Desalination 258 (2010) 154–158

Contents lists available at ScienceDirect

Desalination

journal homepage: www.elsevier.com/locate/desal

Removal of Reactive Black 5 from aqueous solution by ozone for water reuse in textile dyeing processes

P. Colindres [a], H. Yee-Madeira [b], E. Reguera [a,c,*]

[a] Center of Applied Science and Advanced Technology, National Polytechnic Institute, Mexico, Legaria 694, Mexico DF, Mexico
[b] School of Physics and Mathematics, National Polytechnic Institute, Mexico, DF, Mexico
[c] Institute of Materials Science and Technology, University of Havana, Cuba

ARTICLE INFO

Article history:
Received 27 August 2009
Received in revised form 26 February 2010
Accepted 11 March 2010
Available online 10 April 2010

Keywords:
Ozonation
Reactive dye
Dyeing auxiliaries
Water reuse

ABSTRACT

The removal of textile dye Reactive Black 5 from aqueous solution by ozone until total decolorization using a semi-batch bubbling reactor was studied. This compound was selected because of its extended industrial application for cotton dyeing. Decomposition of that textile dye was observed by adding some chemical auxiliaries commonly used in textile dyeing processes such as sodium sulfate, sodium carbonate and sodium hydroxide, between the limits found in a normal dyehouse wastewater. The recording of UV–Vis spectra was used to evaluate the dye decomposition rate. The decomposition rate through this treatment depends on the presence of dyeing auxiliaries. Color disappears for 10 min of ozone treatment when auxiliaries are present. The treated water was then used in dyeing of cotton samples with a set of reactive dyes and direct dyes, separately, until 5 times without further salt addition, in order to evaluate the feasibility to reuse taking advantage of the present salt. For short times of solution ozonation, byproducts accumulation was observed by UV–Vis spectroscopy. The influence of byproducts generated during ozonation of dye solutions on the coloration quality of the water recirculation depends on the nature of dyes used in dyeing processes. The preservation of sodium ions, responsible for the zeta potential neutralization in dyeing process, was demonstrated using atomic absorption spectroscopy.

1. Introduction

Textile industry processes (dyeing, bleaching, printing and finishing) require large water consumption, generating great amount of wastewater. Typically from 200 to 500 L of water are needed to produce 1 kg of finished products [1]. Only the dyeing of 1 kg of cotton with reactive dyes demands from 70 to 150 L of water, 0.6–0.8 kg NaCl and from 30 to 60 g of dyestuffs. More than 80,000 tons of reactive dyes are produced and consumed each year, making it possible to quantify the total amount of pollution caused by their use [2]. Textile wastewater containing significant concentration of dyes causes serious treatment problems. Most of dye molecules have polyaromatic structures with high molecular weight containing nitrogen, sulfur and metals. Hence it is very difficult to biologically break them down and they cannot be treated efficiently by an activated sludge treatment or any combination of biological, chemical and physical methods [3]. Ozone destroys the conjugated chains of dye molecules that impart color [4–8]. From results reported by Maciejewska et al. [9], it may be concluded that the decolorization rate for textile dyes in acidic solution does not depend on the ozone decomposition to form radicals. In this particular case, only direct mechanism of ozonation could be present.

Wastewater reuse in the textile industry is necessary due to the high consumption during processes like printing, washing, dyeing, bleaching, soaking or finishing, among others [10].

Ozonation of spent dyebaths and model solutions of colorants, sometimes in order to their recycling, has been widely investigated [11–13].

In this study the textile dye Reactive Black 5 is decolorized and decomposed by simple ozonation in model solution, simulating a spent dyebath. This dye was selected because of its extended application in textile industry. Summary information about dye decomposition and decolorization processes was obtained by UV–Vis spectroscopy, from the absorbance variation in the 190–700 nm range. In order to study the effect of chemical dyeing auxiliaries on the ozonation process, model solutions were prepared adding typical concentrations found in a reactive spent dyebath of sodium sulfate, sodium carbonate and sodium hydroxide. These auxiliaries are commonly present in large amount in textile spent dyebaths from processes of dyeing using reactive dyes. Despite the demand of reactive dyes, they do currently have several noteworthy deficiencies as a group; these include generally low efficiency of fixation and large amount of salt are needed for their fixation [14], which also constitutes an environmental problem. In order to demonstrate the possibility of taking advantage of the salt present in a

* Corresponding author. Center of Applied Science and Advanced Technology, National Polytechnic Institute, Mexico, Legaria 694, Mexico DF, Mexico.
E-mail address: ereguera@yahoo.com (E. Reguera).

0011-9164/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.desal.2010.03.021