COCI Regional Workshop[1]
Chemical Industry of Sustainable Development
Beijing, 12 September 2016

The IUPAC Committee on Chemistry and Industry (COCI) has held four regional workshops in the past. The 5th and latest one was held in Beijing on 12 September 2016 in Beijing.
The workshop was planned and hosted by Dr. Zaiku Xie and members of his team of SINOPEC. Dr. Xie is Director of Science &Technology Department at SINOPEC and he is a Titular Member of COCI.

IUPAC COCI members are very grateful to Dr. Xie and SINOPEC for hosting an excellent Workshop. The following is a summary of the meeting which was well attended and praised by the attendees in the discussion session at the end of the meeting.

We were also honoured to have the Vice-President of IUPAC, Professor Zhou Qifeng of Peking University to open the workshop. He also participated throughout the day and entertained us at the Peking Duck banquet, which was kindly hosted by SINOPEC.

COCI Members and workshop participants

[1] See IUPAC project 2016-020-1-022 or www.iupac.org/project/2016-020-1-022

The COCI Regional Workshop in Beijing was the 5th such workshop organised by members of the committee and held in different global regions and with relevant topical agendas.
This workshop brought together speakers from China, Korea, India and Switzerland. The focus of the meeting was Sustainability and how the industry is working towards this goal.

In addition to the local speakers there was participation by the Vice-President of IUPAC Prof Qi-Feng Zhou as well as members of the COCI from Canada, USA/Netherlands, Japan, Belgium, Switzerland, Korea and Russia.

The Workshop was opened with welcoming remarks by Director of Science & Technology Department at SINOPEC, a Titular Member of COCI and the Host for the Workshop. Professor Zhou Qi-Feng and Dr. Bernard West Chair of COCI.

The workshop was divided into three sessions, with Q&A. A fourth open session was held to enable broader questions to be discussed and feedback on the day to be given. The agenda and summaries of the presentations are included in Annex.

Points of discussion following the presentations

- IUPAC is starting a new interdivisional committee on Green Chemistry for Sustainable Development. IUPAC and COCI are looking for ideas for potential projects.
- Green technology, products and processes, green chemistry: Green Chemistry Principles are guidelines for industry but are high level. Is there interest in indicators, certification, standards? Would it be interesting for IUPAC to create certification or labels based on sustainable chemistry or green chemistry? How would IUPAC do that? Every division/committee will probably have activities related to this Interdivisional Committee, the challenge will be to coordinate them within the terms of reference of Interdivisional Committee. This could relate to SAICM areas as well (generate list of projects from IUPAC for SAICM to consider). Certification could be controversial.
- Comment: Categorization based on assessments and scores in AICM was interesting to see (in that case, it provided groups that needed to take similar actions). Not yet forcing companies to pick suppliers that already comply. Promoting KPI/Scoring system over certification. Think about ISO, which is a commercial enterprise and compliance more than an organization to drive improvements. We have Responsible Care, other rating systems; to come with a standard is difficult across such a wide range of technologies and sizes. Interesting concept, but need to work with ICCA and other groups. Not have enough communications. Categorization works with reputation/peer pressure – but would we need a mechanism to enforce.
- Start with strong inventory.
- Large companies talk more about sustainability; green chemistry is more discussed by academic institutions. (Sustainability does include green chemistry but includes other things such as economic impact, community, people, etc).
- Top management of companies: sustainable development is the goal of the company. Green chemistry can be a part of it but it is a broader concept.
- COCI should explain difference between Green Chemistry and Sustainability to rest of IUPAC.

- A label on a product may be more interesting to consumers. May be harder to measure or decide who can use it.
- In China, before students come to the lab they must have a safety training. There are required courses for this. Recently had a training for chemical plant workers – most important is the person and their safety knowledge and culture, ability to identify risk. For students, some of the chemistry departments are teaching the students well on safety topics. In India, students do not have enough training and so industry is doing a lot of training as early part of the career. (Relates to IUPAC Safety Training Program and the success that the training has had and what the Fellows have accomplished in home institutions and home countries. Ex: Dr. Grover has probably reached 10,000 people and will be starting an IUPAC Regional Safety Training Program. The Latin America training center will be in Montevideo, Uruguay and has launched in late 2016.
- Appreciate the good opportunity to learn during this workshop. Green chemistry is part of sustainability, produce, use, and transport chemicals safely; green chemistry focuses on producing more efficiently and safely. Government can support these activities. Goal of institute to produce with alternative feedstocks, using less hazardous raw materials. Progress may be slow but it is occurring and takes joint effort between disciplines. Progress integrity important, too: consume less energy, lower emission, may also reduce stress on HS&E.
- Overall umbrella for company: Responsible care: do the right thing and be seen to do the right thing. Sell better products, HS&E standards, improve processes, intensification of process, storage and production rates, transportation.
- IUPAC has many academic volunteers working on new technology developments. Transferring and leveraging to industry could be interesting opportunity.
- Very high quality talks today. Speakers were every impressive with the technology and knowledge that we have. If readers would like specific information, please directly contact the authors.
- Article for Chemistry International and Chemical Weekly (India).
- Need to share this with rest of IUPAC and our home countries.
- Very well organized workshop with excellent speakers.

Conclusion

This was another successful COCI Regional Workshop, thanks to the skill and generosity of Dr Xie and his colleagues at SINOPEC. Thank you all very much.

The Committee on Chemistry and Industry held its annual meeting the day after the Workshop. The draft minutes are on the COCI website. Again, we have to thank SINOPEC for their hospitality in hosting that meeting in SINOPEC Mansion. Also, the traditional COCI family dinner was an excellent informal banquet hosted by Dr. Ma, Senior Vice President of Sinopec Corp. We celebrated Moon Festival with small slices of Moon Cake.

Sustainable Development of Refining and Chemical Industry in China

Dingyi Hong
The Chemical Industry and Engineering Society of China

This paper summarized the status, challenges and development trends of Chinese oil refining and chemical technology based on oil refining capacity, demand structure change and quality upgrade of oil products, shale oil/gas revolution, energy saving and environmental protection and emission reduction standards are increasingly strict etc., introduced the newest refining and chemical technology development in China including technologies of large Aromatic production and gasoline/diesel production for car using of “Chinese National Standard V”, and from the refining industry to conduct technical studies of molecular refining, automotive lithium battery research, new energy vehicle technology including fuel cell vehicle research and development, conducted green hydrogen science research, green carbon science research, researched and optimized processing and full use of coal resources etc., forecasted the cutting-edge science and technology of refining and chemicals for sustainable development in the future.

Petrochemical industry is facing new development opportunities, new challenges. At the same time of promoting the traditional refining and chemical technology development and application, needing for green carbon science, hydrogen as a new scientific concept, strengthen scientific research and theoretical breakthroughs in diversification of raw materials, high-end of chemical products, low-carbon green etc., supporting china refining & chemical industrial transformation and upgrading, speeding up its continued and effective development.

Process Intensification: Higee Technology as an Example

Jian-Feng Chen

State Key Laboratory of Organic-Inorganic Composites, Research Center of the Ministry of Education for High Gravity Engineering and Technology, Beijing University of Chemical Technology, Beijing 100029, PR China

Tel: +86 10 64446466; Fax: +86 10 64434784.

E-mail address: chenjf@mail.buct.edu.cn

Process intensification technology, aiming for a substantially smaller, cleaner, safer, and more efficient process technology, has generated much interest in recent years. Higee (high gravity) technology, originally invented in 1979 by Dr. Ramshaw and his coworkers for separation, is one of the typical process intensification technologies. A rotating packed bed (RPB), to simulate the high gravitational field in Higee technology, was widely used as the key device to intensify the mass transfer and also micromixing processes.

Over 30 years' exploration has demonstrated that RPB is powerful for process intensification in chemical and materials syntheses, etc. Based on our more than 15 years experiences of commercial operations, RPB shows the advantages of small size, rapid attainment of steady state, short startup, and shutdown times. Meanwhile, RPB is reliable, operated similarly as a pump in view of long time industrial running. It becomes a platform for wide applications, such as reaction and separation. We believe that RPB is now opening a door to various commercial applications in chemical, environmental, energy, pharmaceutical and material industries, etc. In this talk, typical development and commercial operations of RPBs developed in my group for the production of MDI, nanoparticles, and desulfurization will be illustrated.

Vehicle Fuel Upgrading Technologies in China

Mingfeng Li
Research Institute of Petroleum Processing (RIPP), SINOPEC, Beijing, 100083

Along with the dramatic consumption of vehicle fuel in China nowadays, the massive pollutant emissions have become an unneglectable concern for the society and thus induced the urge of action for pollutant reduction. Regulations on exhaust emissions have been established and/or executed continuously including State-IV vehicle emission standards on January 1st, 2014 and State-V on January 1st, 2017, respectively. State-VI is now under investigation and examination.

RIPP, as a leading petroleum research institute in China, has been providing comprehensive technical support to not only oil quality control and oil upgrading processing standardizations but also the related catalyst and technology research and development. To meet State-V vehicle emission standards in regards to gasoline production, key technologies for reducing sulfur and benzene content including FCC feed pretreatment, gasoline S-Zorb, selective HDS, and catalytic reforming are developed for reducing benzene content by RIPP. Moreover, specific hydrotreating catalysts and technologies for ULSD and Cetane Number Improvement are also proposed by RIPP in respect to State-V vehicle emission standards on diesel production.

Furthermore, RIPP is steadily and continuously pursing and devoting on technology development and improvement in regards to the existing and developing regulations. For instance, new technologies of environmental friendly C_4 alkylation and new generation of C_5 and C_6 isomerization can be accounted for producing clean gasoline. In terms of clean diesel production, technologies on conversion from Inferior Diesel or LCO to gasoline or aromatics (LTAG or RLG) are beneficial on optimizing the product composition in refining units.

In short, following the specific technologies we developed for vehicle fuel production to meet state-V regulations, RIPP continuously devotes to new technology development for state-VI vehicle emission standard.

Methanol to Olefins Technologies Developed by SINOPEC

Jiawei Teng

SINOPEC Shanghai Research Institute of Petrochemical Technology, Shanghai China

Ethylene and propylene are the most important basic organic products. Almost all the ethylene is supplied from thermal steam cracking of hydrocarbon feedstocks (primarily naphtha and ethane). The naphtha steam cracking process is the main propylene source with about 65% share in the primary production. Propylene could also be generated from FCC units, PDH, OCT or CTO. How to achieve the sustainable development of ethylene and propylene production, olefin manufacturers are seeking cost effective options to increase the ethylene and propylene production. SINOPEC has developed two types of new olefin production technologies from methanol, the latest advance in catalytic materials and process for S-MTO and S-MTP will be reported in the paper.

S-MTO Process was developed by SINOPEC for selective production of ethylene and propylene from methanol. The catalyst used in the process is based on a SAPO-34, which has very high carbon selectivity to lower olefins. The catalyst activity is maintained by continuous transfer of coked catalyst from the reaction section to the regeneration section where the coke is burned with air. A commercial S-MTO plant, which scale capacity is 600 kt methanol/a, was built and started up in 2011 in China. S-MTO combined with SINOPEC Olefin Catalytic Cracking process (OCC) to convert the heavier olefins, the overall yield of ethylene and propylene is over 86%.

SINOPEC Methanol to Propylene (S-MTP) process was developed for selective production of propylene from methanol. The full crystalline hierarchical ZSM-5 was invented and used as catalyst for S-MTP, the unique catalytic material has many characteristics such as small crystal units, hierarchical pores and full crystalline frameworks, which result in more activity sites and longer cycle time than common catalyst. An industrial demo unit, which scale capacity is 5kt methanol/a, was built and stared up in 2012 in China, the performance of catalyst, S-MTP reactor design, reaction process and separation process were verified.

Development and Prospect of Biomass Energy

Kai Qiao
Fushun Research Institute of Petroleum and Petrochemicals, SINOPEC, Fushun 113001, China

Volatile oil price and growing emphasis on environmental conservation have pushed forward the development of biomass as a vital source of renewable energy. In addition, biomass could provide a variety of chemicals and materials. Countries such as Brazil, Japan, USA, the UK and China are actively encouraging the use of biomass to reduce the dependence on fossil fuels.

In the context of current interest in biomass exploitation, considerable efforts have been made at Fushun Research Institute of Petroleum and Petrochemicals (FRIPP). Of late, a number of research schemes based on the utilization of two kinds of common and important biomass feedstocks, lignocellulosic materials and biological oils and fats, are in progress. i) The abundant lignocellulosic materials in nature such as crop residues, grasses, sawdust and wood chips mainly consist of lignin, cellulose and hemicellulose. At FRIPP, the cellulose and hemicellulose components of lignocellulosic materials were converted into promising bioproducts, including bioethanol, biobutanol, L-lactic acid and D-lactic acid with the assistance of the fermentation technology. The conversion usually involves two processes: hydrolysis of cellulose in the lignocellulosic materials to reducing sugars catalyzed by the cellulose enzymes, and fermentation of the sugars to the desired bioproducts carried out by yeasts or bacteria. To date, a 500 t/a pilot plant of bioethanol and a pilot device of 3 m^3 scale for the lactic acid production have been successfully run at FRIPP and its cooperators. More importantly, to make full use of all the components of the lignocellulosic materials, high-pure lignin was extracted from the fermentation residue and used for the synthesis of lignin-based phenolic resins, polyurethanes and agricultural mulch films. Besides the biological conversion route of the lignocellulosic materials, thermal conversion route was also studied (863 project). Taking advantage of the microwave pyrolysis technology, gasification of the lignocellulosic materials for the fuel gas or syngas generation was achieved. A 50 kg/h microwave-assisted gasification device for producing high heating value fuel gas has been successfully run, and a microwave pyrolysis reactor in combination with a directional gasification apparatus for the production of low-tar syngas was developed meanwhile. ii) Biological oils and fats, as another essential part of the biomass resources, could be decomposed into fatty acid and glycerol through hydrolysis treatment. The valuable use of the fatty acid is for the synthesis of fatty acid methyl/ethyl esters, known as biodiesels, which are renewable replacements to petroleum-based diesels. At FRIPP, 14 kinds of fatty acid methyl/ethyl esters derived from vegetable oils were successfully prepared and further studies on the utilization of these synthesized fatty acid methyl/ethyl esters as lubricating additives also showed excellent results. Remarkably, glycerol, the conventional “by-product” of oil hydrolysis, was economically and efficiently fermented into 1,3-propanediol (1,3-PDO) which commonly serves as monomer for the synthesis of functional polymers such as polytrimethylene terephthalate (PTT) and polytrimethylene-2,5-furandicarboxylate (PTF). As early as 2007, a 200 t/a pilot plant of 1,3-PDO was built and run at FRIPP. Later, a 3000 t/a process package for the 1,3-PDO fermentation was also designed and qualified. Furthermore, FRIPP explored the synthesis technology of vegetable oil polyols, which are known as precursors for the synthesis of polyurethanes. Last it should be mentioned that the collection and cultivation work of oil-producing microalgae has started at FRIPP since 2008 to broaden the source of biological oils.

Indeed, biomass industry has a bright future and is of significance for the energy security as well as environmental concerns, whereas two principles should be emphasized in terms of biomass exploitation. First, attention ought to be focused on the atom efficiency. The biomass exploitation process should be a process of high atom economy. The value of each component of biomass feedstocks is equivalent, utilization of the desired component cannot be done at the sacrifice of other components. On the other hand, emphasis is also placed on the need for integrating the development of biofuels with that of the biochemicals and biomaterials, thus circumventing the current lower oil prices.

Status of Safety, Environment and Health in Indian Chemical Industry

Dr. B. Saha

Nagarjuna Agrichem Limited, Lakshmi Tower, Nagarjuna Hills, Hyderabad 500082, India
E-mail: drbsaha@rediffmail.com; bsaha@nagarjunaagrichem.com

Indian chemical industry is 3rd largest in Asia and 6th largest in the world. Unfortunately, one of the worst industrial accidents in the history of chemical industry took place in India (Bhopal Disaster, 1984). Since then, many stringent rules and regulations have been introduced by Government of India and situation is much better now. Indian chemical industry has largely accepted the principles of “Responsible Care”. Government of India in its new draft “National chemical Policy” has given priority to sustainable initiatives. The Indian chemical industry is now making developmental choices which are not only economically efficient, but also socially acceptable and environmentally sound. The objective of National Chemical Policy is “to facilitate the accelerated growth and development of the chemical industry to meet local and global requirements, in an environment friendly manner, with focus on innovation, sustainability and green technologies”. Some of the chemical industries in India have implemented “Zero Liquid Effluent Discharge Plant”. Details will be discussed during the presentation.

Responsible Care in China

Housheng Xu
China Petroleum and Chemical Industry Federation

The RESPONSIBLE CARE working committee established by CPCIF in October, 2011, symbolizes a new normative state for responsible care activities. The committee is composed of six groups such as storage & transportation safety, emergency response, propaganda & training, occupational health, product safety and chemical industrial park. The sponsors of RESPONSIBLE CARE working committee include 56 domestic joint-venture cooperations, such as SINOPEC, CNPC, CNOOC, CSEC, CHEMCHINA, BAYER, and DOW CORNING. Series of important activities have been conducted by the committee, such as CHINA RESPONSIBLE CARE Promotion Conference. The committee is playing more and more significant role in guiding and promotion of responsible care issues, enhancing the propagation of responsible care concept, and making better & deeper influence on petro-chemical industry in China.

Safety Engineering Technology and Response Care for petrochemical industry

Wei Xu
Sinopec Research Institute of Safety Engineering

Health Safety & Environment has become the most important core values in petrochemical industry. Application of Integrated safety engineering technology (ISET) and response care (RC) policies can minimize losses and guarantee normal operation within the process industry. This presentation, by using an" onion" layer protection theory, briefly introduces the group technologies of ISET, such as chemical inherently safer technology, functional safety and safety control system, mechanical integrity technology, lightning and static control, abnormal situation monitoring and precaution and emergency response, which could provide technical support for chemical plants. Reliable safety management methods, as PSM and RC, could prevent the major incidents as well. Combination of technology and management give us an efficient way to improve the safety level for petrochemical plants.

PROGRAM

Time	Event
9:00-9:30	Introduction and welcome, Chaired by Dr. Xie Zaiku, the Chairman of the Workshop Zhou Qifeng Vice-President (President-elect) of IUPAC Dr. Bernard West, the Chairman of COCI, IUPAC.
Section 1: Development of Green Chemical Technology	Co-chaired by Dr. Kazuhiko Ishikiriyama and Dr. Fang Xiangchen
9:30-9:50	Dr. Hong Dingyi, Chemical Industry and Engineering Society of China Topic: Sustainable Development of Refining and Chemical Industry in China
9:50-10:10	Prof. Chen Jianfeng, Beijing University of Chemical Technology Topic: Process Intensification: Higee Technology as an Example
10:10-10:40	Coffee Break
10:40-11:00	Dr. Li Mingfeng, SINOPEC Research Institute of Petroleum Processing Topic: Vehicle Fuel Upgrading Technologies in China
11:00-11:20	Dr. Qiao Jinliang, SINOPEC Beijing Research Institute of Chemical Industry Topic: Opportunity and Challenge of Polymer Industry in China
11:20-11:40	Dr. Teng Jiawei, SINOPEC Shanghai Research Institute of Petrochemical Technology Topic: Methanol to Olefins Technologies Developed by SINOPEC.
11:40-12:00	Prof. Yang Yongrong, Zhejiang University Topic: Combined Principle and Industrial Application on High-efficiency Recovery of Vent Gas from Ethylene Polymerization Process
12:00-13:30	Lunch Time
Section 2: Biomass Energy and Chemicals	Co-chaired by Dr. B.Saha and Dr. Wang Rongwei
13:30-13:50	Prof. Liu Haichao, Peking University Topic: Biomass Chemicals
13:50-14:10	Mr. Qiao Kai SINOPEC Fushun Research Institute of Petroleum and Petrochemicals Development and Prospect of Biomass Energy
14:10-14:40	Coffee Break
Section 3: Responsible Care	Co-chaired by Dr. Changhyun Choi and Dr. Qiao Jinliang
14:40-15:00	Dr. B Saha Topic: Status of Safety, Environment and Health in Chemical Industry in India
15:00-15:20	Mr. Michel Houmard Topic: Responsible Care
15:20-15:40	Mr. Housheng Xu China Petroleum and Chemical Industry Federation Topic: Responsible Care in China
15:40-16:00	Dr. Xu Wei, SINOPEC Research Institute of Safety Engineering Topic: Safety Engineering Technology and Responsible Care for Petrochemical Industry
16:00-17:00	Discussion
17:00-17:15	Summary by Dr. Bernard West