Catalytic upgrading of sugarcane bagasse pyrolysis vapours over rare earth metal (Ce) loaded HZSM-5: Effect of catalyst to biomass ratio on the organic compounds in pyrolysis oil

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ABSTRACT

The main objective of the current work is to investigate the influence of catalyst to biomass ratio (by weight%) on the catalytic upgrading of sugarcane bagasse derived pyrolysis vapours over cerium (Ce) loaded Hydrogen exchanged Zeolite Socony Mobil-5 (HZSM-5) catalyst via in-situ fixed bed reactor. The temperature of pyrolysis was kept at 500 °C for all investigated samples. The HZSM-5 catalyst was used as a support with 1 wt% of Ce as promoter loaded via incipient wetness impregnation method. The biomass sample was fixed at 2 g, while the catalyst mass loading was loaded according to the catalyst to biomass ratio which are 0.5:1.0, 1.0:1.0, 1.5:1.0, and 2.0:1.0. For comparison, the non-catalytic and biomass catalytic over HZSM-5 catalyst was also pyrolyzed at the same operating conditions. The results show that the yields of pyrolysis oil and coke were significantly influenced by the use of Ce/HZSM-5 catalyst at various catalyst to biomass ratio than the catalytic pyrolysis over HZSM-5, in which generate higher pyrolysis oil yield (58.0–68.0 wt%) and lower coke yield (2.9–4.1%). The increasing loading of mass in Ce/HZSM-5 catalyst has additional effect with respect to C_6–C_8 hydrocarbon contents in pyrolysis oil than the catalytic samples over the HZSM-5 catalyst. Among the tested catalyst to biomass ratio, the catalyst to biomass ratio of 1.5:1 has demonstrated to be the potential candidates in the catalytic upgrading of sugarcane bagasse derived oxygenated pyrolysis vapours into higher content of C_6–C_8 hydrocarbons (2.45%) in pyrolysis oil with lower coke yield (3.2%) over Ce/HZSM-5 catalyst. The bi-functional Ce/HZSM-5 catalyst was more effective in suppressing the coke formation in comparison to HZSM-5 catalyst at all investigated catalyst to biomass ratios and this was attributed to the synergistic effect of Ce on HZSM-5 support.

KEYWORDS:

Sugarcane bagasse; HZSM-5 zeolite; Cerium; Oxygenates; Hydrocarbons