

UNIVERSITI TEKNOLOGI MARA

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

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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°C, 500°C, 550°C, and 600°C 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°C. 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°C. 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 CO₂ was produced through the reactions of EFB volatile with NaOH and water to produce hydrogen, sodium carbonate (Na₂CO₃), 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 CO₂, and the process could be optimized at a relatively low temperature of less than 500 °C, which is significantly lower than the normal temperature ranges for biomass gasification to produce syngas fuel.

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