Recent Advances in CO_2 Conversion in CAS

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1. Introduction (Times New Roman or Times-Roman 12 pt)

A global transition to a clean, efficient and diverse energy system is accelerating. With the plan of building an energy sector that is clean, low-carbon, safe and efficient, "Revolutionary Strategy of Energy Production and Consumption (2016-2030)" was drafted and published by Chinese government, providing an insight of energy policy and development paths of China toward 2030 and 2050. Remarkable improvement have been made in technology and equipment, and in the efficiency of both domestic and industrial energy use. Recently, the uptake of renewable energy is greatly enhanced in China. Meanwhile, the fossil fuels still plays and will play a major role in the energy consumption, as well as chemical production in China. With China's ambition of descending CO_2 emissions per unit of GDP in 2030 to 60%-65% than in 2005, the CO_2 utilization technologies are developed rapidly in China. Fossil energy coupled with CO_2 conversion and utilization technology, which has experienced rapid growth in recent years due to the easy access and low cost of fossil energy, will bring huge carbon emission reduction potential and economic benefits in the near future.

2. R&D activities related to clean energy technology

To meet the national strategic demands, a new idea on the development strategy of energy technology of China is proposed, which is construction of a new energy system by integrated development of fossil energy, renewable energy and nuclear power.

Instead of coal-firing for power generation, conversion of coal into diverse chemicals could be an approach for clean coal utilization. DMTO, DMTE, syngas to olefins, and other technologies have been developed and industrialized. Renewable energy related researches have also been conducted from fundamental understanding to applications in solar energy, energy storage, fuel cell, etc. To realize the carbon cycle for coal utilization and decrease the carbon emission, hydrogen, generated from electrolysis with renewable energy, could be taken as the "carrier". And hydrogen related studies, include production, separation, storage and utilization, have been carried out in DICP. The research on conversion of CO_2 has also been conducted, including eletrochemical CO_2 reduction reaction and catalytic reduction of CO_2 to produce olefins, fuels.

3. Specific research activities in renewable energies, next generation energy management system with batteries, hydrogen, CCUS, and related technologies

The CO_2 utilization technologies are developed rapidly in China. Fossil energy coupled with CO_2 conversion and utilization technology, which has experienced rapid growth in recent years due to the easy access and low cost of fossil energy, will bring huge carbon emission reduction potential and economic benefits in the near future. Meanwhile, nuclear/renewable energy assisted CO_2 to fuel and chemicals technology, boosted by the advancement of zero-carbon power generation technologies, promises to be one of the most competitive controllable CO_2 reduction technologies in the medium term. Solar-driven CO_2 conversion technology, which

can realize the ecological carbon cycle, is expected to be the most promising CO_2 reduction technology in the long run.

Related programs/projects conducted by the institute

- Strategic Priority Research Program of Chinese Academy Science/ Hydrogen/liquid fuel from renewable energy (2018-2023)
- Strategic Priority Research Program of Chinese Academy Science/Non-Electric Applications of Nuclear Energy (2018-2023)
- Strategic Priority Research Program of Chinese Academy Science/ 100% Renewable Energy Application Demonstration (2018-2023)
- Strategic Priority Research Program of Chinese Academy Science/Key technologies and demonstration of renewable energy (2018-2023)

4. International collaboration

4-1 International alliance/networking development

DICP is an internationally well connected institution. Through academic communication, personnel exchange, students cultivation, joint projects, symposium and conferences, DICP is tightly cooperated with universities, institutions and companies around the world. Today our faculty members are playing active roles in more than 100 international academic communities. We have also established strategic partnerships with internationally well-established research institutions and companies.

Since 2006, each year, DICP provides more than 1 million Yuan to support the DICP Symposium Program in an effort to promote the international communication and collaboration between DICP and the international scientific community, to discuss new research area or emerging research direction in-depth.

In the past 2 years, 2nd CAS (Chinese Academy of Sciences) and RS (Royal Society) joint Policy Dialogue, CAS-ASSAF (Academy of Science of South Africa) - Leopoldina (German National Academy of Sciences Leopoldina) joint symposium, CAS-CEA (the French Alternative Energies and Atomic Energy Commission) joint symposium, CAS-NST (National Research Council of Science and Technology, South Korea) joint symposium, had been held by DICP in energy related aspects, such as energy storage, energy efficiency, carbon cycling, which promotes the communication of CAS researchers with scientists all over the world.

4-2 International joint R&D activities

DICP is conducting energy related researches with partners all over the world in the field of fundamental and applied research. The topics cover a wide range of fields, including bio-Fuels, solar energy and solar fuels, energy storage, fuel cell, hydrogen generation and storage, catalytic process for fossil energy utilization, etc.

Related programs conducted in the institute

- Efficient Utilization of Heat and Electric power from Renewable Energy in Urban Areas Mediated by Hydrogen Energy Project（2016-2019）

5. Future perspectives

Fossil Fuels, especially coal still dominates the China energy market, and will be an

important component of it in a long time. To realize China's ambition on environment protection, it is critical to integrated develop fossil energy, renewable energy and nuclear energy. The Chinese government has launched a series of policies, regulations and guidance to accelerate the technology development and industrial upgrading. To meet national strategic goals, China encourages innovation in technology, in industry, and in business models, and will pursue green and low-carbon energy development suited to national conditions and adapted to positive international trends in the energy technology revolution. As an institute with long history of conducting energy research, DICP puts best efforts to promote the development of energy technology to meet national strategic demands. Through carrying out the CAS Strategic Priority Research Program "Transformational Technology for Clean Energy and Demonstration" together with other institutions of CAS, DICP is willing to provide cutting-edge theories and technologies and to realize clean utilization of fossil energy, renewable energy demonstration and "Liquid Sunshine" technology application, for the construction of a clean, low carbon, safe and highly efficient energy system.

Prof. Zhongmin LIU

2019 Vice President, Executive committee, International Zeolites Association
2017 Director General, Dalian Institute of Chemical Physics (DICP) and Qingdao Institute of Bioenergy and Bioprocess Technology (QIBEBT),CAS (Current)
2015 Academician, Chinese Academy of Engineering
2011 Director, National Energy Low-carbon Catalysis and Engineering R&D center (Current)
2008 Director, National Engineering Laboratory for Methanol to Olefins (Current)
2008 Deputy Director General, Dalian Institute of Chemical Physics, CAS
1996 Professor, Dalian Institute of Chemical Physics, CAS
1994 Associate professor, Dalian Institute of Chemical Physics, CAS
1991 Assistant professor, Dalian Institute of Chemical Physics, CAS

Research interests:

- Catalysis and New Catalytic Reactions
- Molecular Sieves Synthesis
- Methanol & Derivatives Conversion Technologies
- Syngas Conversion
- Hydrocarbon Conversion Research
- Multiphase Catalytic Process Development and Scale-up
- Engineering R&D

Major Honors
2018 Professional Achievement Award for Innovations in Green Process Engineering by AIChE
2017 National Innovation Competition Awards
2017 The 6th Chinese Catalytic Achievement Award in
2015 The Science and Technology Innovation Award of 2015 HLHL Foundation
2014 The state Technological Invention Awards First Prize on “The technology of methanol to olefins (DMTO)”
2013 The China Petroleum and Chemical Industry Federation (CPCIF) Science and technology Progress Award (special class) on “Sets of Industrial Technology Development and Application in Demonstration Project of Coal to Olefin in Baotou”
2012 National Engineering Laboratory for Methanol to Olefins won the state Innovative Talents Promoting Plan in Key Area
2011 The research group for methanol to olefins won Outstanding Science and Technology Research Achievement Prize of the Chinese Academy of Sciences