Abstract No: MO-03

Pyrolysis of plastic waste into liquid fuel

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The accumulation of plastic waste in the environment has emerged as a significant global concern. The versatile properties of plastics, such as low weight, low cost and durability which led to their widespread use as substituents for traditional materials like wood, metals, ceramics, and glasses. However, the improper handling and disposal of plastic waste have imposed negative consequences for the environment. The non-biodegradable nature of plastics makes them persist in the environment for extended periods, causing pollution and posing threats to ecosystems. Pyrolysis of plastic waste has been studied extensively in recent years as an effective solution, by exposing the plastic waste to high temperatures in an oxygen-free environment to decompose it into fuel oil, char, and gases. In this study, the waste of four types of plastics samples, low-density polyethylene (LDPE), high-density polyethylene (HDPE), polypropylene (PP), and a mixture of these three types of plastics, were subjected to pyrolysis. Lab-scale, low-cost pyrolysis system was used to obtain liquid oils and herein, the non-condensed vapor was trapped into an organic solvent. Thermal pyrolysis or non-catalyzed pyrolysis resulted in a liquid yield of 65.64 ± 5.42 – 79.57 ± 1.66 wt.% at a temperature range of 340 – 360 °C. Considering catalytic activity, high temperature stability, local availability, and abundance, four types of naturally available minerals were selected as potential catalysts for the pyrolysis of waste plastics. The mineral which resulted in the highest liquid yield was identified as the best-performing catalyst and used for further analysis. The catalyzed process resulted in an increased liquid yield of 71.79 ± 0.99 - 80.29 ± 1.76 wt.% at the temperature range of 290 – 320 °C. The calorific value of the resulting oil in thermal and catalyzed pyrolysis processes were 10,850 -10,961 Kcal/kg and 10,556 - 11,473 Kcal/kg respectively. This reveals that the mineral selected is an ideal catalyst for pyrolysis of plastics and further indicates the quality enhancement of the fuel produced in catalyzed pyrolysis. Further, the fuel quality indicators; calorific values, density, kinematic viscosity, ash content, and water content of the resulting liquid oils under both catalyzed and uncatalyzed/thermal pyrolysis processes were significantly compatible with commercial grade diesel and kerosene fuel oils.

Keywords: Pyrolysis, Mixed plastics, Liquid oil, Catalysts, Physical properties

Acknowledgment
This work was supported by World Bank (AHEAD DOR) under the research grant AHEAD/RA3/DOR-12.