Structural and catalytic studies of Mg1-xNixO nanomaterials for gasification of biomass in supercritical water for H2-rich syngas production

ABSTRACT

Nowadays, catalytic supercritical water gasification (SCWG) is undoubtedly used for production of H2-rich syngas from biomass. The present study reported the synthesis and characterisation of Mg1-xNixO (x ¼ 0.05, 0.10, 0.15, 0.20) nanomaterials that were obtained via self-propagating combustion (SPC) method, and catalysed the SCWG for the first time. It had found that increased the nickel (Ni) content in the catalyst reduced the crystallite size, thus, increased the specific surface area, which influenced the catalytic activity. The specific surface area followed the order of Mg0.95Ni0.05O (36.2 m2 g1) < Mg0.90Ni0.10O (58.9 m2 g1) < Mg0.85Ni0.15O (63.6 m2 g1) < Mg0.80Ni0.20O (67.9 m2 g1). From the Rietveld refinement, the Ni that was successfully partial substituted in the cubic crystal structure of MgO resulting in a cell contraction which ascribed the reduction of crystallite size. Increased the amount of Ni also narrowed the pore size distribution ranging between 4.17 nm and 6.23 nm, as well as increased the basicity active site up to 5741.0 mmol g1 at medium basic strength. All the synthesised nanocatalysts were catalysed the SCWG of OPF (oil palm frond) biomass. Among them, the mesoporous Mg0.80Ni0.20O nanocatalyst exhibited the highest total gas volume of 193.5 mL g1 with 361.7% increment of H2 yield than that of the non-catalytic reaction.