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Adsolubilization of Organic Compounds in Surfactant-Modified Alumina

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Abstract — Adsolubilization is the solubilization of organics into the three dimensional micelle like structures formed by the adsorption of ionic surfactants at high concentration on oppositely charged surfaces. Adsolubilization process could efficiently be used for the removal of different organic pollutants like dyes, phenolic compounds, etc. from water environment. In the present work, the adsorption characteristics of sodium dodecyl sulfate (SDS), an anionic surfactant (AS) on neutral alumina were studied in detail. Alumina was found to be an efficient adsorbent for SDS and could be used for the removal of SDS from its highly concentrated (several thousand ppm) solution. The equilibrium time found was 2 h. Though the removal efficiency was low ($\sim$ 65%) at neutral pH, but at slightly acidic condition and in the presence of NaCl, the efficiency could be increased drastically ($>$98%). The adsorption isotherm study showed four distinct regions. The effects of various other parameters such as adsorbent dose, the presence of different ions (Cl^-, NO_3^-, SO_4^{2-} and Fe^{3+}), and non-ionic surfactant on the SDS adsorption were also studied. It was observed that the adsorption capacity was increased due to the presence of these ions in general. After the adsorption of SDS on alumina, the alumina, which was then called the surfactant-modified alumina (SMA), was used for the removal of crystal violet (CV), a well-known cationic dye and phenol from aquatic environment. The kinetic studies showed that 1 h shaking time was sufficient to achieve the equilibrium for CV. The equilibrium time for phenol was 1.5 h. Studies were conducted to see the effects of adsorbent dose on the removal of CV and phenol separately using the SMA. The pH was maintained at 6.7 ± 0.1. The SMA was found to be very efficient, and $\sim$ 99% and $\sim$ 90% efficiency could be achieved under optimised conditions for the removal of CV and phenol when present even at a high concentration (200 ppm for CV and 50 ppm for phenol). Effects of different parameters like SDS coverage on alumina, pH, presence of different ions, temperature, etc. were studied. To test whether the removal of CV and phenol was possible from real water using the SMA, the removal studies were conducted using CV and phenol spiked tap water samples. It was interesting to note that the removal efficiency was better for the tap water samples than for the distilled water ones. Desorption of SDS from the SMA was possible using aqueous sodium hydroxide and desorption of CV and phenol from the exhausted SMA surface could be done by rectified spirit.