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Simulation of Natural Gas Production in Hydrate Reservoirs

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ABSTRACT

This paper simulates a one-dimensional physical model of natural gas production from hydrate dissociation in a reservoir by depressurization. According to the principles of solid hydrate decomposition in stratum and flow of natural gas in porous medium, the pressure governing equations for both gas zone and hydrate zone are set up based on the physical production model. Using the approximation reported by N. N. Verigin et al. (1980), the nonlinear governing equations are simplified and the self-similar solutions are obtained. Through calculation, for different reservoir parameters, the distribution characters of pressure are analyzed. The decline trend of natural gas production rate with time is also studied. The simulation results show that production of natural gas from a hydrate reservoir is very sensitive to several reservoir parameters, such as wellbore pressure and stratum porosity and permeability.

KEY WORDS: Natural gas hydrate; depressurization; simulation model; pressure distribution

INTRODUCTION

Natural gas hydrates are solid, ice-like crystalline materials that compounds of natural gas and water which can steadily existing under high pressure and low temperature conditions. The natural gas molecules are trapped in the cage-like structure of surrounding water molecules. Fig. 1 is the pressure-temperature equilibrium of the simple methane hydrate (Moridis, 2003). There are enormous natural gas hydrates reserving in subsurface of deep-sea sediments and permafrost regions of the earth. Studies have shown that the main natural gas trapped in hydrates are methane, and one volume of solid gas hydrate can release 150 to 180 volumes of methane at standard pressure and temperature condition. Natural gas hydrate is also a sort of clean energy. It is expected to be an alternative energy resource in the future.

Extensive interest in gas hydrates study started in the early part of the

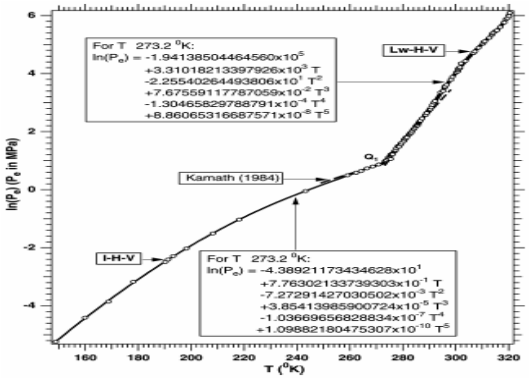

Fig. 1 Pressure-temperature equilibrium of the simple methane hydrate (G. J. Moridis, 2003)

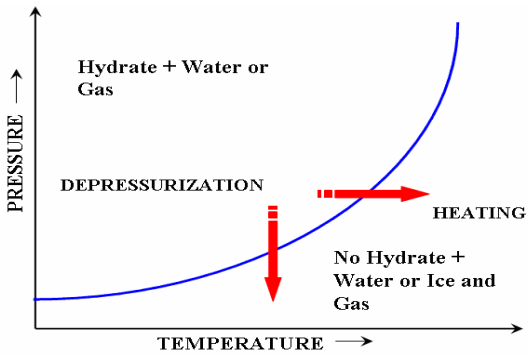

Fig. 2 Scheme of shifting hydrate equilibrium curve

19th century. Davidson firstly studied the properties of gas hydrates in details (1973). Since the Russian discovered in situ hydrates in the 1960's, there are more and more natural scientists and scholars studied the properties and the production schemes of hydrates. In order to force the solid hydrates to dissociate, it is necessary to break the