Efficient methane gas production strategies from gas hydrate reservoir using the numerical simulations

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Abstract

The numerical simulations of the gas hydrate reservoir are used to predict the reservoir response during the production tests. The complexity of the gas hydrate reservoir needs to be carefully studied through the reservoir simulations to model the long-term production tests. The feasibility of the gas production has already been demonstrated from the short-term production tests. However, the critical issues remain challenging during the long-term production. In the present work we analyze the efficient production method as well as the gas production behavior due to different well arrangements and the operating conditions. A 3-D oceanic class-2 reservoir block underlain by an unconfined aquifer layer is modeled in this work.

An In-house multiphase, multicomponent, thermal 3-D finite volume legacy simulator is used with 3 components- water, methane, and hydrate in four phases – gas, aqueous, hydrate and ice. Energy and mass balance equations are solved in space and time domain to compute the production of gas in a reservoir. The depressurization method in an unconfined reservoir becomes ineffective for the vertical wells as well as the horizontal wells. Therefore, warm water injector is used along with the depressurization to explore the impact of different arrangements of horizontal and vertical well. The horizontal wells are more efficient as compared to the vertical wells. The gas produced is 48% original gas in place (OGIP) for horizontal injectors compared to the 22% of OGIP for vertical injectors. The unconfined aquifer layer plays an important role in the gas production using different locations of the horizontal wells. When the horizontal injector is located near the aquifer layer, gas production starts from the day one as the aquifer layer makes water convection easier. However, when the injector is located in the low permeability hydrate layer, the gas production start only after the dissociation front reaches the aquifer, delaying the gas production for initial days. We also investigate the impact of initial reservoir conditions on the gas production. The initial reservoir pressure determines the effectiveness of the depressurization method and have larger impact on the production as compared to the other initial reservoir conditions.