CO_2 Sequestration Research Group

R&D of CO_2 Geological Storage Project

1. Overview of CO_2 Geological Storage Technology

The CO_2 geological storage technology is to store carbon dioxide (CO_2) in geological formation safely for reducing greenhouse gas emissions. The technologies of Enhances Oil Recovery (EOR), Enhanced Coal Bed Methane recovery (ECBM), injection in oil and gas fields and saline formations are developed for the mitigation of the global worming.

RITE is developing the aquifer storage technology which is possible for long-term stable isolation with cap rock layer. CO_2 aquifer storage is thought to be one of the most effective and practical technology because the knowledge of underground natural gas storage and the experience of EOR are applicable.

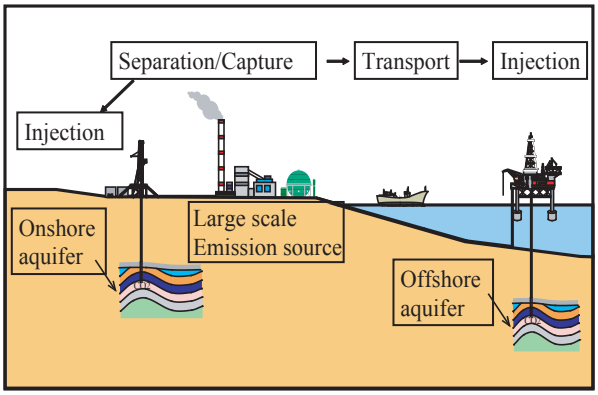

Fig.1 CO_2 geological storage in aquifer

2. Outcome of the recent project

R&D project of CO_2 geological storage technology was launched in 2000 with the support of Ministry Economy Trade Industry. From 2000 to 2004, the possibility of the aquifer storage in Japan was confirmed. Especially the injection experiment in Nagaoka city of Niigata prefecture showed that 10,400 t-CO_2 was able to be stored in a year and half between July 2004 and January 2005. The cross-well seismic tomography, well loggings, measurements of pressure and temperature of reservoir formation, and micro-seismicity monitoring were carried out for developing the simulator of CO_2 behavior. There is not any CO_2 leakage from the reservoir, even when the Nagaoka site was hit on October 23, 2004 by the huge earthquake (M6.8) of which epicenter was about 20km far from the CO_2 injection well. It has been kept to monitor the injected CO_2 for improving the model of CO_2 behavior, until now.

Fig.2 CO_2 injection facilities at Nagaoka site

3.R&D subjects of the project.

The scientific possibility of aquifer storage in Japan has been cleared by the current study. Around same time, the technology of geological storage has been progressed with recognition as mitigation technology in the world. So, the technology verification of CO_2 carbon storage (CCS) should be needed for its implementation. RITE is focusing the studies of total analysis and safty analysis to make the road map of CCS for the large scale CO_2 emission sources.

a.Total analysis

(a) Research on validity

Storage system will be classified in terms of emission source, capture methods, transporting methods, reservoir types and injection methods. Storage potentials, costs, consumed energy and mitigating effects will be analyzed for each classification. A basic scenario plan which will quantitatively explain the validity of aquifer storage in Japan will be made.

(b) Submission of road map for implementation of CCS

Technological issues of CCS implementation in Japan will be summarized, and a first draft of research and development road map which clears milestones of solutions of subjects will be made.

(c) Engineering study for supposed sites

Assumed model areas will be chosen and issues of implementation will be extracted by engineering

study including safety and environmental assessment on emission sources, transportation methods, reservoir conditions and storage methods. Solutions for the issues will be proposed.

(d) Storage potential evaluation in Japan

The storage potential of aquifer in Japan will be re-estimated based on the existing data. Locations and types of emission sources will be considered. Issues of the estimation method will be summarized and a new storage model will be proposed.

(e) Survey for implementation and public outreach of CCS

Investigation on political and technical trends of CCS will be carried out including overseas and a framework for public outreach of CCS will prepared. Investigation of implementation will be carried out in terms of operating scheme, legal framework, regulations, overseas business potentials and public outreach.

(f) Investigation on safety and risk

Safety and risk analysis will be carried out and a guideline of safety assessment and environmental assessment will be presented.

b. Safety analysis

(a) Monitoring of Iwanohara site

CO_2 injected at Iwanohara site in Ngaoka will be monitored to improve the simulation model of CO_2 behavior in aquifer for confirming the safety of storage.

(b) Laboratory experiment for basic research

In order to improve the CO_2 behavior model, the following laboratory experiments will be carried out: influence of CO_2 dissolved into water on mechanical stability of cap rock, quantification of mineral dissolution rates under CO_2 presence, mechanisms of super critical CO_2 substitution for saline water in porous media, etc.

(c) Model integration of underground CO_2 behavior

Based on data and knowledge of the monitoring at Iwanohara and the laboratory experiments, CO_2 behavior in aquifer for a short and long period will be scientifically summarized. The improved model will be presented for safety confirmation.

4.Future of the project

It is scheduled as shown in Fig3 that total analysis and safety analysis of CO_2 geological storage project will be summarized for the future implementation of CCS in Japan in accordance with the R&D of CO_2 capture technology. A workshop entitled "International Workshop on CO_2 Geological Storage , Japan '06" was held on February 20, 21, 2006 at the Toranomon Pastoral Hotel Tokyo Japan. This workshop provided the research result of the Nagaoka Project including overseas CCS trend information and the next step of the project. See details in the page 18 of this report.

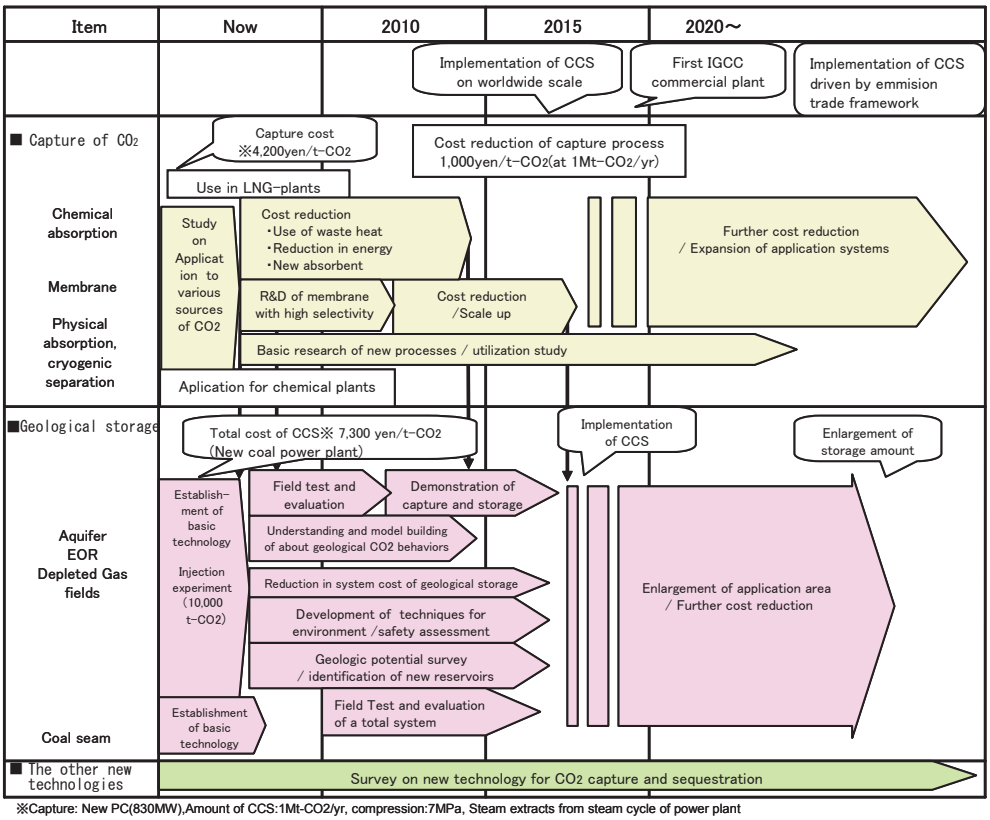

Fig.3 Road map of CCS in Japan

R&D of CO_2 Ocean Sequestration Project

1.Overview of CO_2 Ocean sequestration technology

Increasing of atmospheric CO_2 is one of the factors of global warming. This is the result of imbalance between the dissolution of atmospheric CO_2 in the ocean and the emission of anthropogenic CO_2, mainly due to the combustion of a fossil fuel. This imbalance is also due to the long time scale requires for the absorption of atmospheric CO_2 in the ocean in contrast with the rapid increase of emissions. However, there is a sufficient potentiality to dissolve anthropogenic CO_2 in the middle and deep layers of the ocean. Therefore, a bypass technology of direct injection of atmospheric CO_2, captured from high emissions, into the deep ocean was proposed. The main objection for the utilization of this technology is the resulting biological impacts when the initial concentration of injected CO_2 is high. From the viewpoint of suppressing environmental impact to the minimum extent, RITE is developing a dilution & injection technology to the middle and deep ocean layer using "Moving Ship" approach, as shown in Fig. 1.

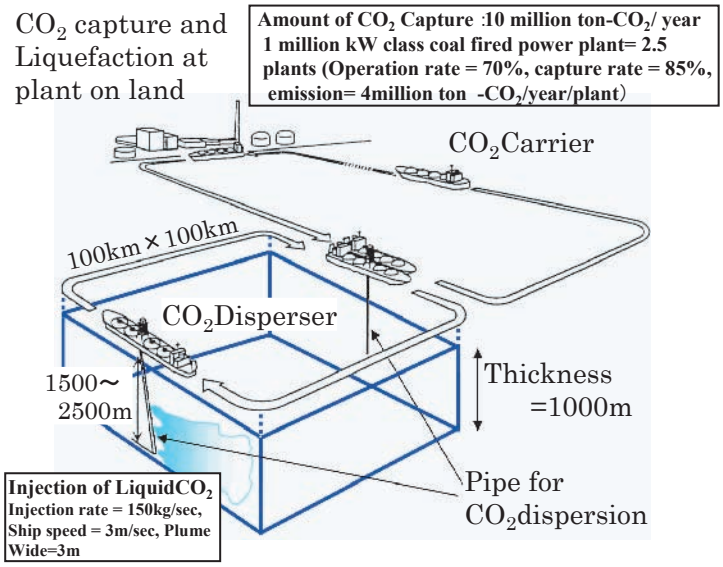

Fig.1 Image of operation for ocean sequestration by Moving ship

2. Purpose of R&D

In order to implement the anthropogenic CO_2 sequestration into the ocean as a practical used technology, it is important a prior understanding of the environmental impacts, especially onto the biosphere, to prevent possible damages caused by the application of this new technology. Therefore CO_2 sequestration technology can be clearly understand with a wide social receptiveness among the international frameworks, such as Framework Convention on Climate Change (FCCC) and Convention on the Prevention and of Marine Pollution by Dumping of Wastes and other Matter (London Convention, LC). This project is being carried out with the purpose of clarifying these subjects towards the utilization of CO_2 ocean sequestration. In addition, during the phase 1, carried out from FY1997 to FY2001, macroscopic CO_2 action grasp in the adjacent seas of Japan, including predictions and investigations of environmental effects, mainly on the biota, produced by the nozzle back discharge of CO_2, were conducted. Followings are the aims of the present projects as the phase 2 which is carried out from FY2002 to FY2006.

a. Technology assessment of CO_2 ocean sequestration
  (a) Technical evaluation of CO_2 sequestration capacity
  (b) Economic evaluation of the CO_2 sequestration
  (c) Investigation on the legal issue related to international laws

b. Development of assessment technology for CO_2 environmental impact
  (a) Investigation of marine environment
  (b) Understanding of deep-sea ecosystem
  (c) Investigation of biological impact
  (d) Development of Biological impact model

c. Development of CO_2 dilution technology
  (a) Development of CO_2 injection technology
  (b) Improvement of the simulation model of CO_2 behavior

3. Present state of the project

The phase 2 of this project started from the FY2002, and now it is the 5th year. A interim assessment of this project was carried out by the subcommittee of METI in the FY2004. As the result, the following comments and advices have been reported. "Ocean sequestration technology is an effective measure for the mitigation of global warming. However, the environmental impact assessment is an important task. Public relation, especially for oversea, international collaboration, and so on should be carried out actively." So, RITE is enhancing public outreach (PO) and the corporation with research institute of overseas, though RITE has already succeed to organize the international work shop on "Advances in Biological Research for CO_2 Ocean Sequestration" in 2003. From FY2004, the collaboration of carbon dioxide impact on marine ecosystem has been carried out with the Norwegian Institute for Water Research (NIVA) in which an experiment was carried out in a fjord of Norway in 2005 and its results will be reported in 2007. In order to promote PO actions, the special symposium of Japan Ocean Society "CO_2 ocean sequestration: what is the appropriate assessment for the environmental impact" was carried out in 2006. Moreover, in order to make clear the image of ocean sequestration, the engineering study of its implementation under the case which is the ocean sequestration of about 50 million tons of CO_2 annually into the ocean near Japan, was carried out and its biological impact is evaluated.

4. Future of the Project

Development of a CO_2 dilution technology and environmental-impact-assessment technology is progressing using laboratory experiments, field observations and numerical simulations. For an effective utilization of the ocean sequestration technology, it is necessary to prove the developed technology using field experiments in the ocean. Finally, it is necessary to trace the CO_2 behavior in several 100 km scale, and to investigate the biological impact. Therefore, field experiments covering a wide range of scale from small-scale to a real scale is desired in the next step of this project. For the final purpose, it is necessary to promote the understanding ocean sequestration in academia and obtain the agreement to the implementation of ocean sequestration in the arena of LC and other international ocean regulation, because the ocean is a human common property and the implementation of CO_2 ocean sequestration needs to build up an international consensus.