Chemical Engineering Journal 213 (2012) 118–124

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

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

Biological treatment of hexanitrostilbene (HNS) produced wastewater using an anaerobic–aerobic immobilized microbial system

Guo-hua Liu [a,b], Zhengfang Ye [a,*], Haoyang Li [a,c], Ran Che [a,c], Lili Cui [a]

[a] Department of Environmental Engineering, Peking University, The Key Laboratory of Water and Sediment Sciences, Ministry of Education, Beijing 100871, China
[b] School of Environment & Natural Resource, Renmin University of China, Beijing 100872, China
[c] The Key Laboratory of Urban Human Residential Environmental Science and Technology, Shenzhen Graduate School, Peking University, Shenzhen 518055, China

HIGHLIGHTS

- A pilot bioreactor system was used to treat actual hazardous wastewater.
- The nitroaromatic compounds could be almost completely mineralized by the system.
- More than 80% of pyridine could be removed by aerobic process of the system.
- The order *Rhizobiales* group was found to be one novel type of pyridine degrader.

ARTICLE INFO

Article history:
Received 26 March 2012
Received in revised form 19 September 2012
Accepted 22 September 2012
Available online 11 October 2012

Keywords:
HNS wastewater
Pyridine
Aromatic compounds
Immobilized microbial technology

ABSTRACT

Hexanitrostilbene (HNS) produced wastewater containing complex organic components was subjected to treatment with immobilized bacterial anaerobic–aerobic bioreactor system. After the biological treatment, the chrominance and pungent pyridine odor of the wastewater decreased greatly. The GC–MS analysis of the treated effluent showed that the nitroaromatic compounds like nitrobenzene and dinitrobenzene were almost completely mineralized, and more than 80% of pyridine was removed. Bacterial community analysis revealed that the *Pseudomonas* group that inhabited the anaerobic filter played a key role in degrading aromatic compounds, while *Rhizobiales* group found in aerated filter was mainly responsible for the removal of pyridine. This result suggested that bacteria such as *Agrobacterium* sp., *Ensifer adhaerens* and *Mesorhizobium* sp. affiliated with the order *Rhizobiales* group may be one novel type of pyridine degraders under aerobic condition. The study may be useful for pretreatment of actual explosive production industry wastewater loaded with high concentration toxic organic components.

1. Introduction

2,2′,4,4′,6,6′-Hexanitrostilbene (HNS) is an important heat-resistant explosive, which can withstand temperature up to 300–325 °C [1,2]. It is also insensitive to impact and electrostatic spark and thus has been widely used in the aerospace and military fields. However, wastewater with high chromaticity and chemical oxygen demand (COD) can be produced during its synthesis and purification processes. The HNS produced wastewater is composed mainly of pyridine and its derivatives, as well as some nitroaromatic compounds (NACs) that are acutely toxic and mutagenic [3–5]. Pyridine is an N-heterocyclic aromatic compound with pungent odor, and has potential applications in manufacturing of dyes, explosives, pesticides and pharmaceuticals [6]. Direct discharge of untreated HNS wastewater may severely contaminate soil and water systems, and also make the organic pollutants hazardous to the health of both humans and wildlife [7]. Therefore, treatment of such wastewater using a suitable approach is necessary before discharging into the environment.

Physico-chemical methods including advanced oxidation [8–10], adsorption [11,12], and incineration, have been widely used for treatment of wastewater containing pyridine or the NACs. However, these methods have been limited due to high cost, energy intensive and incomplete solution to the pollution problem [8,13]. Recently, biological processes have become popular in degrading toxic organic compounds as they are cost-effective and highly efficient [13]. Especially, immobilized cell technology has received considerable attention in the removal of waste organic matters [14], such as oil [15], phenol [16], and dimethyl-sulfoxide [17]. The present study aimed to examine the feasibility and capacity of treatment for the HNS produced wastewater using an anerobic–aerobic immobilized microbial system, as well as explore a suitable biological process for treating the explosive wastewater.

* Corresponding author. Tel.: +86 10 62755914; fax: +86 10 62756526.
E-mail address: yezhengfang@iee.pku.edu.cn (Z. Ye).

1385-8947/$ - see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.cej.2012.09.115