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Performance of wastewater sludge modified with zinc oxide nanoparticles in the removal of methylene blue from aqueous solutions

Z. Noorimotlagh[a], R. Darvishi Cheshmeh Soltani[b], Gh. Shams Khorramabadi[c], H. Godini[c,*], M. Almasian[d]

[a]*Department of Environmental Health Engineering, School of Health, Ilam University of Medical Sciences, Ilam, Iran, Tel. +98 84 12235733; email: noorimotlagh.zahra@gmail.com (Z. Noorimotlagh)*
[b]*Department of Environmental Health Engineering, School of Health, Arak University of Medical Sciences, Arak, Iran, Tel. +98 9168561479; email: darvishi@arakmu.ac.ir (R. Darvishi Cheshmeh Soltani)*
[c]*Department of Environmental Health Engineering, School of Health, Lorestan University of Medical Sciences, Khorramabad, Iran, Tel. +98 9161619466; email: shams_lums@yahoo.com (Gh. Shams Khorramabadi), Tel. +98 9163611395, Tel./Fax: +98 6614208176; email: godini_h@yahoo.com (H. Godini)*
[d]*Department of the English Language, Lorestan University of Medical Sciences, Khorramabad, Iran, Tel. +98 9389270406; email: almasian2@gmail.com (M. Almasian)*

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ABSTRACT

The presence of chromogenic substances in water can potentially be carcinogenic and mutagenic, and thus, it may be hazardous to public health. This study was carried out with the objective of investigating the feasibility of using wastewater sludge, modified with zinc oxide nanoparticles, in the removal of the methylene blue (MB) dye from aqueous solution. The stabilization of nanoparticles onto the sludge was performed using the thermal method in order to increase the active adsorption surface. The effects of the operational parameters (including pH, contact time, MB dye concentration, and adsorbent dosage) on the adsorption of MB by the modified sludge were studied in batch mode. The sludge coated with zinc oxide nanoparticles had higher MB dye removal efficiency (%) than that of raw sludge. The MB adsorption amount (Q_e) increases with a reduction in the adsorbent dosage, an increase in pH, and an increase in the initial concentration of the MB dye. At equilibrium, the amount of MB dye adsorbed onto sludge coated with zinc oxide nanoparticles was 6.6 mg/g, while the amount of adsorbed MB dye onto raw sludge was 2.9 mg/g. The adsorption reached equilibrium after 120 min and the adsorption data fitted the Langmuir isotherm model ($R^2 = 0.99$). The modification of sludge with zinc oxide nanoparticles can provide an appropriate substance to function as the adsorbent in the removal of MB dye from aqueous solution.

Keywords: Adsorption; Zinc oxide nanoparticles; MB dye; Wastewater; Biological sludge

*Corresponding author.