Fixed-bed adsorption of methylene blue by rice husk ash and rice husk/CoFe$_2$O$_4$ nanocomposite

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ABSTRACT

Rice husk ash (RHA) is a promising low-cost adsorbent. Meanwhile, the magnetic and catalytic capabilities of ferrite nanoparticles make it efficient for water purification. In this study, we prepared RHA and rice husk/CoFe$_2$O$_4$ composite (RHC) and studied their methylene blue (MB) adsorption capacities in fixed-bed columns. The column regeneration was also investigated. Both RHA and RHC are amorphous materials with Brunauer, Emmet and Teller (BET) surface area of >180 m^2 g^{-1} and mesopore volume of >0.1 cm^3 g^{-1}. The CoFe$_2$O$_4$ nanoparticles are mainly located on the inner surface of RHC, which significantly increased the mesopore volume and average pore size but decreased the BET surface area and micropore volume. The adsorption ability of RHC was investigated in a fixed-bed column, with RHA as control. The effects of column parameters including bed height, flow rate, and inlet MB concentration on breakthrough curves were studied. The mathematical models, such as bed-depth service time (BDST), Thomas, and Yoon–Nelson models were applied to predict the breakthrough curves. It was found that BDST model fitted the breakthrough curves best. Results showed that the breakthrough time of RHC is more than two times than that of RHA, which may be attributed to the catalytic performance of CoFe$_2$O$_4$ nanoparticles. The exhausted RHA and RHC were retreated by three methods and eluted of the column with ethanol caused the highest regeneration efficiency. In addition, fixed-bed tests of RHA and RHC on real dye wastewater demonstrated that these adsorbents have good practical value and application prospect.

Keywords: Rice hull; Methylene blue; Adsorption; Fixed-bed column; Ferrite

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