122e Desulfurization of Transportation Fuels by Adsorption

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The sulfur compounds in transportation fuels (gasoline, diesel and jet fuels) can be selectively removed by a new class of adsorbents, referred to as pi-complexation sorbents. The sorbents contain d-block metal cations (e.g., Cu+, Ag+, Ni2+, Pd2+) that form pi-complexation bonds with the thiophene rings of the sulfur molecules. A summary of the development of these sorbents is given. High separation factors for sulfur-containing (i.e., thiophenic) compounds over the fuel aromatics were first predicted from molecular orbital calculations. Desulfurization of commercial fuels by using a fixed-bed of Cu(I)Y zeolite were demonstrated. Likewise, NiX and NiY zeolites also showed high selectivity for sulfur removal from a commercial diesel. The sulfur capacities of the sorbents were further increased by using a thin "guard" bed of a commercial sorbent (activated alumina or activated carbon) that removed the heavy aromatics from competing with the sulfur molecules for the cation sites. The sorbents could be effectively regenerated by heating in air at 350oC, followed by reduction of Cu2+ to Cu+. Furthermore, it was shown that ultrasound-assisted desorption could be a promising technique for regeneration at ambient temperature. For the desulfurization capacity, the detrimental effects of organo-nitrogen compounds, moisture, heavy (polynuclear) aromatics, oxygenates (ethanol and MTBE) and possibly other fuel additives that are contained in the commercial fuels are discussed.