Optimization and blends study of heterogeneous acid catalyst assisted esterification of palm oil industry by-product for biodiesel production

ABSTRACT

The optimum conditions to produce palm fatty acid distillate (PFAD)-derived-methyl esters via esterification have been demonstrated with the aid of the response surface methodology (RSM) with central composite rotatable design in the presence of heterogeneous acid catalyst. The effect of four reaction variables, reaction time (30–110 min), reaction temperature (30–70°C), catalyst concentration (1–3 wt.%) and methanol : PFAD molar ratio (3 : 1–11 : 1), were investigated. The reaction time had the most influence on the yield response, while the interaction between the reaction time and the catalyst concentration, with an F-value of 95.61, contributed the most to the esterification reaction. The model had an R2-value of 0.9855, suggesting a fit model, which gave a maximum yield of 95%. The fuel properties of produced PFAD methyl ester were appraised based on the acid value, iodine value, cloud and pour points, flash point, kinematic viscosity, density, ash and water contents and were compared with biodiesel EN 14214 and ASTM D-6751 standard limits. The PFAD methyl ester was further blended with petro-diesel from B0, B3, B5, B10, B20 and B100, on a volumetric basis. The blends were characterized by TGA, DTG and FTIR. With an acid value of 0.42 (mg KOH g−1), iodine value of 63 (g.I2/100 g), kinematic viscosity of 4.31 (mm2 s−1), the PFAD methyl ester has shown good fuel potential, as all of its fuel properties were within the permissible international standards for biodiesel.