IEAGHG Information Paper; 2012-IP15: CO_2 Injection into Methane Hydrates

Background: IEAGHG Reports Ph3/25 and Ph3/27

In 2000 IEAGHG completed two studies that considered the injection of CO_2 into methane hydrates with the production of CH_4. The first was a study entitled "Issues underlying the feasibility of storing CO_2 as hydrate deposits" (Ph3/25), whilst the second (Ph3/27) was a more extensive study to investigate the practicalities and potential for combining methane extraction from natural gas hydrates with CO_2 storage which has now been demonstrated. Ph3/27 also focused on natural gas Potential for CO_2 injection combined with methane extraction from natural gas hydrates.

The study investigated in depth the potential for methane extraction from a permafrost reservoir combined with CO_2 injection and storage. The study examined the experimental work undertaken in four Japanese laboratories and concluded that the kinetics and thermodynamics for the displacement mechanism are, at best, on the margin of being sufficient for this application. The study suggested that injecting CO_2 would not extract all the methane from the methane hydrate. At best some 29% of the methane will remain in the hydrate phase. The gas produced would, therefore, contain significant quantities of CO_2, as soon as the injected gas had filled the void space. Early breakthrough of CO_2 to the gas producing wells could, therefore, be expected. This would add to the field capital and operating costs because CO_2 separation plant would be required for treating the produced gas.

The report also identified steps that be taken before CO_2 enhanced methane hydrate extraction can be further.

1. Planned laboratory and pilot scale tests in Japan and the USA must clearly demonstrate the technical viability of this method. These tests were considered to be completed in 2001/2002.

2. Commercial exploitation of permafrost hydrate deposits must be proven to be technically and economically viable. Exploitation of the permafrost methane hydrate resource is not expected to begin before 2010 at the earliest.

Whilst, the commercial exploitation of the permafrost deposits has not been completed, the laboratory tests have and we can comment on these development's.

The US formed a national hydrate research programme in 1998, and in 2000 there was an act passed that mandated the USDOE to lead this programme. A link to the details of this programme and research to date is:
http://www.netl.doe.gov/technologies/oil-gas/publications/Hydrates/2011Reports/MH_Primer2011.pdf
This summary report provides a lot of back ground information on the global gas hydrate resource etc.,

The pilot testing programme can be summarised as follows:

- In 2002, an international consortium, led by Japan and Canada and including the U.S., conducted a short-duration production testing at the Mallik site in the Canadian North West Territories demonstrated, for the first time, that methane could indeed be produced from methane hydrates

- In 2007 and 2008, Japanese and Canadian researchers returned to the Mallik site to conduct a longer-duration production test. A six-day pressure drawdown test resulted in sustained, stable gas flow from hydrate. The success of this production test was considered to be a major step forward in verifying the producibility of methane from hydrate.
- On May 2 2012, the U.S. Energy Secretary Steven Chu announced the completion of a successful, unprecedented test of technology in the North Slope of Alaska that was able to safely extract a steady flow of natural gas from methane hydrates. The , proof-of-concept test commenced on February 15, 2012, and concluded on April 10. The team injected a mixture of carbon dioxide (CO_2) and nitrogen into the formation, and demonstrated that this mixture could promote the production of natural gas. This test was the first ever field trial of a methane hydrate production methodology whereby CO_2 was exchanged in situ with the methane molecules within a methane hydrate structure. As part of this exchange demonstration, the depressurization (i.e., production through decreasing pressure of the deposit) phase of the test extended for 30 days. The prior longest-duration field test of methane hydrate extraction via depressurization was six days (Japan-Canada 2007/2008 Mallik well testing program).

Ray Boswell the NETL Programme Manager for Methane Hydrates indicated to me that:

"Nitrogen was added to the concept as it was thought it would produce a gas saturation by which the CO_2 could travel and affect exchange without converting directly to CO_2-hydrate. However that N_2 has other impacts as well, including partial pressure effects that dissociate near-well-bore hydrate.

All this is complicated by the fact that numerical codes including the fundamental PTX relationships for N_2-CO_2-CH_4-H_2O do not exist. But we do know that a wide variety of mixed hydrates could be created, both during injection and flow-back.

All this means that we did conduct a complex test, but one that I think will advance us considerably in designing the next field tests of gas hydrate production"

It seems that progress is being made in the development of the methane hydrate energy resource, which is a globally significant future methane resource, however we are still an early stage of development of this technology option and its ability to act as a CO_2 store. We will continue to watch developments in this area over the coming years.

John Gale
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