



Azo dye decolorization assisted by chemical and biogenic sulfide

Dorian Prato-García^a, Francisco J. Cervantes^b, Germán Buitrón^{a,*}

^a Laboratory for Research on Advanced Processes for Water Treatment, Unidad Académica Juriquilla, Instituto de Ingeniería, Universidad Nacional Autónoma de México, Blvd. Juriquilla 3001, Querétaro 76230, Mexico

^b División de Ciencias Ambientales, Instituto Potosino de Investigación Científica y Tecnológica, Camino a la Presa de San José 2055, San Luis Potosí 78216, Mexico

HIGHLIGHTS

- ▶ Azo dyes were reduced efficiently by chemical and biogenic sulfide.
- ▶ Biogenic sulfide was more efficient than chemical sulfide.
- ▶ There was no competition between dyes and sulfate for reducing equivalents.
- ▶ Aromatic amines barely affected the sulfate-reducing process.

ARTICLE INFO

Article history:

Received 13 September 2012

Received in revised form 12 February 2013

Accepted 13 February 2013

Available online 20 February 2013

Keywords:

Azo dye
Decolorization
Sulfate reduction
Sulfide

ABSTRACT

The effectiveness of chemical and biogenic sulfide in decolorizing three sulfonated azo dyes and the robustness of a sulfate-reducing process for simultaneous decolorization and sulfate removal were evaluated. The results demonstrated that decolorization of azo dyes assisted by chemical sulfide and anthraquinone-2,6-disulfonate (AQDS) was effective. In the absence of AQDS, biogenic sulfide was more efficient than chemical sulfide for decolorizing the azo dyes. The performance of sulfate-reducing bacteria in attached-growth sequencing batch reactors suggested the absence of competition between the studied azo dyes and the sulfate-reducing process for the reducing equivalents. Additionally, the presence of chemical reduction by-products had an almost negligible effect on the sulfate removal rate, which was nearly constant (94%) after azo dye injection.

© 2013 Elsevier B.V. All rights reserved.

1. Introduction

Dyes are a significant source of esthetic pollution and affect aquatic life; however, their recalcitrance makes their removal using conventional wastewater treatment plants difficult. Aromatic amines, produced as a result of anaerobic azo bond reduction, are potentially carcinogenic or mutagenic to humans [1]. Azo compounds account for approximately half of the over one million tons dyes produced annually, and it is estimated that between 5 and 50% of the used dye is lost in the effluent [2].

Azo dye decolorization is accomplished by a combination of biological and chemical processes [3–5]. The biological contribution most likely involves a co-metabolic mechanism for dye reduction, in which reducing equivalents and/or cofactors acting as electron donors are used to break the azo bond [4]. On the other hand, chemical reduction implies the use of reductants (sulfide, dithionate, cysteine, etc.) and redox mediators

(anthraquinone-2,6-disulfonate, anthraquinone-2-sulfonate, lawson, riboflavin) to reduce the azo bond [5].

The use of large volumes of water (150–450 L kg⁻¹ fiber), a highly variable organic load (20–100 g kg⁻¹ fiber), and the presence of inorganic salts (2–20 g SO₄²⁻ L⁻¹) have generated remarkable interest in the use of biological processes to address textile effluents [4,5]. The presence of sulfate in textile effluents may improve the performance of the decolorization process, considering that sulfide can in turn serve as an additional electron donor [3,6].

Sulfide and cofactors released by cell lysis can accelerate electron transfer through an abiotic pathway [7]. The decolorization of azo dyes under sulfate-reducing conditions may allow sulfate and dye reduction, which implies some advantages over methanogenic and fermentative consortia due to reduced use of electron donors and the simultaneous removal of heavy metals [8,9].

Several studies have shown the feasibility of biosulfidogenic, bioaugmented, and anaerobic mixed cultures for performing the reductive decolorization of dyes in serum bottles [6,7,10]. Under the tested conditions, dye decolorization and sulfate-reduction were achieved at a low rate (over a 48–190 h period), which may be related to the presence of inhibitory substances. Additionally, suspended and attached-growth methanogenic processes have been

* Corresponding author. Tel.: +52 4421926165.

E-mail address: gbuitronm@ii.unam.mx (G. Buitrón).