

https://dspace.org/

The production of synthetic liquid hydrocarbons from waste-derived syngas for use as fuel

Molaudzi, Vusani

2016-10-11
http://hdl.handle.net/10539/21160

Downloaded from a DSpace repository. https://dspace.org/

ABSTRACT

The last decade has seen a rise in the demand for energy from growing economies such as Brazil, China, India, and South Africa. Recent trends suggest a shift in focus towards the development of sustainable energy processes that are environmentally friendly.

This has led to an increased interest in carbon containing waste materials such as plastic, rubber and biomass that can be converted to synthetic liquid fuels (Doss, T. (2012) Low severity Fischer-Tropsch synthesis for the production of synthetic hydrocarbon fuels. Aston University). Studies have shown that these waste materials can be converted into synthetic liquid fuels by a two-step process: gasification/pyrolysis of waste material to synthesis gas (a mixture of CO + H2) and further conversion of the syngas generated to synthetic liquid hydrocarbons fuels by the Fischer-Tropsch synthesis (FTS) (Tijmensen, M.J., Faaji, A.P., Hamelinck, C.N. and van Hardeveld, M.R. (2002) Exploration of the possibilities for production of Fischer Tropsch liquids and power via biomass gasification. Biomass and Bioenergy 23:129–152). Waste or biomass can be used as feedstock material for Fischer-Tropsch synthesis in producing clean liquid hydrocarbon fuels (Hamelinck, C.N., Faaij, A.P.C., den Uil, H. and Boerrigter, H. (2004) Production of FT Transportation Fuels from Biomass; Technical Options, Process Analysis and Optimisation, and Development Potential. Energy. 29(11): 1743-1771.). Fischer-Tropsch synthesis produces ultra-clean fuels such as the low-sulfur diesel with a high cetane number (Dry, M.E. (1990) The Fischer-Tropsch Process - Commercial Aspects. Catalysis Today 6(3):183-206.). Previous FTS studies have consistently established optimum operating conditions suitable to the Coal-To-Liquid (CTL) and Gas-To-Liquid(GTL) processes. However, this has not been the case for Biomass-to-Liquid (BTL) processes mostly because of the undefined feed syngas composition generated from pyrolysis or gasification of waste materials. Therefore there is a need to investigate these effects of syngas composition (H2/CO molar ratio) particularly at low H2/CO molar ratios of 1:1 to 1.5:1 and low-pressure and this was the motivation behind this work. The motivation behind low-pressure Fischer-Tropsch synthesis studies was the need to evaluate the feasibility of implementing simple and easy to operate Fischer-Tropsch synthesis processes which could be applied to resources that were previously thought to be stranded and uneconomical (waste, etc.) without the need of complex process control and safety requirements.

A maximum average CO conversion of 58% was achieved for Low Temperature Fischer-Tropsch (LTFT) studies conducted at low reactor pressures (8 bars and 15bars) over Fe30K2Cu3.75SiO2 iron-based catalyst while a maximum average CO conversion of 6% was achieved for Low Temperature Fischer-Tropsch (LTFT) studies over Co/Ru/TiO2 cobalt-based catalyst at low reactor pressure of 10bars. The iron-based catalyst was highly selective towards heavy molecular weight hydrocarbons at these operating conditions.