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Application of Functionalized Magnetic Particles as Demulsifier for Oil-in-Water Emulsions

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Abstract : Separating emulsified oil contaminations from waste- or produced water is of interest to various industries. Magnetic particles (MPs) application for separating dispersed and emulsified oil from wastewater is becoming more popular. Stabilization of MPs is required through developing a coating layer on their surfaces to prevent their agglomeration and enhance their dispersibility. In this research, we study the effects of coating material, size, and concentration of iron oxide MPs on oil separation efficiency, using oil adsorption capacity measurements. We functionalize both micro-and nanoparticles of Fe3O4 using sodium dodecyl sulfate (SDS) as an anionic surfactant, cetyltrimethylammonium bromide (CTAB) as a cationic surfactant, and stearic acid (SA). The chemical structures and morphologies of these particles are characterized using Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), and Energy Dispersive X-ray (EDX). The oil-water separation results indicate that a low dosage of the coated magnetic nanoparticle with CTAB (0.5 g/L MNP-CTAB) results the highest oil adsorption capacity (nearly 100%) for 1000 ppm dodecane-in-water emulsion, containing ultra-small droplets (250–300 nm). While separation efficiency of the same dosage of bare MNPs is around 57.5%. Demulsification results of magnetic microparticles (MMPs) also reveal that the functionalizing particles with CTAB increase oil removal efficiency from 86.3% for bare MMP to 92% for MMP-CTAB. Comparing the results of different coating materials implies that the major interaction reaction is an electrostatic attraction between negatively charged oil droplets and positively charged MNP-CTAB and MMP-CTAB. Furthermore, the synthesized nanoparticles could be recycled and reused; after ten cycles the oil adsorption capacity slightly decreases to near 95%. In conclusion, functionalized magnetic particles with high oil separation efficiency could be used effectively in treatment of oily wastewater. Finally, optimization of the adsorption process is required by considering the effective system variables, and fluid properties.

Keywords : oily wastewater treatment, emulsions, oil-water separation, adsorption, magnetic nanoparticles
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