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Evaluation of integrated anaerobic/aerobic fixed-bed sequencing batch biofilm reactor for decolorization and biodegradation of azo dye Acid Red 18: Comparison of using two types of packing media

E. Hosseini Koupaie [a], M.R. Alavi Moghaddam [a,*], S.H. Hashemi [b]

[a] Civil and Environmental Engineering Department, Amirkabir University of Technology, Hafez Ave., Tehran 15875-4413, Iran
[b] Environmental Science Research Institute, Shahid Beheshti University, Tehran, Iran

HIGHLIGHTS

- ▶ Comparison of pumice stones and polyethylene media as biofilm support was performed.
- ▶ First-order decolorization kinetics with respect to dye concentration was observed.
- ▶ Detection and quantification of the dye metabolites by HPLC analysis were conducted.
- ▶ SEM analysis was used to investigate the attached-growth biofilm morphology.
- ▶ More than 92% of COD, 96% of dye and 63% of 1-naphthylamine-4-sulfonate was removed.

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ABSTRACT

Two integrated anaerobic/aerobic fixed-bed sequencing batch biofilm reactor (FB-SBBR) were operated to evaluate decolorization and biodegradation of azo dye Acid Red 18 (AR18). Volcanic pumice stones and a type of plastic media made of polyethylene were used as packing media in FB-SBBR1 and FB-SBBR2, respectively. Decolorization of AR18 in both reactors followed first-order kinetic with respect to dye concentration. More than 63.7% and 71.3% of anaerobically formed 1-naphthylamine-4-sulfonate (1N-4S), as one of the main sulfonated aromatic constituents of AR18 was removed during the aerobic reaction phase in FB-SBBR1 and FB-SBBR2, respectively. Based on statistical analysis, performance of FB-SBBR2 in terms of COD removal as well as biodegradation of 1N-4S was significantly higher than that of FB-SBBR1. Spherical and rod shaped bacteria were the dominant species of bacteria in the biofilm grown on the pumice stones surfaces, while, the biofilm grown on surfaces of the polyethylene media had a fluffy structure.

1. Introduction

Azo dyes account for more than 50% of all colorants used worldwide and are the most common synthetic dyes discharged into the environment (Meng et al., 2012). The release of azo dye-containing wastewaters not only can affect the transparency and aesthetic appearance of natural water, but also can obstruct sunlight penetration diminishing photosynthesis and oxygen solubility (Jonstrup et al., 2011; Meng et al., 2012). Previous researchers also proved that several azo dyes and their aromatic constituents can create serious environmental problems due to their toxicity, mutagenicity and carcinogenicity effects to aquatic life (De Arağao Umbuzeiro et al., 2005; Tan et al., 2005).

Several physicochemical methods such as coagulation/flocculation, electrolysis, adsorption, membrane filtration, ion-exchange, irradiation and advanced oxidation have been tested for removal of azo dyes from wastewaters (Singh and Arora, 2011). None, however, has appeared as a panacea, because most of these methods transfer contaminants into another phase rather than degrade them to less toxic and harmful products (Moussavi and Heidarizad, 2010). High energy consumption, expensiveness and generation of hazardous sludge which require safe disposal are other drawbacks of using these treatment methods (Pandey et al., 2007). As a result, biological processes have aroused interest due to their cost effectiveness, ability to produce less sludge, reliability and

* Corresponding author. Tel.: +98 912 2334600; fax: +98 21 66414213.
E-mail addresses: ehssan.hosseini.k@gmail.com (E. Hosseini Koupaie), alavi@aut.ac.ir, alavim@yahoo.com (M.R. Alavi Moghaddam), h_hashemi@sbu.ac.ir (S.H. Hashemi).

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