Liquefied natural gas is used as a fracturing fluid to stimulate production of hydrocarbons from and/or injectability of fluids into subterranean formations. Proprants may be blended with the LNG prior to pumping the liquefied natural gas into the well. Optionally, the liquefied natural gas is heated after it is pumped and before it is introduced into the subterranean formation.
METHOD AND APPARATUS FOR STIMULATING A SUBTERRANEAN FORMATION USING LIQUEFIED NATURAL GAS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This is the first application filed for the present invention.

MICROFICHE APPENDIX

[0002] Not applicable.

FIELD OF THE INVENTION

[0003] This invention generally relates to well fracturing and well stimulation operations, and, in particular, to a fracturing fluid and method of fracturing a subterranean formation to stimulate production of fluids from a well, or to improve permeability of the subterranean formation to facilitate injection of fluids into the well.

BACKGROUND OF THE INVENTION

[0004] Most subterranean formations used for producing oil and gas, coal bed methane, tar sands, oil shale, or shale gas formations require some form of stimulation to enhance hydrocarbon flow from the formations to make or keep them economically viable. Likewise, most subterranean formations used for fluid storage or disposal require some form of stimulation to enhance fluid flow into those formations. The fracturing of subterranean formations to stimulate production or enhance injectability requires the pumping of fluids under high pressure through the wells and into the formations with which the wells communicate.

[0005] Traditionally, fracturing fluids have been aqueous solutions treated with various chemicals such as surfactants, foamers, cross-linkers and/or gelling agents and often also include proppants such as bauxite, sand or ceramic particulates. The use of aqueous fracturing fluids has certain disadvantages. First, in many parts of the world the water required for these fluids is difficult and expensive to obtain. In cases off-shore wells, sea water is often used for the fracturing fluid but the use of sea water requires filtering and chemical treatment to reduce the detrimental affects of the sea water in the subterranean formations. Second, transfer and disposal of used aqueous fluids is problematic. These fluids must be flowed back out of the subterranean formations, up the well and into tanks for shipping and disposal. Sometimes, they are dumped into the sea. It is well understood that dumping used fracturing fluids laden with chemical treatments and hydrocarbons into the sea is not an environmentally sound practice. In most land jurisdictions the fluids must be disposed of in deep underground formations, which is expensive and may have unpredictable environmental consequences. Third, aqueous fluids are by nature incompatible with most hydrocarbons and many subterranean formation compositions. It is well known that aqueous fracturing fluids can reduce the porosity of coal seams, thus inhibiting the release of coal seam methane. The mixing of aqueous fracture fluids with oil production is also undesirable, so fracturing fluids must be “flowed back” from a fractured well, separated from the oil and gas, and then disposed of in some way. There is inevitable loss of hydrocarbons during the flow back, separation, and transportation, which all results in a loss of time before commercialization of the produced products can begin.

[0006] In addition, aqueous fracturing fluids can have deleterious effects on certain strata, such as clay stratum for example. If aqueous fluids are to be used where a clay stratum is exposed to the fracturing fluid, the fracturing fluid must be treated with a salt such as potassium chloride (KCl) to inhibit damage to the stratum. This adds expense and makes the fracturing fluid corrosive. Furthermore, aqueous fluids used for fracturing introduce different ions, and elements into the subterranean formations which often results in scale formation on production equipment after the stimulation treatment.

[0007] The aqueous fluid fracturing fluids also present other environmental risks. For example, the current methods used for fracturing coal bed methane wells, which are frequently relatively shallow wells and may be in the same strata as a potable water supply used by a local population, employs aqueous fluids generally mixed with chemicals to reduce surface tension of the fluids, reduce the friction of the fluids being pumped, or otherwise enhance the stimulation treatment or recovery of the fracturing fluids. Besides, the injection of aqueous fluids into a coal bed methane strata can contaminate the potable water supply, entrain oxygen and air, stimulate bacterial growth, and induce the production of hydrogen sulfide in the strata.

[0008] Other fluids have also been used for fracturing subterranean formations, including: gases such as nitrogen and carbon dioxide; hydrocarbon solvents such as ethanol and diesel fuel; and liquefied gases such as liquid nitrogen and liquid carbon dioxide. Hydrocarbon gases such as propane, butane, and heavier hydrocarbon solvents have also been injected into wells at sub-fracturing pressures to dissolve heavy oil deposits to stimulate production.

[0009] Most of these fluids also have disadvantages. For example, if liquefied gases are used for well stimulation they have to be flowed back before production from the well can be commercialized. Of course, any natural gas present in the well mixes with these gases used for the fracturing process. Consequently, it is common to have to “flare off” such wells to the atmosphere for several days after a “frac closure” until the concentration of the fracturing gases in the well production fluid stream is low enough that the produced well stream can be commercialized.

[0010] If refined fluids such as ethanol or diesel are used, they are generally dissolved in the oils produced from the well, and/or contaminated by chemicals used in the fracturing process, and cannot be readily recovered for re-use or commercialization.

[0011] It is also been proposed to use methane gas to stimulate production from certain wells.

[0012] For example, U.S. Pat. No. 5,014,788 which issued on May 14, 1991 and is entitled Method of Increasing the Permeability of a Coal Seam describes a method of injecting carbon dioxide, xenon, argon, neon, krypton, ammonia, methane, ethane, propane, butane, and any combination of those gases through standard wellhead equipment into a coal seam in order to clean and cause swelling in the seam and improve methane production after a conventional aqueous fracturing of the coal seam has been completed.
Another example of the use of methane gas for well stimulation is found in U.S. Pat. No. 5,899,272 which issued May 4, 1999 and is entitled Fracture Treatment System for Wells. This patent describes a system in which a fracturing fluid storage vessel, high pressure pump and high pressure conduit are connected in series to a well. A pressure vessel is connected to the high pressure conduit for injecting proppant carrying fracturing fluid into the well without the proppant carrying fracturing fluid passing through the pump. The fracturing fluid is preferably an aqueous solution, though the applicant speculates that the fracturing fluid may also be a gas, such as methane, ethane or nitrogen, in which case the high pressure pumps are replaced with conventional compressors.

Although techniques for stimulating subterranean formations have considerably evolved over time, there still remains a need for inexpensive, universally available, environmentally compatible, recoverable fracturing fluid that is fully compatible with subterranean formations.

There also exists a need for a method of stimulating production and injectability of a subterranean formation that uses inexpensive, universally available, environmentally compatible, recoverable fracturing fluids that reduce fracturing completion time, do not delay the start of production or the commercialization of the well products from the well, and do not cause hydrocarbons to be lost during or after a fracturing closure operation.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide an inexpensive, universally available, environmentally compatible, recoverable fracturing fluid that is fully compatible with subterranean formations.

It is a further object of the invention to provide a method of stimulating production of a subterranean formation using an inexpensive, universally available, recoverable fracturing fluid that reduces fracturing completion time and does not delay the start of production or commercialization of hydrocarbons produced from the well.

The invention therefore provides a fracturing fluid for stimulating hydrocarbon production from a subterranean formation, the fracturing fluid comprising liquefied natural gas or liquefied methane. A proppant is optionally blended with the liquefied natural gas/liquefied methane before it is pumped into the subterranean formation.

The invention further provides a method of stimulating a subterranean formation to increase hydrocarbon production from the subterranean formation. The method comprises, drawing liquefied natural gas/liquefied methane from a source, pumping the liquefied natural gas/liquefied methane at a pressure and a flow rate high enough to induce fracturing of the subterranean formation, and conducting the liquefied natural gas/liquefied methane into the subterranean formation.

The invention also provides a method of fracturing a well to stimulate production or injection. The method comprises connecting wellhead isolation equipment to a wellhead of the hydrocarbon well, pumping liquefied natural gas or liquefied methane down through a tubular connected to the wellhead isolation equipment and suspended in the hydrocarbon well to a subterranean formation at a pressure and a flow rate adequate to induce fracturing in the subterranean formation, removing the wellhead isolation equipment and connecting hydrocarbon production equipment to the wellhead; and producing hydrocarbons from the well to recover the natural gas/methane and produce the hydrocarbons from the subterranean formation.

The invention therefore provides a fracturing fluid and methods for fracturing wells that are fully compatible with subterranean formations. The fracturing fluids are universally available at a reasonable cost, are environmentally compatible, and are commercially recoverable after stimulation is completed. The invention also reduce time to production after stimulation because production can be commenced as soon as a fracturing closure operation is effected. The release of fracturing fluid can be effected at any desired rate to ensure that the stimulation treatment has a desirable and lasting affect.

BRIEF DESCRIPTION OF THE DRAWINGS

Having thus generally described the nature of the invention, reference will now be made to the accompanying drawings, in which:

FIG. 1 is a schematic illustration of a system for fracturing a well in accordance with an embodiment of the invention in which liquefied natural gas is pumped directly into a well;

FIG. 2a is a schematic illustration of a system for fracturing a well in accordance with another embodiment of the invention in which a proppant is blended with liquefied natural gas prior to pumping the liquefied natural gas into the well;

FIG. 2b is a schematic illustration of a system for fracturing a well in accordance with another embodiment of the invention in which a proppant is blended with liquefied natural gas after pumping the liquefied natural gas but prior to conducting the liquid natural gas into the well;

FIG. 3 is a schematic illustration of a system for fracturing a well in accordance with another embodiment of the invention in which liquefied natural gas is heated prior to entry into the well;

FIG. 4 is a schematic illustration of a system for fracturing a well in accordance with another embodiment of the invention in which liquefied natural gas is heated using a heat-exchanging fluid prior to entry into the well;

FIG. 5 is a schematic illustration of a system for fracturing a well in accordance with another embodiment of the invention in which liquefied natural gas is heated by a heat-exchanging fluid during its descent through the wall; and

FIGS. 6a, 6b and 6c are schematic illustrations of a system for fracturing a well in accordance with another embodiment of the invention in which an inert cryogenic fluid is used to cool at least the pumping and fracturing equipment before the liquefied natural gas is pumped into the well.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In general, and as will be explained below in detail, the invention provides a method and system for fracturing a
subterranean formation using liquefied natural gas (LNG) or liquefied methane, hereinafter referred to collectively as liquefied natural gas. The liquefied natural gas is pumped as a cryogenic fluid at pressures and flow rates that are high enough, to fracture the subterranean formation requiring stimulation. After fracturing operations are complete, the natural gas used as fracturing fluid can be recovered and commercialized without loss or damage to the environment, rendering this method of fracturing highly economical and environmentally sound. The LNG can be blended with proppants before or after pumping and is optionally heated either before it enters the well or during descent through the well bore.

[0031] As used in this disclosure, “liquefied natural gas” means liquefied methane and blends of liquefied methane (CH₄) with any other normally gaseous hydrocarbons and/or atmospheric gases normally found in liquefied methane-based products generally referred to as “natural gas”.

[0032] FIG. 1 schematically illustrates an apparatus for practicing a method of fracturing a subterranean formation in accordance with an embodiment of the invention in which liquefied natural gas is pumped directly into a well. As shown in FIG. 1, a fracturing system in accordance with the invention is generally designated by reference numeral 10. A LNG source 12, for example a pressure vessel containing LNG can be a static structure, a mobile unit carried by a tanker truck, a train or a pipeline for on-site delivery of LNG to terrestrial wells, or by a tanker vessel for delivery to offshore wells.

[0033] Liquefied natural gas (“LNG”) is a variable mixture of about 75-95% liquefied methane (CH₄), 5-15% ethane (C₂H₆), with the remainder composed of other hydrocarbons including propane C₃H₈ and butane (C₄H₁₀). The largest constituent of LNG, liquefied methane, has a melting point of -182.5°C (-296.5°F) and a boiling point of -161.6°C (-259°F). Accordingly, in order to pump liquefied natural gas, one or more cryogenic pump(s) 14 associated with a fracturing rig is provided, as schematically illustrated in FIG. 1.

[0034] In this embodiment, each cryogenic pump 14 pumps the LNG into a well 20 equipped with wellhead isolation equipment 22 mounted to a wellhead of the well. The wellhead isolation equipment 22 includes surface fracture conduits 15 (“frac lines”), chucks, manifolds, and a wellhead or well tree isolation tool, all of which are well known in the art. The well 20 has a well bore extending through a subterranean formation 30. As well known in the art, a well system includes wellhead equipment, production tubing(s), hangers, casing, packers, risers, etc. Off-shore well systems include sub-sea wellheads, as well as other components required for sub sea wells. A cryogenically compatible delivery tubular 24 conducts the LNG down through a casing of the well. The tubular 24 passes through any seals, packers or stuffing boxes (not shown) required to isolate the cryogenic fluid from a casing 26 of the well. When the liquefied natural gas enters the subterranean formation 30, geothermal heat in the formation causes the liquefied natural gas to expand to a gaseous state, which contributes significantly to the fracturing effect by increasing pressure in the subterranean formation. The subterranean formation is thus fractured (i.e., stimulated) by the LNG fracturing fluids (illustrated by the arrows indicating ejected CH₄).

[0035] FIG. 2a schematically illustrates a system 10 for fracturing a well in accordance with another embodiment of the invention in which a proppant 18 is blended with liquefied natural gas using a blender 16 prior to pumping the fracturing fluid into the well. As is understood by those skilled in the art, proppants (such as sand, resin-coated sand, sintered bauxite or ceramic particulate) may be added to fracturing fluids to keep fractures created in the subterranean formation open after the fracturing process is completed and pressure is reduced in the subterranean formation. The blender 16 therefore blends a proppant into the LNG and the cryogenic pumps 14 then pump the LNG/proppant mixture into the well 20. As will be understood by those skilled in the art, the blending equipment may also be positioned downstream of the cryogenic pumps 14, as shown in FIG. 2b. When positioned downstream of the cryogenic pumps 14, the blender 16 blends proppant from the proppant source 18 with the high pressure LNG before the LNG/proppant mixture enters the surface fracturing conduits 15.

[0036] FIG. 3 schematically illustrates a system 10 for fracturing a well in accordance with another embodiment of the invention in which the LNG is heated prior to entry into the well 20. In this embodiment, the LNG is heated using a gas boiler 40 to convert the LNG to compressed natural gas. The blender 16 and proppant source 18 are shown in dashed lines in FIG. 3 to indicate that these are optional. In other words, the liquefied natural gas can be cryogenically pumped directly through the boiler 40 and into the well 20 without blending in proppant. As explained above with reference to FIG. 2b, the optional proppant can also be blended into the LNG downstream of the cryogenic pumps 14.

[0037] FIG. 4 schematically illustrates a system 10 for fracturing a well in accordance with another embodiment of the invention in which the liquefied natural gas is heated using a heat-exchanging fluid prior to entry into the well. As shown in FIG. 4, a heat exchanger 42 draws relatively warm heat-exchanging fluid from a heat exchanger fluid source 44. The LNG is thus converted to compressed natural gas prior to entering the well 20. In lieu of the heat exchanger 42, the line from the cryogenic pump 14 to the well 20 can be exposed to a natural (ambient) source of heat. For example, for an offshore rig, the line conveying the LNG from the cryogenic pumps 14 to the rig could be run through ocean water (or any other large body of water) to heat the LNG and to convert it to compressed natural gas (CNG) as it is pumped to the wellhead isolation equipment. Where feasible, the LNG can be conveyed through a line laid on the seabed.

[0038] The blender 16 and proppant source 18 are shown in dashed lines in FIG. 4 to illustrate that these are optional, since the liquefied natural gas can be cryogenically pumped directly through the heat exchanger 42 and into the well 20 without blending in any proppant. As explained above with reference to FIG. 2b, the optional proppant can also be blended into the LNG downstream of the cryogenic pumps 14.

[0039] FIG. 5 schematically illustrates a system 10 for fracturing a well in accordance with another embodiment of the invention in which the liquefied natural gas is heated by heat-exchanging fluids as it descends through the well bore. A down hole heat exchanger 46 associated with the tubular
24 is shown schematically in FIG. 5. The heat exchanging fluids are drawn from the heat-exchange fluid source 44, which may supply a heated inert gas, or any other conveniently circulated heating fluid.

[0040] The blender 16 and proppant source 18 are shown in dashed lines in FIG. 5 to illustrate that these are optional, since the liquefied natural gas can be used as a fracturing fluid without blending in any proppant. As explained above with reference to FIG. 2b, the optional proppant can also be blended into the LNG downstream of the cryogenic pumps 14.

[0041] FIG. 6 schematically illustrates the use of an inert cryogenic fluid to cool and pressure test an LNG flow path, including at least the cryogenic pump(s) 14, surface fracturing lines 15, wellhead isolation equipment 22, and tubular 24 before the liquefied natural gas is pumped into the well. Cooling and pressure testing of the LNG flow-path with an inert cryogenic fluid ensures that the LNG flow path is cooled, free of leaks, and in condition to accept the strain of conducting cryogenic fluids before LNG pumping is begun. In one embodiment, the inert cryogenic fluid is liquid nitrogen. Any other inert cryogenic fluid can also be used.

[0042] As is shown in FIG. 6, the inert cryogenic fluid is stored in an inert fluid container 50 which is regulated by an inert fluid tank valve 52. An LNG tank valve 13 is also provided to regulate the flow of LNG from the LNG source 12. The LNG flow path is pre-cooled by flowing the inert cryogenic fluid through the flow path prior to pumping the liquefied natural gas. This can be achieved by first opening the inert fluid valve 52 to cool the LNG flow path. The inert fluid valve 52 is shut after the flow path has been adequately cooled and tested. The LNG valve 13 is then opened to permit the LNG to be pumped through the pre-cooled LNG flow path and into the well.

[0043] As will also be understood by those skilled in the art, the embodiment of the invention shown in FIG. 6a may also include a proppant blender 16 upstream of the cryogenic pumps 14, as shown in FIG. 6b, or a proppant blender 16 downstream of the cryogenic pumps 14, as shown in FIG. 6c.

[0044] The embodiments of the invention described above are effective for use in fracturing any type of subterranean formation, including gas deposits, oil deposits, coal bed methane seams, oil shale, gas shale, tar sands, storage caverns, and other permeable strata that form a geological trap for hydrocarbon fluids, whether on land or offshore.

[0045] The use of liquefied natural gas as a fracturing fluid is inexpensive, environmentally compatible, and recoverable and compatible with all subterranean formations. Unlike fresh water and other traditional fracturing fluids, LNG is also substantially universally available. Furthermore, the use of liquefied natural gas reduces fracturing completion time and does not delay the start of production from the well. As soon as the well stimulation procedure is completed, frac closure can begin. As soon as frac closure is completed, production can resume without any requirement to flow back fracturing fluids. Furthermore, there are no fracturing fluids to dispose of, and no gases to flare off. Assuming gas collection facilities are available, the LNG fracturing fluid can be collected and sold as an integral part of production from the stimulated well.

[0046] In certain instances, LNG fracturing of a well to promote hydrocarbon production or increase permeability may be periodically beneficial. In such cases, well stimulation equipment can be left permanently or semi-permanently in place to permit periodic injection of LNG fracturing fluids into an injection well which is separate from one or more production wells or injection wells in the same formation.

[0047] As noted above, the term LNG is intended to mean pure liquefied methane or any liquefied methane-based mixture of normally gaseous hydrocarbons, commonly marketed as liquid natural gas.

[0048] Modifications and improvements to the above-described embodiments of the present invention may become apparent to those skilled in the art. The foregoing description is intended to be exemplary rather than limiting. The scope of the invention is therefore intended to be limited solely by the scope of the appended claims.

I/We claim:

1. A fracturing fluid for stimulating hydrocarbon production from a subterranean formation, the fracturing fluid comprising liquefied natural gas.

2. The fracturing fluid as claimed in claim 1 further comprising a proppant carried by the liquefied natural gas.

3. The fracturing fluid as claimed in claim 2 wherein the proppant comprises sand.

4. The fracturing fluid as claimed in claim 2 wherein the proppant is sintered bauxite.

5. The fracturing fluid as claimed in claim 2 wherein the proppant is a ceramic particulate.

6. A method of stimulating a subterranean formation to increase hydrocarbon production from the subterranean formation, the method comprising:

   drawing liquefied natural gas from a liquefied natural gas source;

   pumping the liquefied natural gas at a pressure and a flow rate high enough to induce fracturing of the subterranean formation; and

   conducting the natural gas into the subterranean formation.

7. The method as claimed in claim 6 further comprising an initial step of cooling and pressure testing at least pumps used for the pumping and conduits used for conducting the liquefied natural gas to the subterranean formation using an inert fluid prior to pumping the liquefied natural gas.

8. The method as claimed in claim 7 wherein the inert fluid is nitrogen.

9. The method as claimed in claim 6 further comprising blending a solid particulate with the liquefied natural gas before it is pumped.

10. The method as claimed in claim 6 wherein the subterranean formation comprises a natural gas well.

11. The method as claimed in claim 6 wherein the subterranean formation comprises an oil well.

12. The method as claimed in claim 6 wherein the subterranean formation comprises a coal bed seam.

13. The method as claimed in claim 6 wherein the subterranean formation comprises a storage cavern or permeable strata.

14. The method as claimed in claim 6 wherein the subterranean formation comprises an aquifer.
15. The method as claimed in claim 6 wherein the subterranean formation comprises shale.

16. The method as claimed in claim 6 wherein the subterranean formation comprises a tar sand.

17. A method of stimulating a subterranean formation to increase hydrocarbon production from the subterranean formation, the method comprising:

drawing liquefied natural gas from a liquefied natural gas source;
pumping the liquefied natural gas at a pressure and a flow rate high enough to induce fracturing of the subterranean formation;
heating the liquefied natural gas while it is being pumped down the well; and
conducting the natural gas into the subterranean formation.

18. The method as claimed in claim 17 wherein the heating comprises routing the liquefied natural gas through a gas boiler.

19. The method as claimed in claim 17 wherein the heating comprises laying a conduit for conducting the liquefied natural gas in a large body of water, the conduit being connected on one end to cryogenic pumps for the pumping the liquid natural gas and on the other end to wellhead isolation equipment connected to a wellhead of the well bore that communicates with the subterranean formation, whereby the large body of water provides ambient heat to convert the liquefied natural gas to the compressed natural gas as it is pumped to the subterranean formation.

20. The method as claimed in claim 17 wherein the heating comprises circulating a heating fluid through an annulus that surrounds a tubular used to conduct the liquefied natural gas to the subterranean formation.

21. The method as claimed in claim 17 wherein the subterranean formation comprises a natural gas well.

22. The method as claimed in claim 17 wherein the subterranean formation comprises an oil well.

23. The method as claimed in claim 17 wherein the subterranean formation comprises a coal bed seam.

24. The method as claimed in claim 17 wherein the subterranean formation comprises a storage cavern or permeable stratum.

25. The method as claimed in claim 17 wherein the subterranean formation comprises an aquifer.

26. The method as claimed in claim 17 wherein the subterranean formation comprises a shale.

27. The method as claimed in claim 17 wherein the subterranean formation comprises a tar sand.

28. A method of fracturing a well to stimulate production or injectability, comprising:

connecting wellhead isolation equipment to a wellhead of the well;
pumping liquefied natural gas down a tubular connected to the wellhead isolation equipment and suspended in the well to a subterranean formation at a pressure and a flow rate adequate to induce fracturing in the subterranean formation;
removing the wellhead isolation equipment and connecting hydrocarbon production equipment to the wellhead; and
producing hydrocarbons from the well to recover the natural gas and produce the hydrocarbons from the subterranean formation.

29. The method as claimed in claim 28 wherein prior to pumping the liquefied natural gas into the subterranean formation the method further comprises pumping an inert cryogenic fluid through the wellhead isolation equipment and the tubular to pressure test and pre-cool the wellhead isolation equipment and the tubular.

30. The method as claimed in claim 28 wherein prior to pumping the liquefied natural gas into the subterranean formation the method further comprises pumping an inert cryogenic fluid through the surface pumping equipment and surface fracture conduits, chokes, and manifolds, to pressure test and pre-cool that surface equipment.

31. The method as claimed in claim 28 wherein prior to pumping the liquefied natural gas into the subterranean formation the method further comprises pumping an inert cryogenic fluid through well system tubulars to pressure test and pre-cool the well system.

32. The method as claimed in claim 28 further comprising blending proppant with the liquefied natural gas.

33. The method as claimed in claim 28 further comprising blending proppant with the liquefied natural gas prior to the pumping.

34. The method as claimed in claim 28 wherein the subterranean formation comprises a natural gas well.

35. The method as claimed in claim 28 wherein the subterranean formation comprises an oil well.

36. The method as claimed in claim 28 wherein the subterranean formation comprises a coal bed seam.

37. The method as claimed in claim 28 wherein the subterranean formation comprises a storage cavern or permeable stratum.

38. The method as claimed in claim 28 wherein the subterranean formation comprises an aquifer.

39. The method as claimed in claim 28 wherein the subterranean formation comprises a shale.

40. The method as claimed in claim 28 wherein the subterranean formation comprises a tar sand.

41. A method of fracturing a well to stimulate at least one of production of fluids and injectability of fluids, comprising the steps of:

connecting wellhead isolation equipment to a wellhead of the well;
pumping liquefied natural gas through a heat exchanger in fluid communication with the wellhead isolation equipment and a subterranean formation of the well at a pressure and a flow rate adequate to induce fracturing in the subterranean formation;
removing the wellhead isolation equipment and connecting hydrocarbon production equipment to the wellhead; and
producing hydrocarbons from the well to recover the natural gas and produce the hydrocarbons from the subterranean formation.

42. The method as claimed in claim 41 further comprising blending proppants with the liquefied natural gas prior to the pumping.

43. The method as claimed in claim 41 wherein the heat exchanger comprises a methane boiler.
44. The method as claimed in claim 41 wherein the heat exchanger comprises a tubular in a large body of water.
45. The method as claimed in claim 41 wherein the heat exchanger comprises an annulus surrounding a tubular connected to the wellhead isolation equipment and the method further comprises circulating a heating fluid through the annulus.
46. The method as claimed in claim 41 wherein the subterranean formation comprises a natural gas well.
47. The method as claimed in claim 41 wherein the subterranean formation comprises an oil well.
48. The method as claimed in claim 41 wherein the subterranean formation comprises a coal bed seam.
49. The method as claimed in claim 41 wherein the subterranean formation comprises an aquifer.
50. The method as claimed in claim 41 wherein the subterranean formation comprises a shale.
51. The method as claimed in claim 41 wherein the subterranean formation comprises a tar sand.
52. A fracturing fluid for stimulating a subterranean formation, the fracturing fluid comprising liquefied methane.
53. A method of stimulating a subterranean formation to increase the rate of fluid injectability of a subterranean formation, the method comprising:
   drawing liquefied natural gas from a liquefied natural gas source;
pumping the liquefied natural gas at a pressure and a flow rate high enough to induce fracturing of the subterranean formation; and
conducting the liquefied natural gas into the subterranean formation.
54. A method of fracturing a well to stimulate production or injectability of a subterranean formation, comprising:
   connecting wellhead isolation equipment to a wellhead of the well;
pumping liquefied natural gas down through a cryogenically compatible tubular connected to the wellhead isolation equipment and suspended in the well to a subterranean formation at a pressure and a flow rate adequate to induce fracturing in the subterranean formation;
maintaining the wellhead isolation equipment, cryogenically compatible tubulars, insulated pipes, and cooling conduits, connected at the well site and in the well system to permit periodic injection of liquefied natural gas into the well.