Enhancing decolorization of Eriochrome Blue Black R during nano-size zero-valent iron treatment using ultrasonic irradiation

Shokooh Sadat Khalooa,*, Shokoufeh Fattahib

Faculty of Health, Safety and Environment, Department of Science, Shahid Beheshti University of Medical Sciences, P.O. Box 16858-116, Tehran, Iran
Tel. +98 21 77309961 65; Fax: +98 21 77302969; email: sh_khaloo@sbmu.ac.ir

ABSTRACT

The effectiveness of nano-size zero-valent iron (NZVI) particles for treatment of Eriochrome Blue Black R (EBBR), a representative azo dye, under ultrasonic irradiation was determined. The influence of experimental variables such as, initial solution pH, NZVI dosage, irradiation time, initial dye, NaCl, and Na2CO3 concentrations on removal efficiency of color were investigated. It was found that the kinetic rate constant of sonocatalytic destruction of EBBR in presence of NZVI was significantly enhanced under acidic conditions. The degradation rate constants of dye increased by increasing of NZVI dose and irradiation time, but decreased by increasing the initial dye concentration. Although, increasing NaCl concentration from 0.1 to 1% (w/v) improved the kinetic removal rate from 0.16 to 0.29 min⁻¹ but, presence of Na2CO3 had no significant effect on the degradation rate. The UV–vis spectrum showed that complete decolorization of synthetic solutions contain 100 ppm EBBR by 0.3 g/L NZVI at initial pH solution 3, occurred at 20 min ultrasonic irradiation.

Keywords: Decolorization; Nano-size zero-valent iron; Eriochrome Blue Black R (EBBR)

1. Introduction

Azo dyes are synthetic organic dyes contain the azo chromophoric group (-N=N-). This divalent group is attached to sp2 hybridized carbon atoms on one side, to an aromatic or heterocyclic nucleus on the other; it may be linked to an unsaturated molecule of the carboxylic, heterocyclic, or aliphatic type. No natural dyes contain this chromophore. Commercially, the azo dyes are the largest and most versatile class of organic dyestuffs. There are more than 10,000 Color Index generic names assigned to commercial colorants, approximately 4,500 are in use and over 50% of these belong to the azo class [1]. Azo dyes are used in large quantities in several industries such as textile, paper, inks, leather, drug, and food processing. The effluents from these industries contain dyes and organic pollutants. Most of these dyes are carcinogenic, harmful, and reduce the light penetration in aqueous systems, therefore causing a disturbance in the natural growth activity of aquatic life. On the other hand, some of these dyes pass into drinking water and can cause damage to human life. Therefore, it is essential to remove these dyes from water or treat them in such a way to minimize the damage to the environment. Azo dyes resist aerobic and short-time