Meso- and macroporous sulfonated starch solid acid catalyst for esterification of palm fatty acid distillate

ABSTRACT

In the present work, a heterogeneous solid acid catalyst was successfully developed from starch. The catalyst was prepared by a significant two-step process; the initial step was incomplete carbonization of starch (ICS) at 400°C for 12 h and consequently followed by sulfonation process using concentrated H2SO4 to produce sulfonated-incomplete carbonized starch (ICS-SO3H). The characterization of the ICS-SO3H catalyst was done for chemical and physical properties such as X-ray diffraction (XRD), ammonia-temperature programmed desorption (NH3-TPD), surface area analysis, thermal gravimetric analysis (TGA), elemental analysis and morphology analysis by scanning electron microscope (SEM). BET results showed the structure of ICS-SO3H consists of meso- and macro-porous properties, which allowed high density of the single bondSO3H group attached on its carbon networks. The catalytic activity of ICS-SO3H catalyst was determined by analyzing the catalyst performance to esterify palm fatty acid distillate (PFAD) and sequentially produced methyl ester. The maximum free fatty acid (FFA) conversion and FAME yield were as high as 94.6% and 90.4%, respectively, at 75°C using 10:1 methanol-to-PFAD molar ratio and 2 wt.% of catalyst within 3 h. The catalyst has sufficient potential to recycle up to 6 reactions without reactivation step and any remarkable loss of catalytic activity. It revealed that the heterogeneous ICS-SO3H catalyst exhibits high stability, reusability and catalytic activity.

Keyword: Meso- and macroporous carbon; Heterogeneous solid acid catalyst; Physico-chemical characterization; Esterification; Biodiesel