

Heat and ultrasound enhanced degradation of DB71 direct azo dyes using biotite-activated persulfate process

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Despite the abundance of Fe-content minerals, relatively little is studied regarding the use of it as persulfate (PS) activator in decontamination purposes. This study investigated the use of persulfate oxidation activated with biotite (BT/PS) for degradation of an azo dye Direct Blue 71, which is difficult to be oxidized biologically. Experimental results showed that either thermally activated PS or ultrasound-activated PS was barely effective in oxidizing DB17. However, PS activated with powdered biotite enabled true color of ADMI reducing from 12,480 to 4,505, which is due mainly to the production of $\text{SO}_4^{\cdot-}$ radicals in the process. When BT/PS coupled with a 20-min US (20 kHz, 88W/cm²) period, cavitation effect derived from US irradiation caused more Fe^{2+} releasing from biotite available for generating more $\text{SO}_4^{\cdot-}$ radicals, thereby drastically decreasing ADMI further to 480 within 40 min treatment. Complete decolorization achieved within 10 min in BT/PS that combined with heat (BT/PS/60°C). Results also indicated that the oxidation power of the PS/ Fe^0 process was determined by duration of US irradiation and reaction temperature. Based on the first-order decolorization rate constants, an activation energy (19.68 kcal/mol) was estimated, implying the BT/PS process is better performed at higher temperature for the DB71 decolorization. In process BT/PS/60°C, the DB71 was completely mineralized after 50 min based on the depletion of COD and the disappearance of aromatic groups of UV-vis spectra. The estimated operating cost of BT/PS/60°C in considering the cost of Na_2SO_8 and biotite is only 0.21 USD/m³ for treating elevated temperature of fresh dye effluent, indicating the practical effectiveness of the process. Completely achieving ADMI decolorization under an application of 20 min-US resulted in a substantial increase in electricity (2.76 USD/m³). This study demonstrates that biotite activated PS combined with either ultrasound and heat is a promising process for the treatment of fresh dye wastewater, in particular as containing DB71.

Keywords: Biotite, persulfate, direct azo dye, decolorization, ultrasound