Multi-objective optimization using genetic algorithm for CO_2 geological storage

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In Carbon dioxide Capture and Storage (CCS), optimization is required for efficient injection planning under uncertainty of storage reservoirs. As a means to this end, an application of multi-objective optimization (MOO) is being considered. The MOO is a method to obtain Pareto solutions that can simultaneously evaluate indices in a trade-off relationship. Although a genetic algorithm (GA) has been verified in various industry fields, the MOO using GA has never been applied to optimization problems in CCS. In this study, optimization of well placement was examined in order to verify the feasibility of the MOO method using GA to CO_2 geological storage. TOUGH2/ECO2N was used for flow simulation and Non-dominated sorting genetic algorithm-2 (NSGA-2) was implemented for optimization. NSGA-2 is known as a high-performance algorithm in MOO methods and has many applications in the oil industry. We formulated the MOO problem as to find the optimal well placement for simultaneously minimizing the mass fraction of movable CO_2 and the bottom hole pressure under the condition of fixed injection rates. Obtained Pareto solutions were compared with the exact Pareto solutions which were found in advance by the exhaustive simulations. Most of the obtained Pareto solutions were found consistent with the exact Pareto solutions; and thus, it was shown that NSGA-2 properly found possible solutions to the optimization problem in CO_2 geological storage. In addition, multiple optimized well placements exhibited two main clusters, and the decision makers can select a final scenario based on these optimal alternatives. The study concludes that NSGA-2 is effective for the optimization of well placement in CO_2 geological storage.

Keywords: Multi-objective optimization, NSGA-2, well placement, Reservoir simulation, TOUGH2, CO2 geological storage

