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Novel Nano-adsorbents for Oil Spill Removal

TECH ID #: 1138.1

Background

Researchers from the University of Calgary in collaboration with the National University of Colombia have developed novel nano-adsorbents for the removal of oil from fresh and/ or brine water emulsions using functionalized hydrophobic nanoparticles. These nanoparticles are functionalized with vacuum residue (VR) or waste industrial hydrocarbons as they are known to enhance the adsorption of oil onto the nanoparticles. These nano-adsorbents can also be used as an upgrading catalyst after oil adsorption. In comparison to other methods of oil removal, this method is more effective in terms of its applicability and expansion at an industrial scale with a high oil adsorption capacity of up to 100%.

Existing technologies such as filtration, reverse osmosis, air flotation, membrane bioreactors, chemical coagulation and bioremediation have proven to be expensive, inefficient and time-consuming. The nanomaterial engineered adsorption technique employed here can overcome these challenges due to its superior performance owing to their increased surface area and higher reactivity. Furthermore, the oil uptake onto the surface of nanoparticles is achieved in very short time (< 20 minutes, Figure 1a), the amount adsorbed decreases with the temperature and increases exponentially with the oil concentration (Figure 1b).

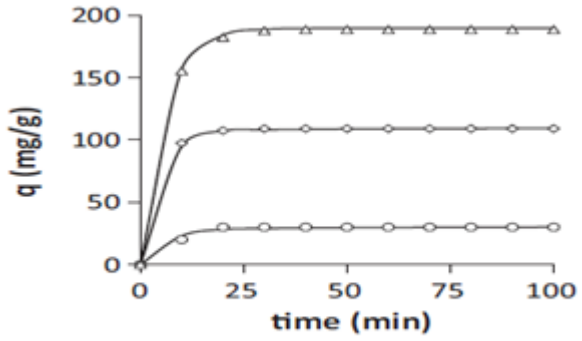

Figure 1a
Amount of oil adsorbed onto Al/VR nanoparticles at pH 7 for initial oil concentrations of 100 (O), 300 (◊) and 500 (Δ) mg/L in Saltwater

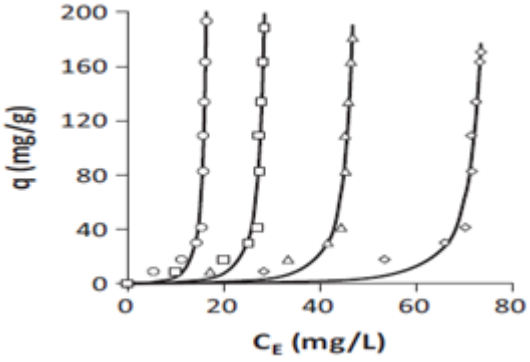

Figure 1b
Effect of temperature on oil adsorption onto Al/VR and nanoparticles at pH 7 and 283 K (O), 298 K (□), 313 K (Δ) and 328 K (◊). Shaking rate, 600 rpm; amount of adsorbent, 2.5 g/L.

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Competitive Advantages

- Accelerated rate of oil removal and reduction of corrosion and toxicity related compounds
- Commercially sustainable and cost efficient as vacuum residue is derived from waste byproducts
- Applications in both produced water and freshwater oil separations
- Use as a surfactant to facilitate integrated, continuous and high-speed separation process
- Can use magnetic cores for easy removal of adsorbed nanoparticles from water
- Material can be recovered, regenerated and reused with extended lifespan of adsorbent and catalyst
- Adaptable to different forms including sponges, carpets, liquid- and powder-based removal agents
- Can be readily integrated into oil spill remediation technologies such as oil skimmer vessels

Areas of Application

- Oil spill remediation
- Process optimization of oil-water emulsion separation
- Wastewater treatment and recycling of oil field produced water

Stage of Development

- Various adsorption experiments involving tests with fresh water/ brine water emulsions and magnetized nanoparticles for assessing oil removal efficiency have been completed
- Different variables such as adsorption time, loading of VR, temperature, salinity and solution pH have been investigated in these tests
- Researchers have also developed a system for regenerating adsorbents and subsequent steam catalytic cracking of the adsorbed oil to generate Syngas

Intellectual Property Status

- Patent filed

Publications

- Franco, Camilo A., Farid B. Cortés, and Nashaat N. Nassar. "Adsorptive removal of oil spill from oil-in-fresh water emulsions by hydrophobic alumina nanoparticles functionalized with petroleum vacuum residue." *Journal of colloid and interface science* 425 (2014): 168-177

- Franco, Camilo A., Nashaat N. Nassar, and Farid B. Cortés. "Removal of oil from oil-in-saltwater emulsions by adsorption onto nano-alumina functionalized with petroleum vacuum residue." Journal of colloid and interface science 433 (2014): 58-67