION OF POLYSTYRENES

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A working novel UWI/BP/Strata polymer cracking rig prototype, sustainable polymer to olefin recycling technology (SPORT) reactor was developed. The polymer cracking rig is a combination of two reactors, a semi-batch reactor and a continuous flow reactor connected in series. The polymer cracking rig is called the SPORT reactor. Its main advantage over contemporary reactor systems is in its increase cracking feasibility through more diversity and flexibility options by influencing thermal degradation mechanisms and producing a wider variety of products by simply controlling the process parameters; temperature, stirring rates and residence times, and cracking independently in the semi-batch and continuous flow sections of the reactor. Product analysis provided information on thermal cracking mechanisms occurring in the SPORT reactor operating in either semi batch or dual batch continuous mode. The products, product distribution, physical and thermal properties of products obtained from polymer degradation in the rig were analysed using FT-IR, GC, GPC/SEC, MALDI TOF MS, NMR, TGA/DTA and Melt flow index analysis.

Polypropylene, poly(methyl methacrylate), polystyrene general purpose grade, polystyrene of molecular weight 192 000, polystyrene of molecular weight 350 000 and poly(styrene-co-α-methylstyrene) polymers were used to study thermal cracking in the SPORT reactor. Polypropylene was used in the standardization and modification stage of the reactor's development. While depolymerisation of poly(methyl methacrylate), polystyrene and poly(styrene-co-α-methylstyrene) in the SPORT reactor operating in both semi batch and dual batch continuous modes were used to show the flexibility of the reactor for thermal degradation. In the SPORT reactor, poly(methyl methacrylate) underwent a 100% monomer reversion, polystyrene monomer reversion ranged from 67% to 80% and monomer reversion for poly(styrene-co-α-methylstyrene) range from 20 to 40% for styrene monomer, and 60 to 80% for α-methylstyrene monomer. Depending on the product type demand, the operating conditions of the SPORT reactor can be manipulated to produce different product types for maximum economic benefit. Poly(methyl methacrylate) degradation in the SPORT reactor was limited to semi batch mode while degradation of polystyrene and poly(styrene-co-α-methylstyrene) in the reactor operating in dual batch continuous mode favor depolymerisation more than semi batch mode.

Keywords: Polymer cracking; Depolymerisation; Polyolefin thermal degradation; SPORT polymer cracking reactor; Dual batch continuous flow reactor.