离子液体绿色工程应用

Green Processes and Applications Based on Ionic Liquids

成果简介：

本项目面向绿色化工的重大需求，以离子液体为核心，通过介质－工艺－系统的原始创新，突破了离子液体共性科学及工程化等难题，在工业催化、分离及电化学领域形成了 10 项具有自主知识产权的绿色技术和成套工艺。实现了 20 万吨 / 年离子液体协同催化烷基化生产汽油添加剂、3 万吨 / 年离子液体催化 CO_2 转化合成 DMC/EG、2 万吨 / 年替代剧毒氢氰酸的异丁烯生产 MMA/MAO 的工业化应用。建立了千吨级 PET 聚酯化学降解示范装置，完成了 800 万 Nm^3/ 年离子液体法氨回收示范装置，并推广到三聚氰胺尾气氨回收。开发了新型离子液体锂电池电解液，建立了 5 千吨 / 年工业装置并实现稳定生产，研发了离子液体导电液和柔性导电纤维技术。上述成果已获国内外授权发明专利 30 多件，形成了具有自主知识产权的专利群。6 项成果通过了中科院或中国石化联合会的鉴定，达到国际领先或国际先进水平。

2 万吨 / 年替代剧毒氢氰酸的异丁烯生产 MMA/MAO 工业装置

Industrial demonstration plant for production of MMA/MAO from isobutene instead of the toxic hydrocyanic acid and corrosive solvents (capacity: 20,000 tons/a)

Introduction:

The research of Ionic Liquids (ILs) is one of the frontiers and hot topics in chemistry and chemical engineering field. Taking ILs as the core media, this project faces at the major demands of green chemical engineering to solve the problems of the fundamental researches and applications of ILs through the original innovations of media, technics and system integration. In the fields of industrial catalysis, separation and electrochemistry, 10 green technologies with independent intellectual property rights have been developed successfully with a series of efficient ILs-based catalyst, absorbent, electrolyte and system integration. These technologies include the new industrial process for production of alkylation oil by using ILs as the promoter instead of sulfuric acid (capacity: 200,000 tons/a), the pilot plant of co-production of EG (ethylene glycol)/DMC (dimethyl carbonate) with the capacity of 30,000 tons/a, the industrial demonstration plant of green process for production of MMA (methyl methacrylates)/MAO (methallyl alcohol) from isobutene instead of the toxic hydrocyanic acid and corrosive solvents (capacity: 20,000 tons/a), the kiloton demonstration plant for depolymerization of PET polyester, the demonstration of NH_3 recovery (capacity: 8,000,000 standard cubic meter/a) with ILs as the solvent replacing water; the new generation of lithium battery electrolytes with ILs as additives (capacity: 5,000 tons/a), etc. More than 30 pieces of international and domestic innovation patents have been issued for this project. The research is at the worldwide advanced level, with some part reaching the leading international level, as evaluated by Chinese Academy of Sciences and China Petroleum and Chemical Industry Federation.

3 万吨 / 年离子液体催化 CO_2 转化合成 DMC/EG 工业装置

Pilot plant of co-production of EG (ethylene glycol)/DMC (dimethyl carbonate) (capacity: 30,000 tons/a)

推荐单位 / Recommended Units

中国科学院过程工程研究所
Institute of Process Engineering, Chinese Academy of Sciences.

完成单位 / Accomplished Units

中国科学院过程工程研究所
Institute of Process Engineering, Chinese Academy of Sciences.

合作单位 / The Main Cooperation Units

林州市科能科技材料有限公司
Linzhou Keneng Materials Technology Co., Ltd.
山东易达利化工有限公司
Shandong Yidali Chemical Co., Ltd.
河南省濮阳市盛源石油化工有限公司
Puyang Shengyuan Petrochemicals Co. Ltd.
惠州市宙邦化工有限公司
Huizhou Zhoubang Chemical Co., Ltd.
江苏奥克化学有限公司
Jiangsu Oxiranchem, Inc.
吴江宏力纺织企业发展有限公司
Wujiang Hongli Textile Enterprise Development Co., Ltd.

中国石油和化学工业协会技术发明二等奖

China Petroleum and Chemical Industry Association Technological Invents Prize (Second Class)

2015 年中国优秀专利奖

2015 Chinese patent award of excellence

社会效益和经济效益：

本项目成功地开发和应用了诸多新型化工过程，技术推广应用 10 余套。近三年累计销售额 16.64 亿元，新增就业岗位 1000 多个，技术辐射至“带路” 国家，产生了显著的经济和社会环境效益。受到德国 BASF、美国 Ford 等 40 多家企业高度评价或开展合作，引领并推动了离子液体及绿色技术的产业化进程。

Economic and Social Benefits:

Several green chemical processes have been successfully developed in this project, which have been applied in 10 backbone enterprises in chemical industry. In the past 3 years, the total sales income has amounted to 16.64 billion RMB, more than 1,000 new job opportunities have been created. Some related technologies can be applied in OBOR countries through joint efforts, which could greatly promote the local economic, social and ecological construction. These innovative technologies, which would lead and promote the industrialization process of ionic liquids and green technology, have been well recognized by more than 40 international and Chinese companies, such as BASF, Ford, and SINOPEC, etc.

20 万吨 / 年离子液体协同催化烷基化生产汽油添加剂

Industrial production line of alkylation oil by using ILs as the promoter instead of sulfuric acid (capacity: 200,000 tons/a)

5 千吨 / 年新型离子液体电解液生产线

Production line of lithium battery electrolytes with ILs as additives (capacity: 5,000 tons/a)

团队成员 / Team Members:

张锁江
Zhang Suojiang

中国科学院过程工程研究所

主要贡献：首席科学家，项目总体设计和总体负责。

Institute of Process Engineering, Chinese Academy of Sciences

Chief scientist. He was responsible for overall idea and design of the whole project.

张香平
Zhang Xiangping

中国科学院过程工程研究所

主要贡献：核心研发人员，研发了离子液体规模制备及NH_3回收技术，为其他工艺的集成做出了重要贡献。

Institute of Process Engineering, Chinese Academy of Sciences

Core R&D personnel. Developing the scale-up preparation technology of ILs and NH_3 recovery technology, making contributions to system integration for several technologies.

何宏艳
He Hongyan

中国科学院过程工程研究所

主要贡献：研发和管理人员，开展过程机理研究，进行项目管理。

Institute of Process Engineering, Chinese Academy of Sciences

R&D and project management personnel. Making contributions to the process mechanism research, responsible for projects management.

吕兴梅
Lv Xingmei

中国科学院过程工程研究所

主要贡献：核心研发人员，研发了离子液体规模制备及PET聚酯化学转化利用技术。

Institute of Process Engineering, Chinese Academy of Sciences

Core R&D personnel. Developing the scale-up preparation technology of ILs and PET polyester chemical conversion technology.

成卫国
Cheng Weiguo

中国科学院过程工程研究所

主要贡献：核心研发人员，研发了离子液体催化的CO_2转化合成DMC/EG技术。

Institute of Process Engineering, Chinese Academy of Sciences

Core R&D personnel. Developing the CO_2 conversion to DMC/EG technology based on the ILs-catalyst.

聂　毅
Nie Yi

中国科学院过程工程研究所

主要贡献：核心研发人员，研发了离子液体碳纳米导电液及导电纤维制备技术。

Institute of Process Engineering, Chinese Academy of Sciences

Core R&D personnel. Developing the preparation technology of nano-carbon conductive solution and conductive fibers.

王　蕾
Wang Lei

中国科学院过程工程研究所

主要贡献：研发人员，研发了替代剧毒氢氰酸的异丁烯生产MMA/MAO技术。

Institute of Process Engineering, Chinese Academy of Sciences

R&D personnel. Developing a new technology of the direct oxidation of isobutene for manufacturing MMA/MAO to replace the highly toxic hydrocyanic acid.

赵国英
Zhao Guoying

中国科学院过程工程研究所

主要贡献：研发人员，研发了离子液体协同催化烷基化生产汽油添加剂技术。

Institute of Process Engineering, Chinese Academy of Sciences

R&D personnel. Developing the synergetic catalyzed alkylation technology with ILs to produce gasoline additive.

董海峰
Dong Haifeng

中国科学院过程工程研究所

主要贡献：研发人员，离子液体法氨回收技术的研发及推广。

Institute of Process Engineering, Chinese Academy of Sciences

R&D personnel. The development and promotion of ammonia recovery technology with ILs.

张　兰
Zhang Lan

中国科学院过程工程研究所

主要贡献：研发人员，研发了高电压锂电池和高温离子液体电解液。

Institute of Process Engineering, Chinese Academy of Sciences

R&D personnel. Developing the high-voltage lithium battery and high-temperature ILs electrolyte.