Clean Techn Environ Policy
DOI 10.1007/s10098-013-0649-8

ORIGINAL PAPER

An integrated approach for enhanced textile dye degradation by pre-treatment combined biodegradation

Sivarajan Meenatchisundaram · Murugan Devaraj · Chockalingam Lajapathi Rai · Kathiravan Mathur Nadarajan

Received: 30 January 2013 / Accepted: 7 June 2013

Abstract The wastewater released by the textile industries affects aquatic, plant and human life. Though there are many conventional wastewater treatment techniques, interest on coupled treatment methods has increased in the recent times owing to their increased efficiency. In the present study, the textile wastewater was pre-treated by three different techniques, viz. sonication, photocatalysis and ozonation. Increasing the treatment time increased the biological oxygen demand to chemical oxygen demand (BOD/COD) ratio, and thus the biodegradability was about 0.6–0.73. Effluent pre-treated by photocatalysis showed relatively higher biodegradability compared to ozonation and sonication. The degradation of aromatic compounds due to pre-treatment was substantiated by Fourier transform infrared (FTIR) and proton nuclear magnetic resonance (^{1}H NMR) spectroscopy. Since pre-treatment increased the biodegradability of the effluents, further biological degradation using acclimatized sludge biomass resulted in COD removal efficiencies 94, 91 and 82 %, respectively, for photocatalysis, sonication and ozonation. The morphology of the organisms which played a major role during the degradation of pre-treated effluent was examined under scanning electron microscope (SEM).

Keywords Aerobic processes · Biodegradation · Integrated processing · Wastewater treatment · Pre-treatment

S. Meenatchisundaram · M. Devaraj · C. Lajapathi Rai (✉)
Chemical Engineering Division, CSIR - Central Leather Research Institute, Adyar, Chennai 600 020, India
e-mail: clrai@hotmail.com

K. M. Nadarajan
Department of Environmental Engineering, Chosun University, Gwangju, People Republic of Korea

Introduction

Textile effluent stream contains organic matters, dyes and synthetic chemicals that pollute the ground water and nearby water bodies when let out without proper treatment. As a consequence, dissolved oxygen content gets reduced and eco system in the water bodies are affected (Mandal et al. 2010). This problem may be highly important to address in future due to ever growing population and increasing number of industries. The developments in wastewater treatment systems are aimed at modifications which can enhance the contaminants removal efficiency. Many studies have reported advanced oxidation process (AOP) approach as a more viable option due to various reasons. Its applicability in the treatment of effluents containing a mixture of different dyes, efficient removal of organic matters, better reduction of odour and colour are few reasons to mention (Kuo 1992; Kang and Chang 1997; Alaton and Teksoy 2007; Srinivasan et al. 2012). The biodegradability (BOD/COD) of the dyes has been reported to improve by Fenton's and induced-Fenton's reactions (Tekin et al. 2006). Microorganisms can thereby take part in the COD level reduction of various industrial effluents. In particular, chemolithotropic bacteria have been found to play a vital role in treating the wastewater under aerobic conditions (Brock and Madigan 1998). This proves that AOP reduces the toxic level and subsequently allows bacteria to feed on the effluent, thereby improving its biodegradability. A study combining photo-Fenton and biological treatment on model and actual industrial wastewater shows different results regarding coupling strategies for different wastewaters (Malato et al. 2007; Zapata et al. 2008). Biological hybrid technologies have been reported to be the most promising techniques that can efficiently eliminate the pesticides and reduce organic content and COD in the wastewater (Oller et al. 2011). In addition, various

Published online: 26 June 2013