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Adsorptive Desulfurization of Disel Fuel Using Cobalt-Molybdenum over Alumina (CoMo/Al2O3) as an Adsorbent; Effect of key variables

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Abstract:

The production of clean hydrocarbon fuels with low sulfur content has become one of the challenges for modern petroleum refinery. The use of environmentally friendly fuels requires the removal of organic sulfur compounds in diesel. However, these compounds are a major contributor to acid rain and air pollution by sulfur oxides (SOx). The present study investigated the adsorption desulfurization (ADS) of diesel fuel containing 1093.5 ppm sulfur based on a batch adsorption process using Cobalt-Molybdenum-Alumina (CoMo/Al2O3). The characterization results of the adsorbent CoMo/Al2O3 using XRD, SEM and EDX showed that the adsorbent has a potential of a good capability to desulfurize diesel. The effect of adsorption temperature, adsorbent particle size, stirring rate, adsorption time and the amount of CoMo/Al2O3 on the desulfurization capacity were studied. At best conditions of 1hour adsorption time, 30oC, 15ml diesel/3.75gm, 0.106mm CoMo/Al2O3 particle size and 100 rpm stirring rate, the residual sulfur concentration in diesel fuel dropped from 1093.5 to 580,6 ppm, indicating a 47% desulfurization capacity. The kinetics and thermodynamics of the process were investigated to fit the experimental results by employing different kinetic models. With a correlation coefficient of R2= 0.995, the results showed that the pseudo-second order models were successful in predicting the equilibrium sorption capacity. The process was non-spontaneous and endothermic as indicated by the positive values of the free energy (ΔG) and enthalpy (ΔH) increases respectively. On the other hand, the negative entropy (ΔS) changes showed that the adsorbed species randomness has decreased. This study demonstrates that CoMo/Al_2O_3 is an effective material for diesel desulfurization and highlights the critical influence of particle size on adsorption performance