

ABSTRACT

The scarcity of fossil fuels and increasing environmental issues have driven the search for alternative energy sources, one of which is biofuel. One potential raw material for conversion into biofuel is waste cooking oil. The conversion of waste cooking oil into biofuel is carried out through a hydrocracking reaction, which can be more efficient with the aid of heterogeneous catalysts. The use of mesoporous silica as a carrier for active metals such as Ni and Cu can increase the surface area and availability of active sites thereby increasing catalytic activity. The characteristics of silica as a carrier are influenced by synthesis conditions, one of which is the hydrothermal treatment time. The hydrothermal process plays a crucial role in controlling pore structure, crystallinity, and particle size homogeneity through condensation and polymerization mechanisms during synthesis. This study evaluated the effect of varying hydrothermal time on the synthesis of mesoporous silica as a carrier for Ni-Cu catalysts, as well as its characteristics, activity, and selectivity in the hydrocracking reaction. Mesoporous silica as a carrier material was synthesized through varying hydrothermal times of 24, 48, and 72 hours. The Ni-Cu/SiO₂ catalyst was synthesized using the wet impregnation method and characterized using FTIR, XRD, and GSA, and its acidity was tested and applied in the hydrocracking reaction of waste cooking oil. The results showed that the Ni-Cu/SiO₂ catalyst with a hydrothermal time variation of 72 hours had the highest surface area of 510.71 m²/g, a pore volume of 0.45 cm³/g, an average pore diameter of 3.80 nm, a total acidity of 14.03 mmol/g, and a uniform pore size distribution. The highest biofuel yield was obtained by the KS-48 catalyst, which provided the best performance with a surface area of 146.48 m²/g and a product selectivity of 77.08% towards the C₁₆–C₁₈ fraction. The Ni-Cu/SiO₂ catalyst was proven to be effective in increasing the conversion and selectivity of biofuel from waste cooking oil.

Keywords: Biofuel, waste cooking oil, hydrocracking, Ni-Cu catalyst, mesoporous silica, hydrothermal