A Comprehensive Study of CO₂-EOR for Mature Oil Field in South Sumatra

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Abstract

A feasibility study of CO₂-EOR (Enhanced Oil Recovery) project in a mature oil field in South Sumatra has been conducted with PERTAMINA, the Indonesian state-owned oil company.

In the target area, there are several mature oil fields, which are considered as EOR targets, and also as a target of CCS for CO₂ emission from thermal power plants by retrofitting the CO₂ capture system and other possible facilities such as gasification system with use of low-rank coal. The application of CCS-EOR is expected in this area.

The target reservoir for CO₂-EOR was selected by the evaluation using the EOR screening software, considering reservoir condition. The followings were pointed out as features common to oil fields in this area.

1) Mature oilfield with production history of more than 50 years
2) Geologically complicated and multi-layered reservoir
3) High water cut (more than 90%) and pressure depleted.
4) Lack of special fluid analysis data (MMP, etc.)
5) Old oilfield surface facilities

This comprehensive study including following items, was conducted, aiming for grasping the production performance and the enhancement of the recovery by the application of CO₂-EOR to the target reservoir.

- Geological modeling
- Reservoir rock and fluid properties, reservoir fluid modeling based on the special fluid analysis to new fluid sample
- Reservoir modeling and long term history matching
- Reservoir simulation for the prediction performance and evaluation of recoverable reserve
- Conceptual design of the surface facilities for EOR and cost estimation
- CO₂ storage as a CCS
- Feasibility as a CO₂-EOR project

The figure shows processes on the geological modeling to the predictive reservoir simulation of CO₂-EOR. For the reservoir simulation (history matching and prediction studies), the special workflow, using properly 2 types of reservoir model and 2 types of simulation model (black oil type and compositional model) was constructed.
As a result, the appropriate reservoir model with good history matching can be obtained. In addition, as a result of the prediction simulation, the recovery factor by (immiscible) CO2-EOR was estimated to be about 18% of original oil in place. The recovery factor of natural depletion and water flooding was only about 5 to 6%. This result shows the technical applicability of CO2-EOR is expected in the oil fields. Also, this recovery factor and Utilization Factor of CO2 themselves show good values comparing with those of actual CO2-EOR projects in the United States and others. From the viewpoint of optimization of development, sensitivity analysis on the number of wells (including use of existing wells), CO2 injection rate, CO2 injection method (WAG and slag injection), etc. were also conducted.

The feasibility of the EOR in the target oil field, involving the installation of pipelines, etc. was severe from the economic point of view because of the recoverable reserve of the single oil field by CO2-EOR. However, the study result shows good recovery and the possibility of CCS - EOR in the mature oil field is suggested. The application of CCS-EOR to multiple oil fields including the usage of common infrastructure (not only surface facilities but also CO2 pipeline) is considered to be an important key and expected for the CCS-EOR application to this area.

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