Methane Hydrate Studies

Using Teledyne ISCO Syringe Pumps

TELEDYNE ISCO
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Syringe Pump Application Note
AN14

Overview

Methane Hydrates consist of methane (natural gas) locked inside the crystalline lattices of water molecules, existing in sediment below the ocean floor, which can be released when exposed to the atmosphere.

Also known as “burning ice” for their unique physical properties, methane hydrates are a potential, relatively clean energy source that could provide a solution to our growing energy needs.

Figure 1: Release of methane from ice through heating

According to the U.S. Geological Survey, the organic carbon content of methane hydrates worldwide is estimated at 104 gigatons—roughly twice the amount contained in all fossil fuels combined.

Each volume of hydrate can contain over 160 volumes of methane gas. If these hydrates are harvested, there could be as much as 20,000 trillion cubic meters available worldwide, compared to 250 trillion cubic meters of conventional natural gas in remaining worldwide reserves.

Formation

Methane hydrates are formed under specific conditions of temperature and pressure where there have been accumulations of organic remains, from which bacteria have generated methane, and where sediment has rapidly collected, protecting the remains from oxidation.

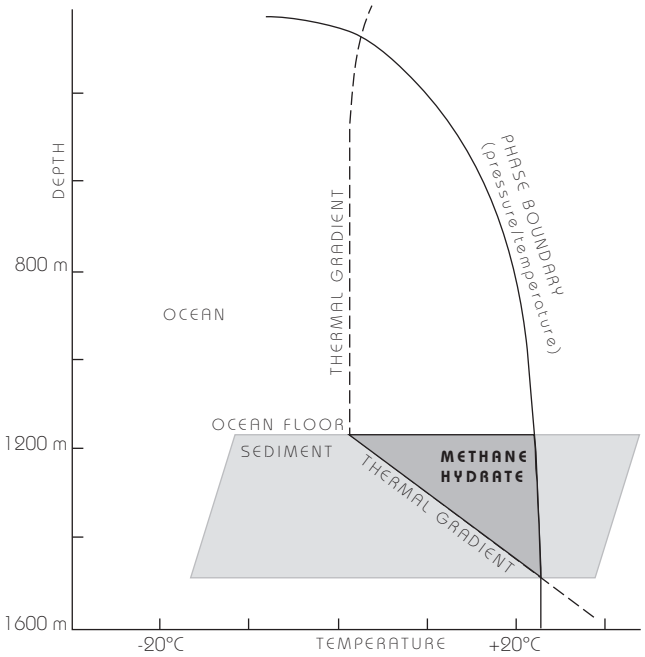

Figure 2: Formation conditions of methane hydrates

Potential Recovery Sites Worldwide

Methane hydrates can be found offshore along most continents in the world and in some permafrost regions, such as Canada and Russia, where specific temperatures and pressures exist.

In Canada alone, there are an estimated 500 trillion cubic meters of methane hydrate located mainly in permafrost of Mallik field, in the Beaufort-Mackenzie region above the Arctic Circle. This field contains one of the highest concentrations of natural gas hydrates in the world, and studies indicate that significant gas recovery is possible. Methane hydrates are also found in the Nankai Trough located offshore from Japan, where there is an estimated 14-year supply.

Preliminary Research

While the potential benefits are tremendous, there are also many issues to overcome, such as how to retrieve the hydrates and extract the methane from them. Research is currently underway in Japan, Canada, and the United States to answer these important questions:

- How are methane hydrates formed?
- What are the phase saturations and resulting fluid flow in hydrate reservoirs?
- What is the total amount of recoverable methane worldwide?
- How can this gas be harvested in a safe and cost effective manner?
- What is the environmental impact of mining and using methane hydrates?

Experimental Studies

Current research into the extraction of methane hydrates requires laboratory modeling of site conditions. More immediate data requirements include determining the hydrate distribution within the ice framework, the ability of hydrate-bearing sediments to transmit pressure-temperature impacts, relative permeability, phase saturations and resulting fluid flow in hydrate reservoirs, and methane production and migration rates in the subsurface.

Teledyne ISCO Pumps

Teledyne ISCO Syringe Pumps can be used in experiments such as determining phase or relative permeability of core samples by accurately controlling fluid volumes, flow rates, and pressures. They can be used for fluid delivery, overburden pressure, and pressure regulation.

Figure 3 shows two pairs of continuous flow pumps, one pair for receiving and one for delivery. The receive pumps are set in constant pressure mode and will dispense to waste when filled. The switchover between pumps is pulseless, thereby minimizing pressure fluctuations.

Table 1: Recommended ISCO Pump

Model	500x
Flow Range (ml/min)	0.001 - 204
Pressure Range (psi)	0 - 5,000

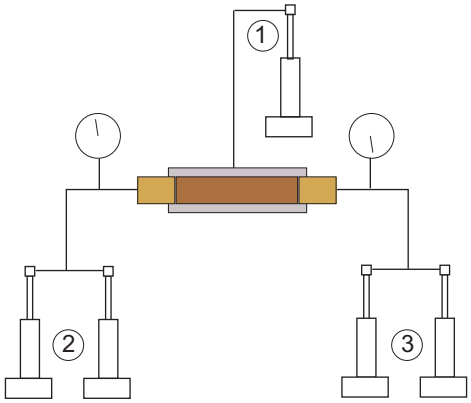

Figure 3: Continuous pumping in constant pressure mode

1. Overburden pump
2. Receive pumps
3. Delivery pump

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Product model names have been updated in this document to reflect current pump offerings.

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