

Conversion of Waste Polypropylene into Hydrocarbon Fuel — Analysis of the Effect of Set Temperature on Reaction Time and Liquid Yield

E.P. Rohan^{1*}, B. Sumith² and L.K.T. Srimal²

¹*Department of Engineering Technology, University College of Matara, University of Vocational Technology, Matara, Sri Lanka*

²*Department of Mechanical and Manufacturing Engineering, University of Ruhuna, Galle, Sri Lanka*

Plastic waste and management is a serious environmental issue. The methods available to date such as incineration, land filling etc., are cost intensive. Attention is thus being given to new recycling methods which are more environmentally attractive. Pyrolysis is one such promising method for the treatment of mixed and contaminated plastic wastes. In pyrolysis, plastics are thermally degraded to produce liquid hydrocarbons. Pyrolysis of waste plastics was investigated in a reactor system which consists of a semi batch reactor, a condenser and a liquid-gas separator. Developed reactor system is capable of converting waste plastics (polyethylene, polypropylene and polystyrene) into hydrocarbon fuel at a maximum conversion rate of 99%. Liquid yield and gas yield at optimum conditions are 66% and 31% respectively. Liquid fuel obtained by the process was found to consist of light and middle distillates in the range of C₅ to C₁₂ hydrocarbons with higher concentrations of C₇, C₈ and C₉ fractions. Non-condensable gas obtained was chemically equivalent to the LP (liquid petroleum) gas. Polypropylene waste samples of 3000 g by weight were used for the experiments carried out to investigate the effects of set temperature on reaction time and liquid yield. The reaction time was found to decrease from 390 min to 115 min and the liquid yield was found to decrease from 68.2% to 39.2%, when the set temperature of the reactor increases from 375 °C to 475 °C. The solid residue left in the reactor was also observed to be decreased from 19.1% to 0.4%, during the experiments. Low set temperatures such as 400, 375 °C were found to drastically increase solid residue amount and reaction time at an approximately same liquid yield. High set temperatures such as 450, 475 °C were found to decrease liquid yield and reaction time at an approximately same solid residue amount. Waste plastic pyrolysis process is affected by many process parameters such as pressure, batch size, set temperature, heating rate, reactor design etc. Optimized process parameters lead to obtain high liquid yield at a minimum input energy in a comparatively small reaction time.

Keywords: Liquid yield, Pyrolysis, Reaction time, Set temperature, Waste polypropylene