Magnetic adsorbents – where are we head it?

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Global water pollution is one of the major problems facing the world today. Water can contaminated with a wide variety of chemicals, from heavy metal ions to pharmaceutical compounds, and research is aimed at improving the removal of harmful compounds from aqueous solutions. In addition to the many methods used in water purification is adsorption, which can accommodate low operating costs and easy maintenance of the material used as adsorbent. However, the effectiveness of the materials proposed for adsorption studies depends on experimental conditions, including pH, ionic strength, the presence of additional molecules, as well as contact time and adsorbent dose [1]. It is worth mentioning that one of the main environmental concerns related to the use of materials for adsorption of pollutants is ensuring that the adsorbed pollutants on the surface of the material do not get back into the environment during the adsorbent regeneration process [2].

Functional adsorbents including magnetic nanostructures and processed biomass are presented here and the results of their application in water purification are discussed. Both, magnetic and non-magnetic adsorbents were used to remove model pollutants like: crystal violet (CV), malachite green (MG) and methylene blue (MB). The effectiveness of the composite was compared to the literature and individual components of the functional nanostructures. The efficiency of the removal of dyes using nanostructural adsorbents was higher than 98% during the 2 hours for MG, MB, CV accordingly, where for carbon was close to 70% for CV. The effect of pH was studied, it confirmed that the adsorbent is stable and it has similar effectiveness of adsorption in the pH range 4 – 12. However, the ionic strength effect has an impact on the adsorption process for CV and MB, where the effectives decreasing to the 85%, therefore for MG ionic strength has not influence for adsorption process.

The effectiveness of the operation in highly saline environment also relates to the composition of used material. In the case of the incorporation of the magnetic nanostructures into the adsorbent the material applied for the water purification can be easily removed from the treated solutions through the magnetic separation and offers multiple cycles of operation. Application of highly acidic or alkali media can limit the operation of magnetic adsorbents reducing the pollutants removal effectiveness. Post-treated adsorbents can be reused in different fields including production of new composites.

References

[1] P. Pietrzyk-Thel, M. Osial, A. Pregowska, M. Ambramowicz, T. P. Nguyen, W. Urbańska and M. Giersig, "SPIONs doped with cobalt from the Li-ion battery acid leaching waste as a photocatalyst for tetracycline degradation – synthesis, characterization, DFT studies, and antibiotic treatment," *Desalination and Water Treatment,* vol. 305, p. 155–173, 2023.

[2] M. Krajewski, P. Pietrzyk, M. Osial, S.-C. Liou and J. Kubacki, "Iron−Iron Oxide Core−Shell Nanochains as High-Performance," *Langmuir,* vol. 39, no. 23, pp. 8367-8377, 2023.