

## **Analysis of reservoir performance of Messoyakha Gas hydrate Field**

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## ABSTRACT

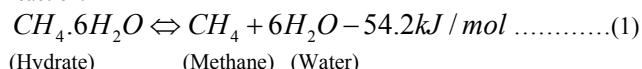
The Messoyakha Gas Field is located in Siberian permafrost. The field has been described as a free gas zone, overlaid by hydrate layer and underlain by an aquifer of unknown strength. The field was put on production in 1970 and has produced intermittently since then. Some characteristic observations were increase in average reservoir pressure during shut-in, perforation blocking due hydrate formation and no change in gas-water contact. It is believed the increase in reservoir pressure was caused by the hydrate layer dissociation, rather than aquifer influx. The objective of this study was to use numerical model to analyze the observed production data from the Messoyakha field. In this study, a range of single-well 2D cross-sectional models representative of Messoyakha have been developed using the TOUGH+Hydrate reservoir simulator. The simulation results were then analyzed and compared with various field observations. Further, we have done a parametric study of reservoir properties of hydrate capped gas reservoir.

KEYWORDS: Methane Hydrates, Messoyakha, Depressurization

INTRODUCTION

Gas hydrate is a crystalline substance in which the gas molecules are trapped in the voids created by arrangement of water molecules. The water molecules are held together by the hydrogen bonds. Natural gas consists mainly of methane. It also consists of heavier hydrocarbon gases like ethane, propane, butane and non-hydrocarbon gases like CO<sub>2</sub>, N<sub>2</sub> and H<sub>2</sub>S, etc. Only methane hydrate is considered in this study. One m<sup>3</sup> of methane hydrate (formed at 26 atm and 0°C) on dissociation yields 164 m<sup>3</sup> of methane at standard

temperature and pressure (Makogon et al., 2007). Naturally occurring gas hydrates are found in two distinct settings; in marine sediments and in permafrost. The volume of gas resource in the form of natural gas hydrate is huge as compared to the conventional gas reservoirs. Current estimates of hydrated gas worldwide are in the range of  $10^5$  to  $10^6$  Trillion cubic feet (TCF). These estimates will keep on narrowing down as more data from exploratory drilling becomes available. (Makogon, 1981) first suggested three basic phenomena to dissociate the hydrates i.e. depressurization, thermal stimulation and inhibitor injection. Hydrate dissociation reaction is an endothermic reaction.



Naturally occurring gas hydrates are divided into three main classes (Moridis and Collett, 2003, 2004). Class 1 systems are hydrate deposits underlain by mobile gas and water, Class 2 systems are hydrate deposits underlain by mobile water and Class 3 systems are hydrate deposits not underlain by any fluids.

In the permafrost settings, hydrates have been found in McKenzie Delta in Canada, Alaska North Slope and Messoyakha in Siberia. However, only Messoyakha Gas Field has been suggested by some experts to be producing from a hydrate capped gas reservoir and has been used as a template to study other hydrate occurrences around the world. There were many observed phenomena at Messoyakha Field, which has been suggested to have occurred due to the presence of gas hydrates. The most characteristic observations were 1) the increase in the average reservoir pressure during the shutdown of the field, 2) No change in gas-water contact during last 30 years of production. The wells completed in hydrate layer flowed at very low rates as compared to the wells completed in the free gas zone. During the injection of methanol in certain wells, it was possible to operate certain wells at higher wellhead pressures.

## **OBJECTIVES AND METHODOLOGY**

The main objective of this study was to model the various phenomena and pressure behavior at Messoyakha gas field. We started our analysis with a detailed analysis of Messoyakha Field. The main purpose of this was to reconcile the available data on Messoyakha with conceptual and fundamental knowledge of hydrates. The reconciliation study essentially was important to delineate the uncertainties in the available data. These uncertainties prompted us to develop a range of 2D cross sectional models representative of Messoyakha Field. We then simulated the gas production from these range of models to match the various observed data and phenomena. Eventually, we did the parametric study for a hydrate capped gas reservoir. We have enlisted the various controlling parameters for production from hydrate capped gas reservoirs.

## MESSOYAKHA GAS FIELD

## Thermodynamic state

Messoyakha gas field is under a unique thermodynamic regime in reference to natural gas hydrates. Figure 1 shows the equilibrium curve for methane hydrate and the location of the top and bottom of the Messoyakha gas reservoir. It can be seen from this figure that upper part of Messoyakha reservoir is under hydrate stable region and lower part is outside the stable boundary. This was the main driving force for

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