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Characterization of rice husk-based catalyst prepared via conventional and microwave carbonisation

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Abstract

Carbon-based sulphonated catalysts (CBSCs) were made from rice husk for biodiesel production. The CBSCs were prepared by microwave (MW) and conventional heating processes from the same feedstock. In both heating systems, the preparation was a two-step process: carbonisation and sulphonation. The aim of this study was to use MW heating to reduce the conventional CBSC preparation time and enhance the $–SO_3H$ group attachment to the solid catalyst. The biomass based solid acid catalysts from the two systems were characterised and compared in terms of physicochemical properties including: sulphonation, morphology, surface area and structure. The reaction times for MW assisted carbonisation and for sulphonation were significantly reduced compared to the conventional heating system; these were 30 min vs 4 h and 20 min vs 12 h, respectively. The MW prepared catalyst showed higher sulphur content (4.91%) as compared to the conventional catalyst (2.10%). The FTIR analysis showed well distinguished peaks for $–SO_3H$ for the MW prepared catalyst suggesting the solid catalyst was successfully sulphonated, while these peaks were very weak for the conventional catalyst. SEM analysis revealed a highly porous structure in the MW prepared catalyst, whilst a denser solid resulted for its conventionally prepared analogue, owing to the higher temperatures applied and longer sulphonation time. The surface area for the MW was higher than the conventionally prepared catalysts (43.63 m^2/g and 37.01 m^2/g, respectively). The structure of the samples was identified as amorphous for both catalysts as confirmed by XRD. The prepared CBSC is expected to catalyse biodiesel production reaction as evidenced by its total acidity and surface area.

Abbreviations:
MW: microwave, CBSC: carbon-based sulphonated catalyst, RH: rice husk, CRH: carbonised rice husk, FFA: free fatty acid.

Keywords: biomass, carbonisation, solid acid catalyst, rice husk, microwave energy.