Outcome Report

On the Study Tour to Japan

Under

CEA-JCOAL

Clean Coal Technology Transfer program.

29th Nov 2017 to 7th Dec 2017

Japan

1. Introduction

The study tour was organized by Japan Coal Energy Center (JCOAL) acts as the secretariat and coordinator of the entire program under the supervision of New Energy and Industrial Technology Development Organization (NEDO), Japan.

The on-going cooperation between CEA and JCOAL is expected to expedite support for efficient and environmentally - compliant coal power generation by extending the scope of activities to new development while addressing the relevant needs of the existing power stations remains the mainstay of the Cooperation.

The power sector in India especially the Coal Fired thermal generating units are struggling to comply with the new environment norms notified in December 2015. Japan has more than 30 years of experience in DeNox & DeSox of flue gas from thermal power station and also has the manufacturing capabilities of these equipment.

Moreover, 35000 MW capacity of Indian thermal power generating units have completed 25 years of operation and are finding it difficult to operate at stringent environmental as well as performance parameters. Japan has experience with replacement of old inefficient plants with new efficient environment friendly supercritical units at ISOGO TPS and Takehara TPS. Hence, CEA-JCOAL Cooperation is expected to firmly address the needs and requirements of the Indian power sector.

The current visit to Japan's state of the art power plants and manufacturing facilities was attended by participants from MoP, CEA and central & state power utilities.

2. The schedule of visits undertaken in Japan.

Two thermal power stations and four manufacturing facilities were visited by the participants during their seven days stay in Japan. A brief itinerary is given below.

1. Kick off meeting with JCOAL on 30.11.17 at 1200 hrs at Tokyo
2. Visit to Isogo Thermal Power Station of J-Power on 30.11.17 at 1400 hrs at Tokyo
3. Horiba E-Harbour Factory visit on 01.12.17 from 1000 hrs to 1400 hrs at Kyoto
4. Chugai Technos Research Technology Center visit on 04.12.17 from 1000 hrs to 1300 hrs at Hiroshima

5. Visit to MHPS Akitsu/Kure Works on 04.12.17 from 1400 hrs to 1700 hrs at Hiroshima
6. Takehara Thermal Power Plant of J-Power visit on 05.12.17 from 1000 hrs to 1200 hrs at Hiroshima
7. Visit to Generator & Turbine works of Toshiba Keihin on 06.12.17 from 1000 hrs to 1300 hrs at Tokyo
8. Wrap-Up Meeting on 06.12.2017 at 1430 hrs at Tokyo

3. Kick off meeting with JCOAL

Ten members of visiting team met the President and other members of JCOAL at JCOAL office, Tokyo and shared the expectations from the programme. Mr. Osamu Tsukamoto, President, JCOAL welcomed the visiting team to Japan. He extended all support and co-operation for successful study tour. The JCOAL team explained the programme module to participants.

Visiting members also met Dr.Purnima Rupal (Counsellor Science and Technology) at Indian Embassy in Tokyo and discussed about the programme and achievements during the previous modules. Considering the stringent environment norms in India, the installation of DeSox and DeNox are essential and Japan has more than 30 years of experience in manufacture and installation of these systems.

4. Isogo Thermal Power Station of J-Power

The team visited the ISOGO TPS operated and owned by J-Power. It is the only coal-fired power plant located in Tokyo Bay area. It is constructed over 12 hectares of land. ISOGO TPS is an example of Coal Fired Power Plant operating in a city and its emissions are lowest in the world.

It is a tower type ultra-super critical plant consisting of two units each of 600MW constructed in 2002 and 2009 respectively. Efficiency of the plant is 45%. The new units are replacement of old 2x265MW (constructed in 1967 and 1969).

The plant uses activated carbon for Flue Gas desulfurization. The activated carbon adsorbs the SOx and SOx is extracted from activated carbon during the regeneration process of activated carbon. The SOx are expelled from activated as highly concentrated sulphuric acid.

Ash generated at ISOGO TPS is fully utilized. The stack height is 200m, despite the low emissions. Cooling water discharge temperature differential is 7 deg C.

Emissions of ISOGO TPS	**Unit 1**	**Unit 2**	**Old Units 1 & 2**
SPM (mg/Nm3)	10	20	50
NOx (ppm)	20	13	159
Sox (ppm)	20	10	60

5. Horiba E-Harbour Factory – 01.12.17

The team visited the HORIBA manufacturing facility at E-HARBOUR. They have developed extractive type NH_3 analyzer for checking the NOx removal efficiency at SCR outlet and this can be operated with Indian coal where smoke dust concentration in the flue gas is high. The company is also manufacturing instruments and analyzers for the flue gas, which are able to trace almost all existing elements. Optical method is used for analysing and measuring the gas concentrations. The equipment are capable of spot analysis and continuous monitoring. The HORIBA group is a 140 billion Japanese Yen turnover company. The quality control process were explained to the participants and considered to be reliable and appreciated by the participants.

6. Chugai Technos Research Technology Center – 04.12.17

The team visited Chugai Technos Research Technology Center. The presentation was made to participants in respect of Environment Business Division. They stated that majority of plants adopt wet desulphurization and this is the reason for mist generation, which causes corrosion in the downstream device. Flue gas properties like (i) Gas temperature (ii) Gas flow (iii) Desulphurization rate (iv) Mist concentration should be measured at the outlet of FGD. They have developed equipments, sampling process and analysis method for performance test of ESP and FGD. Measurement of environment norms related parameters (NOx, SOx, CO, Unburnt carbon, excess O2 etc) has also been covered including the odor detection. The company is in business since 1953 and has a turnover of 140 billion Japanese yen. It is a third party measurement agency and provides services during commissioning, maintenance schedules and environment monitoring process. All US and Japanese standards are followed as per client requirement. All measurement are done after the consent of OEM and power plant owner. The sampling equipment used for measurement were seen by the participants and the process for onsite sampling was explained.

7. MHPS Akitsu/Kure Works – 04.12.17

MHPS claims to have the most advanced FGD & SCR technologies, which are of critical importance to Indian power plant in order to meet the new environment norms. They have 35 yrs. Experience in denitrification (de- NOx) by SCR catalyst.

NOx systems – using Titanium Oxide based SCR

The Kure works have the catalyst manufacturing facility upto 40,000 m^3/annum. Generally 1 m^3 of catalyst is adequate for 1 MW of power plant, thus the works can supply catalyst to the extent of 40,000 MW/annum. The company has supplied 1699 DENOX systems worldwide in 20 countries. Manufacturing process of catalyst was shown to the participants. Titanium oxide- based denitrification catalysts are classified by their geometry into honeycomb and plate type catalysts. The plate type catalyst manufactured in the works is claimed to be suitable for high ash content coal. The MHPS is conducting a pilot of DENOX system with slipstream using the plate catalyst at Sipat TPS of NTPC. The key challenge in the SCR process is uniform ammonia distribution across the catalyst section, which is done very efficiently by MHPS.

FGD

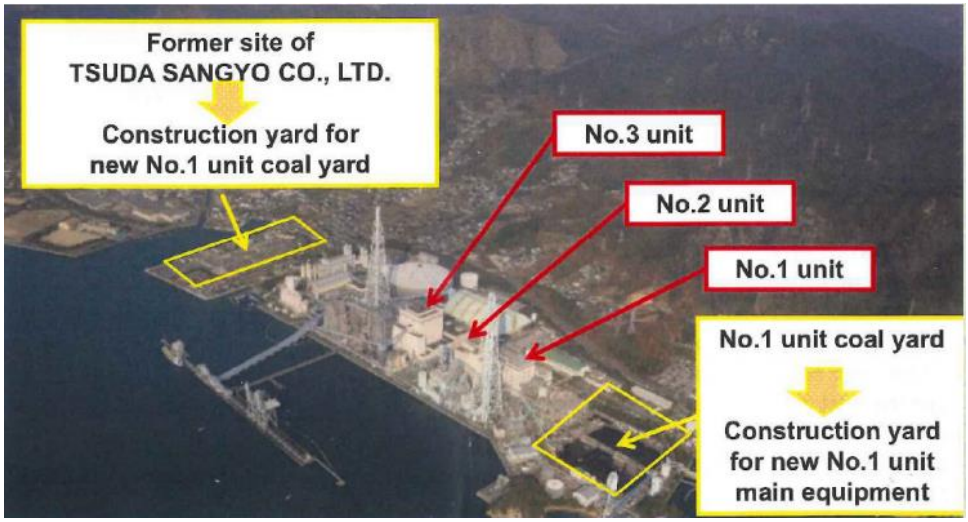
MHPS have two type of FGD, double contact blow scrubber and spray tower scrubber. Selection of type in depending on flue gas condition and site layout. They provide wet FGD system and have worldwide experience in new and retrofit systems. The computer tools like CFD are using for system design of FGD flow dynamics. This practice ensures zero sneakage and low liquid to gas ratio. The **innovative concept of single scrubber tower** for multiple boilers was explained to participants, for the situations where the space limitation around the boilers is a major constraint. This is very important in the context of FGD retrofitting at old

power plants in India. In this system, the existing chimney may or may not be used depending upon site condition and flue gas characteristics. The lining of chimney with an anticorrosion material is recommended in wet FGD operation.

ESP

The high resistivity of ash in Indian coals is known to be a limitation for ESP performance. The use of GGH before ESP to reduce the ash resistivity and to improve ESP performance is considered one of the option for high resistivity of coal ash. Another option is MEEP (moving electrode ESP) to handle the situation of high ash resistivity and improve ash collection in the ESP. Both the systems, low -low ESP and MEEP are very important to Indian Power Plant in order to meet the new environmental norms.

8. Takehara Thermal Power Plant of J-Power – 05.12.17



Unit #1, 250 MW, Natural Circulation Boiler, commissioned in 1967

Unit #2, 350 MW, FBC Boiler, Commissioned in 1974

Unit #1 & #2 have operated for more than 40 years.

Unit #3, 700 MW, is a Cross compound machine with once through boiler, commissioned in 1983. The unit has a unique combination of boiler technology and Turbine configuration at one place. It has two generators, which are working at different speeds (i.e. 3600rpm & 1800rpm).

Covered coal storage is used for storing coal. Existing Unit #1 & 2 (250 MW & 350 MW) are being replaced by new No.1 (700 MW) unit. The new unit will be supercritical (@ 42.8% efficiency) and will have lower emissions of SOx, NOx and SPM. Build and scrap method is being followed. The new unit no.1 is being constructed while the existing unit 1 & 2 are under operation for as long as possible. The existing units will be removed after COD of new unit. The existing chimney is being used for the new unit.

9. Toshiba Keihin Works (Turbine and Generator)

Toshiba is a leading company in super-critical (SC) and ultra-super-critical (USC) technology. They have decades of experience as a power plant equipment manufacturer and have supplied equipment for more than 118GW. Toshiba is also on the leading edge of technology in designing and manufacturing a wide range of equipment of power plants from steam turbines to I&C systems. This factory is the base of the energy apparatus production of Toshiba.Main products are nuclear plant component, generator, turbine and various energy apparatuses

10.Wrap Up Meeting

A Wrap up meeting was arranged at 2:30 PM on 6th December 2017 at Tokyo. The meeting was attended by members from Ministry of Economy, Trade and Industry (METI), Japan, New Energy and Industrial Technology Development (NEDO), Japan, Japan Coal Energy Center (JCOAL), Mitsubishi Hitachi Power Systems Ltd (MHPS), Japan, Horiba Ltd. Japan, Chugai Technos Corporation, Japan, Toshiba Corporation, Japan and the visiting team.

Shri B. C. Mallick, Chief Engineer (TPRM), CEA thanked Director, METI, Director, NEDO and President, JCOAL for arranging the technical study tour. He also highlighted the present issues & challenges and the future direction of Indian power sector during his presentation. Shri S. K. Kassi, Director, Thermal, Ministry of Power also underlined the governments initiative on various issue in Indian Power Sector as well as the main learnings gathered by the participants from the study tour. Representatives from NEDO, METI and JCOAL expressed their willingness for more cooperation between India and Japan in various frontiers of power sector.

11.Conclusion

- Japan's more than 30 yrs. of experience in manufacturing and installation of DeSox & DeNox systems was evident to the visiting team. TiO2 based SCR system with plate type catalyst for NOx and Wet FGD systems for Sox are suitable for Indian conditions of high ash contained coal.
- Japan's large manufacturing base in power plant equipment including Turbine, Turbine Blades, Generator and environmental equipment can be utilized by India to meet its power equipment demand. It is also revealed that 5% generation increase is possible over rated capacity of old unit by replacing latest design turbine.
- The expertise of several measuring instruments manufacturers like Chugai and Horiba can be employed to monitor the stack emission level of Indian power plants in order to ensure long-term environment compliance.
- Considering the example of Japan's ISOGO and Takehara TPS, India can learn useful skills regarding plant operation and maintenance for clean, efficient, reliable, safe operation and high availability of Indian power plants. India can also utilize the experience of construction for replacement of old unit by supercritical & ultra-supercritical unit at a small piece of land without shutdown of the old units as being done by Japan.
- Indian power plants can consider employing covered coal storage for environmental improvement and maximum utilization of land which is being used at Takehara TPS. It is a Clover-type Silo having capacity of 1,00,000 tons.