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Catalytic supercritical water gasification of biomass waste using iron-doped alkaline earth catalysts

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Abstract

The objective of this study is to optimise the process of supercritical water gasification of rice husk biomass utilising a low-cost catalyst made from alkaline-earth materials. The interactions between catalyst loading and Fe content on gasification yield were investigated using response surface methodology. The catalyst characterisation findings revealed that the catalysts' predominant reactive site is on iron oxide, calcium ferrite, and calcium oxide. Under all the conditions tested, the manufactured catalyst was highly active in promoting char gasification, gas volume, and gasification efficiency whilst the tar yield was substantially elevated. The maximum gasification efficiency of 69.57%, gas yield of 402.8 mL/g biomass, char yield 24.68 wt%, and gravimetric tar yield of 57.5 mg/g were obtained under the catalytic conditions of 15% catalyst loading with 5%Fe/limestone, 492 °C, 120-min residence time, and 9.5 wt% feed concentrations. Thus, the manufactured catalyst showed a potential for optimising gasification outputs.

Keywords

Supercritical water gasification; Rice husk; Catalyst; Limestone; Dolomite; Iron