

Synthesis of ferric-manganese doped tungstated zirconia nanoparticles as heterogeneous solid superacid catalyst for biodiesel production from waste cooking oil

ABSTRACT

The solid superacid catalyst ferric-manganese doped tungstated zirconia (FMWZ) nanoparticles was prepared by impregnation reaction followed by calcination at 600°C for 3 hr and had been characterized by X-ray diffraction (XRD), thermal gravimetric analysis (TGA), temperature programmed desorption of NH₃ (TPD-NH₃), X-ray fluorescence (XRF), transmission electron microscopy (TEM), and Brunner-Emmett-Teller (BET) surface area measurement. The transesterification reaction was used to determine the optimum conditions of methanolysis of waste cooking oil with FMWZ nanoparticles as heterogeneous solid superacid catalyst. The reactions variables such as reaction temperatures, catalyst loading, molar ratio of methanol/oil and reusability were also assessed which effects the waste cooking oil methyl esters (WCOME's) production yield. The catalyst was reused ten times without any loss in activity and maximum yield of 96% was achieved at the optimized conditions of reaction temperature of 200°C; stirring speed of 600 rpm, 1:25 molar ratio of oil to alcohol and 4% w/w catalyst loading. The fuel properties of the WCOME's were discussed in light of ASTM D6751 biodiesel standard.

Keyword: Ferric–manganese promoted tungstated zirconia (FMWZ); Superacid; WCOME's; Debye-Scherrer's relationship