

R & D Achievements on Carbon Capture and Storage in ITRI, Taiwan

Industrial Technology Research Institute (ITRI) was commissioned by Bureau of Energy, Ministry of Economic Affairs (MOEABOE) to conduct assessment of various carbon capture technologies in 2007. According to assessment results, ITRI selected two solid sorbent carbon dioxide capture technologies as priority research items, one is Calcium Looping Capture technology; another is Mesoporous Silica Particles (MSP) carbon dioxide capture technology. Research and development results of these two technologies are described as below.

■ Calcium Looping Capture Technology

ITRI established 3kWt calcium looping carbon capture test facility composed of a fluidized bed carbonator and a rotary kiln calciner, and carried experiments out in 2008. To prove the operating stability, a 100-hour run had been completed, in which the carbon capture efficiency can be kept above 85%. Then, ITRI would like to verify the feasibility of Calcium Looping Capture technology for flue gas emitted from industrial processes, the installation for 1.9MWt Calcium Looping Capture pilot plant was begun to plan in 2011. ITRI has cooperated with Taiwan Cement Company (TCC) to build 1.9MWt Calcium Looping Capture pilot plant located at TCC's Heping campus. Basic design, detail design, construction, and test run stages were completed in succession May 2013. This Calcium Looping Capture pilot plant is the largest capacity of its kind both in Taiwan and also in the rest of the world, and continuous trial operation for long-term and technical validation is in progress now. The capture cost of pilot plant is estimated as around US\$40 per ton carbon dioxide (in the condition of combined heat recovery and utilization).



3kWt calcium looping
carbon capture test



1.9MWt calcium looping
carbon capture pilot

Now, ITRI is working on the development of advanced Calcium Looping Capture technology which combined cascade cyclones and steam hydration processes. Steam hydration process could convert calcium oxide to calcium hydroxide, and regenerate its activity, while cascade cyclones tower is a vertical structure which could facilitate fully mixture of sorbent with flue gas and reclaim waste heat. This advanced capture system could keep energy consumption to be less than 20% and capture efficiency to be over 90%, and capture cost per ton carbon dioxide to be less than US\$30 because of lower equipment cost and smaller footprint. ITRI has won the 2014 R&D 100 Awards due to this innovation technology which will be deployed in 30MWt Calcium Looping Capture demonstration plant planned to be built in 2017.



■ Mesoporous Silica Particles carbon dioxide Capture Technology

MSP capture technology is mainly used in low-temperature exhaust for carbon capture. From 2008 until now, ITRI has established an MSP preparation system with the capacity of 1kg/h,



and completed recipe research for decreasing preparation cost to

3kWt MSP carbon adsorption system

NT\$800/kg and modification study for raising adsorption efficiency. This year, ITRI has set up a 3kWt bench scale fixed-bed system for carbon adsorption and is conducting a field test in an existing glass furnace, and also investing in research for carbon capture of indoor air by MSP.

■ Chemical Looping Technology

In addition to above two technologies, ITRI introduced chemical looping process technology with gas feedstock from Ohio State University of US in 2013, and constructed a 30kWt combustion system with chemical looping process. The test for main components of system and study of operation/control technology are being carried out now, and development of cheap, high reactivity, and low attrition rate oxygen carrier is also in progress. Preliminary study results show that oxygen carrier's preparation cost can be less than NT\$100/kg. With an abundant reserves and low cost, coal can be utilized as fuel for combustion system of chemical looping process, which would reinforce the competitive power of chemical looping technology.

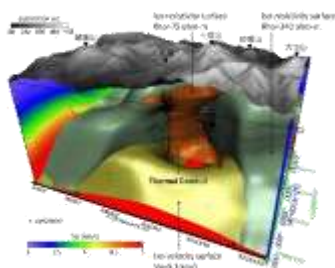
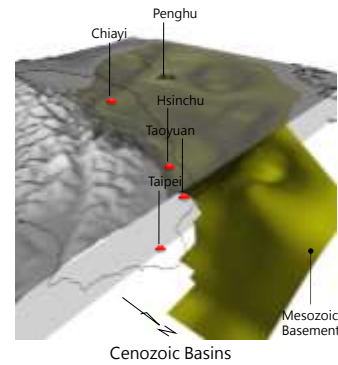


30kWt combustion system with chemical looping process

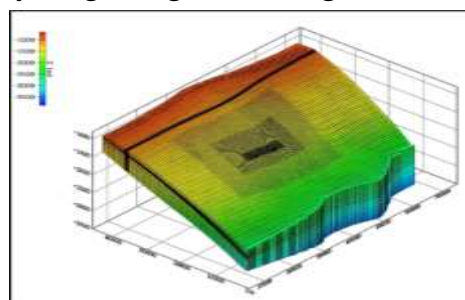
Therefore ITRI will begin to conduct research and development for hydrogen production and chemical looping technology with solid feedstock (coal) in 2015.

■ Geological Storage Technology

ITRI initiated the technology development on geological storage from the year of 2007. Evaluation of carbon storage potential, site characterization, and establishment of numerical simulation capability were completed successively. Promising potential for geological storage in Taiwan has been confirmed with the support of integrated assessment on regional geology and supplemental investigation. Priority sites for further evaluation were also proposed. Good reservoir-to-caprock matching was found inside thick Cenozoic foreland basin sediment along the western coast of Taiwan, which could allow for injecting carbon dioxide for more than one hundred years. The establishment of an integrated framework on monitoring and risk assessment technology is currently a priority research item. ITRI has deployed a monitoring network which incorporates soil gas, shallow groundwater, and ground leveling information. This network is designed to collect important baseline data before injection. In addition, ITRI is also conducting an international collaboration with United States to introduce advanced monitoring and risk assessment technology. Experience and best practice from existing pilot and demonstration projects from U.S. shall facilitate to establish localized requirement and standard to ensure the safety of geological storage.



Joint Geophysical Image



Numerical Simulation

