

A Simple Model for Evaluating the Role of Hydrates on Top of Gas Reservoirs of the North

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ABSTRACT

Gas hydrates are being evaluated for their potential as a future energy source. To facilitate this evaluation, a few numerical reservoir simulators have been developed over the past decade. These models are quite comprehensive and include the important mechanisms of multi-phase flow, convection and conduction, as well as intrinsic kinetics of hydrate decomposition. Currently, three of these simulators are being used to evaluate the feasibility of suggested production methods through sensitivity studies, and to interpret the results of the production testing in Mallik field, Northwest Territories, Canada. However, many of producing companies have limited access to such models since no commercial hydrate simulator has yet been developed.

Based on recent mechanistic studies using one of these hydrate simulators, we identify a number of approximations which do not affect the gas-production rate from a hydrate reservoir that includes free gas at the bottom and a hydrate cap at top. In such a reservoir, hydrates at top contribute to the produced gas once the reservoir pressure is reduced by gas production from the free-gas zone. The endothermic heat of hydrate decomposition is provided by the sensible heat of the formation and that naturally conducted into the reservoir when the hydrate cap cools. Large gas reservoirs of this type are known in the Mackenzie Delta of the Northwest Territories, Canada and in Alaska.

In this work, we invoke the above approximations to develop a semi-analytical model to calculate rate of gas production including that from the hydrates. The model is simple and can be programmed on a spreadsheet. While its use outside its limits can lead to overestimation of rate of gas production, it is shown in this work that the model closely reproduces results of the more comprehensive numerical models for a wide range of conditions. The conditions of validity of the simple model are discussed.

The results of the modeling studies indicate that under natural depletion, a substantial amount of the top hydrate decomposes, significantly contributing to reserves and rate of gas production. The calculations suggest that the producing life of such a reservoir is much longer than would have been estimated if the hydrate cap were not accounted for.