

R & D Achievements on Carbon Storage in TPC, Taiwan

Major planning considerations of the CCS development of Taiwan Power Company (TPC) account for two factors including the availability of adequate site and the market maturity of relevant CCS technology. The carbon capture method will consider importing the well-defined technologies provided by foreign competitive supplier and yet retain a domestic research momentum in parallel. Due to the need of governmental carbon reduction policy, TPC has to look for a relevant site by its own effort. Up to 2009, a TPC project entitled " Building-up Geo-Database System and Site Screening for Carbon Dioxide Geo-Sequestration" has completed, by which a deep saline aquifer within the southern flank of Tai-Hsi Basin is regarded as a feasible reservoir (fig.1) and more detailed site characterization will be required to verify the adequacy of the reservoir rock, cap rock, and potential retardation layers. Up to 2011, two successive TPC projects entitled "Investigation, Pilot Planning and Research of Preferred Test Site for Carbon Dioxide Geo-Sequestration" (fig.2) and "Setup Two-phase Flow Test Facility with Functional Validation " (fig.3) have completed, by which identifying the feasibility of carbon dioxide geo-sequestration development in Chang-Gong pilot site and make a practical preparation for the pilot test. Now, a TPC project entitle "Characterization on Pilot Site and Study of Validation Methods for Carbon Geo-Sequestration Application (1)" has been executed from 2011 to 2013. In this step, one 3,000m deep monitoring well construction and 1,500~3,000m deep continuous rock core sampling works have completed. This 3,000m deep monitoring well would be used for geologic characterization investigation. Also, it would be taken as the first monitoring well of the pilot test (fig.4).

A further program from 2014 to 2017 has been scheduled to construct deep wells to contribute more precise geological model and to examine the injectivity of the carbon dioxide reservoir in the pilot site.

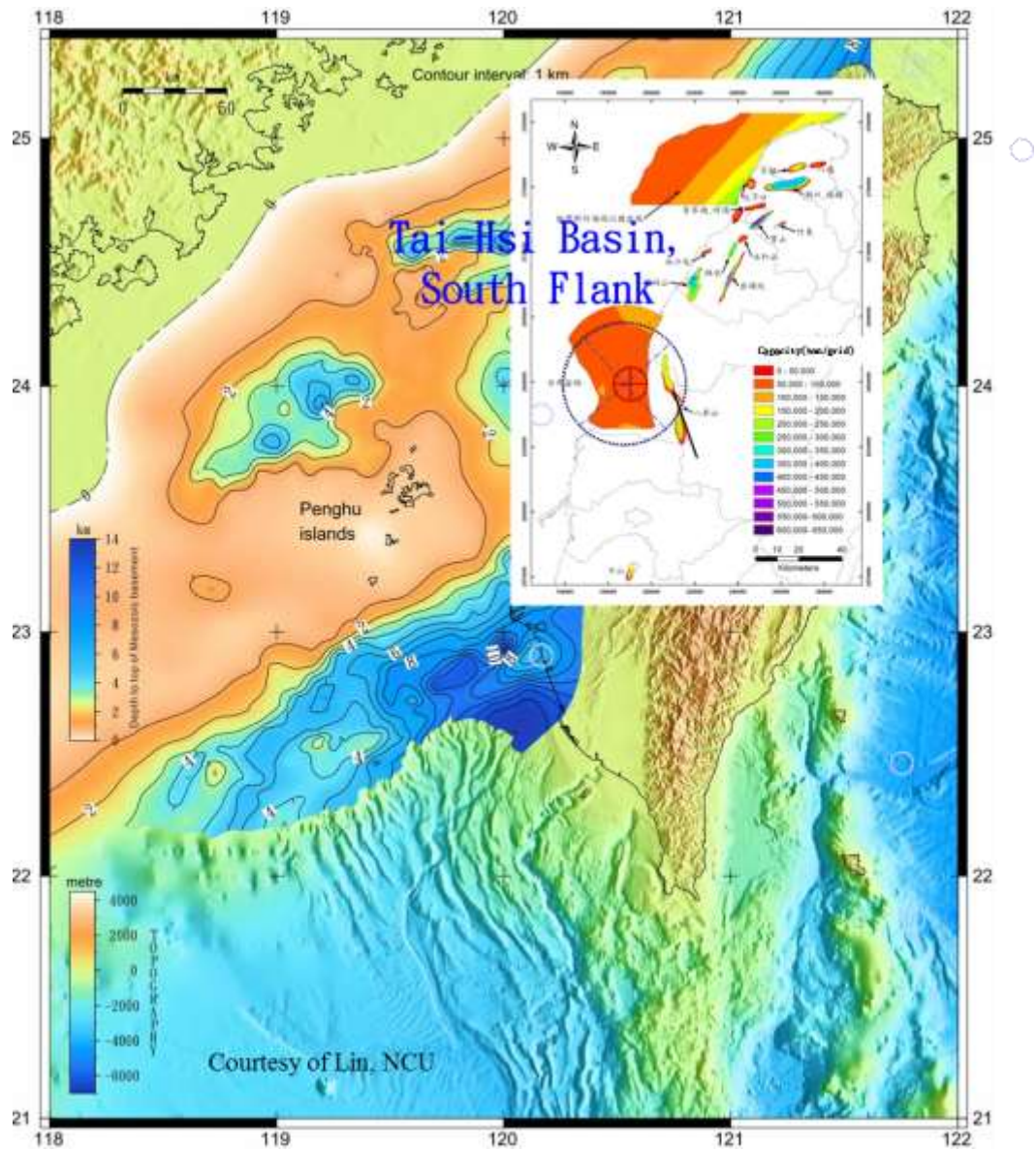


Fig.1 Carbon dioxide geo-sequestration feasible reservoir-Tai-Hsi Basin south flank

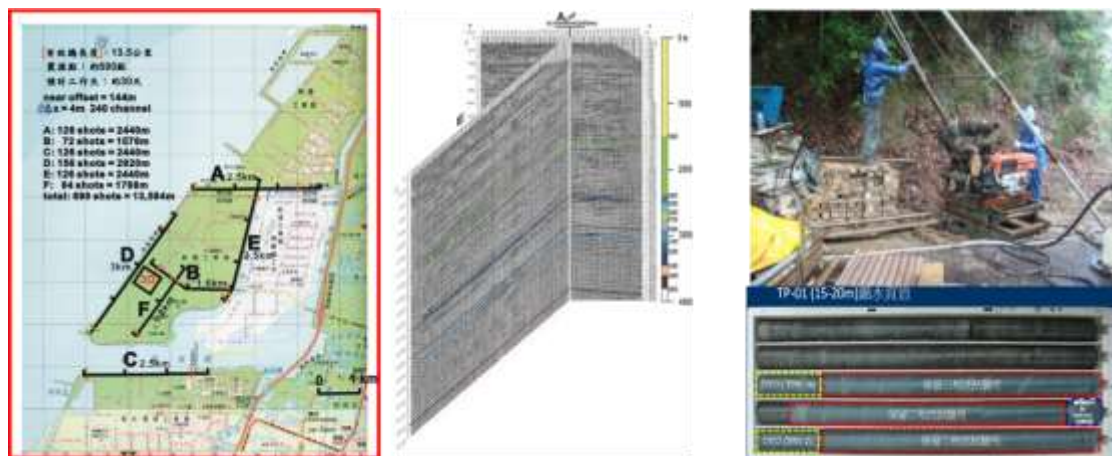


Fig.2 Carbon dioxide geo-sequestration preferred test site investigation



Fig.3 Carbon dioxide geo-sequestration two-phase flow test facility



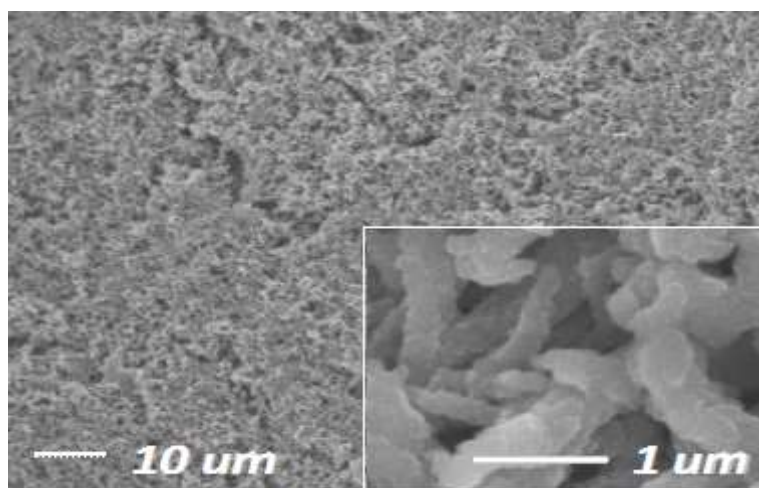
Fig.4 Carbon dioxide geo-sequestration pilot site geologic characterization investigation

R & D Achievements on Carbon Capture in TPC, Taiwan

At present, Taiwan Power Company (TPC) emits about 1/3 of the country's total CO₂ emissions. All of them are from stationary thermal power plants. Seeking appropriate CO₂ capture and storage (CCS) processes can help the company to reduce its operation cost on CCS. Those CCS research activities within TPC can help the company to fulfill its social responsibility, and to build a good corporate image.

■ Evaluation and Establishment of Advanced CO₂ Capture Technologies (2009-2010)

The screening of novel CO₂ absorbent was performed in order to achieve the purpose of reducing CO₂ capture cost. According to the electro-negativity properties of amine-functionalized compounds, the feasibility of replacing MEA absorbent with aromatic amine compound in CO₂ capture system in this work was studied through means of physical and chemical properties investigation in details. With regard to the practical application, the aromatic amine compounds were further immobilized onto the surface of silica substrate as a solid CO₂ absorbent.



Novel CO₂ Absorbent

■ The Study of Micro-algal Skin-care Products Active Components Analysis and Safety Assessment (2009-2010)

In this study, two skin-care products made from CO₂ cultured alga was analyzed by GC-MS in this study. Both of two products from algal polysaccharides show there are no delay allergic reaction in animals test, and no any contamination by

microorganisms. In addition there are no contaminated by heavy metals such as mercury, lead, arsenic and cadmium and no contaminated of hydroquinone and tretinoin.

■ **Microalgae Culturing for CO₂ Fixation and Gasification Usage of Algal Biomass (2009-2010)**

A combination of micro algae cultivation system and carbon dioxide absorber was studied in this study. An optimized operation condition was found in the study to enhance the efficiency of carbon sequestration in overall system. Moreover, algae as biomass for gasification usage also studied.

■ **Effects of Light from LED on the Microalgae Photo-bioreactor (2010-2011)**

Light is the most important factor of microalgal photoautotrophic growth. The objective of the study was to evaluate the culture of spirulina sp. in 28,728 L photobioreactor with Light-emitting diodes (LEDs). The net CO₂ fixation rate of the reactor is about 16.58 times more than the open pond system in the same area.



Open Pond System



Photobioreactor

■ **The First Assessment of Accelerated Weathering of Limestone for Capturing and Sequestering CO₂ from Power Plant (2011)**

Accelerated Weathering of Limestone (AWL) is a technique for carbon dioxide capture and storage. The result shows that cost of about \$1417 to \$3953 NTD/ton CO₂; limestone consumption of about 0.2 to 1.54 ton/ton CO₂; and water consumption of about 1843 ~ 3885 ton/ton CO₂. Note that carbon dioxide partial pressure above sea surface is much less than the equilibrium pressure against the wastewater form AWL reactor. Therefore, dissolved bicarbonate ions react with calcium to form calcium carbonate precipitation and carbon dioxide when seawater left the AWL reactor. Resulting that carbon dioxide, which was absorbed from flue gas in AWL reactor, re-emits into the air. Therefore, AWL only can temporary shift the equilibrium state of carbon species within the reactor. No (or less) carbon dioxide can be sequestered in seawater via AWL route.

■ **Future Work - Study on Cleansing of Flue Gases form Fossil Fuel Power Plants and Carbon Dioxide Capture, Storage, and Utilization (2012-2015)**

- A new microalgae-based-CO₂ capture system for thermal power plant
- Study on Microalgae Harvest Technologies for algal-based CO₂ capture
- Study on CO₂ capture technologies- evaluation of low cost CO₂ absorbent preparation and its application
- The study of CO₂ adsorption and reduction to hydrocarbons
- Macroalgae-based CO₂ capture from power plant and its biomass conversion processes
- Technological and economic analysis of carbon capture, storage, and utilization for power plants
- Evaluating adsorption behavior of solid sorbent in CO₂ capture process
- Utilizing mix solvent for CO₂ capture