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(54) **METHOD OF PROCESSING AND SEPARATING A MULTIPHASE WELL EFFLUENT MIXTURE**

(76) Inventor: **Edwin Poorte**, Nesbru (NO)

Correspondence Address:
SHELL OIL COMPANY
P O BOX 2463
HOUSTON, TX 772522463

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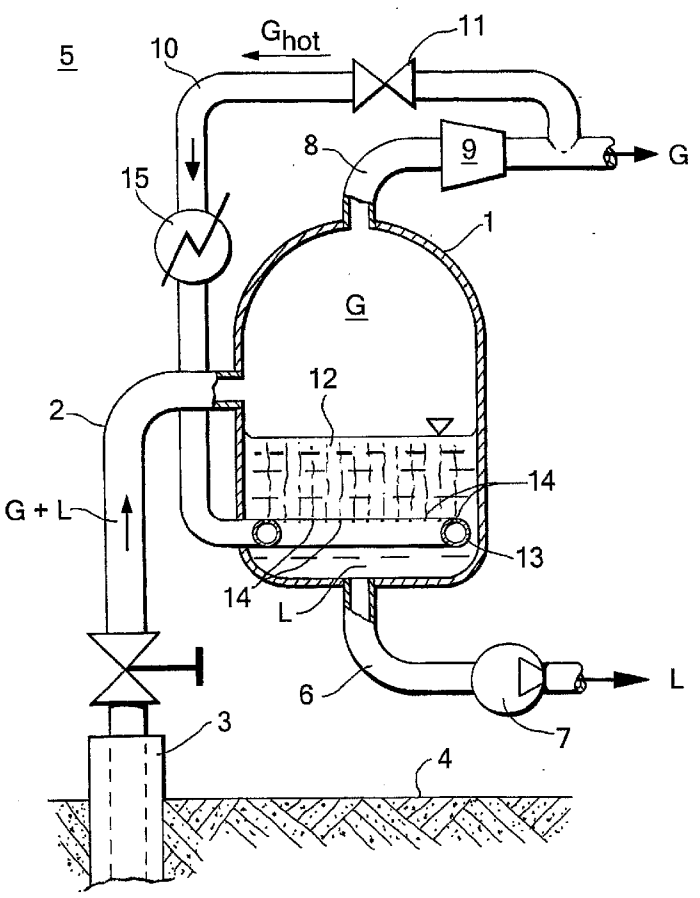
(57) **ABSTRACT**

A method of processing a multiphase well effluent mixture comprises: transferring the mixture (L+G) via a multiphase well effluent flowline (**2**) to a gas liquid separator (**1**) in which the multiphase well effluent mixture is separated into substantially gaseous and liquid fractions; transferring the substantially liquid fraction (L) into a liquid flowline (**6**) in which liquid pump (**7**) is arranged; transferring the substantially gaseous fraction (G) into a gas flowline (**8**) in which a gas compressor (**9**) is arranged; protecting the gas compressor (**9**) against liquid and/or pressure surges due to low gas flow rate and/or backflow of compressed gas by recirculating a recycled gas stream (G_{hot}) via a gas recycling conduit (**10**) through the gas compressor in response to detection of the onset of a liquid surge in the multiphase well effluent mixture and/or of a pressure surge due to low gas flow rate and/or a high pressure differential across the gas compressor (**9**); and cooling the recycled gas stream by contacting recycled hot gas (G_{hot}) with relatively cold liquid L within the separator (**1**) or associated flowlines (**2**, **6**) preferably using an array of gas injection nozzles (**14**) which inject the hot gas (G_{hot}) as finely dispersed gas bubbles into the liquid (L).



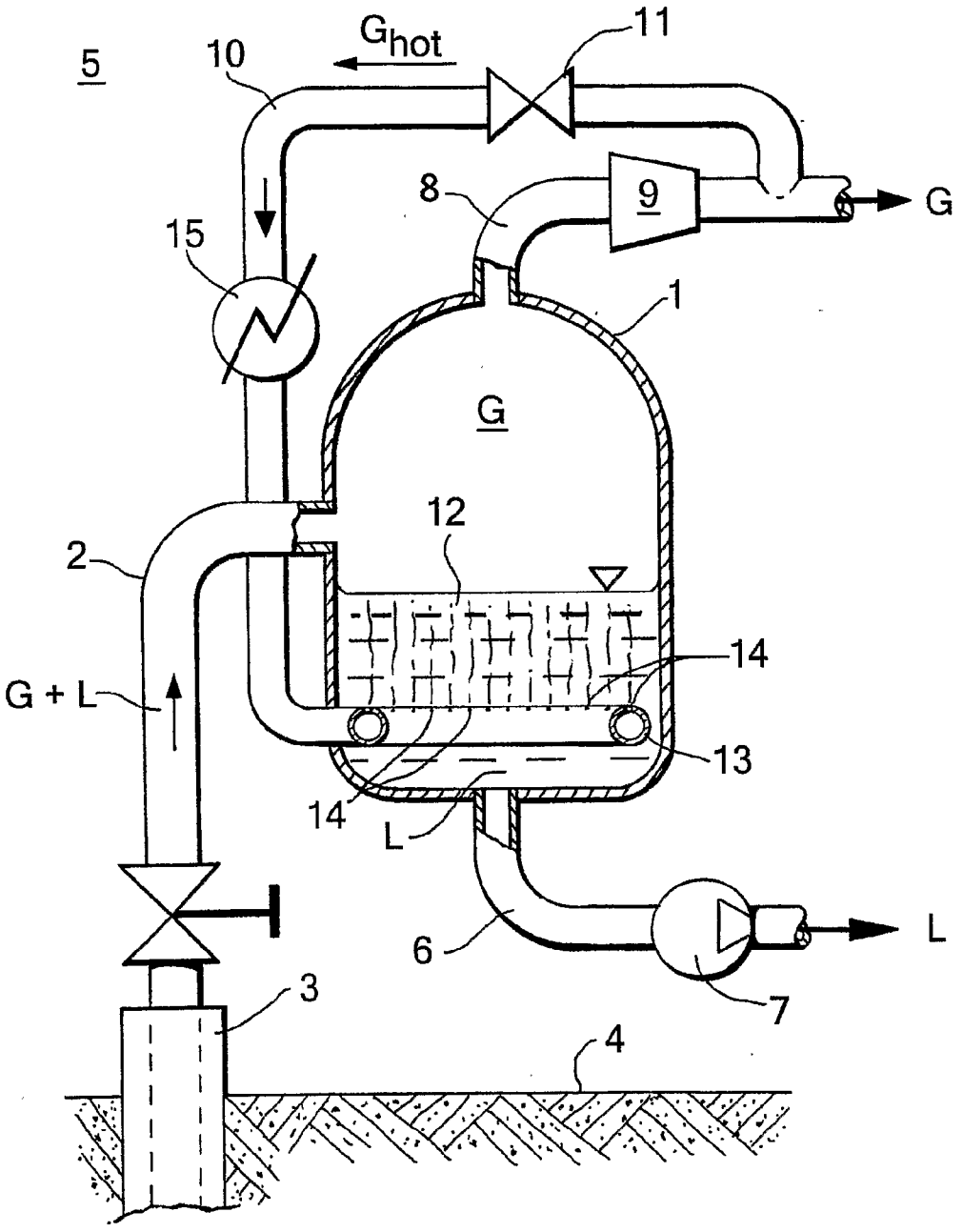
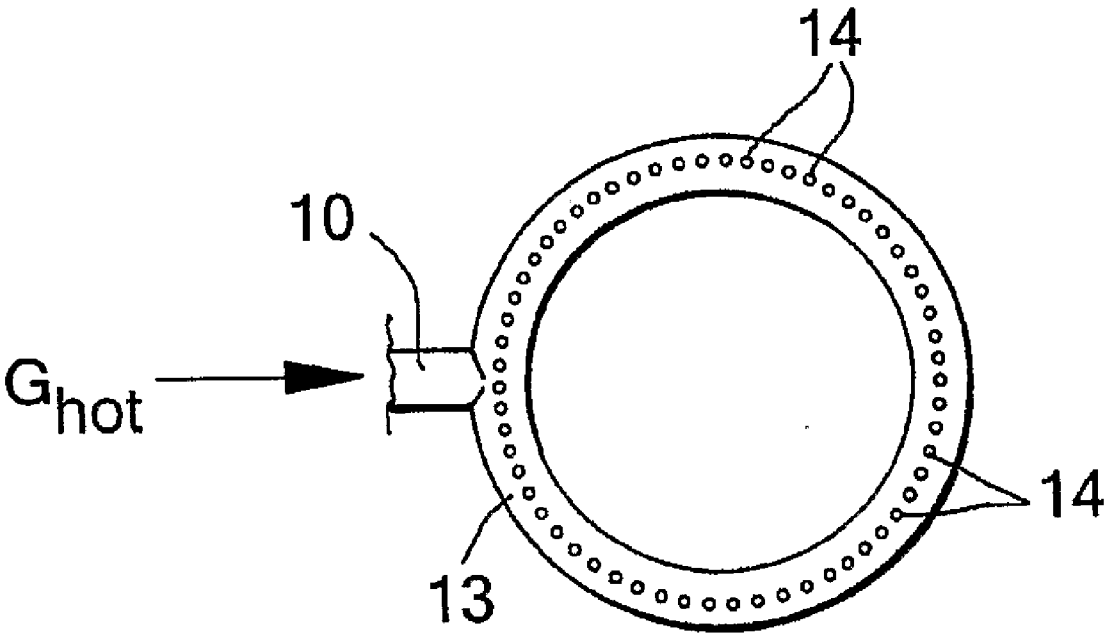


Fig.1

Fig.2



METHOD OF PROCESSING AND SEPARATING A MULTIPHASE WELL EFFLUENT MIXTURE

BACKGROUND OF THE INVENTION

[0001] The invention relates to a method of processing and separating a multiphase well effluent mixture.

[0002] Such a method is known from OTC paper 17399 "Subsea Gas Compression—Challenges and Solutions" presented by R. Fantoft at the Offshore Technology Conference held in Houston, USA on 2-5 May 2005 and from International patent applications WO30/033870, WO03/035335 and WO 2005/026497. The method known from WO2005/026497 comprises:

[0003] transferring the multiphase well effluent mixture via a multiphase well effluent flowline to a gas liquid separator in which the multiphase well effluent mixture is separated into substantially gaseous and liquid fractions;

[0004] transferring the substantially liquid fraction into a liquid flowline in which a liquid pump is arranged;

[0005] transferring the substantially gaseous fraction into a gas flowline in which a gas compressor is arranged;

[0006] protecting the gas compressor against pressure and/or liquid surges by recirculating a recycled gas stream via a gas recycling conduit through the gas compressor in response to detection of the onset of pressure and/or liquid surges in the multiphase well effluent mixture.

[0007] In the method known from WO2005/026497 the recycled gas is heated up each time when it is compressed in the gas compressor and subsequently cooled in a heat exchanger arranged in the gas recycling conduit. Such a heat exchanger is a large piece of equipment because heat conductivity of the recycled gas is small, so that a large heat exchanging surface is required to cool the recycled gas stream to such a temperature that overheating of the gas compressor is prevented.

[0008] In the known method liquid in the liquid flowline may be cooled and recycled into the multiphase well effluent flowline, but in case the well effluents are substantially liquid, then the gas compressor may be substantially solely fed with recycled gas, so that the influx of substantially liquid well effluents and of recycled cooled liquid is inhibited.

[0009] It is an object of the present invention to provide an improved method of processing and separating a multiphase well effluent mixture.

[0010] It is a further object of the present invention to provide an improved method of processing and separating a multi-phase well effluent mixture in which a gas compressor is protected against liquid surges and overheating by a gas recirculating conduit in which the need for a bulky gas-liquid heat exchanger in the gas recycling conduit is obviated.

SUMMARY OF THE INVENTION

[0011] In accordance with the invention there is provided a method of processing and separating a multiphase well effluent mixture, the method comprising:

[0012] transferring the multiphase well effluent mixture via a multiphase well effluent flowline to a gas liquid separator in which the multiphase well effluent mixture is separated into substantially gaseous and liquid fractions;

[0013] transferring the substantially liquid fraction into a liquid flowline in which a liquid pump is arranged;

[0014] transferring the substantially gaseous fraction into a gas flowline in which a gas compressor is arranged;

[0015] protecting the gas compressor against pressure and/or liquid surges by recirculating a recycled gas stream via a gas recycling conduit through the gas compressor in response to detection of a pressure and/or liquid surge in the multiphase well effluent mixture and/or of a high pressure differential across the gas compressor; and

[0016] cooling the recycled gas stream by contacting recycled gas with liquid.

[0017] It is preferred that recycled gas is contacted with liquid by injecting recycled gas into a liquid filled section of the gas liquid separator.

[0018] The gas liquid separator may be a gravity separation vessel and liquid filled section is located near the bottom of the vessel.

[0019] Optionally recycled gas is injected into the liquid filled section by a series of gas injection nozzles, which inject the recycled gas as an array of finely dispersed gas bubbles into the liquid.

[0020] Preferably the series of gas injection nozzles is arranged in a ring shaped gas injection conduit, which is located at a selected distance above the bottom of the gravity separation vessel.

[0021] These and other features, embodiments and advantages of the method according to the invention are described in the accompanying claims, abstract and the following detailed description of preferred embodiments in which reference is made to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. **1** depicts a schematic view of a gas processing and separation assembly in which recycled gas is cooled by the method according to the invention; and

[0023] FIG. **2** is a top view of the ring-shaped gas injection conduit for injecting finely dispersed gas bubbles into the gas liquid separating vessel.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0024] FIG. **1** depicts a gas liquid separator **1** into which a multiphase well effluent mixture G+L is injected via a multiphase well effluent flowline **2**, which is connected to one or more subsea wells **3**. The separator **1** is installed on the seabed **4** and is immersed in the sea or other body of water **5**.

[0025] The separator **1** is a gravity separator in which liquid is collected at the bottom of the separating vessel and gas rises to the top of the vessel. A liquid stream L is subsequently drained from the bottom of the separator **1** via a liquid flowline **6** in which a liquid pump **7** is arranged. A gaseous stream G is discharged from the top of the separator via a gas flowline **8** in which a gas compressor **9** is arranged.

[0026] In order to protect the gas compressor **9** against damage due to back flow of gas through the interior of the compressor **9** and/or against surges of liquid due to liquid overflow of the gas liquid separator **1** a gas recycling conduit

10 is arranged between the gas flowline **9** at a location downstream of the compressor **9** and the interior of the separator **1**. The gas recycling conduit **10** comprises an anti surge valve **11**, which is opened if sensors detect the onset of a pressure surge across compressor **9**, which may be due to a lack of gas supply at the inlet of the compressor and/or backflow of compressed gas through the compressor **9**, which may cause severe mechanical damage to the rotating or static parts of the compressor **9**, and/or of a liquid surge within the separator **1**. If the valve **11** is opened compressed gas G_{hot}, which is heated by the compressor **9** is recycled into the separator **1**. In order to cool the recycled gas, which may be recycled several times and is further heated during each recycling step, the recycled gas is injected as a finely dispersed array of gas bubbles **12** into the liquid L at the bottom of the separator **1** via a ring-shaped gas injection conduit **13** in which a series of gas injection nozzles **14** is arranged. FIG. **2** depicts a top view of the ring-shaped gas injection conduit **13** and gas injection nozzles **14**.

[0027] In order to further cool the recycled hot gas G_{hot} the gas recycle conduit **10** is optionally provided with a heat exchanger **15**, which may be relatively small since at least part of the cooling of the recycled gas is accomplished by contacting the small gas bubbles **12** with the relatively cold liquid near the bottom of the separator. At least part of the liquid L may evaporate as a result of the contact with the hot recycled gas stream G_{hot}. The liquid L may comprise gas condensates (C2-C6) and calculations indicate that if a volume of 5 m^3 of gas condensates is heated from 10 to 50° C. then this will correspond to about 10 MW during about 20 seconds, such that the recycled gas stream G_{hot} is cooled substantially and the heat exchanger **15** may be small or even redundant.

[0028] It will be understood that the use of a ring shaped gas injection conduit **14** is optional and that there may be alternative ways to vigorously mix the recycled gas stream G_{hot} with liquid within the separator **1** or within the well effluent and/or liquid flowlines **2**, **6**.

1. A method of processing and separating a multiphase well effluent mixture, the method comprising:

transferring the multiphase well effluent mixture via a multiphase well effluent flowline to a gas liquid separator in which the multiphase well effluent mixture is separated into substantially gaseous and liquid fractions;

transferring the substantially liquid fraction into a liquid flowline in which a liquid pump is arranged;

transferring the substantially gaseous fraction into a gas flowline in which a gas compressor is arranged;

protecting the gas compressor against pressure and/or liquid surges by recirculating a recycled gas stream via a gas recycling conduit through the gas compressor in response to detection of the onset of a pressure and/or liquid surge in the multiphase well effluent mixture and/or of a high pressure differential across the gas compressor; and

cooling the recycled gas stream by contacting recycled gas with liquid.

2. The method of claim **1**, wherein recycled gas is contacted with liquid by injecting recycled gas into a liquid filled section of the gas liquid separator.

3. The method of claim **2**, wherein the gas liquid separator is a gravity separation vessel and liquid filled section is located near the bottom of the vessel.

4. The method of claim **3**, wherein gas is injected into the liquid filled section by a series of gas injection nozzles, which inject the recycled gas as an array of finely dispersed gas bubbles into the liquid.

5. The method of claim **4**, wherein the series of gas injection nozzles is arranged in a ring shaped gas injection conduit, which is located at a selected distance above the bottom of the gravity separation vessel.

6. The method of claim **1**, wherein the gas liquid separation vessel is located near the bottom of a body of water.

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