EGU21-9142
https://doi.org/10.5194/egusphere-egu21-9142
EGU General Assembly 2021

Application of dimensional analysis in removal prediction of 2-[4-(dimethylamino) styryl]-1-methylpyridinium iodide dye using humic acid coated magnetic nanoparticle

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Numerous factors affect adsorption phenomena in solid–liquid systems. Critical factors are the sorbent dose and initial concentrations of the contaminants in the system. However, the combination of these two factors and their effects on removal prediction are largely unexplored. In this study, batch experiments were conducted to examine such effects on the adsorption of 2-[4-(dimethylamino) styryl]-1-methylpyridinium iodide cationic dye (2-ASP) in contaminated water to humic acid coated magnetic nanoparticles (HA-MNPs). Dimensional analysis and Buckingham's π theorem were subsequently used to assess the relationship between the sorbent dose, initial concentration, and percent removal. Results of dimensional analysis along with experimental data suggest that sorbent dose and sorbate concentration ratio are the main variables controlling sorption of dye on HA-MNPs. In conventional isothermal studies, the isotherm equations are developed based on experiments of one sorbent dose which cannot be generalized for all sorbent doses. In this study, a power function (Isotherm-like) model was obtained from the dimensional analysis that can describe precisely the sorption process of dye on HA-MNPs as a function of equilibrium concentration and sorbent dose ratio. Moreover, a relation is deduced for prediction of removal percent as a function of sorbent dose and initial concentration ratio with R^2 of 0.98.

Keywords: Remediation, Dimensional analysis, Isotherm-like model, Magnetic nanoparticle, Styryl pyridinium dyes, Water treatment