METHOD AND APPARATUS FOR EXTRACTING GAS HYDRATE DEPOSITS

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ABSTRACT

An apparatus and method for disassociating natural gas from a deposit of natural gas hydrates and producing natural gas. A reactor module is located downhole in a heating and injection well. Water is provided to the reactor module where it is heated and a solvent is injected into the water prior to heating. The heated water and solvent passes to the deposit of natural gas hydrates where the natural gas is disassociated under the influence of the heat from the reactor module.
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BACKGROUND OF THE INVENTION

[0001] Natural gas hydrate deposits are known to exist in numerous regions in great quantities in the world and contain many times the known producible reserves of conventional natural gas. Natural gas hydrates are crystals of principally methane within a lattice of water molecules and are formed naturally under conditions of low temperature and high pressure. The deposits can generally be reached using conventional well drilling and well completion technology. However, heating and disassociating such deposits to release the trapped natural gas is a problem.

SUMMARY OF THE INVENTION

[0002] According to one aspect of the invention, there is provided a method of extracting natural gas from a deposit of natural gas hydrates, said method comprising supplying water to said deposit of said natural gas hydrates, heating said water supplied to said deposit of natural gas hydrates and flowing said deposit of said natural gas hydrates to disassociate said natural gas hydrates in order to recover said natural gas and the water from said disassociation of said natural gas hydrates, said natural gas and said water migrating from said deposit of natural gas hydrates to an area of lower pressure being production casing.

[0003] According to a further aspect of the invention, there is provided apparatus for heating a deposit of gas hydrates to disassociate said gas hydrates and obtain natural gas comprising a reactor module located within casing of a heating well, a water injector to supply water to said reactor module and a heater within said reactor module to heat said water supplied to said reactor module and to inject said heated water into said deposit of gas hydrates.

[0004] According to yet a further aspect of the invention, there is provided a method of heating a deposit of natural gas hydrates comprising positioning an induction tool in downhole well casing and generating an induction flux in said tool to excite and heat said well casing and said deposit of natural gas hydrates.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0005] Specific embodiments of the invention will now be described, by way of example only, with the use of drawings in which:

[0006] FIG. 1 is a diagrammatic layout illustrating the overall technique for extinction of the natural gases from the natural gas hydrate formation; and

[0007] FIG. 2 is a diagrammatic plan view of a plurality of injector and heating wells drilled about the boundaries of a natural gas hydrate formation.

DESCRIPTION OF SPECIFIC EMBODIMENT

[0008] Referring now to the drawings, a natural gas hydrate formation is generally illustrated at 100. The formation may be located at relatively shallow or relatively deep depth and conventional well drilling and well completion is sufficient to reach the formation 100.

[0009] A production well 101 is drilled and put into operation using conventional technology. A horizontal portion 102 extends into the gas hydrate formation 100 and a perforated production liner 103 is installed at the retrieval area of the natural gas hydrate formation 100. A pump 122 is located downhole in the production well 101 for the purpose of pumping the water produced from the disassociation of gas hydrates to the surface 111. Natural gas from the dissociated hydrate flows to the surface within the production casing where a compressor (not illustrated) is located to compress and transport the recovered gas.

[0010] A second drill hole, namely an injection and heating well is generally illustrated at 104. It extends from the surface 111 substantially vertically in a vertical portion 112 and terminates at the end of a horizontal portion 113. A water injection unit 120 and a water tank 121 are located on the surface 111 and act to provide water and a fluid solvent, such as methanol or ethylene glycol solvent for injection into the injection and heating well 104. The use of solvent prevents the re-association of the water and the natural gas into hydrates causing blockage of production.

[0011] A reactive module according to the invention is generally illustrated at 114. It is located within the horizontal portion 113 of the heating and injection well 104. The reactive module 114 takes the form generally illustrated in U.S. Pat. No. 6,384,389, the contents of which are incorporated by reference. The reactive module 114 has a hollow bore and in a first embodiment, it is inductively powered; that is, it projects electromagnetic flux outwardly to optically heat the steel well casing 123 of the injection and heating well 104. A hydraulic pump 124 is provided within the reactor module 114 which hydraulic pump 124 utilizes a motor driven piston contained within a cylinder. The hydraulic pump 124 provides pressure to a bladder 130 which seals the reactor module 114 within the well casing 123 as will be described. Telemetry and control electronics are provided within the reactor module 114 to monitor various sensors and transducers embedded within the reactor module 114, which sensors and transducers are used to measure process variables such as downhole temperatures and pressures, as well as to control actuation of the reactor module 114, the hydraulic pump 124, the bladder or seal 130, the fluid removal pump 122 and the methanol injection process. Taking place in the water injection unit 120. A DC to AC inverter is provided to supply power to the reactor module 114.

[0012] The downhole tooling used to install and operate the reactor module 114 includes centralizers (not illustrated) to maintain the reactor module 114 centrally located within the injection and heating well 113 as is known and the reactor module 114 is supported by tubing (not illustrated) supplied from the topside tube spool as is also known. The tubing incorporates a high pressure tube for the supply of solvent, a fluid extraction tube for extraction of liquids, a power cable and a data telemetry cable all as is known. The topside tubing spool will further include the necessary electrical and fluid slip rings to interface the downhole tool with the topside subsystems used to process the downhole data.

[0013] A power control unit(PCU) (not illustrated) controls three phase power to high voltage DC power to be supplied to operate the reactor module 114. The PCU provides an operator interface and the control logic.
The gas extraction system used by the production well 101 enhances the separation of the natural gas from the water flowing from the production well 101. The gas extracted from the gas hydrate formation to the surface 111 is then compressed for storage and/or transport.

A fluid separator subsystem (not illustrated) separates water and solvent fluid pumped out of the production well 101. The water is collected for recycling to the solvent mixing systems, with excess water going to disposal. Recovered solvent plus the addition of any required make-up is mixed with water to an optimal concentration and re-injected into the injection and heating well 112.

OPERATION

Using the downhole tooling previously described, the reactor module 114 is deployed to its initial operating position within the horizontal portion 113 of the injection and heating well 104. The operation of the hydraulic pump 124 is initiated and the bladder or seal 130 is inflated in order to provide a pressure seal between the reactor module 114 and the casing 123. The reactor module 114 is powered on to heat the well casing 123 and the injected solvent/water mixture causing the hydrate within the gas hydrate formation to disassociate into a two phase gas and fluid mixture. Hot water permeates the formation causing the hydrates and water to migrate to the lower pressure perforated production liner 103. Water within the casing is pumped to the surface 113 by pump 122. Solvent is injected into the well being supplied to the injection and heating well 104 from injection unit 120. The injected solvent/water mixture may be partially or completely vaporized by the heat generated by the reactor modules thus forming a high pressure vapor “cloud” which emanates from the injection liner 131. The vapor “cloud” expands the heating zone further into the gas hydrate formation 100 which contributes further to the disassociation of the gas hydrates resulting in increasing amounts of natural gas being passed to the low pressure zone of the perforated production liner 103 and into the production well 101 where it passes to the surface 113.

The reactor module 114 is moved along the horizontal portion 102 of the heating and injection well 104. Prior to movement, the bladder or seal 130 is deflated to allow for movement of the reactor module 114 and when the new operating position of the reactor module 114 is reached, the bladder or seal 130 is inflated to provide a new seal between the reactor module 114 and the casing 123. As the movement of the reactor module 114 takes place, the heated zone within the gas hydrate formation is increased and expanded to disassociate the gas hydrates and thereby to contribute to more complete natural gas flow to the production well 101.

While the reactor module 114 has been illustrated and described in a horizontal portion of the injection and heating well 104, it is apparent that the benefits of the invention would also apply equally to the reactor module 114 being deployed in a vertical well or a slant well. Thus, the reactor module 114 may be deployed and operated in an injection and heating well of virtually any configuration.

Many further modifications in the invention will readily occur to those skilled in the art to which the invention relates and the specific embodiments described herein should be taken as illustrative of the invention only and not as limiting its scope as defined in accordance with the accompanying claims.

We claim:

1. A method of extracting natural gas from a deposit of natural gas hydrates, said method comprising supplying water to said deposit of said natural gas hydrates, heating said water supplied to said deposit of said natural gas hydrates and flooding said deposit of said natural gas hydrates to disassociate said natural gas hydrates in order to recover said natural gas and the water from said disassociation of said natural gas hydrates, said natural gas and said water migrating from said deposit of natural gas hydrates to an area of lower pressure being production casing.

2. A method as in claim 1 wherein a solvent is added to said water supplied to said deposit of said natural gas hydrates.

3. A method as in claim 1 wherein said heated water is injected into said deposit of said natural gas hydrates from a vertical, a deviated or a horizontal casing.

4. A method as in claim 2 wherein said solvent is methanol or ethylene glycol.

5. A method as in claim 1 wherein said water is heated by a reactor module located within a heating well having casing, said water supplied to said deposit of gas hydrates being heated by said reactor module.

6. A method as in claim 5 wherein said reactor module further heats said casing of said heating well.

7. Apparatus for heating a deposit of gas hydrates to disassociate said gas hydrates and obtain natural gas comprising a reactor module located within casing of a heating well, a water injector to supply water to said reactor module and a heater within said reactor module to heat said water supplied to said reactor module and to inject said heated water into said deposit of gas hydrates.

8. Apparatus as in claim 7 and further comprising an injector for a solvent to be added to said water supplied to said reactor module.

9. Apparatus as in claim 8 wherein said reactor module provides heat by either induction or by resistive heating.

10. Method of heating a deposit of natural gas hydrates comprising positioning an induction tool in downhole well casing and generating an induction flux in said tool to excite and heat said well casing and said deposit of natural gas hydrates.

11. Method as in claim 10 wherein at least two induction tools are positioned in locations within said deposit of natural gas hydrates.

12. Apparatus as in claim 7 and further comprising a bladder to seal said reactor module within said well casing.