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Sonolytic Decolourisation of Acid Red 88 Dye in the presence of Titanium Dioxide and some Rare Earths

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ABSTRACT

The decolourisation of Acid Red 88 (AR-88), in the presence of ultrasound (US), TiO_2 and rare earth (REs) ions (La^{+3}, Pr^{+3}, Gd^{+3}, Ce^{+3}) in the aqueous solution, has been examined in the dye concentration range from 24 –48 ppm. AR-88 was decolorized to about 97.19% in the presence of US+TiO_2+Gd in 40 min. The rate of decolourisation was estimated spectrophotometrically from the residual concentration of dye and found to decrease in the order, in systems comprising; US+TiO_2+Gd > US+TiO_2+La > US+TiO_2+Ce > US+TiO_2+Pr > US+TiO_2 > US+Gd > US+La > US+Ce > US+Pr >TiO_2>US. Adsorption behaviour has been analysed using Langmuir, Freundlich and Temkin adsorption isotherms. It was found that adsorption followed pseudo second order kinetics. The mechanism of dye adsorption process was determined from the Weber-Morris intraparticle diffusion and Boyd kinetic models. The decolourisation of dye was maximum in the presence of rare earths due to the enhancement of adsorption of dye on RE-TiO_2 as a result of a chemical complexation between RE and the dye, through the donation of non-bonding electron pair from the elements of dye to the vacant f-orbitals of RE and the subsequent transfer of the complex to the TiO_2 surface. In the presence of rare earth cations, the surface of TiO_2 particles, which was negatively charged, is mostly occupied with positively charged rare earth ions. Thus the adsorption of AR-88 was enhanced on the surface of TiO_2 through electrostatic attraction, resulting into sand witched structure between TiO_2, REs and Dye molecule. A detailed sonochemical degradation pathway has been suggested based on electro spray ionization mass spectrometry (ESI-MS).

Keywords: Ultrasound, Adsorption, Kinetics, TiO_2, Rare Earths.
