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Magnetic Biomaterials for Removing Organic Pollutants from Wastewater

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Abstract : The adsorption process is one of the most efficient methods to remove pollutants from wastewater provided that suitable adsorbents are used. In order to produce environmentally safe adsorbents, natural polymers have received increasing attention in recent years. Thus, alginate and chitosane are extensively used as inexpensive, non-toxic and efficient biosorbents. Alginate is an anionic polysaccharide extracted from brown seaweeds. Chitosan is an amino-polysaccharide; this cationic polymer is obtained by deacetylation of chitin the major constituent of crustaceans. Furthermore, it has been shown that the encapsulation of magnetic materials in alginate and chitosan beads facilitates their recovery from wastewater after the adsorption step, by the use of an external magnetic field gradient, obtained with a magnet or an electromagnet. In the present work, we have studied the adsorption affinity of magnetic alginate beads and magnetic chitosan beads (called magsorbents) for methyl orange (MO) (an anionic dye), methylene blue (MB) (a cationic dye) and p-nitrophenol (PNP) (a hydrophobic pollutant). The effect of different parameters (pH solution, contact time, pollutant initial concentration…) on the adsorption of pollutant on the magnetic beads was investigated. The adsorption of anionic and cationic pollutants is mainly due to electrostatic interactions. Consequently methyl orange is highly adsorbed by chitosan beads in acidic medium and methylene blue by alginate beads in basic medium. In the case of a hydrophobic pollutant, which is weakly adsorbed, we have shown that the adsorption is enhanced by adding a surfactant. Cetylpyridinium chloride (CPC), a cationic surfactant, was used to increase the adsorption of PNP by magnetic alginate beads. Adsorption of CPC by alginate beads occurs through two mechanisms: (i) electrostatic attractions between cationic head groups of CPC and negative carboxylate functions of alginate; (ii) interaction between the hydrocarbon chains of CPC. The hydrophobic pollutant is adsolubilized within the surface aggregated structures of surfactant. Figure c shows that PNP can reach up to 95% of adsorption in presence of CPC. At highest CPC concentrations, desorption occurs due to the formation of micelles in the solution. Our magsorbents appear to efficiently remove ionic and hydrophobic pollutants and we hope that this fundamental research will be helpful for the future development of magnetically assisted processes in water treatment plants.

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