Hybrid mesoporous silicates: A distinct aspect to synthesis and application for decontamination of phenols

Abstract

Water pollution due to organic compounds is of great concern and efforts are being made to develop efficient adsorbents for remediation of toxic pollutants. The development of new functionalized materials with increased performance is growing to meet the regulatory standards in response to public concerns for environment. In this study, an attempt has been made to investigate the influence of synthesis parameters like the reaction temperature, the surfactant-to-silica ratio and reaction time on the structural and textural properties of novel ordered mesoporous silica hybrids. In order to understand the effect of different synthesis parameters, all the prepared materials were systematically characterized by various analytical, spectroscopic and imaging techniques such as XRD, BET, TG etc. It was deduced from these studies that the synthesis temperature influence greatly the structural order whereas both the P104/Na_2SiO_3 molar ratio and reaction time found to influence textural properties significantly. However, under optimized experimental condition, we could achieve the functionalized silica hybrids that offers successful incorporation of -Amino, -Glucidoxy, -Methacrylate, -Vinyl and -Phenyl moieties indicated by FTIR peaks at 793 cm^{-1}, 2870 cm^{-1}, 796 cm^{-1}, 1630 cm^{-1} and 954 cm^{-1}. XRD studies reveal orthorhombic and tetragonal symmetry for the hybrids and these materials were found to be thermally stable due to incorporation of organic moiety in silica matrix. Functionalized silica hybrids then applied as adsorbents demonstrated efficient and comparable removal of 4-aminophenol and p-nitrophenol in 20 min facilitated through organic moiety. Detailed modeling of the sorption using equilibrium and kinetic isotherms has been carried out to get an insight into the transport process. The adsorption isotherms of phenol derivatives are well-fitted with the Langmuir, Freundlich and Temkin Isotherms and the adsorption kinetics follows the pseudo second order model. The modeling confirms that the uptake is a chemisorption process.