7th International Conference

# WASTES

SOLUTIONS
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## BOOK OF PROCEEDINGS

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# CATALYTIC CONVERSION OF LDPE POWDER INTO SUSTAINABLE AVIATION FUEL: A PATHWAY TO CIRCULAR ECONOMY

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## ABSTRACT

The transport sector consumes approximately one-third of the world's total energy, with the majority derived from oil. Transition to renewable fuels can drastically reduce greenhouse gas emissions and provide a sustainable alternative to petroleum-based fuels. Among these, sustainable aviation fuel (C8-C16) – produced from waste – holds great promise, potentially reducing emissions by up to 80 % compared to fossil fuels. However, current technologies remain underdeveloped, and advances in efficient waste-to-fuel conversion systems are needed to combat climate change and secure the future of upcoming generations [1-5]. The development of integrated systems that convert waste into aviation fuel that meets stringent quality standards is, therefore, critical. The aim of this study was to develop heterogeneous catalysts for the production of aviation fuels from commercial low-density polyethylene (LDPE) powder. LDPE powder with two size ranges (from Goodfellow) was used as substrate: i) particles with a maximum size of 300 μm (LDPE300) and ii) particle sizes of 300-600 μm (LDPE600). Ru (2.5 wt.%) was supported on original carbon nanotubes (CNT, Nanocyl-7000) and CNT oxidised with $HNO_3$ (CNTox), using the incipient wetness impregnation method. After drying at 110 ºC overnight, the materials were thermally treated under N2 at 250 ºC for 3 h and subsequently reduced under H2 at the same temperature for 3 h. The catalysts were characterised by various techniques, such as nitrogen adsorption at -196 ºC, temperature programmed reduction, determination of total acidity by chemical titration, inductively coupled plasma-optical emission spectroscopy, elemental analysis and X-ray diffraction. The catalytic performance was evaluated in a 100 mL stainless steel Parr batch reactor. In a typical run, 5 g of LDPE and 0.5 g of catalyst were loaded into the reactor. After purging the reactor with N2, followed by H2, the reactor was set to an initial H2 pressure of 40 bar and operated at 300 ºC with stirring at 400 rpm for 4 h. The liquid products were analysed by gas chromatography-mass spectrometry (GC-MS) using a ZB-5MSPlus column and docosane as the internal standard. The results are summarised in Table 1. Although a high conversion of 90.6 % could be obtained over Ru/CNT, the carbon range of the products obtained was between 7 and 35. In contrast, when Ru/CNTox was used, its acidity favoured cracking, yielding products with carbon chain lengths ranging from 7 to 28 and achieving a high conversion of 95.8 %. Furthermore, although the product distribution was similar in both tests, the substrate's particle size significantly affected its conversion.

*Table 1 – Catalytic results obtained after 4 h of reaction.*

| Substrate | Catalyst | Conversion (%) | Products obtained |
|---|---|---|---|
| LDPE300 | Ru/CNT | 90.6 | C7-C35 |
| DPE300 | Ru/CNTox | 95.8 | C7-C28 |
| LDPE600 | Ru/CNTox | 43.1 | C7-C28 |

**Keywords**

Plastic waste valorisation, one-pot process, heterogeneous catalysts, jet fuel