Computational Modeling of Natural Gas Production From Hydrate Dissociation

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Abstract
This paper provides an overview of computational modeling of hydrate dissociation. A simplified axisymmetric model for natural gas production from the dissociation of methane hydrate in a confined reservoir by a depressurizing well was first described. During the hydrate dissociation, the heat and mass transfer in the reservoir were analyzed, assuming a sharp dissociation front. The system of governing equations was solved by a finite difference scheme, and the distributions of temperature and pressure in the reservoir, as well as the natural gas production from the well were evaluated. The numerical results were compared with those obtained by the linearization method.
Hydrate dissociation in a porous sandstone core was then studied using a kinetic model. The ANSYS-FLUENT code was used for analyzing hydrate dissociation in an axisymmetric core. When the core was opened exposing the core to low pressure, the hydrate in the core dissociates and the methane gas and liquid water begin to flow in the pores. A Users' Defined function (UDF) for analyzing hydrate dissociation was developed and included in the FLUENT code. The New UDF used the Kim-Bishnoi kinetic model for hydrate dissociation. Variations of relative permeability of the core were included in the model. Sample simulation results were presented and discussed.

1. Introduction
Gas hydrates (gas clathrates) are solid compounds of natural gas molecules that are encaged within a crystal structure composed of water molecules. Hydrates are formed under certain thermodynamically favorable conditions. Physical appearance of gas hydrates resemble packed snow or ice (Sloan, 1998). According to Makogon (1997), there are tremendous amounts of natural gas trapped in hydrates in arctic regions and in the continental shelves beneath the oceans around the globe.
Per unit volume, gas hydrates contain a tremendous amount of natural gas. According to Kvenvolden (1993), 1 m3 of hydrate dissociating at atmospheric temperature and pressure forms 164 m3 of natural gas and 0.8 m3 of water.
Thus, developing methods for commercial production of natural gas from hydrates have attracted considerable attention in the recent years. Extensive reviews of properties of hydrates were provided by Sloan (1998), Makogon (1974, 1997) and Englezos (1993).