

CO₂ Sequestration Research Group

R&D of CO₂ Geological Storage Project

1. Overview of CO₂ Geological Storage Technology

The CO₂ geological storage technology is to store carbon dioxide (CO₂) 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 warming.

RITE is developing the aquifer storage technology which is possible for long-term stable isolation with cap rock layer. CO₂ 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.

20km far from the CO₂ injection well. It has been kept to monitor the injected CO₂ for improving the model of CO₂ behavior, until now.



Fig2 CO₂ injection facilities at Nagaoka site

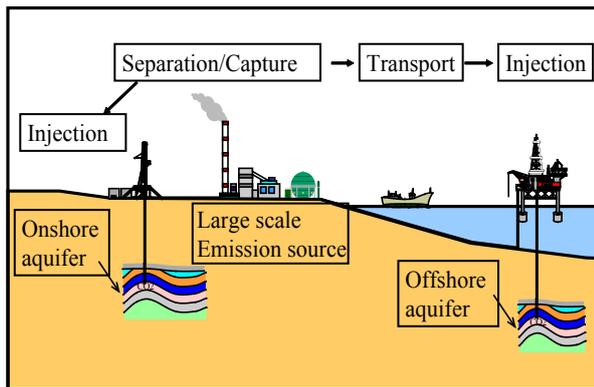


Fig1 CO₂ geological storage in aquifer

2. Outcome of the recent project

R&D project of CO₂ 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-CO₂ 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 CO₂ behavior. There is not any CO₂ 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

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 CO₂ 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 CO₂ 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 be 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

CO₂ injected at Iwanohara site in Ngaoka will be monitored to improve the simulation model of CO₂ behavior in aquifer for confirming the safety of storage.

(b) Laboratory experiment for basic research

In order to improve the CO₂ behavior model, the following laboratory experiments will be carried out: influence of CO₂ dissolved into water on mechanical stability of cap rock, quantification of mineral dissolution rates under CO₂ presence, mechanisms of super critical CO₂ substitution for saline water in porous media, etc.

(c) Model integration of underground CO₂ behavior

Based on data and knowledge of the monitoring at Iwanohara and the laboratory experiments, CO₂ 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 CO₂ geological storage project will be summarized for the future implementation of CCS in Japan in accordance with the R&D of CO₂ capture technology.

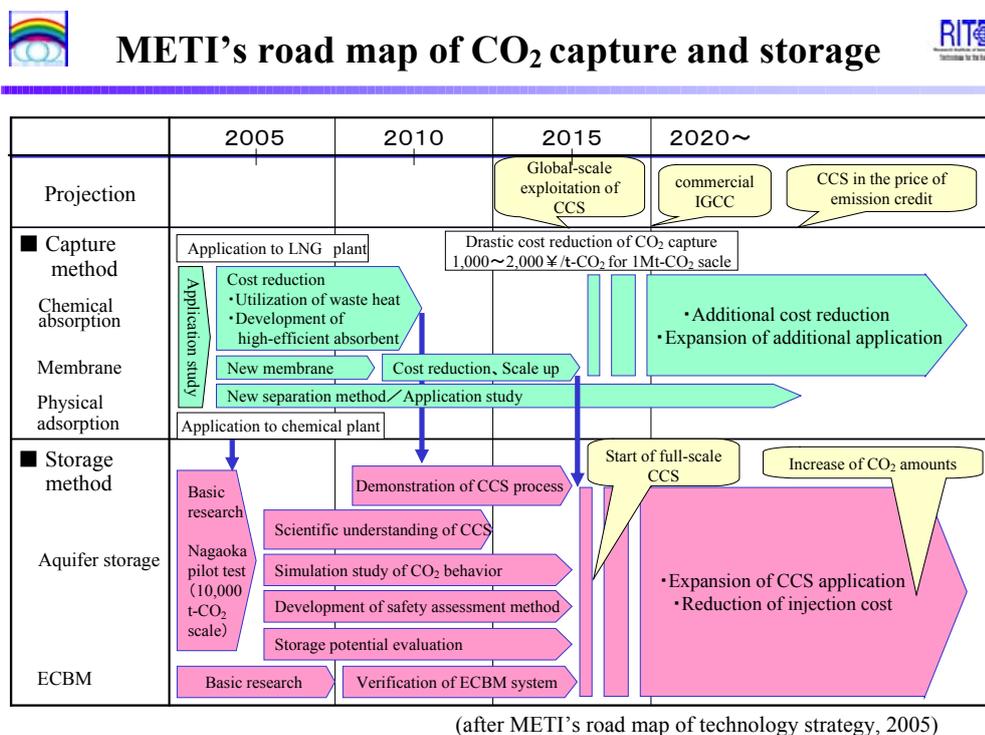


Fig3 Road map of CCS in Japan

R&D of CO₂ Ocean Sequestration Project

1. Overview of CO₂ Ocean sequestration technology

Increasing of atmospheric CO₂ is one of the factors of global warming. This is the result of imbalance between the dissolution of atmospheric CO₂ in the ocean and the emission of anthropogenic CO₂, 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 CO₂ in the ocean in contrast with the rapid increase of emissions. However, there is a sufficient potentiality to dissolve anthropogenic CO₂ in the middle and deep layers of the ocean. Therefore, a bypass technology of direct injection of atmospheric CO₂, captured from high emissions, into the deep ocean was proposed. The main objection for the utilization of this technology is the biological impacts when the initial concentration of injected CO₂ 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" method, as shown in Fig. 1. The current states of CO₂ ocean sequestration concerning the storage mechanisms and technology, the ecological and environmental

impacts and risks, the cost of ocean storage, and the legal aspects and public perception are reported in the chapter 6 of special report on CO₂ capture and storage which was accepted by IPCC last September and interested by COP11 last November, respectively.

2. Purpose of R&D

In order to implement the anthropogenic CO₂ 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 CO₂ sequestration technology can be clearly understood 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 CO₂ ocean sequestration. In addition, during the phase 1, carried out from FY1997 to FY2001, macroscopic behavior of CO₂ dissolved in the adjacent seas of Japan, including predictions and investigations of environmental impacts, mainly on the biota, induced by the injection of liquid CO₂ into the sea water, were conducted. Followings are the aims of the present project as the phase 2 which is carried out from FY2002 to FY2006.

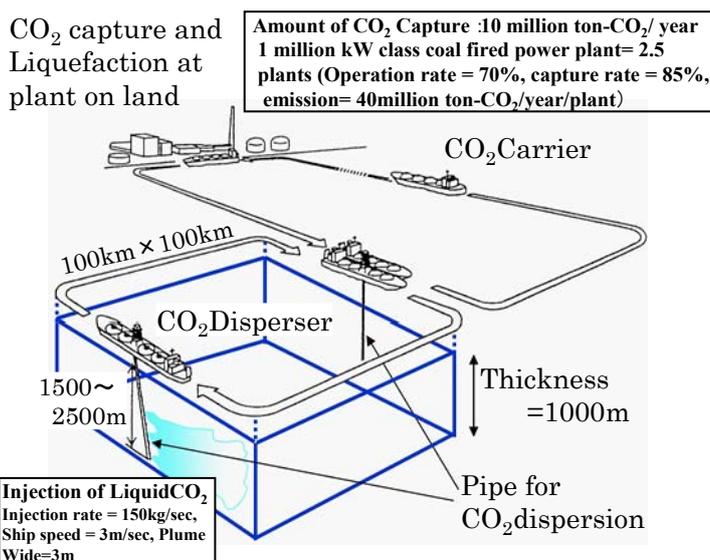


Fig.1 Image of enterprise for ocean sequestration by Moving ship

a. Technology assessment of CO₂ ocean sequestration

- (a) Technical evaluation of CO₂ sequestration capacity
- (b) Economic evaluation of the CO₂ sequestration
- (c) Investigation on the legal issue related to international laws

b. Development of the assessment technology for CO₂ 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 CO₂ dilution technology
- (a) Development of CO₂ injection technology
 - (b) Improvement of the simulation model of CO₂ behavior

3. Present state of the project

The phase 2 of this project started from FY2002, and now it is the 4th year. An 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 oversea, though RITE has already succeed to organize the international work shop on "Advances in Biological Research for CO₂ 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 has been carried out in a fjord of Norway from August to October in 2005. In addition, it is planed a possible international joint research project together with U.S.A, Brazil, and a South Korean. Moreover, in order to promote PO actions, investigations of the PO working group were started from FY2005. The working group has started a working plan on publicity, education and production of PO materials among other actions.

4. Future of the project

Development of a CO₂ 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 CO₂ behavior in several 100 km scale, and to investigate the biologi-

cal 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 CO₂ ocean sequestration needs to build up an international consensus.

