ABSTRACT

This research discusses the design and component selection of a High Density Polyethylene (HDPE) waste plastic pyrolysis machine with a 10 kg reactor capacity and a three-stage condensation system. The primary objective was to determine the technical specifications of the main components, namely the reactor and condenser, capable of producing liquid fuel with optimal efficiency. The reactor was designed using used 12 kg LPG cylinders, selected for their thermal resistance, structural strength, ease of modification, and availability. The condensation system utilizes three spiral condensers made of copper tubing (total length 7.80 m) designed to reject 35,625 W of heat based on calculations of sensible and latent heat loads and logarithmic temperature differences. Test were conducted by processing 10 kg of HDPE plastic at an operating temperature of 350–500 °C using an LPG gas heater and ice-water cooler. As a result, the first condenser produced 65 ml of bio-oil (ρ = 0.7 g/ml), the second condenser 22 ml (ρ = 0.8 g/ml), and the third condenser 13 ml (ρ = 0.8 g/ml), so that the total conversion efficiency is around 0.01% of the initial plastic mass. These results indicate that the condenser configuration and material selection have a significant influence on the process efficiency, although the efficiency value is still low. This study provides a technical overview for the development of a more effective pyrolysis system through condenser design optimization, catalyst addition, and improvement of the operation control system.

Keywords: Pyrolysis, HDPE, Spiral Condenser, Component Selection, Bio-Oil.