

## **The Second Onshore Methane Hydrate Production Test in the Mackenzie Delta**

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In the vicinity of the Mackenzie Delta, in shallow areas of the Beaufort Sea located in the Northeast of North West Territories, Canadian Arctic, the occurrences of methane hydrate (MH) under permafrost was well known. In 1998, the collaborative research between Japan and Canada has been undertaken and the physical occurrence was confirmed by obtaining the geological and geochemical data through wireline logging and coring. In 2002, the collaborative research of the first onshore MH production test was conducted by seven partners from five countries, Japan, Canada, Germany, USA and India. The 2002 program successfully produced the gas from hydrate reservoir by thermal stimulation method using hot warm fluid as the world first. In mean time, the limitation of thermal stimulation method was understood. The physical parameters in reservoir such like permeabilities were obtained, and the reservoir response were tested through in-situ formation tester by decreasing and increasing the pressure. This result potentially indicated the depressurization method for MH gas production could be more effective than other method under certain condition.

Based on these results, the MH21 Methane Hydrate Research Consortium under the contract by Ministry of Economy, Trade and Industry embarked on the second onshore MH production test at the same location, and a new collaborated research program with Natural Resource Canada has been agreed. The main purpose of this test is to verify if depressurization method is effective to produce gas from the hydrate reservoir. The plan involved re-entry of the well originally drilled in 1998, and drilling and completion the well to facilitate the production. Production testing would be carried out by pumping out fluid inside casing in order to draw-down the formation pressure. The physical parameters before/after the test must be measured through wireline logging and monitoring device deployed behind the casing.

Testing site were located in the area where was accessible through the ice road constructed on the frozen channel and sea shore. This location also overlaps with key arctic habitats and important harvesting areas. Therefore, the reduction of the potential damage to the environment must be taken into account and there was significant environmental regulation to be applied for designing the testing facility and operation plan. The program consists of two-year (2006 to 2007 and 2007 to 2008) winter operations. 2006 to 2007 winter (the first winter) operation has been conducted by involving drilling, completion of the well and short period of production test. Based on this results, the 2007 to 2008 (the second winter) operation was planned.

The gas hydrate zone continues from 890m to 1100m intermittently under the permafrost which has 650 m thickness. The lowest gas hydrate occurrence zone (GHOZ) near above the basis of the gas hydrate stability zone was selected for production test. The 12m interval of the casing at the

selected zone was perforated, and borehole assembly (BHA) with electrical submersible pump (ESP) below the perforated zone was deployed. The BHA was set to reverse flow direction in order to inject produced water to the lower water bearing zone since the produced water could not be carried to the surface per license at that time. This method allowed us to draw down the bottom pressure from 11 Mpa to 7Mpa successfully and flow of methane gas was measured. While pump operation, the pressure could not be decreased several times. For workaround, the pump was stopped and re-started by waiting a while. Then, the situation was recovered. Eventually, the operation could not be continued when this happened at fourth time. The total amount of gas estimated during 12.5 hours of mean pump operation from the time of gas measured to the time of reaching maximum draw-down were 830m<sup>3</sup> gas (calculated by surface and downhole pressure). The approximately 2.5m<sup>3</sup> of the sand production inside the casing was also recognized. This indicated that the sand was produced with dissociated gas and water from the hydrate formation and this could be the cause of pump trouble. The countermeasure of the sand production must be taken into consideration for the second winter operation.

For the 2007-2008 winter program, it is planned to execute production test with longer test period at the same perforated interval by deploying the sand control device and injecting the produced water back to underground through surface to injection well. It is expected to confirm the dissociation of gas hydrate in the formation by obtaining the pressure & temperature data and sampling the gas & water, and to understand formation response quantitatively.