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Solvent-Free Synthesis of Sorbents for Removal of Oil Spills

Authors : Mohammad H. Al-Sayah, Khalid Jarrah, Soleiman Hisaindee

Abstract : Hydrophobic sorbents are usually used to remove oil spills from water surfaces. In this study, the hydrophilic fibers of natural cotton were chemically modified with a solvent-free process to modify them into hydrophobic fibers that can remove oil from water surfaces. The cellulose-based fibers of cotton were reacted with trichlorosilanes through gas-solid reaction in a dry chamber. Cotton fibers were exposed to vapors of four different chloroalkylsilanes at room temperature for 24 hours. The chlorosilanes were namely trichloromethylsilane, dichlorodimethyl silane, butyltrichlorosilane, and trichloro (3,3,3-trifluoropropyl) silane. The modified cotton fibers were characterized by IR-spectroscopy, thermogravimetric analysis (TGA) and Scanning Electron Microscopy/Energy Dispersive X-Ray Spectroscopy (SEM-EDS). The degree of substitution for each of the grafted alkyl groups was in the range between 0.1 and 0.3 per glucose residue. As a result of sialylation, the cotton fibers became hydrophobic; this was reflected by water contact-angle measurements of the fibers which increased from zero for the unmodified cotton to above 100 degrees for the modified fibers. In addition, the adsorption capacity of the fibers for oil from water surfaces increased by about five times that of the unmodified cotton reaching 18 g oil/g of cotton modified by dimethyl substituted silyl ethers. The optimal fiber-oil contact time and temperature for adsorption were 10 mins at 25°C, respectively. Therefore, the efficacy of cotton fibers to remove oil spills from contaminated water surfaces was significantly enhanced by using a simple solvent-free and environment-friendly process.

Keywords : gas-solid silyl reaction, modified cellulose, solvent-free, oil pollution, cotton
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