**Hydrogen production from palm kernel shell via integrated catalytic adsorption (ICA) steam gasification**

**ABSTRACT**

The present study investigates the integrated catalytic adsorption (ICA) steam gasification of palm kernel shell for hydrogen production in a pilot scale atmospheric fluidized bed gasifier. The biomass steam gasification is performed in the presence of an adsorbent and a catalyst in the system. The effect of adsorbent to biomass (A/B) ratio (0.5-1.5 wt/wt), fluidization velocity (0.15-0.26 m/s) and biomass particle size (0.355-2.0 mm) are studied at temperature of 675 °C, steam to biomass (S/B) ratio of 2.0 (wt/wt) and biomass to catalyst ratio of 0.1 (wt/wt). Hydrogen composition and yield, total gas yield, and lower product gas heating values (LHVgas) increases with increasing A/B ratio, while particle size has no significant effect on hydrogen composition and yield, total gas and char yield, gasification and carbon conversion efficiency. However, gas heating values increased with increasing biomass particle size which is due to presence of high methane content in product gas. Meanwhile, medium fluidization velocity (0.21 m/s) favoured hydrogen composition and yield. The results showed that the maximum hydrogen composition and yield of 84.62 vol% and 91.11 g H2/kg biomass, respectively, are observed at A/B ratio of 1.5, S/B ratio of 2.0, catalyst to biomass ratio of 0.1 and temperature of 675 °C. The product gas heating values are observed in the range of 10.92-17.02 MJ/Nm3. Gasification and carbon conversion efficiency are observed in the range of 25.66-42.95 % and 20.61-41.95 %, respectively. These lower efficiencies are due to significant CO2 capturing using in-situ CO2 adsorption in pilot scale fluidized bed gasification system. The comparative study with literature shows that the combination of adsorbent and catalyst produces better results in terms of hydrogen composition and gas heating values compared to that of biomass steam catalytic gasification and steam gasification with in-situ CO2 adsorbent.