

# 环境工程学报

HUANJING GONGCHENG XUEBAO

月刊 1980 年创刊

2022 年 5 月 第 16 卷 第 5 期

主管 中国科学院

主办 中国科学院生态环境研究中心

主编 刘俊新

编辑 《环境工程学报》编辑部

北京市海淀区双清路 18 号

邮政编码 100085

电话/传真 010-62941074

E-mail cjee@rcees.ac.cn

网址 www.cjee.ac.cn

出版 科学出版社

北京东黄城根北街 16 号

邮政编码 100717

印刷装订 北京科信印刷有限公司

国内发行

中国邮政集团有限公司北京市报刊发行局

出版日期 每月 26 日

国际标准连续出版物号 ISSN 1673-9108

国内统一连续出版物号 CN 11-5591/X

国内外公开发行

国内邮发代号 82-448

国内定价 150.00 元

订阅 全国各地邮局

科学出版社期刊发行处

电话 010-64017032, 64017539

## Chinese Journal of Environmental Engineering

Monthly Started in 1980

Vol.16 No.5 May 2022

Supervised by Chinese Academy of Sciences

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

Editor-in-Chief LIU Junxin

Edited by The Editorial Board of Chinese  
Journal of Environmental Engineering

Published by Science Press  
16 Donghuangchenggen North Street  
Beijing 100717, China

Printed by Beijing Kexin Printing Co., Ltd.

Foreign Distributed by China National  
Publishing Industry Trading Corporation  
(CNPITC)

P.O.Box 782, Beijing 100011, China

# 目次

## 研究综述

- 1407 有机污染场地原位热脱附工程尾水尾气的处理技术进展  
籍龙杰,沈宗泽,刘鹏,迟克宇,郭丽莉,李书鹏,秦之瑞,岳勇,  
韩自玉,焦文涛

## 水污染防治

- 1416 磁性污泥基生物炭对  $Pb^{2+}$  的吸附性能  
郭可心,田佳一,孙煜璨,林若汐,龚迎莉,杨婷,陈坦,褚玉群
- 1429 ZnFe-LDHs 改性粉煤灰对模拟废水中镉离子的吸附性能  
刘博伟,张长平,李秀仙,龚焱,王晓欧,王相,孙优善
- 1440 双波长紫外 ( $UV_{185}/UV_{254}$ ) 直接光降解有机染料的效能及反应  
机制  
耿聪,赵志伟,徐鑫栋,梁志杰,高维春,梁吉艳
- 1451 镉铁负载给水厂污泥复合材料在完全混合式反应器中的动态吸  
附除磷特征  
刘文芬,王毅力,刘晨阳,李小林,仝瑶,周妍卿
- 1459 倒极长寿命的  $Ti/RuO_2-IrO_2-RhO_x$  电极对氨氮废水的处理效能  
张月,金华长,陈雪明
- 1469 微气泡催化臭氧深度处理制药废水的效果及 DOM 组分特性  
的变化  
张静,杨旭,康帆,刘春,吕少岩,刘苗奇,庞勃
- 1480 海藻酸钠固定硫酸盐还原菌、镍-铁纳米粒子生物微球对污水中  
 $Cd^{2+}$  的去除  
何蕊,康志超,朱国鹏,王琪荣,于洪文
- 1490 新型旋流式涡流空化器的流场仿真及该空化器对废水中土霉素  
的去除效果  
王宝娥,张日红,李义勇,练晓明,余梓鹏
- 1497 强化混凝-平板折转错流超滤工艺处理脱墨废水  
吴月,何沛然,张健,魏宁,张忠国,张凤山,程洪顺
- 1506 硅酸盐-磷酸盐对酸法地浸采铀退役采区模拟地下水的修复  
张琪,马建洪,张丹,张悦,谭国焱,胡南,张辉,丁德馨
- 1516 室内模拟地表 PRB 处理离子型稀土矿区尾水  
王军锋,陈明,王玉荣,王兴祥,周志高
- 1525 基于 AQUATOX 模型的集装箱养殖尾水净化塘生态系统模拟及  
调控预测  
冯丽娟,肖耿锋,程香菊,谢骏,舒锐
- 1537 外加植物碳源强化人工湿地处理农田退水效能分析  
卢兴顺,丁晓宇,林岩,吕航,武琳慧
- 1549 漫水河清远流域磷污染特征及富里酸对沉积物释磷的影响  
黄镁宁,宁寻安,张建易,邱国强,谢江玮,庄小薇

## 大气污染防治

- 1558 BiOBr/RGO/硅藻土复合催化剂的制备及其在可见光条件下催化  
降解甲醛气体  
令玉林,周建红,安俊霖,曾伯平,肖菡曦,肖焯,戴友芝
- 1569 Pt-CuMnCeO<sub>x</sub>/堇青石微波催化燃烧 VOCs 性能  
张继宾,卜龙利,陈瑾,张丹庆,田野,任帅康,鲁香港,代菁雯

- 1579 2种制备方法对 Pt/Co-Ce 催化氧化甲苯性能的影响  
刘艺,宋浩,刘少俊,吴卫红,郑成航
- 1589 多孔收尘电极电场中荷电粒子的沉降规律及其除尘性能预测  
张金龙,党小庆,乐文毅,冯晓峰,刘明坤,李世杰,于欣,郑华春,  
王赫

### 土壤污染防治

- 1602 高效铈氧化菌的筛选鉴定及其对土壤中铈迁移转化的影响  
李姍颖,张立鑫,李梅
- 1610 燃气热脱附技术土壤修复效果及影响因素  
陈俊华,李绍华,刘晋恺,詹明秀,岳勇
- 1620 铝酸盐材料对镉污染土壤的稳定化修复及其机理  
沈连峰,陆夏梓,贾睿琪,李璞,吕正勇,姚晨,赵艳阳,郭虹好,  
李烜楨

### 固体废物处理与资源化

- 1629 混气悬浮磁化焙烧铁尾矿及其磁分选效果  
李日文,宁寻安,沈君华,何晓,王逸
- 1639 木屑生物质热解制备高还原性气体机理  
谢鸿智,宁寻安,邱国强,邓金环
- 1649 铁路隧道弃渣的本地资源化利用  
严志伟,刘大刚,赵大铭,王众乐

### 环境生物技术

- 1657 生物电化学措施下 SBBR 中的亚硝酸盐累积性能及微生物学特征  
潘玲阳,余昕洁,夏渝,赵子健,刘燕燕,李刚,王振
- 1668 两级 ANAMMOX 串联快速启动后置反应器的性能及机理  
王晓瞳,杨宏,王佳伟
- 1681 UASB 处理高硫酸盐二元酸废水的效果及硫化物控制技术  
王庆宏,余静诗,付信格,梁家豪,王鑫,詹亚力,陈春茂

### 生态修复工程

- 1691 乌梁素海水体富营养化原位生态修复实验及效果分析  
李根东,周改芳,谷仙,吴茹茹,刘美珍
- 1702 景观湖泊黑臭水体生态修复措施和效果——以武汉市金湖生态  
修复工程为例  
王子健,胡婧,张晨,阙红明,刘洋,黄冰冰
- 1713 北方滨海人工湿地水生生物群落重建效果评估——以天津临  
港湿地二期生态重建工程为例  
李艳英,顾修君,周滨,田杰,刘红磊
- 1721 基于微生物载体技术的沟渠生态修复治理体系的构建及工程  
应用  
马莹,孙鹏,许占军,康红勃,张盛华,孙亚刚,韦仁杰

### 环境监测技术

- 1730 新型吡啶鎓盐分子的合成及其对  $Fe^{3+}$  的检测  
陈红硕
- 1737 水体中 27 种有机磷阻燃剂 (OPFRs) 的检测及风险评价  
韩超,梁存珍,高欲乾,关东
- 1748 加油站油气回收系统 VOCs 泄漏 FID 现场检测方法及其效果分析  
冯雨钦,刘扬,刘畅通,刘泽华,王佩,张锦龙

## 《环境工程学报》

### 第 3 届编辑委员会

#### 指导委员会委员

曲久辉 郝吉明 张全兴  
任南琪 侯立安 张远航  
贺泓 张福锁 马军

#### 主 编

刘俊新

#### 副主编

王晓昌 崔福义 李金惠  
高宝玉 刘会娟 王爱杰

#### 编 委 (以姓氏笔画为序)

王凯军 王洪臣 王跃思 仇荣亮  
吕锡武 全 燮 刘双江 刘勇弟  
刘维屏 孙德智 李玉友 李爱民  
杨 敏 何 强 何品晶 余 刚  
宋存义 张付申 陈 卫 陈少华  
陈光浩 陈嘉平 季 民 金 波  
周 琪 单保庆 赵勇胜 郝晓地  
俞汉青 党 志 徐向阳 黄 勇  
曾光明 解跃峰

#### 编委会秘书

张利田 金曙光

#### 编辑部主任

张利田

#### 副 主 任

郑晓梅

#### 学术编辑

郑晓梅 靳 炜  
金曙光 曲 娜

#### 校对出版

郑晓梅

#### 特邀编辑

王毅力 刘振刚  
豆小敏 杨晓芳  
宋冀营

#### 终审终校

张利田

#### 制 图

邵 鑫

#### 封面设计

北京中科幻彩动漫  
科技有限公司

#### 排 版

北京仁和汇智信息  
技术有限公司

## CONTENTS

- 1407 **Progress in the treatment of tail water and gas generated by in-situ thermal desorption of organic contaminated sites**  
JI Longjie, SHEN Zongze, LIU Peng, CHI Keyu, GUO Lili, LI Shupeng, QIN Zhirui, YUE Yong, HAN Ziyu, JIAO Wentao
- 1416 **Adsorption performance of magnetic sludge-derived biochar towards Pb<sup>2+</sup>**  
GUO Kexin, TIAN Jiayi, SUN Yucan, LIN Ruoxi, GONG Yingli, YANG Ting, CHEN Tan, ZHUO Yuqun
- 1429 **Adsorption performance of ZnFe-LDHs modified fly ash to cadmium ions in simulated wastewater**  
LIU Bowei, ZHANG Changping, LI Xiuxian, GONG Yan, WANG Xiaou, Wang Xiang, SUN Youshan
- 1440 **Efficacy and mechanism of direct photodegradation of organic dyes by dual-wavelength ultraviolet (UV<sub>185</sub>/UV<sub>254</sub>) irradiation**  
GENG Cong, ZHAO Zhiwei, XU Xindong, LIANG Zhijie, GAO Weichun, LIANG Jiyan
- 1451 **Dynamic phosphorus removal from aqueous solutions by lanthanum/iron-loaded drinking water treatment residues in a continuous stirred tank reactor**  
LIU Wenfen, WANG Yili, LIU Chenyang, LI Xiaolin, TONG Yao, ZHOU Yanqing
- 1459 **Treatment performance of Ti/RuO<sub>2</sub>-IrO<sub>2</sub>-RhO<sub>x</sub> electrode with a long polarity inverted lifetime on ammonia nitrogen wastewater**  
ZHANG Yue, JIN Huachang, CHEN Xueming
- 1469 **Performance of advanced treatment of pharmaceutical wastewater by microbubble catalytic ozonation and component variation characteristics of dissolved organic matter**  
ZHANG Jing, YANG Xu, KANG Fan, LIU Chun, LV Shaoyan, LIU Miaoqi, PANG Bo
- 1480 **Removal of Cd<sup>2+</sup> in sewage by sodium alginate immobilized sulfate-reducing bacteria and nickel-iron nanoparticle biological microspheres**  
HE Rui, KANG Zhichao, ZHU Guopeng, WANG Qirong, YU Hongwen
- 1490 **Flow field simulation in a novel swirling vortex cavitator and its performance on oxytetracycline removal from wastewater**  
WANG Baoc, ZHANG Rihong, LI Yiyong, LIAN Xiaoming, SHE Zipeng
- 1497 **Deinking wastewater treatment by a hybrid process of enhanced coagulation and flat-plate ultrafiltration in turn-around cross-flow mode**  
WU Yue, HE Peiran, ZHANG Jian, WEI Ning, ZHANG Zhongguo, ZHANG Fengshan, CHENG Hongshun
- 1506 **Remediation effect of silicate-phosphate on simulated groundwater in the decommissioned mining area of acid in situ leach uranium mining**  
ZHANG Qi, MA Jianhong, ZHANG Dan, ZHANG Yue, TAN Guochi, HU Nan, ZHANG Hui, DING Dexin
- 1516 **Indoor simulation of surface PRB treating tailwater in ionic rare earth mining area**  
WANG Junfeng, CHEN Ming, WANG Yurong, WANG Xingxiang, ZHOU Zhigao
- 1525 **Simulation and regulation prediction of container aquaculture wastewater-ponds ecosystem based on AQUATOX model**  
FENG Lijuan, XIAO Gengfeng, CHENG Xiangju, XIE Jun, SHU Rui
- 1537 **Analysis on the efficiency of a constructed wetland treating agricultural drainage water by adding plant carbon sources**  
LU Xingshun, DING Xiaoyu, LIN Yan, LV Hang, WU Linhui
- 1549 **Characteristics of phosphorus pollution in Manshui River and the effects of fulvic acid on phosphorus release from sediments**  
HUANG Meining, NING Xunan, ZHANG Jianyi, QIU Guoqiang, XIE Jiangwei, ZHUANG Xiaowei
- 1558 **Fabrication of BiOBr/RGO/diatomite and its photocatalytic degradation performance of formaldehyde gas under visible light**  
LING Yulin, ZHOU Jianhong, AN Junlin, ZENG Boping, XIAO Hanxi, XIAO Ye, DAI Youzhi
- 1569 **Application of Pt-CuMnCeO<sub>x</sub>/Cordierite catalyst in microwave catalytic combustion of VOCs**  
ZHANG Jibin, BO Longli, CHEN Jin, ZHANG Danqing, TIAN Ye, REN Shuaikang, LU Xianggang, DAI Jingwen
- 1579 **Effects of two preparation methods on the performance of Pt/Co-Ce catalytic oxidation of toluene**  
LIU Yi, SONG Hao, LIU Shaojun, WU Weihong, ZHENG Chenghang
- 1589 **Sedimentation law of charged particles in electric field of porous dust collecting electrode and prediction of dust removal performance**  
ZHANG Jinlong, DANG Xiaoqing, YUE Wenyi, FENG Xiaofeng, LIU Mingkun, LI Shijie, YU Xin, ZHENG Huachun, WANG He
- 1602 **Isolation and identification of a high efficiency antimony oxidizing bacterium and its effect on the migration and transformation of antimony in soil**  
LI Shanying, ZHANG Lixin, LI Mei
- 1610 **Soil remediation effect and influencing factors of gas thermal desorption technology**  
CHEN Junhua, LI Shaohua, LIU Jinkai, ZHAN Mingxiu, YUE Yong
- 1620 **Stabilization and remediation of Cadmium contaminated soil by Aluminate and its mechanisms**  
SHEN Lianfeng, LU Xiazi, JIA Ruiqi, LI Pu, LYU Zhengyong, YAO Chen, ZHAO Yanyang, GUO Hongyu, LI Xuanzhen
- 1629 **Recycling Fe<sub>3</sub>O<sub>4</sub> from iron tailings via suspension magnetized roasting by mixed gas and magnetic separation**  
LI Riwen, NING Xunan, SHENG Junhua, HE Yao, WANG Yi
- 1639 **Mechanism of pyrolysis of sawdust biomass to produce highly reducing gas**  
XIE Hongzhi, NING Xun-an, QIU Guoqiang, DENG Jinhuan
- 1649 **Study on key technologies of green and efficient utilization of huge abandoned slag of railway tunnel**  
YAN Zhiwei, LIU Dagang, ZHAO Daming, WANG Zhongle
- 1657 **Accumulation performances of nitrite and associated microbiological characteristics in a sequencing batch biofilm reactor assisted by bioelectrochemical technology**  
PAN Lingyang, YU Xinjie, XIA Yu, ZHAO Zijian, LIU Yanyan, LI Gang, WANG Zhen
- 1668 **Performance and mechanism analysis of two-stage ANAMMOX in series to realize fast start-up of post reactor**  
WANG Xiaotong, YANG Hong, WANG Jiawei
- 1681 **Treating effect of dicarboxylic acids wastewater with high sulfate content by UASB and the sulfite control technology**  
WANG Qinghong, YU Jingshi, FU Xinge, LIANG Jiahao, WANG Xin, ZHAN Yali, CHEN Chunmao
- 1691 **Experiment study and effect analysis of in situ ecological restoration for eutrophication in Wuliangsu Lake, China**  
LI Gendong, ZHOU Gaifang, GU Xian, WU Ruru, LIU Meizhen
- 1702 **Ecological restoration measures and effects of black and odorous water bodies in landscape lakes—Taking Jinhu ecological restoration project in Wuhan city as an example**  
WANG Zijian, HU Jing, ZHANG Chen, KAN Hongming, LIU Yang, HUANG Bingbing
- 1713 **Evaluation on the ecological reconstruction of aquatic communities in the coastal constructed wetland of northern China: A case study of Tianjin Lingang constructed wetland (phase II)**  
LI Yanying, GU Xiujun, ZHOU Bin, TIAN Jie, LIU Honglei
- 1721 **Construction and engineering application of canal ecological restoration and treatment based on microbial carrier technology**  
MA Ying, SUN Peng, XU Zhanjun, KANG Hongbo, ZHANG Shenghua, SUN Yagang, WEI Renjie
- 1730 **Syntheses of novel pyridinium salt and its performance on ferric ion detection**  
CHEN Hongshuo
- 1737 **Determination and risk assessment of 27 organophosphorus flame retardants (OPFRs) in water**  
HAN Chao, LIANG Cunzhen, GAO Yuqian, GUAN Dong
- 1748 **Effect analysis of FID field detection method for VOCs leakage in oil and gas recovery system of gas station**  
FENG Yuqin, LIU Yang, LIU Changtong, LIU Zehua, WANG Pei, ZHANG Jinlong