ABSTRACT

The removal of sulfur compounds from transportation fuel is an important aspect for protecting environment and for fuel cell applications. On the other hand, an innovative way to remove the sulfur is necessary because clean low-sulfur diesel is more widely used in the world today. In this work, we studied the effect of microwave irradiation power and time on the extractive catalytic oxidative desulfurization (ECODS) process of diesel fuel model (40 mL with initial S-content of 450 ppm), using vanadyl acetylacetonate ($VO(acac)_2$) as a catalyst and *N*-carboxymethylpyridine hydrosulphate ionic liquid ($[CH_2COOHPy][HSO_4]$ IL) as an extractant, and hydrogen peroxide (H_2O_2) as an oxidant agent. The optimal microwave-assisted extractive catalytic – oxidative desulfurization (MECODS) experimental conditions were as follows: microwave irradiation power = 500 W, microwave irradiation time = 90 s, IL/diesel volume ratio = 1:10, $VO(acaca)_2$/diesel mass ratio = 0.5 wt%, and H_2O_2 volume = 1 mL. Under these conditions, the sulfur content in commercial diesel fuel was reduced from 450 to 60 ppm (sulfur removal efficiency of 86.67%), which was superior to that of the simple oxidation with no IL (22.6%) or oxidation with not including catalyst (11.3%), and without affecting the physicochemical properties of diesel fuel. The catalytic system $VO(acac)_2$/IL can be recycled 5 times with merely a negligible loss in activity. Based on these experimental results, a MECODS mechanism was proposed. Ultra-deep desulfurization with 99.1% of sulfur removal efficiency was reached, using MECODS reaction under optimum conditions by adding 3 mL of H_2SO_4 (0.1 N) to the main reaction. This highest sulfur removal efficiency can be attributed to the synergetic effect between microwave activation heating energy and the additional protonation, which multiplied the sulfones' (BTO_2s and $DBTO_2$s) formation pathways and thus accelerated the desulfurization reactions.