

JES

JOURNAL OF
ENVIRONMENTAL
SCIENCES

ISSN 1001-0742
CN 11-2629/X

2013 Volume 25 Supplement
www.jesc.ac.cn

The 5th International Symposium on Environmental Economy and Technology



Sponsored by
Research Center for Eco-Environmental Sciences
Chinese Academy of Sciences

CONTENTS

The 5th International Symposium on Environmental Economy and Technology (ISEET-2012): Preface	
Dong-Ying Ju	S1
Improvement of production of lipopeptide antibiotic iturin A using fish protein	
Umme Salma Zohora, Mohammad Shahedur Rahman, Abdul Wahab Khan, Masahiro Okanami, Takashi Ano	S2
Determination of vanillin in vanilla perfumes and air by capillary electrophoresis	
Saaya Minematsu, Guang-Shan Xuan, Xing-Zheng Wu	S8
Economic analysis of gradual "social exhaustion" of waste management capacity	
Hideo Koide, Hirofumi Nakayama	S15
Determinants of eco-efficiency in the Chinese industrial sector	
Hidemichi Fujii, Shunsuke Managi	S20
Study on preparation and microwave absorption property of the core-nanoshell composite materials doped with La	
Liqu Wei, Ruxin Che, Yijun Jiang, Bing Yu	S27
Application of hinokitiol potassium salt for wood preservative	
Junyi Hu, Yu Shen, Song Pang, Yun Gao, Guoyong Xiao, Shujun Li, Yingqian Xu	S32
Synthesis and characteristic of polyaniline/Dy ₂ O ₃ composites: Thermal property and electrochemical performance	
Shaoyu Wang, Yan Li, Zihang Huang, Hui Li	S36
Numerical simulation of alga growth and control in Dalian Bay	
Ying Li, Caisheng Huang, Jiti Zhou	S41
Simultaneous preconcentration of cadmium and lead in water samples with silica gel and determination by flame atomic absorption spectrometry	
Hongbo Xu, Yun Wu, Jian Wang, Xuewei Shang, Xiaojun Jiang	S45
Effect of stress corrosion cracking at various strain rates on the electrochemical corrosion behavior of Mg-Zn-In-Sn alloy	
Zhan Yu, Dongying Ju, Hongyang Zhao	S50
Study on the optical property and surface morphology of N doped TiO ₂ film deposited with different N ₂ flow rates by DCPMS	
Honglin Liu, Tingting Yao, Wanyu Ding, Hualin Wang, Dongying Ju, Weiping Chai	S54
Preparation of MgO/B ₂ O ₃ coatings by plasma spraying on SUS304 surface and effects of heat-resistant	
Bo Song, Ningning Zhou, Dongying Ju	S59
Degradation mechanism of Direct Pink 12B treated by iron-carbon micro-electrolysis and Fenton reaction	
Xiquan Wang, Xiaokang Gong, Qiuxia Zhang, Haijuan Du	S63
Synthesis and characterization of agricultural controllable humic acid superabsorbent	
Lijuan Gao, Shiqiang Wang, Xuefei Zhao	S69
Electrochemical in situ regeneration of granular activated carbon using a three-dimensional reactor	
Hong Sun, Zhigang Liu, Ying Wang, Yansheng Li	S77
Photocatalytic degradation of C. I. Reactive Red 24 solution with K ₆ SiW ₁₁ O ₃₉ Sn ^{II}	
Guixiang Guo, Xiuhua Zhu, Fuyou Shi, Anning Wang, Wei Wang, Jun Mu, Quanli Wan, Rong Zhang	S80
Microalgae cultivation using an aquaculture wastewater as growth medium for biomass and biofuel production	
Zhen Guo, Yuan Liu, Haiyan Guo, Song Yan, Jun Mu	S85
Determination of thiocyanate in the vacuum carbonate desulfurization wastewater	
Luyuan Wang, Lin Dong, Wenhui Song	S89
Effect of acid solutions on plants studied by the optical beam deflection method	
Liangjiao Nie, Mitsutoshi Kuboda, Tomomi Inoue, Xingzheng Wu	S93
Synthesis of the starch grafting of superabsorbent and high oil-absorbing resin	
Zhi Xu, Qingzhi Fei, Xiaoyu Zhang	S97
Effect of calcium on adsorption capacity of powdered activated carbon	
Gang Li, Junteng Shang, Ying Wang, Yansheng Li, Hong Gao	S101
Interface-mediated synthesis of monodisperse ZnS nanoparticles with sulfate-reducing bacterium culture	
Zhanguo Liang, Jun Mu, Ying Mu, Jiaming Shi, Wenjing Hao, Xuewei Dong, Hongquan Yu	S106
Influence of reactivation on the electrochemical performances of activated carbon based on coconut shell	
Xin Geng, Lixiang Li, Meiling Zhang, Baigang An, Xiaoming Zhu	S110
Effect of mass fraction of long flame coal on swelling pressure and microstructures of cokes	
Zhenning Zhao, Jinfeng Bai, Jun Xu, Yaru Zhang, Xiangyun Zhong, Hongchun Liu, Dekai Yang	S118
Screening of endophytic bacteria against fungal plant pathogens	

Tatsuya Ohike, Kohei Makuni, Masahiro Okanami, Takashi Ano	S122
Isolation of antifungal bacteria from Japanese fermented soybeans, natto	
Daichi Murata, Sayaka Sawano, Tatsuya Ohike, Masahiro Okanami, Takashi Ano	S127
Evaluation of the water quality of the Hakata River based on diatoms	
Masami Sakai, Mitsuyasu Kawakami, Kei Amada	S132
Entrepreneur environment management behavior evaluation method derived from environmental economy	
Lili Zhang, Xilin Hou, Fengru Xi	S136
Catalytic activities of zeolite compounds for decomposing aqueous ozone	
Ai KUSUDA, Mikito KITAYAMA, Yoshio OHTA	S141
Nitrogen and phosphorus removal in an airlift intermittent circulation membrane bioreactor	
Haiyan Guo, Jiandong Chen, Yun Li, Tengfeng Feng, Shoutong Zhang	S146
Electroreductive dechlorination of chlorophenols with Pd catalyst supported on solid electrode	
Caixia, Atsushi Matsunaga, Meguru Tezuka	S151
Quantitative analysis of microbial biomass yield in aerobic bioreactor	
Osamu Watanabe, Satoru Isoda	S155
Chemical constituents of <i>Prunella vulgaris</i>	
Xiaojie Gu, Youbin Li, Jun Mu, Yi Zhang	S161
Decolorization of oxygen-delignified bleaching effluent and biobleaching of oxygen-delignified kraft pulp by non-white-rot fungus <i>Geotrichum candidum</i> Dec 1	
Noboru Shintani, Makoto Shoda	S164
Overexpression of NADH oxidase gene from <i>Deinococcus geothermalis</i> in <i>Escherichia coli</i>	
Sase Kazuya, Iwasaki Tomomi, Karasaki Hatsune, Ishikawa Masahide	S169
Modeling the current-voltage characteristics of thin-film silicon solar cells based on photo-induced electron transfer processes	
Satoru Isoda	S172
Degradation of monofluorophenols in water irradiated with gaseous plasma	
Haiming Yang, Giya Mengen, Yuki Matsumoto, Meguru Tezuka	S180
Research on the evolvement of morphology of coking coal during the coking process	
Xiangyun Zhong, Shiyong Wu, Yang Liu, Zhenning Zhao, Yaru Zhang, Jinfeng Bai, Jun Xu, Bai Xi	S186
Effects of atamp-charging coke making on strength and high temperature thermal properties of coke	
Yaru Zhang, Jinfeng Bai, Jun Xu, Xiangyun Zhong, Zhenning Zhao, Hongchun Liu	S190
Enriching blast furnace gas by removing carbon dioxide	
Chongmin Zhang, Zhimin Sun, Shuwen Chen, Baohai Wang	S196
Removement of thiocyanate from industrial wastewater by microwave-Fenton oxidation method	
Bai Xi, Qingzhong Shi	S201
Effect of bulk density of coking coal on swelling pressure	
Jinfeng Bai, Chunwang Yang, Zhenning Zhao, Xiangyun Zhong, Yaru Zhang, Jun Xu, Bai Xi, Hongchun Liu	S205



Electrochemical *in situ* regeneration of granular activated carbon using a three-dimensional reactor

Hong Sun, Zhigang Liu*, Ying Wang, Yansheng Li

School of Environmental & Chemical Engineering, Dalian Jiaotong University, Dalian 116028, China

Abstract

Electrochemical *in situ* regeneration of granular activated carbon (GAC) saturated with phenol was experimentally investigated using a three-dimensional electrode reactor with titanium filter electrode arrays. The feasibility of the electrochemical regeneration has been assessed by monitoring the regeneration efficiency and chemical oxygen demand (COD). The influence of the applied current, the effluent flow rate, and the effluent path of the electrochemical cell have been systematically studied. Under the optimum conditions, the regeneration efficiency of GAC could reach 94% in 2 hr, and no significant declination was observed after five-time continuous adsorption-regeneration cycles. The adsorption of organic pollutants was almost completely mineralized due to electrochemical oxidation, indicating that this regeneration process is much more potentially cost-effective for application.

Key words: granular activated carbon; electrochemical regeneration; phenol; three-dimensional

Introduction

As an adsorbent with specific surface area, pore structure and surface functional groups, granular activated carbon (GAC) has been widely used for removing organic compounds in water and wastewater (Wang and Balasubramanian, 2009). During the use of GAC, the porosity becomes progressively saturated and inactive. It would not only be uneconomic but also bring environmental pollution if the exhausted GAC is subjected for landfill. Therefore, the regeneration of GAC has gained greater attention, especially carbon saturated with organic pollutants such as phenol (Zhang, 2002; Weng and Hsu, 2008). There are many well-established techniques used to regenerate GAC including extractive regeneration, thermal regeneration, wet air oxidation and chemical regeneration. However, these methods are either too expensive or have low efficiency (Bercic et al., 1998; Leng and Pinto, 1996).

Electrochemical regeneration methods are alternative strategies that have attracted less attention in the past decades. This technique presents some advantages compared to the conventional methods. Essentially, it can be conveniently operated at ambient temperature and pressure, with low energy consumption and with short time requirements. Moreover, it can allow the recovery, modification of organic pollutants into less hazardous compounds or even complete mineralization without additional chemicals (Berenguer et al., 2010; Narbaitz and Karimi-

Jashni, 2009; Zhou and Lei, 2006).

In this article electrochemical *in situ* regeneration of GAC saturated with phenol was experimentally investigated using a three-dimensional electrode reactor with titanium filter electrode arrays. The feasibility of the electrochemical regeneration was assessed by monitoring the regeneration efficiency and chemical oxygen demand (COD). The influence of the applied current, the electrolysis time, the electrolyte concentration and the effluent path of the electrochemical cell were also evaluated.

1 Materials and methods

1.1 Materials

The GAC with a specific surface area of 900 m²/g and an average pore diameter of 2.00 nm was purchased from Tianjin Kermel Chemical Reagent Co., Ltd. (Tianjin, China). GAC samples were washed several times with distilled water and dried in an oven at 105°C for 2 days to a constant weight prior to the experimentation. The phenol wastewater in the experiment was prepared dissolving phenol in distilled water with 1.0 g/L Na₂SO₄.

All other reagents used in the experiment are of analytical grade and used without further purification.

1.2 Apparatus and procedure

The regeneration experiments of GAC were carried out in a three-dimensional reactor that designed in our lab-

* Corresponding author. E-mail: lzg@djtu.edu.cn

oratory with a net working volume of 750 cm³ (Fig. 1). The cylindrical reactor was constructed from polymethylmethacrylate and titanium filter electrodes with regular polygon staggered, which were cylinders of 0.6 cm internal diameter and 30–50 μm apertures. A known amount of exhausted GAC was fixed in the reactor. The electric power was supplied with regulated DC power supply (WSA-H 100V/30A, Shenzhen, China).

The fresh GAC was saturated with 2.00 g/L phenol solution by counter flow the GAC bed to a constant concentration of the outlet phenol at room temperature. The saturated GAC was regenerated by 1.0 g/L Na₂SO₄ solution counter flow the GAC bed in an electric field. The adsorption-regeneration cycle was repeated.

1.3 Analysis and calculation

The analytical determination of phenol was carried out using UV-spectrophotometer (Unico, model UV-2102PCS) by analyzing the color resulting from reaction of phenol with 4-aminoantipyrine at maximum wavelength 500 nm. The COD value of all solutions and samples were determined according to standard methods (Fochedey and Lierde, 2002). The saturated adsorption values of phenol before and after regeneration were analyzed to calculate the regeneration efficiency. The regeneration efficiency was computed comparatively to the saturated adsorption of fresh GAC under the same equilibrium solution concentration.

2 Results and discussion

2.1 Effect of electric current

Different electric current was applied to investigate the electrochemical regeneration of GAC (Fig. 2). It was found that the regeneration efficiency increased with increasing electric current. The maximum regeneration efficiency was from 90% to 98% for the electric current of 1.0 to 3.0 A. The results indicated that the effect of the apparent electric current on the regeneration efficiency was insignificant

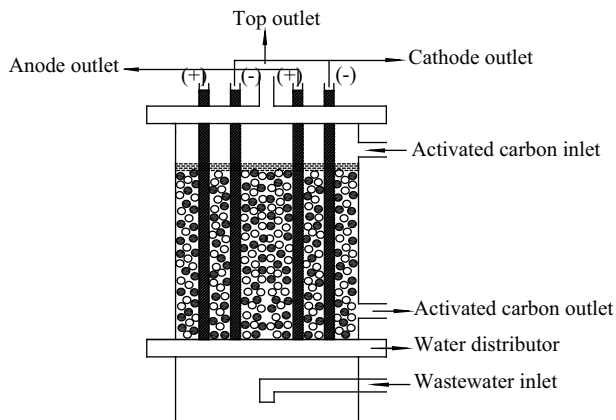


Fig. 1 Schematic diagram of the three-dimensional electrode reactor.

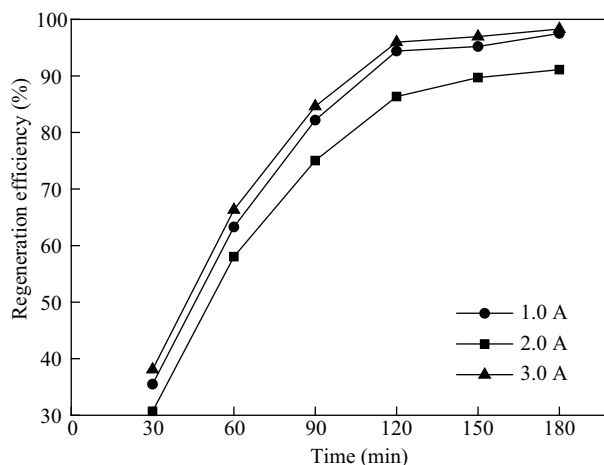


Fig. 2 Effects of electric current on regeneration performance. Experimental conditions: Na₂SO₄ concentration 1 g/L, effluent flow rate of 20 mL/min and top effluent.

when the apparent electric current exceeded 2.0 A. Since the consumption of electric energy increased with the electric current, the best applied current in this system was 2.0 A when the accepted regeneration efficiency and the energy consumption were considered simultaneously.

2.2 Effect of effluent flow rate

In general the Na₂SO₄ and NaCl solutions were chosen as a supporting electrolyte for electrochemical oxidation of organic compounds. But the highly toxic intermediates may be generated in using the latter. Therefore, 1.0 g/L Na₂SO₄ solution was select as the effluent in electrochemical regeneration of GAC. The effect of effluent flow rate on the regeneration process is shown in Fig. 3. At the electric current 2.0 A, the maximum values of electrochemical regeneration under the effluent flow rate of 5, 20 and 30 mL/min were about 94%, 97% and 99%, respectively. The higher flow rate caused higher regeneration efficiency, but higher flow rate increase the amount of phenol in the

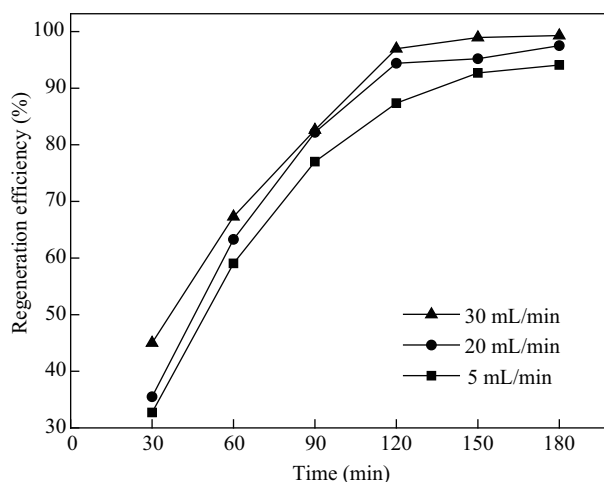


Fig. 3 Effects of flow rate on regeneration performance. Experimental conditions: Na₂SO₄ concentration 1g/L, electric current of 2.0 A and top effluent.

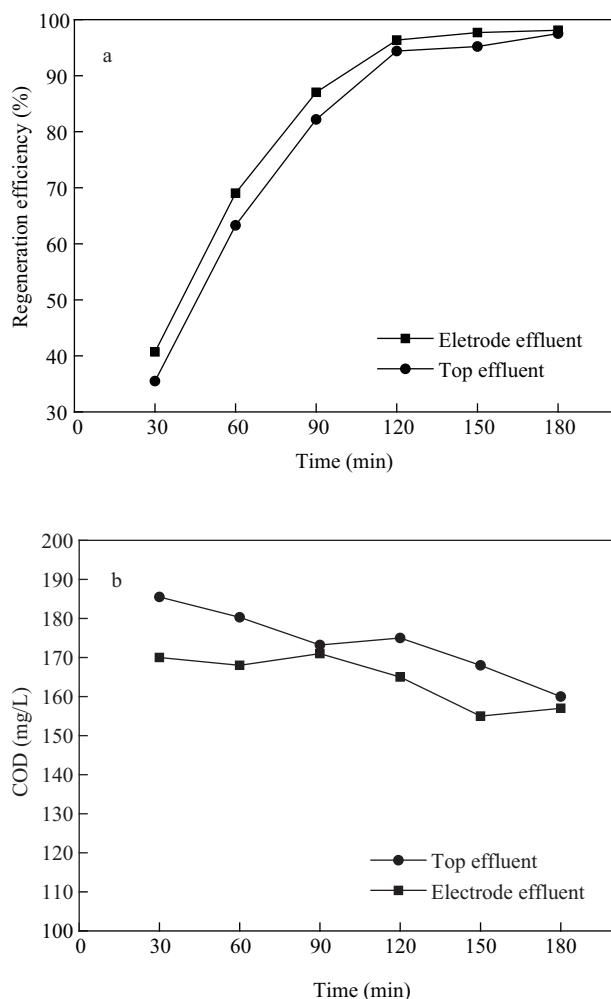


Fig. 4 Effects of effluent path on regeneration efficiency (a) and COD values (b). Experimental conditions: Na_2SO_4 concentration 1 g/L, electric current of 2.0 A and effluent flow rate of 20 mL/min.

effluent because of part of phenol being rushed out of the reactor instead of being oxidized. Thus, the optimal flow rate is 20 mL/min.

2.3 Comparison of the top and anode effluent

The regeneration efficiency by the top effluent was compared with that by the anode as shown in **Fig. 4a**. The two tests were carried out under the same experimental conditions at Na_2SO_4 concentration 1 g/L, electric current 2.0 A and flow rate 20 mL/min. For the top effluent, the regeneration efficiency was lower than that of the electrode in initial stage of the experiment, while with the time increase, the efficiency was consistency.

But it was found that COD value of the top effluent was lower than that of electrode effluent (**Fig. 4b**), which illuminated the more phenol was mineralized by the electrode effluent.

2.4 Effect of adsorption-regeneration cycles

Under the optimum conditions, the GAC regeneration efficiencies after 1, 2, 3, 4, 5 times adsorption-regeneration cycles were 94.4%, 93.2%, 91.2%, 90.8%, and 91.0%, respectively. No significant declination was observed after five-time continuous adsorption-regeneration cycles.

3 Conclusions

Electrochemical *in situ* regeneration of GAC saturated with phenol was experimentally investigated using a three-dimensional electrode reactor with titanium filter electrode arrays. Under the optimum conditions of electric current 2.0 A, flow rate of the electrolyte 20 mL/min, the regeneration efficiency of GAC could reach 94% in 2 hr, and no significant declination was observed after five-times continuous adsorption-regeneration cycles. The adsorption of organic pollutants was almost completely mineralized due to electrochemical oxidation, indicating this regeneration process is much more potentially cost-effective for application.

References

- Berčić G, Pintar A, Levec J, 1996. Desorption of phenol from activated carbon by hot water regeneration: desorption isotherms. *Industrial & Engineering Chemistry Research*, 35(12): 4619–4625.
- Berenguer R, Marco-Lozar J P, Quijada C, Cazorla-Amorós D, Morallón E, 2010. Electrochemical regeneration and porosity recovery of phenol-saturated granular activated carbon in an alkaline medium. *Carbon*, 48(10): 2734–2745
- Fochedey E, Lierde A V, 2002. Coupling of anodic and cathodic reactions for phenol electro-oxidation using three-dimensional electrodes, *Water Research*, 36(16): 4169–4175.
- Leng C C, Pinto N G, 1996. An investigation of the mechanisms of chemical regeneration of activated carbon. *Industrial & Engineering Chemistry Research*, 35(6): 2024–2031.
- Narbaitz R M, Karimi-Jashni A, 2009. Electrochemical regeneration of granular activated carbons loaded with phenol and natural organic matter. *Environmental Technology*, 30(1): 27–36.
- Wang L Z, Balasubramanian N, 2009. Electrochemical regeneration of granular activated carbon saturated with organic compounds. *Chemical Engineering Journal*, 155(3): 763–768
- Weng C H, Hsu M C, 2008. Regeneration of granular activated carbon by an electrochemical process. *Separation and Purification Technology*, 64(2): 227–236
- Zhang H P, 2002. Regeneration of exhausted activated carbon by electrochemical method. *Chemical Engineering Journal*, 85(1): 81–85.
- Zhou M H, Lei L C, 2006. Electrochemical regeneration of activated carbon loaded with p-nitrophenol in a fluidized electrochemical reactor. *Electrochimica Acta*, 51(21): 4489–4496.

Editorial Board of Journal of Environmental Sciences

Editor-in-Chief

Hongxiao Tang Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, China

Associate Editors-in-Chief

Jiuhui Qu Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, China

Shu Tao Peking University, China

Nigel Bell Imperial College London, United Kingdom

Po-Keung Wong The Chinese University of Hong Kong, Hong Kong, China

Editorial Board

Aquatic environment

Baoyu Gao

Shandong University, China

Maohong Fan

University of Wyoming, USA

Chihpin Huang

National Chiao Tung University

Taiwan, China

Ng Wun Jern

Nanyang Environment & Water Research Institute, Singapore

Clark C. K. Liu

University of Hawaii at Manoa, USA

Hokyong Shon

University of Technology, Sydney, Australia

Zijian Wang

Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, China

Zhiwu Wang

The Ohio State University, USA

Yuxiang Wang

Queen's University, Canada

Min Yang

Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, China

Zhifeng Yang

Beijing Normal University, China

Han-Qing Yu

University of Science & Technology of China

Terrestrial environment

Christopher Anderson

Massey University, New Zealand

Zucong Cai

Nanjing Normal University, China

Xinbin Feng

Institute of Geochemistry, Chinese Academy of Sciences, China

Hongqing Hu

Huazhong Agricultural University, China

Kin-Che Lam

The Chinese University of Hong Kong

Hong Kong, China

Erwin Klumpp

Research Centre Juelich, Agrosphere Institute Germany

Peijun Li

Institute of Applied Ecology, Chinese Academy of Sciences, China

Michael Schloter

German Research Center for Environmental Health Germany

Xuejun Wang

Peking University, China

Lizhong Zhu

Zhejiang University, China

Atmospheric environment

Jianmin Chen

Fudan University, China

Abdelwahid Mellouki

Centre National de la Recherche Scientifique France

Yujing Mu

Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, China

Min Shao

Peking University, China

James Jay Schauer

University of Wisconsin-Madison, USA

Yuesi Wang

Institute of Atmospheric Physics, Chinese Academy of Sciences, China

Xin Yang

University of Cambridge, UK

Environmental biology

Yong Cai

Florida International University, USA

Henner Hollert

RWTH Aachen University, Germany

Jaе-Seong Lee

Hanyang University, South Korea

Christopher Rensing

University of Copenhagen, Denmark

Bojan Sedmak

National Institute of Biology, Ljubljana

Lirong Song

Institute of Hydrobiology, the Chinese Academy of Sciences, China

Chunxia Wang

National Natural Science Foundation of China

Gehong Wei

Northwest A & F University, China

Daqiang Yin

Tongji University, China

Zhongtang Yu

The Ohio State University, USA

Environmental toxicology and health

Jingwen Chen

Dalian University of Technology, China

Jiaying Hu

Peking University, China

Guibin Jiang

Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, China

Sijin Liu

Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, China

Tsuyoshi Nakanishi

Gifu Pharmaceutical University, Japan

Willie Peijnenburg

University of Leiden, The Netherlands

Bingsheng Zhou

Institute of Hydrobiology, Chinese Academy of Sciences, China

Environmental catalysis and materials

Hong He

Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, China

Junhua Li

Tsinghua University, China

Wenfeng Shangguan

Shanghai Jiao Tong University, China

Yasutake Teraoka

Kyushu University, Japan

Ralph T. Yang

University of Michigan, USA

Environmental analysis and method

Zongwei Cai

Hong Kong Baptist University, Hong Kong, China

Jiping Chen

Dalian Institute of Chemical Physics, Chinese Academy of Sciences, China

Minghui Zheng

Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, China

Municipal solid waste and green chemistry

Pinjing He

Tongji University, China

Environmental ecology

Rusong Wang

Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, China

Editorial office staff

Managing editor Qingcai Feng

Editors Zixuan Wang Suqin Liu Zhengang Mao

English editor Catherine Rice (USA)

JOURNAL OF ENVIRONMENTAL SCIENCES

环境科学学报(英文版)
(<http://www.jesc.ac.cn>)

Aims and scope

Journal of Environmental Sciences is an international academic journal supervised by Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences. The journal publishes original, peer-reviewed innovative research and valuable findings in environmental sciences. The types of articles published are research article, critical review, rapid communications, and special issues.

The scope of the journal embraces the treatment processes for natural groundwater, municipal, agricultural and industrial water and wastewaters; physical and chemical methods for limitation of pollutants emission into the atmospheric environment; chemical and biological and phytoremediation of contaminated soil; fate and transport of pollutants in environments; toxicological effects of terrorist chemical release on the natural environment and human health; development of environmental catalysts and materials.

For subscription to electronic edition

Elsevier is responsible for subscription of the journal. Please subscribe to the journal via <http://www.elsevier.com/locate/jes>.

For subscription to print edition

China: Please contact the customer service, Science Press, 16 Donghuangchenggen North Street, Beijing 100717, China. Tel: +86-10-64017032; E-mail: journal@mail.sciencep.com, or the local post office throughout China (domestic postcode: 2-580).

Outside China: Please order the journal from the Elsevier Customer Service Department at the Regional Sales Office nearest you.

Submission declaration

Submission of an article implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis), that it is not under consideration for publication elsewhere. The submission should be approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out. If the manuscript accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder.

Submission declaration

Submission of the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis), that it is not under consideration for publication elsewhere. The publication should be approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out. If the manuscript accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder.

Editorial

Authors should submit manuscript online at <http://www.jesc.ac.cn>. In case of queries, please contact editorial office, Tel: +86-10-62920553, E-mail: jesc@263.net, jesc@rcees.ac.cn. Instruction to authors is available at <http://www.jesc.ac.cn>.

Journal of Environmental Sciences (Established in 1989)

Vol. 25 Supplement 2013

Supervised by	Chinese Academy of Sciences	Published by	Science Press, Beijing, China
Sponsored by	Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences		Elsevier Limited, The Netherlands
Edited by	Editorial Office of Journal of Environmental Sciences P. O. Box 2871, Beijing 100085, China Tel: 86-10-62920553; http://www.jesc.ac.cn E-mail: jesc@263.net , jesc@rcees.ac.cn	Distributed by	Domestic Science Press, 16 Donghuangchenggen North Street, Beijing 100717, China Local Post Offices through China Foreign Elsevier Limited http://www.elsevier.com/locate/jes
Editor-in-chief	Hongxiao Tang	Printed by	Beijing Beilin Printing House, 100083, China
CN 11-2629/X	Domestic postcode: 2-580		Domestic price per issue RMB ¥ 110.00

ISSN 1001-0742

