Regular Course on Future Advanced Technology for Petroleum Industry

1. Background and Aim

This course gives priority to the new technologies those should be applied to the oil industry in the future, and thus differs from other ordinary regular courses. According to this objective, its main themes were selected from among future energy technologies, such as biomass fuel technologies, photovoltaic generation, carbon dioxide capture and storage (CCS), underground methane production, fuel cell vehicles and hydrogen stations. The course was implemented over a period of 18 days, from April 8 to 25, 2013.

2. Course Content

2.1 Training at JCCP

(1) Future Strategies of Japanese Oil Companies

This lecture introduced the characteristics of Japan's oil industry and discussed the various problems facing Japan today and their impact on the industry. It focused particularly on the shrinking oil market, which is due to such factors as the declining birth rate, the increasing numbers of fuel-efficient cars, and the transition from oil-fired to LNG-fired power plants. It also introduced new business activities initiated by Japan's major oil companies based on information collected from each company's public website. Their challenges to develop new technology not only in their core business but also other business fields have produced various seeds of future business. Hopefully this session has provided a useful vision of reference to the participants.

(2) Simulation for Optimization of Refinery Unit Configurations Using a Virtual Refinery

In this lecture, a simulator practice demonstrated how profit could be changed by refinery configuration. The participants were asked to examine more profitable

operational methods on their own after completion of the planned simulation, and the top three participants with the highest scores were awarded. This simulation workshop was a new approach taken this fiscal year.

(3) Carbon Dioxide Capture and Storage (CCS) Technology
(Lecturer: Mr. Masaki Iijima, Mitsubishi Heavy Industries, Ltd.

The topic of this lecture was the development of improved amine solutions as a means for a more efficient removal of carbon dioxide, the main substance of global warming. It focused particularly on providing a good understanding of the characteristics of amine solutions, such as their corrosion resistance and low consumption of heat energy for regeneration. The carbon dioxide that is captured could also be used for enhanced oil recovery (EOR) in oil fields.

Mitsubishi Heavy Industries has conducted CCS demonstration tests in 10 locations to date, and has plans to begin a 500 t/day operation in Qatar in 2014.

(4) Development Status of Fuel Cell Vehicles and Hydrogen Infrastructure
(Lecturer: Mr. Kazuhiro Kikuchi, JPEC)

JPEC provided a lecture that widely covered the development trend of fuel cell vehicles, related technologies (pressure vessels, regulations), and the construction of hydrogen infrastructures.

The lecture also introduced Toyota Motors' plan to launch fuel cell vehicles in 2015 and a project that is being planned for the construction of infrastructure to connect the Kanto, Chukyo, Osaka and Kitakyushu areas.

(5) Photovoltaic Generation
(Lecturers: Mr. Masahiro Kakuwa, Showa Shell Sekiyu K.K.; Mr. Soichi Ogawa, Toa Oil Co., Ltd.)

A lecture was given on photovoltaic generation as an important fundamental technology to cope with global warming, centered on Solar Frontier's system, which boasts an outstanding track record in and outside of Japan. Showa Shell Sekiyu began R&D activities in this field from an early stage.

The lecture also introduced the installation of a photovoltaic generation system in a waste treatment facility (BeAAT) operated by TAKREER in UAE (including ceremony photos) and a 10MW project being implemented in Saudi Aramco.

(6) World's Energy Situation
(Lecturer: Mr. Mitsuyuki Maeda, Energy & Innovation Institute)

As a comprehensive wrap-up of the course, the last lecture at JCCP discussed the world's energy situation and trends in alternative energies. The lecture triggered many questions from the participants, stemming from their serious concern about the impacts of shale gas and shale oil, which are recently being produced in the United States and Canada, on crude oil producers.

2.2 Offsite Training

(1) Chugai Technos Corporation, Biofrontier Center

Chugai Technos' Biofrontier Center provided training in the following three areas.

1) Methane production in depleted oil fields
   An overview was given of the technology for producing methane by injecting carbon dioxide in depleted oil fields in the presence of hydrogen-producing bacteria and nutrient salts.
2) Carbon dioxide leakage monitoring at carbon dioxide capture and storage (CCS) sites
   CCS technology is believed to be able to capture and retain carbon dioxide deep beneath the ground for long periods of time, but changes in bedrock conditions could cause the carbon dioxide to leak out to the ground surface. Thus, a systematic technology is needed that would allow monitoring of a wide area at reasonable cost.
3) Treatment of oil-contaminated soil
   A technology for treating oil-contaminated soil using bacteria that live in the root of plants was introduced. The hands-on experience in the dyeing and microscopic observation of aerobic and anaerobic bacteria was highly evaluated by the participants.

(2) Cosmo Oil Co., Ltd., Research & Development Center

Cosmo Oil, the only oil company that was visited in this course, provided training in (1) bioethanol, (2) biomass to liquid (BTL), and (3) catalyst development (diesel fuel deep desulfurization, FCC) in relation to its research activities as an oil company.

Comments from the participants indicated a strong interest in bioethanol in Southeast Asia, but also gave the impression that fermentation of cassava as the primary raw material is the basic method of production. Second generation technologies using raw materials that do not

conflict with food have not attracted Southeast Asia's interest.

(3) Toyota Motors Corporation, Commemorative Museum of Industry and Technology & Toyota Hall

At Toyota Motors, where preparations to launch fuel cell vehicles in 2015 to the market are in full progress, the participants studied not only the latest technologies, but also the history of improvements that have been made in automotive exhaust gas cleanup and fuel efficiency improvement. Since the fact that Toyota began operations as a manufacturing company of textile machines is not well known abroad, the participants seemed surprised and impressed that the company diversified into a manufacturer of automobiles, which was a new business area at the time.

(4) Kansai Electric Power Co., Inc., Nanko Power Station

Kansai Electric's Nanko Power Station operates three 600MW LNG-fired thermal power plants (started in 1990). Here, the participants received an overview of the operations of a facility that was developed and tested jointly with Mitsubishi Heavy Industries, Ltd. for the removal of carbon dioxide from exhaust gas.

(5) Osaka Gas Co., Ltd., Energy Technology Center

Today, Osaka Gas uses LNG for city gas, although in the past town gas had been produced by coal gasification. The transition from coal gas to LNG took place between 1975 and 1990, and applied research for the effective utilization of by-product coal as carbon fiber began around 1980. This technology reduces nitrogen oxide by activating carbon fiber and creating a hydrophobic function on its surface. The removal of nitrogen oxide is energy-free, as it requires only a natural draft, and no motors are necessary. The Energy Technology Center was selected as a training site for new business models, as these technologies could also be applied to petroleum pitch.

(6) Kawasaki Heavy Industries, Ltd., Kobe Plant

The main theme of training at Kawasaki Heavy Industries was on combined power generation systems that use solar power, wind power and an electricity storage system using batteries, but the lecture also covered gas turbines, which have energy-efficient and energy-saving features, and high-efficiency power generation system, in addition to small hydroelectric

Launching ceremony at Kawasaki Heavy Industries

generation and the eco-town concept (power generation from urban waste).

Kawasaki Heavy Industries has adopted a vertical type of wind vane instead of the more commonly seen windmill type, and rated output (5kW) is achieved at wind speeds of 12m and more. The participants went up to the rooftop of the actual demonstration site to feel the strength of the wind (there was a northwest wind of 7m/s on this day), and gained straightforward knowledge of the difficulty of finding areas suitable for wind power generation close to consuming areas. To mitigate fluctuations in the output of electricity from photovoltaic and wind power generation, the demonstration site is also equipped with a 50kWh storage battery system called Gigacell.

The participants had the good fortune to visit the Kobe Plant on the day of a ship launching ceremony and share an inspiring event.

(7) Electric Power Development Co., Ltd. (J-POWER), Wakamatsu Research Center

At J-POWER's Wakamatsu Research Center, the participants received lectures on the EAGLE Project, which aims to separate carbon dioxide from the coal gasification process, as well as on the use of the biofuel technology to produce hydrocarbon that corresponds to

gas oil from algae, and on the company's 1MW mega-solar power plant (located in Hibikinada).

The lecture on biofuel production explained that the key to efficient biofuel production lies in reducing energy input as much as possible. Since light can penetrate up to depths of roughly 20cm, there is a limit to the depth (thickness) of the fermenter. Regarding photovoltaic generation, a demonstration showed how power generation falls sharply when the panels are covered by a cloud. In regard to the removal of carbon dioxide, the relevant facility was introduced as being able to test two methods: the chemical adsorption method and physical adsorption method.

(8) Kitakyushu Water Plaza

The desalination of seawater by reverse osmosis is a method that is widely used in the Middle East and elsewhere. Especially in the Middle East, however, seawater salinity is high, desalination treatment requires a large amount of power, and the highly saline seawater that is discharged ends up further increasing the seawater salinity. As a result, there is a real possibility that the sea will become salty like as the Dead Sea and will have adverse impacts on the eco-system and fishery industry in the future.

By mixing an equal amount of treated sewage water to raw water, the necessary power for reverse osmosis could be reduced (the reverse osmosis system can be operated at lower pressures), and an energy-saving operation can be realized. At the same time, wastewater salinity could also be reduced, so environmental conservation could be achieved.

(9) Kitakyushu Hydrogen Town

Fukuoka Prefecture believes hydrogen energy would be a core technology of a new industry in the future, and engages in demonstration testing of a hydrogen town in Yahatahigashi Ward in cooperation with the Research Association of Hydrogen Supply/Utilization Technology (HySUT). At the hydrogen town, the participants learned about hydrogen stations for fuel cell vehicles that utilize hydrogen generated as a by-product from steel plants, 1kW solid polymer fuel cells for detached houses, and the operational conditions of 100kW phosphate fuel cells for a museum, and took a demonstration ride to experience the practical utility of fuel cell vehicles. The smooth and powerful acceleration and quietness inside the car attracted all participants.

3. Summary

This course covered contents not conventionally covered by regular courses, such as photovoltaic generation, fuel cells and biofuels, and was widely appreciated by the participants.

<by Bunsuke Kariya, Training Dept.>

At a hydrogen station in Kitakyushu