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Development of Nanoporous Iron Oxide-pillared Clay for Dye-containing Wastewater Treatment

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Extended Abstract

Pillared clays have attracted the attention as economic natural adsorbents for physicochemical treatment of textile industrial wastewater since they possess not only the lamellar structure with high surface area providing a large number of adsorption sites, but also good thermal stability for regeneration (Liu and Zhang, 2007, Molu and Yurdakoc, 2010, Gil et. al., 2011). In this research, high power ultrasonic has been used in order to accelerate the intercalation process for preparing the nanoporous iron(III) oxide-pillared montmorillonite (Fepill-MMT) adsorbent.

A starting solution of iron(III) acetate complex (FeCPX) was added into suspension of sodium montmorillonite (Na^+-MMT) and treated with high power ultrasonic for 15 min, resulting in the cation exchange between FeCPX cations and Na^+ balancing ions in the *001* plane of MMT interlayers. The FeCPX intercalated MMT was calcined at 500 ºC for 4 hrs in order to obtain the Fepill-MMT. Specific surface area of Fepill-MMT determined by the N_2-BET method was 96.2 m^2 g^{-1}. The XRD pattern revealed that the Fepill-MMT consisted of several interplanar spacing of *001* plane, corresponding to multiple pore sizes in the range of mesoporous (≈ 40 nm) and macroporous (≈ 200 nm), therefore, it possessed higher specific surface area and pore volume than the starting Na^+-MMT.

Adsorption capacity of Fepill-MMT was investigated using basic blue 66 (cationic dye) and acid red 91 (anionic dye) with initial dye concentration of 500 mg/L in batch adsorption system. The Fepill-MMT shows significantly high percentage of BB66 removal upto almost 100% when 0.5 g Fepill-MMT was loaded in 50 ml dye solution in 30-min contact time. In addition, when the Fepill-MMT loading was reduced to 0.05 g, the BB66 removal was about 95%, equaling to adsorption capacity of 950 mg/g. On the other hand, the percentage of AR91 removal was lower than 13%. It was; therefore, the AR91 removal system was achieved when the H_2O_2 or H_2O_2/UV was introduced into the treatment system together with the Fepill-MMT, acting as heterogeneous catalyst for Fenton or photo-Fenton oxidation processes, respectively. The percentages of AR91 removal in the Fenton and photo-Fenton systems were 68 and 80% respectively, in which they were significantly higher than that in the batch adsorption system.

It can be concluded that the high power ultrasonic could assist to create nanoporous Fepill-MMT in very short reaction time. The Fepill-MMT possesses multiple pore sizes, high surface area and catalytic activity, promoting its competency for treatment of wastewater containing both cationic and anionic organic molecules.

Acknowledgments

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