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Synthesis of ZnO-TiO_2/activated carbon (ACαZnO/TiO_2) nanoparticles and its application in adsorption of arsenic from aqueous media: study of isotherm and adsorption kinetics and optimization using response surface methodology-central composite design

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ABSTRACT

Arsenic contaminated water is a serious threat to human health. Therefore, the aim of this study was to use a new method of stabilization of ZnO/TiO_2 on activated carbon (I ZnO/TiO_2) for the effective removal of arsenic from aqueous solutions. In this experimental study, a container with a useful volume of 3.14 L (height of 40 cm and diameter of 10 cm) was used. For this purpose, four main factors including pH (3–11), nanosorbent dose (1–3 g/L), initial arsenic concentration (1–10 mg/L), and reaction time (30–300 min) as effective factors in the arsenic removal efficiency. The results showed that arsenic adsorption increased with increasing contact time, adsorbent dose, and decreasing pH and arsenic concentration. A quadratic model was selected to estimate the removal of arsenic by the adsorption process with the modified adsorbent under study. The linear regression coefficient (R^2) between experiments and different response values in the model for arsenic was >0.99. The optimal value for the studied variables was obtained for pH of 6.75, arsenic concentration of 9.76 mg/L, reaction time of 287.62 min, and nanosorbent dosage of 2.45 g/L. The maximum arsenic adsorption capacity under optimal conditions was predicted to be 4.53 mg/g. The results showed that the studied adsorbent for arsenic removal follows the Langmuir isotherm and quadratic kinetics ($R^2 > 0.99$). The results of this study showed that the adsorption process using nano-photocatalytic adsorbents of TiO_2 and ZnO has relatively high efficiency in arsenic adsorption and can be used as a suitable complementary treatment method for water and wastewater containing carcinogenic heavy metals such as arsenic.

Keywords: Adsorption process; Arsenic; ACαZnO/TiO_2 nanoparticles; Central composite design; Optimization; Aqueous solutions

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