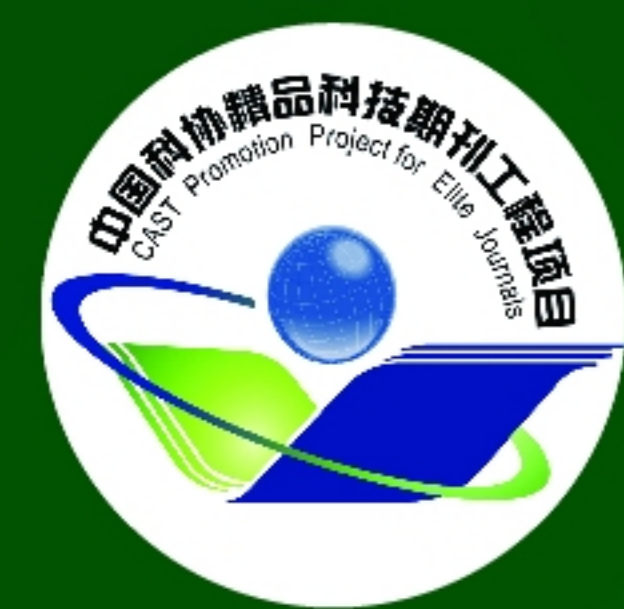


中国化工学会会刊

Journal of Chemical Industry and Engineering Society of China

CODEN HUJIEK

ISSN 1000-6613 / CN 11-1954/TQ



# 化工进展

## Chemical Industry and Engineering Progress

### 2019

### 第38卷

### EI 收录期刊

# 2



精馏技术国家工程研究中心 (天津大学)  
北洋国家精馏技术工程发展有限公司

ISSN 1000-6613

9 771000 661195



主办 中国化工学会  
 化学工业出版社



## 目次

### 特约评述

- 创新强化传热策略与应用 提升炼化企业竞争力····· 孙丽丽(711)  
生物质原料供应链技术经济研究进展····· 马国杰,常春,陈俊武(720)  
受激辐射损耗超分辨荧光成像探针研究进展····· 刘母凡,陈楚芳,潘文慧,熊佳,屈军乐,杨志刚(726)

### 化工过程与装备

- 液相中气泡上升行为与界面传质:实验研究与数值计算····· 李鑫,张攀,陈光辉,李建隆(740)  
壁面润湿性对微细通道内R141b流动沸腾不稳定性的影响····· 罗小平,廖政标,周建阳,张霖(752)  
基于非逆流传热的热交换网络系统的3E优化····· 蒋宁,郭风元,韩文巧,刘华菁,林露(761)  
甘露醇喷雾干燥过程中液滴粒度分布变化的群体粒数衡算模拟和实验研究····· 吕凤,张扬,马才云,王学重(772)  
油水界面测量过程中自适应阈值聚类优化算法····· 任喜伟,何立风,姚斌,宋安玲,钟岩,刘艳玲(779)  
乳化剂对动态膜分离油水乳化液过程的影响····· 张雪芳,潘艳秋,陈鹏鹏,俞路(790)  
静压支承技术在海水淡化旋转式能量回收装置中的应用····· 田俊杰,王越,吴家能,周杰,徐世昌(798)  
小尺度超临界CO<sub>2</sub>管道小孔泄漏减压及温降特性····· 顾帅威,李玉星,滕霖,王财林,胡其会,张大同,叶晓,王婧涵(805)  
基于膜分离器的NH<sub>3</sub>-H<sub>2</sub>O-LiBr吸收式制冷系统的研究分析····· 岳小洋,李舒宏,徐梦凯,李彦军,杜垚,杨柳(813)  
扰流板太阳能空气集热器的流道优化····· 贾斌广,刘芳,王达,张大鹏,韩韬(819)  
弹性棒对仿生学柔性反应器的流体混合强化····· 张广达,刘明慧,邹超,肖杰,陈晓东(826)  
内部热耦合塔的热力学分析和节能研究····· 方静,刁梦宇,李春利,轩碧涵(834)

### 能源加工与技术

- 合成煤中钠对煤燃烧及灰特性影响····· 孙保民,高满达,丁世兴,苏逸峰(842)  
工质泵变运行工况对有机朗肯循环系统性能的影响····· 杨宇鑫,张红光,赵蕊,李健,赵腾龙,张梦茹(851)  
La改性多级孔HZSM-5在线催化提质生物油····· 张小雷,李小华,邵珊珊,张瑾,董良秀,胡超,蔡忆昔(858)

### 工业催化

- MoS<sub>2</sub>基催化剂加氢脱硫反应活性相和作用机理研究进展····· 李硕,刘熠斌,冯翔,杨朝合(867)  
氯化氢氧化反应催化剂研究进展····· 石坚,杨建明,惠丰,袁俊,梅苏宁,余秦伟,张前,李亚妮,王为强,赵锋伟,吕剑(876)  
CuO含量对Pd/Al<sub>2</sub>O<sub>3</sub>催化剂乙醇氧化性能的影响····· 张申,郭玉玉,李星颖,李哲(885)  
固相研磨法制备AgI/Ag<sub>3</sub>PO<sub>4</sub>复合光催化剂及其光催化性能····· 张晓君,李佳乐,刘一儒,张凌云,于大禹(892)  
锐钛型TiO<sub>2</sub>对尿素热解过程的影响····· 郭闯,仲兆平,杜浩然,彭代军(899)  
新型CBS凝胶催化剂的合成及催化性能····· 黄迪,李国华,宋晓玲,戴双雄,胡凌峰(905)  
碳掺杂ZnO薄膜及可见光催化氮合成氨····· 姚凯,姜宏,熊春荣(913)

### 材料科学与技术

- 湿法回收退役三元锂离子电池有价金属的研究进展····· 黎华玲,陈永珍,宋文吉,冯自平(921)  
SiO<sub>2</sub>/Zn<sub>2</sub>SnO<sub>4</sub>/环氧丙烯酸酯涂层的阻燃性能····· 郑炳云,杨磊(933)  
玄武岩纤维池窑熔制过程的数值模拟····· 朱立平,于守富,吕士武,吴嘉培,唐秀凤,孙雪坤(940)

- 钛酸锂/石墨烯复合负极材料的制备及电化学性能 ..... 张利辉, 徐宇兴, 刘振法, 魏爱佳, 李文(949)
- 碳纳米管流动电极分散性和悬浮稳定性的优化 ..... 赵晓童, 徐世昌, 马冬雅, 王越, 王巧灵(956)
- 固载化L-脯氨酸及其衍生物的最新研究进展 ..... 徐伟伟, 刘宽, 王琴雅, 唐斌, 申迎华, 李新娟, 肖霄(964)
- P84共聚聚酰胺-聚乙烯吡咯烷酮/聚丙烯腈复合膜的制备及其渗透汽化分离甲醇/四氢呋喃  
..... 戚律, 周元冲, 徐荣, 张琪, 钟璟(971)
- 细乳液法制备MnO<sub>2</sub>/PPy复合材料及其电化学性能 ..... 梁芳楠, 刘志伟, 张宁, 刘有智(979)
- 稳定且宽电位窗口的掺铁二氧化锰超级电容器材料 ..... 白瑞娟, 吴强, 符有辉, 窦桂媛(987)
- 豆荚结构聚乙烯醇缩丁醛/氧化铝复合相变纤维的制备及性能 ..... 张秀, 谢锐, 汪伟, 巨晓洁, 刘壮, 褚良银(993)
- TNAs的制备条件及可见光下GQDs/TNAs复合材料的性能初探 ..... 曹浩, 陆金仁, 李伟琪, 包木太, 李一鸣, 马威伊(1000)
- 基于选择性吸附实现有机染料分离的一种金属有机框架薄膜材料制备与表征 ..... 邢以晶, 李赏, 朱从懿, 郭伟(1010)
- 整体型大孔/介孔PDA/SiO<sub>2</sub>复合材料固定化漆酶及其在染料降解中的应用 ..... 鹿乾辉, 吴一鑫, 俞丽萍, 张辉, 梁云霄(1018)

## 生物与医药化工

- 基于微藻培养的沼液处理相关耦合技术进展 ..... 郭沛, 马荣江, 余南阳, 袁艳平(1027)
- Aspergillus niger NL-1来源的木聚糖酶的耐热性能改造及其在水解木聚糖中的应用  
..... 李琦, 蒋雯怡, 孙雨薇, 吴涛, 赵林果(1038)
- 复合壁材布拉酵母微胶囊的制备 ..... 刘开放, 席志文, 黄林娜, 惠丰立(1045)

## 精细化工

- 驱油剂对三元复合驱含油污水中油滴稳定性的影响 ..... 黄斌, 张威, 王捷, 傅程(1053)
- 4-(6-羟基-5-硝基-2-苯并噁唑基)-2,6-二羟基苯甲酸的合成 ..... 董斌, 付聪, 吴纯鑫, 张建庭, 金宁人, 赵德明(1062)
- 棕榈酰基蛋氨酸表面活性剂的合成与性能 ..... 龚哲, 尚小琴, 杨金蝉, 黄文进, 赖心翹, 刘丹彤, 黄炯浩(1068)
- 牛血清白蛋白纳米球接枝杨梅单宁的制备以及吸附去除水体中Pb<sup>2+</sup>的性能  
..... 冯健, 余杰, 周建, 张永德, 林晓艳, 罗学刚(1075)

## 资源与环境化工

- 环境中磷化氢的产生、分布及转化研究进展 ..... 刘树根, 李婷, 宁平, 吴孟, 余硕(1085)
- 微生物燃料电池在水与废水脱氮方面的研究进展 ..... 李文英, 刘玉香, 任瑞鹏, 吕永康(1097)
- 天然气脱汞吸附剂的制备及其性能评价 ..... 林富荣, 仲艳艳(1107)
- 磁性响应茶渣制备及其对水溶液中亚甲基蓝的吸附 ..... 龚新怀, 辛梅华, 李明春, 李素琼, 赵晓杰(1113)
- Fe<sub>2</sub>O<sub>3</sub>改性蒙脱土对邻苯二酚的高效去除机理 ..... 王朋, 常亚洲, 石林, 郎笛, 张迪(1122)
- 酸洗废液及污泥制备磁性氧化铁颜料的工艺 ..... 冯海军, 王冠宁, 王立宝, 孙雅男, 张彪, 陈涛, 张炜(1129)
- 不同时期排泥对培养SBBR生物膜的影响 ..... 吴绍琳, 刘文文, 魏镇欢, 陈滢, 张东(1134)

## 产品与市场

- 华东地区某市重点行业优控环境激素的筛选及分布特征 ..... 侯爽, 隋倩(1140)

责任编辑: 郑宇印

英文顾问: 蔡家琦, 李保庆, 龙秉文, 吕效平, 王运东



## Contents

### Invited review

- Innovating heat transfer enhancement application to improve the competitiveness of refinery and petrochemical enterprises** ..... SUN Lili (711)  
**Advance on technical and economic analysis of the biomass supply chain** ... MA Guojie, CHANG Chun, CHEN Junwu (720)  
**Research progress on stimulated emission depletion using fluorescent probes**  
..... LIU Wufan, CHEN Chufang, PAN Wenhui, XIONG Jia, QU Junle, YANG Zhigang (726)

### Chemical processes and equipment

- Rising behavior of bubbles and interfacial mass transfer in liquid: experimental study and numerical simulation**  
..... LI Xin, ZHANG Pan, CHEN Guanghui, LI Jianlong (740)  
**Influence of wall surface wettability on instability of R141b flow boiling in microchannels**  
..... LUO Xiaoping, LIAO Zhengbiao, ZHOU Jianyang, ZHANG Lin (752)  
**3E Optimization of heat exchanger network system based on non-counterflow heat transfer**  
..... JIANG Ning, GUO Fengyuan, HAN Wenqiao, LIU Huajing, LIN Lu (761)  
**Simulation and experimental study on the evolution of droplet size distribution during spray drying of mannitol**  
..... LÜ Feng, ZHANG Yang, MA Caiyun, WANG Xuezhong (772)  
**Clustering optimization algorithm with adaptive threshold for oil-water interface detection process**  
..... REN Xiwei, HE Lifeng, YAO Bin, SONG Anling, ZHONG Yan, LIU Yanling (779)  
**Impact of emulsifier on separation of oil-in-water emulsion by dynamic membrane**  
..... ZHANG Xuefang, PAN Yanqiu, CHEN Pengpeng, YU Lu (790)  
**Application research of hydrostatic bearing technology in rotary energy recovery device for seawater desalination system**  
..... TIAN Junjie, WANG Yue, WU Jianeng, ZHOU Jie, XU Shichang (798)  
**Decompression and temperature drop characteristics of small-scale supercritical CO<sub>2</sub> pipeline leakage with small holes**  
..... GU Shuaiwei, LI Yuxing, TENG Lin, WANG Cailin, HU Qihui, ZHANG Datong, YE Xiao, WANG Jinghan (805)  
**Analysis of NH<sub>3</sub>-H<sub>2</sub>O-LiBr absorption refrigeration system based on membrane separator**  
..... YUE Xiaoyang, LI Shuhong, XU Mengkai, LI Yanjun, DU Kai, YANG Liu (813)  
**Optimization of flow path for the spoiler solar air collector**  
..... JIA Binguang, LIU Fang, WANG Da, ZHANG Dapeng, HAN Tao (819)  
**Enhancement of liquid mixing in a soft-elastic reactor based on bionics with an elastic rod**  
..... ZHANG Guangda, LIU Minghui, ZOU Chao, XIAO Jie, CHEN Xiaodong (826)  
**Study on thermodynamic analysis and energy saving of heat integrated distillation column**  
..... FANG Jing, DIAO Mengyu, LI Chunli, XUAN Bihan (834)

### Energy processes and technology

- Effect of sodium in synthetic coal on coal combustion performance and ash characteristics**  
..... SUN Baomin, GAO Manda, DING Shixing, SU Yifeng (842)  
**Effects of variable operating conditions of working fluid pumps on the performance of organic Rankine cycle system**  
..... YANG Yuxin, ZHANG Hongguang, ZHAO Rui, LI Jian, ZHAO Tenglong, ZHANG Mengru (851)  
**La modified hierarchical porous HZSM-5 catalysts for online upgrading of the pyrolysis vapors from rape straw**  
..... ZHANG Xiaolei, LI Xiaohua, SHAO Shanshan, ZHANG Jin, DONG Liangxiu, HU Chao, CAI Yixi (858)

### Industrial catalysis

- Research progress in active phase structure and reaction mechanism of MoS<sub>2</sub>-based catalysts for hydrodesulfurization**  
..... LI Shuo, LIU Yibin, FENG Xiang, YANG Chaohe (867)  
**Progress on catalysts for catalytic oxidation of hydrogen chloride**  
..... SHI Jian, YANG Jianming, HUI Feng, YUAN Jun, MEI Suning, YU Qimwei, ZHANG Qian, LI Yani, WANG Weiqiang,  
ZHAO Fengwei, LÜ Jian (876)  
**Effects of CuO content on the performance of Pd/Al<sub>2</sub>O<sub>3</sub> catalysts in ethanol oxidation**  
..... ZHANG Shen, GUO Yuyu, LI Xingying, LI Zhe (885)  
**Synthesis of AgI/Ag<sub>3</sub>PO<sub>4</sub> composite photocatalysts using solid state grinding method and their photocatalytic activities**  
..... ZHANG Xiaojun, LI Jiale, LIU Yiru, ZHANG Lingyun, YU Dayu (892)  
**Effect of anatase TiO<sub>2</sub> on the pyrolysis of urea** ..... GUO Chuang, ZHONG Zhaoping, DU Haoran, PENG Daijun (899)  
**Preparation of novel CBS gel catalyst and its catalytic properties**  
..... HUANG Di, LI Guohua, SONG Xiaoling, DAI Shuangxiong, HU Lingfeng (905)  
**Carbon doped ZnO thin films for visible-light driven conversion of nitrogen to ammonia**  
..... YAO Kai, JIANG Hong, XIONG Chunrong (913)

### Materials science and technology

- Research progress on the recovery of valuable metals in retired LiNi<sub>x</sub>Co<sub>y</sub>Mn<sub>z</sub>O<sub>2</sub> batteries by wet process**  
..... LI Hualing, CHEN Yongzhen, SONG Wenji, FENG Ziping (921)

- Flame retardancy of nano-SiO<sub>2</sub>/Zn<sub>2</sub>SnO<sub>4</sub> epoxy acrylate coating ..... ZHENG Bingyun, YANG Lei (933)
- Numerical simulation of the melting process in basalt fiber tank  
..... ZHU Liping, YU Shoufu, LÜ Shiwu, WU Jiapei, TANG Xiufeng, SUN Xuekun (940)
- Synthesis and electrochemical properties of Li<sub>4</sub>Ti<sub>5</sub>O<sub>12</sub>/graphene composite as an anode material for Li-ion batteries  
..... ZHANG Lihui, XU Yuxing, LIU Zhenfa, WEI Aijia, LI Wen (949)
- Optimization of dispersion and suspension-stability for carbon nanotube flow-electrode  
..... ZHAO Xiaotong, XU Shichang, MA Dongya, WANG Yue, WANG Qiaoling (956)
- Recent advances in the immobilization of L-proline and its derivative  
..... XU Weiwei, LIU Kuan, WANG Qinya, TANG Yu, SHEN Yinghua, LI Xinjuan, XIAO Xiao (964)
- Preparation of P84 copolyimide-polyvinylpyrrolidone/polyacrylonitrile composite membranes for separation of methanol/tetrahydrofuran by pervaporation ..... QI Lü, ZHOU Yuanchong, XU Rong, ZHANG Qi, ZHONG Jing (971)
- Synthesis of MnO<sub>2</sub>/PPy composite materials by miniemulsion polymerization and its electrochemical performances  
..... LIANG Fangnan, LIU Zhiwei, ZHANG Ning, LIU Youzhi (979)
- Fe-doped manganese dioxide for stable wide-potential-window supercapacitors  
..... BAI Ruijuan, WU Qiang, FU Youhui, DOU Guiyuan (987)
- Preparation and properties of polyvinyl butyral/Al<sub>2</sub>O<sub>3</sub> composite phase change microfibers with peapod-like structure  
..... ZHANG Xiu, XIE Rui, WANG Wei, JU Xiaojie, LIU Zhuang, CHU Liangyin (993)
- Preliminary investigation of the preparation conditions of TNAs and performance of QDs/TNAs composites under visible light ..... CAO Hao, LU Jinren, LI Weiqi, BAO Mutai, LI Yiming, MA Weiyi (1000)
- Dye separation based on selective adsorption by used a SURMOF thin film: the preparation and characterization  
..... XING Yijing, LI Shang, ZHU Congyi, GUO Wei (1010)
- Immobilization of laccase on monolithic macroporous/mesoporous PDA/SiO<sub>2</sub> composite and its application in dye degradation ..... PANG Qianhui, WU Yixin, YU Liping, ZHANG Hui, LIANG Yunxiao (1018)

## Biochemical and pharmaceutical engineering

- Recent progress in coupling technologies of biogas slurry treatment based on microalgae cultivation  
..... GUO Pei, MA Rongjiang, YU Nanyang, YUAN Yanping (1027)
- Thermostability modification of the GH11 xylanase MxynB from *Aspergillus niger* NL-1 and its application in xylooligosaccharide production ..... LI Qi, JIANG Wenyi, SUN Yuwei, WU Tao, ZHAO Linguo (1038)
- Preparation of compound wall materials microcapsules of *Saccharomyces boulardii*  
..... LIU Kaifang, XI Zhiwen, HUANG Linna, HUI Fengli (1045)

## Fine chemicals

- Effect of oil displacement agent on oil droplet stability in alkali/surfactant/polymer flooding oily wastewater  
..... HUANG Bin, ZHANG Wei, WANG Jie, FU Cheng (1053)
- Synthesis of 4-(6-hydroxy-5-nitro-2-benzoxazolyl)-2,6-dihydroxybenzoic acid  
..... DONG Bin, FU Cong, WU Chunxin, ZHANG Jianting, JIN Ningren, ZHAO Deming (1062)
- Synthesis and properties of palmitoyl methionine surfactant  
..... GONG Zhe, SHANG Xiaoqin, YANG Jinchan, HUANG Wenjin, LAI Xinqiao, LIU Dantong, HUANG Jionghao (1068)
- Removal of Pb<sup>2+</sup> from aqueous solution using bovine serum albumin nanospheres grafted with bayberry tannin  
..... FENG Jian, YU Jie, ZHOU Jian, ZHANG Yongde, LIN Xiaoyan, LÜO Xuegang (1075)

## Resources and environmental engineering

- Research progress of the release, distribution and transformation of phosphine in environment  
..... LIU Shugen, LI Ting, NING Ping, WU Meng, YU Shuo (1085)
- Research progress on removal of nitrogen in water and wastewater by microbial fuel cell  
..... LI Wenyang, LIU Yuxiang, REN Ruipeng, LÜ Yongkang (1097)
- Preparation and performance evaluation of mercury removal adsorbents for natural gas  
..... LIN Furong, ZHONG Yanyan (1107)
- Preparation of magnetically responsive tea waste and its adsorption of methylene blue from aqueous solution  
..... GONG Xinhua, XIN Meihua, LI Mingchun, LI Suqiong, ZHAO Xiaojie (1113)
- Efficient removal mechanism of catechol by Fe<sub>2</sub>O<sub>3</sub> modified montmorillonite  
..... WANG Peng, CHANG Yazhou, SHI Lin, LANG Di, ZHANG Di (1122)
- Process for preparing magnetic iron oxide pigment by pickling waste liquid and sludge  
..... FENG Haijun, WANG Guanning, WANG Libao, SUN Yanan, ZHANG Biao, CHEN Tao, ZHANG Wei (1129)
- Effects of sludge discharge stage on SBBR biofilm cultivation  
..... WU Shaolin, LIU Wenwen, WEI Zhenhuan, CHEN Ying, ZHANG Dong (1134)

## Products and market

- Screening and distribution of priority environmental hormones in the key industrial sectors in a city of East China  
..... HOU Shuang, SUI Qian (1140)

**Executive Editor:** ZHENG Yuyin

**English Consultant:** CAI Jiaqi, LI Baoqing, LONG Bingwen, LÜ Xiaoping, WANG Yundong