A Study on hydrological parameters in the CO2 geological storage -sensitivity analysis using 2D model-

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1. Introduction

The first promising period of the Kyoto Protocol commenced in January 2008 and the countries that ratified the protocol are expected to meet CO_2 emission targets by 2012. Geological storage of CO_2 is expected to be one of the technologies which the Kyoto signers would deploy to meet the emission targets. In Norway, they are injecting CO_2 into the anticline formation because of the long storage of oil and gas in the formation. Saline aquifers with monocline and syncline structures, on the contrary, keep water soluble methane gas and are widely distributed around Japan with significant CO_2 storage capacity. AIST commenced the new 3 year project in 2005FY. The main focus areas of the project are 1) technologies to construct a hydrological model and analysis of the groundwater, 2)geochemical characterization of the saline aquifer, and 3) technology to evaluate micro crack and fractures in the cap rocks. In this study we will present the study results associated with the construct of the geological model and computer simulation using the model.

2. Geological model

A 2D geological model with 25km horizontally and 2.5km vertically is selected for the sensitivity analysis. CO_2 reservoir layer composed of sandstone is located at the depth between 1350m and 1650m overlaid by the mudstone layer of 300m width as a cap rock layer. The reservoir and cap rock layers incline toward the surface at the one side. The model is divided by the grids for the computing with 100m horizontally and 1km vertically. The grid spaces around the injection points between 1400m and 1500m are much narrower. The porosities of the sandstone and mud stone are both 20% and the horizontal and vertical permeability of the reservoir is 50mdarcy and 10mdarcy, respectively. The horizontal and vertical permeability of the cap rock layer is 10mdarcy and 1mdarcy. The boundary conditions of the pressure are set 1atm at the surface and hydrostatic pressure along the sides and there is no water and CO_2 flows at the bottom of the model. The temperature is set to 15^oC at the surface and between 40^oC and 60^oC at the bottom. An equal amount of 1 million tones of CO_2 with the width of 1km is injected for 50 years. The relative permeability of water is assumed to be followed by the van Genuchten type with the residual saturation factor of 0.2. The relative permeability of CO_2 is assumed to be followed by the Corey type with the residual saturation factor of 0.1. The capillary pressure is followed by the van Genuchten type.

3. Sensitivity analysis

The expansion and phase change of CO_2 were computed using the geological model and the simulation code of STAR. The simulation was carried out under the several conditions as follows; 1)vertical permeability change to 50mdarcy in the reservoir, 2) horizontal and vertical permeability changes in the reservoir to be 500mdarcy and 100mdarcy, 3)capillary pressure increase in the cap rock layer, 4)hysteresis of the CO_2 relative permeability.

4. Conclusive remarks

The research study on the CO_2 geological storage in AIST has the final goal to construct a generalized numerical model for CO_2 storage in saline aquifers in Japan. The numerical model will be used for the evaluation of the storage potential in the saline aquifer and the risk assessment studies. The mode is also useful to determine feasibility of CO_2 sequestration in saline aquifers. The knowledge and data developed as a result of this project will be applicable not only to saline aquifers but also other potential geologic sequestration sites such as depleted oil and gas fields. The result of the sensitivity analysis will provide the important information to select the injection site and geophysical parameters.

Acknowledgment

This study is fiscally supported by the R&D project conducted by RITE.