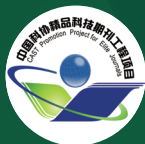


# 化工进展

Chemical Industry and Engineering Progress

Vol.40 No.10

2021年10月



中国化工学会会刊

ISSN 1000-6613

CN 11-1954/TQ

CODEN HUJIEK

化工进展

第四十卷

第十期

二〇二一年十月

**ATV 安特威**

助您安心享受美好生活

### 全金属三偏心蝶阀

#### 双向密封、零泄漏

- 双向VI级密封, 100000次以上开关寿命
- 密封环可以互相更换
- 全数字化生产, 远程可视、实时可控
- 大幅延长使用寿命, 降低维修成本

助您安心享受美好生活

智能蝶阀柔性产线



扫码获取更多产品案例

迭片式三偏心蝶阀

高温蝶阀

深冷蝶阀

广告

ISSN 1000-6613



9 771000 661218



主办



中国化工学会



化学工业出版社有限公司



## 目次

### 资源循环与增值利用

——《化工进展》创刊40周年系列专栏(客座主编:徐盛明;客座编辑:黄国勇)

- 铜渣综合回收利用研究进展 ..... 王林松,高志勇,杨越,韩海生,王丽,孙伟(5237)
- 再生铝合金中含Fe杂质的控制技术现状 ..... 何学峰,刘波,张深根(5251)
- 典型合金循环利用研究进展及挑战 ..... 王曼,席晓丽,王亚楠,唐康尧(5270)
- 转炉钒渣提钒技术研究现状及展望 ..... 邱玉超,石俊杰,余彬,肖攀,赵斐,马文远,李建中,刘常升(5281)
- 化工废催化剂污染特征及资源化途径 ..... 曹礼梅,邱兆富,张巍,杨骥(5293)
- 废加氢催化剂的回收现状与研究进展 ..... 史志胜,丁云集,张深根(5302)
- 废钒钛基SCR催化剂的处置方法研究进展 ..... 侯学军,章小明,程文博,王馨,王春霞,徐盛明,黄国勇(5313)
- 热力学研究在锂离子电池回收中的应用 ..... 刘子潇,张家靓,杨成,陈永强,王成彦(5325)
- 电石制备清洁生产和工程化研究进展 ..... 徐婉怡,王红霞,崔小迷,张早校(5337)
- 生物原油炼制:副产物内循环及水热自催化 ..... 高传瑞,田纯焱,李志合,易维明,袁巧霞,付鹏,张玉春,李治宇(5348)
- 黏土钒矿直接常压活化酸浸提钒热力学分析 ..... 张豪,叶国华,陈子杨,谢禹,左琪(5360)
- Fe掺杂宣纸基碳纤维材料的储锂性能 ..... 胡思思,孙丽芝,张迪,王波(5370)
- 仿生酶菌协同体系预处理木质素机理及特性 ..... 唐亮,廖强,夏昇,黄云,朱贤青,朱恂(5378)

### 化工过程与装备

- 平板形蒸发器环路热管的研究进展 ..... 熊康宁,吴伟,汪双凤(5388)
- 太阳能膜蒸馏系统进展与展望 ..... 李逸航,戴绍铃,于楨,顾若男,成少安(5403)
- 脱乙酰基改性乙酸纤维薄膜对乳化油分离及积垢机理的探究 ..... 饶瑞晔,毛竹筒,林晓榆,郭绍英,胡家朋(5415)
- 平抑电耗波动的热泵蓄热-供热系统优化 ..... 刘雪玲,付伟娟,牛锦涛,王源铭(5424)
- 带引射器的跨临界CO<sub>2</sub>机械过冷热泵系统性能分析 ..... 董丽玮,李敏霞,姚良,马一太,詹浩森(5431)
- 固体冷表面上液滴凝结过程分析 ..... 张哲,赵恩惠,严雷,杨文哲,袁晖,张秋梅,田津津(5441)
- 电场作用下液滴的变形及库仑分裂模式 ..... 王军锋,范志恒,王东保,陆帅全(5451)
- 不同外绕盘管结构热泵热水器蓄能与用能性能分析 ..... 刘恒,谭建明,李舒宏,杜明浩,叶强(5459)
- 混合澄清槽内离子液体体系的三相流体动力学模拟 ..... 汤祺,鲍迪,邵少雄,徐平,刘联伟,郑维明(5468)
- 输气站场过滤分离器压降与除尘效率变化特性 ..... 敬佩瑜,郑思佳,张帅,唐超,段林林,付斌(5480)
- NO<sub>x</sub>硝化正己烷及其理论计算 ..... 李星彦,王墨,戴璇,彭新华,唐双凌(5491)

### 能源加工与技术

- 掺氢天然气管道输送研究进展和挑战 ..... 尚娟,鲁仰辉,郑津洋,孙晨,花争立,于文涛,张一苇(5499)
- 量热法多孔沉积物内CH<sub>4</sub>水合物生成过程中的放热行为 ..... 朱玉洁,谢炎,钟瑾荣,孙长宇,陈光进,王晓辉(5506)
- 基于RHDS-SIM的固定床渣油加氢装置全流程模拟与应用 ..... 范明,赵元生,王苑,何盛宝(5514)

### 工业催化

- 电催化析氢催化剂研究进展 ..... 王春霞,宋兆毅,倪基平,潘宗卫,黄国勇(5523)
- 合成气经含氧化合物中间体一步法制芳烃研究进展 ..... 尚蕴山,王前进,杨加义,袁德林,张凡,刘华,邢爱华,季生福(5535)
- 不同形貌ε-MnO<sub>2</sub>催化剂的制备及其催化燃烧甲苯性能 ..... 余伟雄,程高,崔晓斌,曾小红,蓝邦,李永峰,张灿仰,孙明,余林(5547)

## 材料科学与技术

- 微胶囊相变材料制备与应用研究进展·····公雪,王程遥,朱群志(5554)
- 自具微孔聚合物PIM-1膜在气体分离领域的研究进展·····郭海燕,彭东来,冯孝权,金业豪,田志红,王景,张亚涛(5577)
- 二硫化钼纳米片基水处理纳滤/反渗透膜研究进展·····赵东升(5590)
- 静电纺丝/静电喷雾技术在电池领域的应用进展·····邓建辉,杨晓青,方称辉,曹栋清,李梁君,张国庆,郭建维(5600)
- 混凝土表层防护涂料研究进展·····刘竞,苗同梦,姜子清,徐永杰,钟子龙,郁培云(5615)
- 纳米纤维素/Al<sub>2</sub>O<sub>3</sub>胶体/PE锂离子电池隔膜的制备及其成膜机理·····时培东,胡春蕊,郑苗苗,赵娟,刘锐,贾原媛(5624)
- 煤沥青基吸水树脂的制备与性能·····马欣如,郭涛,王群,李俊美,张振楠,曹青(5634)
- 银耳菌糠衍生的三维多级孔炭及其电化学应用性能·····邓秀春,卓祖优,白小杰,孙杰,陈燕丹(5642)
- Cu(Qc)<sub>2</sub>强化Pebax混合基质膜分离CO<sub>2</sub>·····宁梦佳,代岩,郝元,章星,刘红晶,贺高红(5652)

## 精细化工

- 固废基无机高分子混凝剂研究进展及改进途径·····刘丁仪,王冰玉,李姝霖,谢慧芳(5660)
- 基于密度泛函理论的羟胺阻聚剂的筛选与应用·····唐亚芳,黄占凯,赵甲,何艳贞,赵福利,张春丽,刘红光,韩恩山(5670)
- 微反应器内邻氨基苯甲酸甲酯的连续重氮化工艺·····王霖,王超,尹进华(5678)
- 废弃芳纶粉末环氧化改性及其固化物性能·····于鹏达,张晓娟,张金峰,谈继淮,王芳,王芳,付博,朱新宝(5692)

## 生物与医药化工

- 湿法纳米研磨制备药物纳米晶体——铝碳酸镁·····王小康,张扬,FALOLA Akinola,何运良,王学重(5699)

## 资源与环境化工

- 环境中1,4-二噁烷污染处理技术研究进展·····田坤,姚丹丹,赵元添,郭丽莉,董元华,刘云(5708)
- 反渗透/纳滤膜剖检分析与膜污染诊断研究进展·····海玉琰,何灿,马瑞,熊日华(5720)
- 餐饮油烟中典型VOCs催化氧化研究进展·····隗晶慧,冯勇超,于庆君,易红宏,唐晓龙,张媛媛,孟宪政,袁雨婷(5730)
- 吸附法净化室内甲醛研究进展·····肖康,王琮(5747)
- 生物质热解碳烟的研究进展·····蒋好,朱有健,邵敬爱,成伟,吴贵豪,杨海平,陈汉平(5772)
- 基于Aspen Plus的煤-炼化污泥高温气化特性分析·····陈廷贵,张纹齐,王银峰,廖传华,朱跃钊(5786)
- 电渗-帽封联用技术对底泥内源污染释放的阻控效果·····刘柳君,胡悦,李彦,岳瑞,胡将军,朱华,王旭,毛旭辉(5794)
- 铜锰负载型石化企业剩余活性污泥基活性炭制备及吸附甲苯性能·····李小斐,杜改平,段滩超,孙慧,赵东风,李石(5804)
- ZIF-8/乙二醇浆液连续捕集二氧化碳·····潘勇,陈驰,徐保明,陈光进(5812)
- 机械力-微波活化对稀土尾矿NH<sub>3</sub>-SCR脱硝性能的影响·····侯丽敏,闫笑,乔超越,付善聪,武文斐(5818)
- 硫自养/异养协同反硝化深度脱氮处理三氯蔗糖生产废水·····耿雅雯,刘锋,冯震,陈俊,张雪智(5829)
- 臭氧催化氧化降解煤化工生化进水有机物的实验及机理·····王吉坤,李阳,陈贵锋,刘敏,李文博,何毅聪(5837)

## 化工园区

- 中国化工园区建设管理的“六个一体化”·····杨挺(5845)

## 观点

- 中国炼油转型化工现状及发展约束因素的思考·····王德亮,周志茂,林梦蕾,李超(5854)

责任编辑:奚志刚

英文顾问:郭梅芳,金仁村,李保庆,龙秉文,王运东



## Contents

### Special column: Resource recycling and value-added utilization

(Guest editor in chief: XU Shengming; Guest editor: HUANG Guoyong)

- Research progress on comprehensive recovery and utilization of copper slag**  
.....WANG Linsong, GAO Zhiyong, YANG Yue, HAN Haisheng, WANG Li, SUN Wei (5237)
- Current status of control technology of Fe impurity in recycled aluminum alloy** .....HE Xuefeng, LIU Bo, ZHANG Shengen (5251)
- Research progress and challenges in recycling of typical alloys** .....WANG Man, XI Xiaoli, WANG Yanan, TANG Kangyao (5270)
- Review and perspective of vanadium extraction techniques from converter vanadium-bearing slag**  
.....QIU Yuchao, SHI Junjie, YU Bin, XIAO Pan, ZHAO Fei, MA Wenyuan, LI Jianzhong, LIU Changsheng (5281)
- Pollution and utilization of chemical industry spent catalysts** .....CAO Limei, QIU Zhaofu, ZHANG Wei, YANG Ji (5293)
- Status and research progress on recovery of spent hydrogenation catalysts** .....SHI Zhisheng, DING Yunji, ZHANG Shengen (5302)
- Research on disposal methods of spent vanadium-titanium-based catalysts**  
.....HOU Xuejun, ZHANG Xiaoming, CHENG Wenbo, WANG Xin, WANG Chunxia, XU Shengming, HUANG Guoyong (5313)
- Applications of thermodynamic research in recycling of lithium ion battery**  
.....LIU Zixiao, ZHANG Jialiang, YANG Cheng, CHEN Yongqiang, WANG Chengyan (5325)
- Research progress on cleaner production and engineering of calcium carbide preparation**  
.....XU Wanyi, WANG Hongxia, CUI Xiaomi, ZHANG Zaoxiao (5337)
- Biorefining of biocrude oil: recirculation of by-products and hydrothermal autocatalysis**  
.....GAO Chuanrui, TIAN Chunyan, LI Zhihe, YI Weiming, YUAN Qiaoxia, FU Peng, ZHANG Yuchun, LI Zhiyu (5348)
- Analysis of thermodynamics of vanadium extraction from clay vanadium ore by direct atmospheric pressure activation**  
.....ZHANG Hao, YE Guohua, CHEN Ziyang, XIE Yu, ZUO Qi (5360)
- Lithium storage performance of Fe-doped Xuan paper-based carbon fiber materials** .....HU Sisi, SUN Lizhi, ZHANG Di, WANG Bo (5370)
- Mechanism and characteristics of nature inspired enzyme-fungi synergistic system for lignin pretreatment**  
.....TANG Liang, LIAO Qiang, XIA Ao, HUANG Yun, ZHU Xianqing, ZHU Xun (5378)

### Chemical processes and equipment

- Research and development of loop heat pipe with flat evaporator** .....XIONG Kangning, WU Wei, WANG Shuangfeng (5388)
- Development and prospect of solar-driven membrane distillation system**  
.....LI Yihang, DAI Shaoling, YU Zhen, GU Ruonan, CHENG Shao'an (5403)
- Study on the separation of emulsified oil and fouling mechanism by deacetylated cellulose acetate membrane**  
.....RAU Juiyeh, MAO Zhuqian, LIN Xiaoyu, GUO Shaoying, HU Jiapeng (5415)
- Optimization of heat pump heat storage-heating system for suppressing fluctuation in power consumption**  
.....LIU Xuelling, FU Weijuan, NIU Jintao, WANG Yuanming (5424)
- Analysis of performance of CO<sub>2</sub> transcritical heat pump system with mechanical subcooling and ejector**  
.....DONG Liwei, LI Minxia, YAO Liang, MA Yitai, ZHAN Haomiao (5431)
- Analysis of droplet condensation process on solid cold surface**  
.....ZHANG Zhe, ZHAO Enhui, YAN Lei, YANG Wenzhe, YUAN Hui, ZHANG Qiumei, TIAN Jinjin (5441)
- Deformation and Coulomb splitting mode of droplets under electric field**  
.....WANG Junfeng, FAN Zhiheng, WANG Dongbao, LU Shuaiquan (5451)
- Performance analysis of heat pump water heater with different wrap-around condenser coil structure on the charging and discharging** .....LIU Heng, TAN Jianming, LI Shuhong, DU Minghao, YE Qiang (5459)
- Three-phase fluid dynamics simulation of ionic liquid system in mixer-settler**  
.....TANG Qi, BAO Di, SHAO Shaoxiang, XU Ping, LIU Lianwei, ZHENG Weiming (5468)
- Change characteristics of pressure drop and collection efficiency of the filter separators in the gas transmission station**  
.....JING Peiyu, ZHENG Sijia, ZHANG Shuai, TANG Chao, DUAN Linlin, FU Bin (5480)
- Nitration of *n*-hexane with NO<sub>2</sub> and theoretical calculation** .....LI Xingyan, WANG Mo, DAI Xuan, PENG Xinhua, TANG Shuangling (5491)

### Energy processes and technology

- Research status-*in-situ* and key challenges in pipeline transportation of hydrogen-natural gas mixtures**  
.....SHANG Juan, LU Yanghui, ZHENG Jinyang, SUN Chen, HUA Zhengli, YU Wentao, ZHANG Yuwei (5499)
- Heat-release behaviors during CH<sub>4</sub> hydrate formation in porous sediments by differential scanning calorimeter**  
.....ZHU Yujie, XIE Yan, ZHONG Jinrong, SUN Changyu, CHEN Guangjin, WANG Xiaohui (5506)
- Simulation and application of fixed-bed residuum hydrotreating unit process model based on RHDS-SIM**  
.....FAN Ming, ZHAO Yuansheng, WANG Yuan, HE Shengbao (5514)

### Industrial catalysis

- Progress of electrocatalytic hydrogen evolution reaction catalysts**  
.....WANG Chunxia, SONG Zhaoyi, NI Jiping, PAN Zongwei, HUANG Guoyong (5523)
- Recent advance in directing synthesis of aromatic hydrocarbon from syngas via oxygenated compound intermediates**  
.....SHANG Yunshan, WANG Qianjin, YANG Jiayi, YUAN Delin, ZHANG Fan, LIU Hua, XING Aihua, JI Shengfu (5535)

Preparation of  $\epsilon$ -MnO<sub>2</sub> with different morphologies and their catalytic combustion of toluene .....YU Weixiong,  
CHENG Gao, CUI Xiao'e, ZENG Xiaohong, LAN Bang, LI Yongfeng, ZHANG Canyang, SUN Ming, YU Lin (5547)

## Materials science and technology

- Research progress on preparation and application of microcapsule phase change materials .....GONG Xue, WANG Chengyao, ZHU Qunzhi (5554)
- Progress in the membranes of polymers of intrinsic micro-porosity PIM-1 for gas separation .....GUO Haiyan, PENG Donglai, FENG Xiaoquan, JIN Yehao, TIAN Zhihong, WANG Jing, ZHANG Yatao (5577)
- Research progress in molybdenum disulfide nanosheet-based NF/RO membranes for water treatment .....ZHAO Dongsheng (5590)
- Application of electrospinning and electrospray technology in battery/cell field .....DENG Jianhui, YANG Xiaoqing, FANG Chenghui, CAO Dongqing, LI Liangjun, ZHANG Guoqing, GUO Jianwei (5600)
- Research progress of surface protection coatings for concrete .....LIU Jing, MIAO Tongmeng, JIANG Ziqing, XU Yongjie, ZHONG Zilong, YU Peiyun (5615)
- Preparation of nanocellulose/Al<sub>2</sub>O<sub>3</sub> sol/PE lithium-ion battery separation membrane and its film-forming mechanism .....SHI Peidong, HU Chunrui, ZHENG Miaomiao, ZHAO Juan, LIU Rui, JIA Yuanyuan (5624)
- Preparation and properties of coal pitch-based water-absorbing resin .....MA Xinru, GUO Tao, WANG Qun, LI Junmei, ZHANG Zhennan, CAO Qing (5634)
- Three-dimensional hierarchical porous carbon derived from spent culture substrate of white fungus and its electrochemical application .....DENG Xiuchun, ZHUO Zuyou, BAI Xiaojie, SUN Jie, CHEN Yandan (5642)
- CO<sub>2</sub> separation of Pebax-based mixed matrix membranes promoted by Cu(Qc) .....NING Mengjia, DAI Yan, XI Yuan, ZHANG Xing, LIU Hongjing, HE Gaohong (5652)

## Fine chemicals

- Progress and improvement of inorganic polymer coagulant based on solid waste .....LIU Dingyi, WANG Bingyu, LI Shulin, XIE Huiyang (5660)
- Screening and application of hydroxylamines as inhibitors based on density functional theory .....TANG Yafang, HUANG Zhankai, ZHAO Jia, HE Yanzhen, ZHAO Fuli, ZHANG Chunli, LIU Hongguang, HAN Enshan (5670)
- Continuous-flow diazotization of methyl anthranilate in microreactor system .....WANG Ben, WANG Chao, YIN Jinhua (5678)
- Epoxidation modification of waste aramid fiber powder and properties of curing products .....YU Pengda, ZHANG Xiaoxian, ZHANG Jinfeng, TAN Jihuai, WANG Fang, WANG Fang, FU Bo, ZHU Xinbao (5692)

## Biochemical and pharmaceutical engineering

- Preparation of pharmaceutical nanocrystals using wet nanomilling—Hydrotalcite .....WANG Xiaokang, ZHANG Yang, FALOLA Akinola, HE Yunliang, WANG Xuezhong (5699)

## Resources and environmental engineering

- Advances in 1,4-dioxane remediation methods: a review .....TIAN Kun, YAO Dandan, ZHAO Yuantian, GUO Lili, DONG Yuanhua, LIU Yun (5708)
- A review on RO/NF membrane autopsy and membrane fouling diagnosis .....HAI Yuyan, HE Can, MA Rui, XIONG Rihua (5720)
- Research progress of catalytic oxidation of typical VOCs in cooking oil fumes .....WEI Jinghui, FENG Yongchao, YU Qingjun, YI Honghong, TANG Xiaolong, ZHANG Yuanyuan, MENG Xianzheng, YUAN Yuting (5730)
- Progress in research on adsorption for abatement of indoor formaldehyde .....XIAO Kang, WANG Qiong (5747)
- Review on soot formation during biomass pyrolysis .....JIANG Hao, ZHU Youjian, SHAO Jing'ai, CHENG Wei, WU Guihao, YANG Haiping, CHEN Hanping (5772)
- Analysis of gasification characteristics of coal-petrochemical sludge at high temperature based on Aspen Plus .....CHEN Yangui, ZHANG Wenqi, WANG Yinfeng, LIAO Chuanhua, ZHU Yuezhao (5786)
- Performance of electroosmosis plus capping technology on preventing sediment contaminants from release .....LIU Lujun, HU Yue, LI Yan, YUE Rui, HU Jiangjun, ZHU Hua, WANG Xu, MAO Xuhui (5794)
- Preparation and toluene adsorption performance of sludge based activated carbon with loading Cu and Mn .....LI Xiaofei, DU Gaiping, DUAN Weichao, SUN Hui, ZHAO Dongfeng, LI Shi (5804)
- Continuous capture of carbon dioxide by ZIF-8/ethylene glycol slurry .....PAN Yong, CHEN Chi, XU Baoming, CHEN Guangjin (5812)
- Effect of mechanical force and microwave on the NH<sub>3</sub>-SCR denitration of rare earth tailings .....HOU Limin, YAN Xiao, QIAO Chaoyue, FU Shancong, WU Wenfei (5818)
- Deep treatment of sucralose wastewater with sulfur autotrophic/heterotrophic synergistic denitrification .....GENG Yawen, LIU Feng, FENG Zhen, CHEN Jun, ZHANG Xuezhi (5829)
- Experimental and mechanism studies on degradation of the organics in biochemical influent of coal chemical industry by ozone catalytic oxidation .....WANG Jikun, LI Yang, CHEN Guifeng, LIU Min, LI Wenbo, HE Yicong (5837)

## Chemical industry park

- “Six Integrations” of establishing and managing chemical parks in China .....YANG Ting (5845)

## Perspective

- Status and thinking of development constraints of refining to chemical transformation in China .....WANG Deliang, ZHOU Zhimao, LIN Menglei, LI Chao (5854)

**Executive Editor:** XI Zhigang

**English Consultant:** GUO Meifang, JIN Rencun, LI Baoqing, LONG Bingwen, WANG Yundong