

Organic/Inorganic Adsorbents Based on Chitosan/MCM-48 for Removal of Heavy Metal Ions

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Extended Abstract

Recently, the application of biopolymers in solving environmental problems has received considerable attention (Ghaedi et al., 2013). Natural polymers, especially polysaccharides (typical examples, chitosan and alginate) that are readily available, inexpensive and biodegradable, possess numerous reactive amino groups able to participate in metal ion adsorption (Hritcu et al., 2012). To improve chitosan's performance as an adsorbent, cross-linking reagents such as glyoxal, formaldehyde, glutaraldehyde, epichlorohydrin, ethylene glycon diglycidyl ether and isocyanates have been used (Wan Ngaha W.S et al., 2011). The quality and characteristics of chitosan products, such as purity, viscosity, molecular weight, polymorphic structure and the degree of deacetylation may differ due to many factors in the production process, thereby affecting the nature of the final product (Radomski et al., 2014). Organic-inorganic hybrids are promising classes of materials whose structure includes both organic and inorganic units that interact with each other at the molecular level. Organic-inorganic hybrid polymers can be obtained through different ways: 1 - sol-gel process; 2 - self-assembly process; 3 - assembling or dispersion of nanobuilding blocks; 4 - hierarchical structures and 5 - interpenetrating networks (Samiey et al., 2014).

This paper describes the method of synthesis for the hybrid organic-inorganic polymeric based on chitosan reinforced with MCM-48 mesoporous silica functionalized with aminopropyltrimethoxysilane (APTMS), used for removal of divalent metal ions from wastewaters.

The MCM-48 mesoporous silica was functionalized using the post-synthesis way using ethyl alcohol as dispersion medium to which 10ml APTMS were added and subjected to magnetic stirring for 1h at room temperature for the reaction to occur. The solvent was removed in oven at 80°C.

The chitosan/MCM-48-APTMS composites were obtained in several stages. In this regard, chitosan with average molecular mass was dissolved in weakly acid medium under mechanical stirring, using a mixture of water and glacial acetic acid at pH=3 - 3.5. In the first stage a viscous 5% chitosan solution was obtained followed by subsequent dilution to 3 and 1%, respectively. A set of composite materials was obtained starting from 30 mL chitosan solution, 3% to which 0.9g MCM-48 functionalized with APTMS were added, according to calculations, followed by cross-linking with GA in the amount of 1% reported to the amount of chitosan existing in the solution (900µL GA solution in water, 1%). Another set of composites was obtained starting from chitosan solution, 1% to which 0.2 g MCM-48 functionalized with APTMS was added, cross-linked with 200µL of glutaraldehyde, 1%. The composite materials were freeze dried and tested for retention of divalent metal ions (Cu²⁺, Ni²⁺) from synthetic aqueous solutions by UV-VIS.

XRD confirms the synthesis of MCM-48 silica powder with cubic structure, and FTIR shows that the reaction with APTMS took place. The retention degree (Gr%) of bivalent Ni²⁺ and Cu²⁺ metal ions from synthetic aqueous solutions, in the case of using MCM-48-APTMS is 100% in the first 24 hours. In the case of using crosslinked chitosan, Gr% is 84 during an interval of 80h and in the case of using chitosan/MCM-48-APTMS composite, it is 87%.

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- Ghaedi, M., & Mosallanejad, N. (2013). Removal of Heavy Metal Ions from Polluted Waters by Using of Low Cost Adsorbents. *Journal of Chemical Health Risks*, 3(1), 07-22.
- Hritcu, D., Dodi, G., & Popa, M. I. (2012). Heavy Metal Ions Adsorption on Chitosan-Magnetite Microspheres. *International Review of Chemical Engineering*, 4, 364-368.
- Radomski, P., & Piatkowski, M. (2014). Application Of Chitosan And Its Modified Derivatives For Removing Of Heavy Metal Ions From Industrial Wastes. *Chemik*, 68, 1, 39–46.
- Samiey, B., Cheng, C.H., & Wu, J. (2014). Organic-Inorganic Hybrid Polymers as Adsorbents for Removal of Heavy Metal Ions from Solutions. *Materials*, 7, 673-726.
- Wan Ngaha, W.S., Teong, L.C., & Hanafiah, M.A.K.M. (2011). Adsorption Of Dyes And Heavy Metal Ions By Chitosan Composites: A Review. *Carbohydrate Polymers*, 83, 1446–1456.