Pyrolytic oil with aromatic-rich hydrocarbons via microwave-induced in-situ catalytic co-pyrolysis of empty fruit bunches with a waste truck tire

ABSTRACT

Microwave-induced in-situ catalytic co-pyrolysis of empty fruit bunch (EFB) with truck tire (TT) using a low-cost heterogeneous catalyst to produce aromatic-rich pyrolytic oil is proposed. In this study, the effect of catalyst type and catalyst-to-feedstock ratio were investigated. Three types of catalysts were used, namely activated carbon (AC), clay (CL) and calcium oxide (CaO), while the catalyst-to-feedstock ratios of 1:5, 2:5, 3:5 were investigated. Although the catalytic co-pyrolysis significantly reduced the yield, high monoaromatic hydrocarbon fraction and BTEX (benzene, toluene, ethylbenzene, xylene) selectivity were observed in the pyrolytic oil. The study showed that the AC-to-feedstock ratio of 2:5 (AC-0.4) contained a high fraction of monoaromatic hydrocarbon (54.32%) with high selectivity of BTEX (30.42%). The elemental analysis also found the AC catalyst produced hydrogenrich pyrolytic oil with lower undesirable compounds, mainly from oxygenates (ketone group), nitrogen and sulphur compounds. Moreover, the catalytic co-pyrolysis using AC reduces pyrolytic oil's pH value from 4.7 (un- Cat) to pH 5.02 (AC-0.4). However, the AC catalyst had little effect in increasing the higher heating value (HHV) of pyrolytic oil from 42.29 (un-Cat) to 42.47 MJkg -1 (AC-0.4) with a slightly decreased energy recovery from 62.0% (un-Cat) to 56.5% (AC-0.4). The residual gas analysis determined that the dominant gaseous produced from catalytic cracking using AC were CO2 and CH4. A reaction mechanism between the volatiles of EFB and TT is proposed. Overall, the study has successfully demonstrated an approach for producing pyrolytic oil with high monoaromatic fraction and high selectivity of BTEX from in-situ catalytic co-pyrolysis of EFB with TT using lowcost heterogeneous catalyst.