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Investigation of formaldehyde interaction with carbon nanotubes and quartz sand

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Assessment of the potential impact of synthetic carbon nanotubes on the fate and transport of common chemical contaminants (pesticides, pharmaceuticals, etc.) in groundwater systems is considered to be an increasingly important aspect of environmental research. This study investigates the interaction of formaldehyde with multi-walled carbon nanotubes (MWCNTs) and quartz sand under static and dynamic conditions. Due to polarity, formaldehyde, is expected to develop strong adsorptive interactions with carbon nanotubes. Several batch adsorption experiments were conducted in test tubes, under controlled conditions. Various initial formaldehyde solution concentration (2, 5, 8 ppm), contact times, and temperatures (8, 18, 25 ºC) were considered. Supernatant liquid samples were collected at regular intervals, and centrifuged. Subsequently, the formaldehyde concentration in the supernatant was quantified indirectly, by derivatization with Nash reagent and subsequent measurement of the resulting complex using spectrophotometry in the visible spectral range. Experimental results suggested that formaldehyde has a low affinity for quartz sand, but an enhanced potential for adsorption onto carbon nanotubes. Formaldehyde adsorption onto both absorbents (quartz sand and MWCNTs) was more pronounced under dynamic than static conditions, probably, because agitation improves the mixing of the absorbent within the solution. Also, it was shown that the adsorption data were adequately described by the pseudo-second order kinetic model, suggesting that the primary adsorption mechanism was chemisorption, where two or more (sequential or parallel) processes (e.g. surface chemisorption, intraparticle diffusion) were taking place. Therefore, MWCNTs could be promising adsorbent materials for groundwater remediation.