UNIVERSITI TEKNOLOGI MARA

HYDROGEN PRODUCTION ENHANCEMENT FROM LOW-TEMPERATURE CATALYTIC THERMOCHEMICAL PROCESSING OF PALM OIL EMPTY FRUIT BUNCHES

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Thesis submitted in fulfilment
of the requirements for the degree of
Master of Science
(Mechanical Engineering)

Faculty of Mechanical Engineering

July 2018

ABSTRACT

A low-temperature thermo-chemical conversion of biomass to maximise the hydrogen-rich sync gas product to replicate a one-step hydrogen production using palm oil empty fruit bunches (EFB) pellets as an alternative process for renewable hydrogen production was studied. Catalysts CaO and NaOH were selected due to its availability and low price. The yields and distributions of the gas products were studied under various operating conditions. The thermochemical characterization was completed which include proximate, ultimate and thermogravimetry analysis in determining the need for pre-treatment as well as the design of suitable thermal conversion process. The EFB pellets were reacted at temperatures 450℃, 500℃, 550℃, and 600℃ using a horizontal tube furnace. The product gas in this study was analyzed using a gas chromatography with Thermal Conductivity Detector (GC-TCD). At lower temperature, CaO and NaOH had significant influences in improving the hydrogen production in comparison to those of the control samples. The maximum hydrogen yield from the control samples was around 51 mol % at a temperature of around 450℃. The addition of CaO and NaOH improved the hydrogen yield to 82 % and almost 100 % mol respectively and obtained at a slightly higher temperature of around 500℃. However, the hydrogen yield varies significantly across the temperature range in the study, which was more prominent in the samples with CaO. The final gas composition does behave according to the assumption, that water gas shift reaction and steam methane reforming takes place and enhance the hydrogen production. However, at a higher temperature, the hydrogen production s decreased due to the reversing reaction which could be explained by the Le Chatelier's Principle. Hydrogen without CO and CO_2 was produced through the reactions of EFB volatile with NaOH and water to produce hydrogen, sodium carbonate (Na_2CO_3), and a small amount of methane as the by-product. The thermal process with inexpensive and abundant catalysts such as CaO and NaOH could produce hydrogen-rich gas which is free of CO and CO_2, and the process could be optimized at a relatively low temperature of less than 500 ^oC, which is significantly lower than the normal temperature ranges for biomass gasification to produce syngas fuel.

ACKNOWLEDGEMENT

Firstly I wish to thank Allah the Merciful for giving me the opportunity to embark on my Master’s Degree and for completing this long and challenging journey successfully. My gratitude and thanks go to my supervisor Assoc. Prof Dr Ramlan Zailani, and co-supervisors, Dr Raja Razuan Raja Deris and Prof Khudzir Ismail. Thank you for your support, patience, and ideas for assisting me with this project. I would also like to express my gratitude to the Ministry of Higher Education (MOHE) for the Fundamentals Research Grant Scheme (FRGS/2/2013/TK06/UITM/02/3), Research Management Institute (RMI), staff of the Faculty of Mechanical Engineering and Faculty of Applied Sciences, especially Mr Kamarudin, for providing support, knowledge, and excellent facilities.

My appreciation goes to my colleagues and friends for their help on this project. Thank you for providing a different perspective and insights, for without it I would be simply lost in my own world without being able to see thing differently.

Finally, this thesis is dedicated to my loving family, especially my mother [redacted] for their undying support in many forms. Without their care, understanding, patience, and love I would not be where I am today. Alhamdulillah.

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