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Economic Evaluation of CO_2 Ocean Sequestration in Korea

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ABSTRACT

In 2005, Korea launched several carbon management R&D projects as one of the governmental global climate change policies, specifically about the CO_2 storage in geologic and oceanic reservoirs. CO_2 ocean sequestrations have been developed as an effective method to sequester amount capacity of CO_2, because the capacity of terrestrial sequestration sites on land is very limited in Korea. However, cost-ineffectiveness has been indicated as one of the key barriers.

In this paper, the preliminary evaluation of the technical and economic feasibility by the "Moving Ship" method in Korea is carried out and its prospects are outlined. Also, we try to discuss the issues of elemental technologies and emphasize the necessity of continuing R&D efforts for the effective system development of CO_2 ocean sequestration.

KEYWORDS: CO_2 ocean sequestration, CO_2 recovery, compression, economic evaluation, economic balance point.

INTRODUCTION

The CO_2 storages in geological formations such as oil and gas fields, deep saline formation in ocean water column or onto the seafloor from large point sources of CO_2 include large fossil fuel or biomass energy facilities and major CO_2-emitting industries are considered to be potential technical storage methods.

The R&D project for developing CO_2 geological sequestration technology aims to establish a technology that provides stable, safe and long-term geological sequestration of CO_2 emitted from large-scale sources (Gunter et al. 1997; Gunter et al. 1998; Parson and Keith 1998; Natl. Energy Tech. Lab. 2002).

CO_2 ocean sequestration is purposeful storage acceleration into the ocean of large amounts of carbon that would accumulate in the atmosphere and naturally enter the ocean over a longer time span (Brewer et al. 1999; Saito et al. 1999; Kvamme 2001; Tsuchiya et al. 2001; Chadwick et al. 2003; Koide et al. 2003).

Since 2002, Korea is ranked the ninth CO_2 emission country in the world by emitting 450million tons per year (http://co2.kemco.or.kr). Currently, Korea is conducting a 10-year fundamental engineering research project for the large reduction of CO_2 emissions on a global scale from 2005 to 2015. The project aims to establish a technological R&D for CO_2 ocean sequestrations, depleted oil/gas reservoir storage, and deep saline aquifer storage.

Some technologies for CO_2 sequestrations in oceanic reservoirs have been developed by Dewey et al. (2000) and Murai et al. (2003). CO_2 ocean sequestrations are attractive having such advantages as vast sequestration capacity, remote location from industrialized area, and easier way of monitoring, while it can also be the cost-ineffectiveness.

Japan has carried out the CO_2 Ocean Sequestration Project since 1995. The RITE (Research Institute of Innovative Technology for the Earth) has established a "Moving Ship" concept (Ozaki et al. 1999; Murai et al. 2003; http://www.rite.or.jp/Japanese/project/kaiyou/kaiyop40.html). The idea of the "Moving Ship" concept is that CO_2 droplets are released in mid depth of 1000 to 2000m where CO_2 is lighter than seawater and the maximum dilution rate of injected liquid CO_2 is achieved. The AIST (Advanced Industrial Science and Technology) has done original research called GLAD (Gas Lift Advanced Dissolution) system (Saito et al. 2000; Kosugi et al. 2001; Saito et al. 2001). Also, the MRI (Maritime Research Institute) has proposed the technology called COSMOS (CO_2 Sending Method for Ocean Storage). The COSMOS system is to store CO_2 in a depression on the ocean floor deeper than 3500m where liquid CO_2 is heavier than CO_2 saturated seawater (Aya et al. 1999; Aya et al. 2003).

Also, USA and Canada in North America have conducted a system study to elucidate the significance of geological sequestration technology in terms of cost, environmental impact, safety, social acceptance and others factors against global warming (Gunter et al. 1997; Wong et al. 2000; Ledwell et al. 2000; Rao and Rubin 2002).

Norway in the European Union (EU) carried out the SACS program for the CO_2 injection and storage in saline formation from 1994 to 1998 and the AZEP program for the CO_2 capture from 1998 to 2002 (Kvamme 2001; Chadwick et al. 2003; IEA 2003). England lead an active support through International Energy Agency (IEA 2001; IEA 2003).

In this paper, an economic feasibility evaluation of CO_2 ocean sequestration is carried out in Korea. Also, a conceptual system design based on a review of the known R&Ds is introduced in detail, and the issues and the role of elemental technologies for CO_2 ocean sequestration program are discussed.

ECONOMIC EVALUATION MODEL

Project Outline

The CO_2 emitted from power plant is captured and liquefied by