Radiation Physics and Chemistry 124 (2016) 203–207

Contents lists available at ScienceDirect

Radiation Physics and Chemistry

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

Enhancement of biodegradability of real textile and dyeing wastewater by electron beam irradiation

Shijun He [a], Weihua Sun [b], Jianlong Wang [a,c,*], Lvjun Chen [b], Youxue Zhang [d], Jiang Yu [d]

[a] Collaborative Innovation Center for Advanced Nuclear Energy Technology, INET, Tsinghua University, Beijing 100084, PR China
[b] School of Environment, Tsinghua University, Beijing 100084, PR China
[c] Beijing Key Laboratory of Radioactive Waste Treatment, INET, Tsinghua University, Beijing 100084, PR China
[d] Jiangsu Dasheng Electron Accelerator Device Co., Ltd. Suzhou, Jiangsu 215214, PR China

HIGHLIGHTS

- Irradiation pre-treatment did not improve the raw textile wastewater biodegradability.
- Irradiation can highly enhance the biodegradability of biological treated effluent.
- EB irradiation can be used as a post-treatment after biological process.

ARTICLE INFO

Article history:
Received 29 September 2015
Received in revised form
25 November 2015
Accepted 30 November 2015
Available online 2 December 2015

Keywords:
Dyeing wastewater
Irradiation
Biodegradability
Wastewater treatment
Advanced oxidation processes

ABSTRACT

A textile and dyeing wastewater treatment plant is going to be upgraded due to the stringent discharge standards in Jiangsu province, China, and electron beam irradiation is considering to be used. In order to determine the suitable location of the electron accelerator in the process of wastewater treatment plant, the effects of electron beam (EB) irradiation on the biodegradability of various real wastewater samples collecting from the different stages of the wastewater treatment plant, the values of chemical oxygen demand (COD), biochemical oxygen demand (BOD_5), and the ratio of BOD_5 and COD (BOD_5/COD), were compared before and after EB irradiation. During EB irradiation process, color indices and absorbance at 254 nm wavelength (UV_{254}) of wastewater were also determined. The results showed that EB irradiation pre-treatment cannot improve the biodegradability of raw textile and dyeing wastewater, which contains a large amount of biodegradable organic matters. In contrast, as to the final effluent of biological treatment process, EB irradiation can enhance the biodegradability to 224%. Therefore, the promising way is to apply EB irradiation as a post-treatment of the conventional biological process.

1. Introduction

The textile and dyeing wastewater is one of the largest pollution sources in Jiangsu Province, China. It was estimated that about 400,000 m^3/year industrial wastewater dumped into the receiving rivers and lakes. The effluents from this industry may cause scum formation, thermal impacts, color problems, and loss of esthetic beauty in the environment. Fig. 1 showed the existing treatment train for the textile and dyeing wastewater in Wujiang, Jiangsu Province, China. By means of conventional physical–chemical processes (i.e. dissolved air flotation, coagulation/flocculation, sedimentation, etc.) and biological processes, the COD value of the initial raw wastewater could be successfully decreased from 330 mg/L to 60 mg/L in the final effluent. However, stringent discharge standards were introduced in January, 2015, in which COD and color indices would be ordered less than 30 mg/L and 20 times, respectively. Therefore, a more advanced purification process is needed to comply with the new pollution control requirements.

For this reason, chemical coagulation/flocculation, activated carbon adsorption (Yeh et al., 2002) and membrane filtration (Metivier-Pignon et al., 2003) are proposed as possible alternatives to improve the quality of textile and dyeing wastewater. However, these methods proved to be less efficient to decompose the stable dyes, in many cases pollutants only transfer from one phase to another phase. On the other hand, advanced oxidation processes (AOPs), including ozonation (Bertanza et al., 2013; Fernando et al., 1997a; Tabrizi et al., 2011), Fenton and Fenton-like reaction (Lucas and Peres, 2006; Papadopoulos et al., 2007; Teixeira et al., 2005),

* Corresponding author at: Beijing Key Laboratory of Radioactive Waste Treatment, INET, Tsinghua University, Beijing 100084, PR China.
E-mail address: wangjl@tsinghua.edu.cn (J. Wang).

http://dx.doi.org/10.1016/j.radphyschem.2015.11.033
0969-806X/

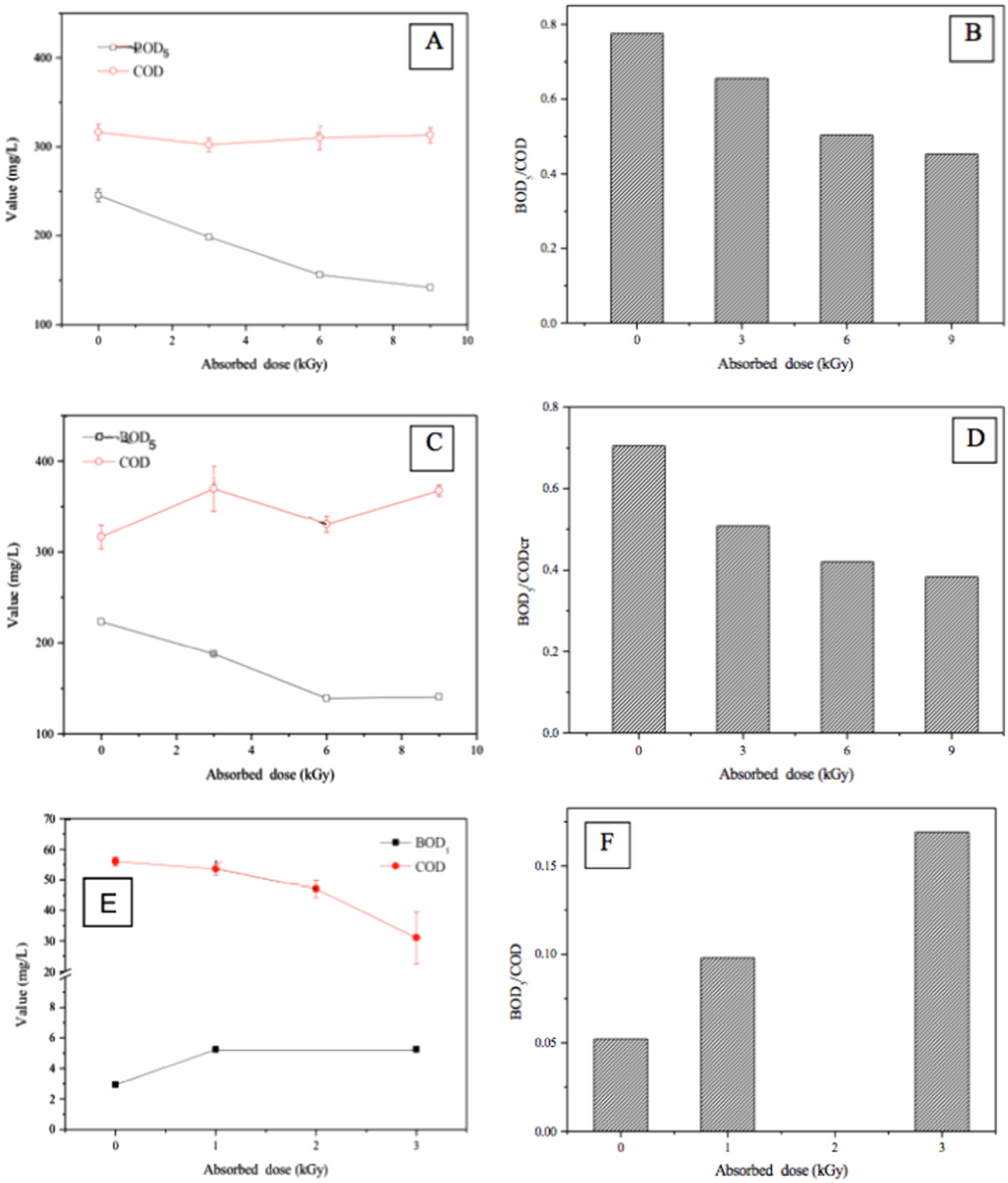

Fig. 1. Variation of the biodegradability of different wastewater sample after EB irradiation. The initial raw wastewater before (A) and after (B) irradiation; the wastewater collecting form the primary sedimentation before (C) and after (D) irradiation; the biologically treated wastewater before (E) and after (D) irradiation.

photocatalysis (Bandala et al., 2008; Fernando et al., 1997b) and plasma (Tichonovas et al., 2013) have been studied for the tertiary treatment of textile and dyeing wastewater. The ionizing radiation process (including gamma ray and electron beam irradiation) also belongs to the AOPs family (Wang and Wang, 2007; Wang and Xu, 2012), which has been widely used for the degradation of chlorophenols (Hu et al., 2006; Hu and Wang, 2007; Xue and Wang, 2008), nitrophenols (Yu et al., 2010), and pharmaceutical and personal care products (PPCPs) (Liu and Wang, 2013; He et al., 2014; Liu et al., 2014). A number of researches have been conducted at bench-scale and pilot-scale textile and dyeing wastewater treatment (Duarte and Sampa, 2000; Solpan and Guven, 2002, 2003; Sun et al., 2013). However, relatively few researches had investigated the effect of ionizing radiation on the biodegradability of real industrial wastewater (Bae et al., 1993; Wang et al.,1994; Zhao and Owen, 2001; Sun et al., 2012). In general, EB