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(12) # EUROPEAN PATENT SPECIFICATION

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(54) **Pipeline system to separate at least a two-phase fluid flow.**

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US-A- 4 708 793

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OIL & GAS JOURNAL, vol. 77, no. 46, November 1979, pages 230-238, Pennwell Publishing Co., Tulsa, Oklahoma, US; Z.SCHMIDT et al.: "Choking can eliminate severe pipeline slugging"

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Description

The present invention relates to a system for the separation underwater of the phases of a two-phase fluid flow into respective risers, e.g. as with an offshore platform, where oil and gas are transported by a pipeline along the seabed and by risers to the platform.

When developing an oil and gas offshore field it is desirable to transport the oil/condensate and gas in a two-phase flow-line. The pipeline will be connected to a main riser leading the oil and gas to the platform. However, slugging is a relatively common problem associated with two-phase flow of oil and gas in pipelines and in risers. It constitutes the formation of a plug of oil, which has separated from the two-phase flow. The probability of slugging is relatively large. Hence the process apparatus have to be designed to handle the phenomenon.

A two-phase flow in a horizontal pipeline system gives various flow patterns depending on the pipe diameter, geometry temperature and type of oil. Generally said, the flow pattern can be divided into the following categories: stratified, bubble, slug and annular flow.

A two-phase flow in a vertical pipe can also be divided into various flow patterns. Technically speaking the slug flow will give the greatest problems as mentioned above. There are two types of slugging, the normal slugging and extreme slugging. The extreme slugging depends on the geometry and occurs only in the riser when the oil and gas velocity is so low that the horizontal flow is stratified. Normal slugging is hydrodynamic and can be formed both in the horizontal and the vertical pipe section.

To avoid slugs having to be carried directly to a slug catcher system in process apparatus on an offshore platform, a separator for separation of the liquid- and gaseous phase has previously been developed. In such a known pipe separator the gas and oil are separated by feeding the flow from one common pipe into two or more parallel pipes. Such separators require large space and are expensive to build.

Separators based on a large volume tank, where the tank capacity is dimensioned to handle the peak value of the liquid flow, are also known. Such separators require less space than the above-mentioned separator, but they require a complicated regulation system of the liquid level.

One other type of separator is known from Norwegian patent application No. 853656. This is a separator for dealing with the accumulation of slugs during transmission of offshore natural oil and gas. It is partly based on a separator located on the platform, partly on a separator located at the seabed. The apparatus comprises a secondary riser teed off the main transportation pipeline at a point where the pipeline starts to make a large loop, and the secondary riser leads to a separator tank on the platform after passing a choke valve. When a slug passes the teed off secondary riser, some of the liquid will pass into the secondary riser. At the time when the slug has passed the tee, the liquid in the secondary riser will partly flow back into the main pipeline and partly, due to the line pressure, will ascend the secondary riser and pass through the choke valve and into the separator on the platform.

One disadvantage with the last-mentioned separator is that it is only useful for so-called normal slugs, e.g. slugs located in the main pipeline, and not extreme slugs in the riser. If this device had been designed to deal with extreme slugs in the riser, the separator on the platform would have had to have been designed according to the previously mentioned methods for separation of a two-phase flow, and in those circumstances the secondary riser would be redundant.

A common feature of the aforementioned three types of slug catchers is that all three make use of some type of phase separator on the platform. Since the total capacity of the slug catchers has to be-.larger than the largest expected slugs it will occupy expensive and limited space on the platform.

In accordance with the invention a system for underwater phase separation of a fluid flow having at least two phases, such as oil and gas, from a seabed oil well, the system including an underwater pipeline, a main riser connected to the pipeline and a secondary riser provided with flow restriction means and connected to the pipeline via a T-junction located upstream of the main riser is characterised in that the main riser is connected to a storage tank, the secondary riser is for gas transport and is connected to a gas scrubber, the flow restriction means is a controlled regulating valve, and in that there is a control means in the pipeline between the risers and responsive to the position of the liquid/gas interface along the pipeline so as to control the setting of the regulating valve to maintain the position of the said interface constant. This allows for a total separation of the phases of a two-phase flow on the seabed and outside the platform, e.g. in a pipe system connecting the oil/gas pipeline on the seabed with the processing plant onshore.

The system is especially designed to deal with extreme slugs which occur normally at low liquid and gas velocity, i.e. at startup and shut-down of the production. The main advantage of the system, which is designed to be located on the seabed, is that it has no moving parts, is simple and easy to manufacture, and is reliable and simple to maintain.

The invention is now described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a schematic drawing of an offshore oil platform including a system generally in accor-

dance with the invention; and

Fig. 2 is a simplified process illustrating the system.

Figure 1 illustrates an offshore platform 10 for transportation and processing of oil and gas from a remote subsea installation or well via riser 2 to the processing plant on the platform 10. The pipeline 1 is connected to a separate secondary riser 3 via T-junction 5 located at a distance X from the riser 2.

As shown in Fig. 2, the secondary riser is connected to a gas scrubber 6 located on the platform. A storage tank 4 is provided with a drainpipe 12 for the oil and one discharge pipe 13 for any gas that has evaporated from or was mixed with the oil.

A detection means 8 is provided to determine the location along the pipe 1 of any oil/gas interface. As shown, this detector comprises five capacitive detectors K_1-K_5 arranged in the pipeline section between the T-junction 5 and the riser 2. The capacitive detectors K_1-K_5 detect the presence of an oil/gas interface in the pipeline. The capacitive detectors are connected to a level indicator and give electrical signals to a control unit (not shown) which controls a regulating valve 7 located on the secondary riser 3.

The oil and gas transported in the main pipeline 1 are separated at the T-junction 5, where the gas components of the two-phase flow pass into the secondary riser 3 and the oil components pass into the pipeline 1 downstream of the T-junction and into the riser 2. The pipeline 1 between the T-junction and the riser 2 should be slightly sloped so that a liquid seal is formed in the riser. The regulating valve 7, by venting the gas, regulates the pressure in the pipeline 1 and in the riser 2. The regulation is done according to the signals from the capacitive detectors K_1-K_5 in the pipeline. Thus the regulating valve 7 will open at increasing gas pressure in the secondary riser when the liquid/gas interface reaches the detector K_1. The riser 2 will therefore contain fluid which is 100% oil and the oil/gas interface at all times will be located between the T-junction and the riser 2.

The accuracy of the oil/gas interface detection is of course dependent on the number of detectors situated in the pipeline and the distance between them. The detection means may comprise more or less than five capacitive detectors or equivalent detectors of another type capable of detecting the presence of the liquid/gas interface. Such detectors might comprise pressure sensors located in the scrubber, the storing tank and the pipeline. By means of the difference and the variation of pressure the position of the liquid/gas interface in the pipeline can be determined.

To optimize the separation of the oil and gas the pipes may have different diameters and lengths. To determine the optimum length of the pipes it is important to make sure that the system can deal with the peak values of slugs. Tests have shown that a distance X between the T-junction 5 and the riser 2 should be at least two times the height of the riser.

Although as noted above the pipes can be of different diameters, it is regarded as being an advantage to be able to clean the inside of the pipes by using a "pig". The pipeline 1 and the risers 2, 3 should therefore have the same diameter and be as free as possible of obstacles such as valves, bends, etc.

The angle of inclination of the pipeline between the tee section and the riser is also important. Tests have indicated that it should be approximately 2° to the horizontal. To achieve the best separation of the two-phase flow the angle between the upright of the T-junction 5 and the main pipeline 1 may be an angle other than 90°, as illustrated in the drawings.

Claims

1. A system for the underwater phase separation of a fluid flow having at least two phases, such as oil and gas, from a seabed oil well, the system including an underwater pipeline, a main riser connected to the pipeline and a secondary riser provided with flow restriction means and connected to the pipeline via a T-junction located upstream of the main riser, characterised in that, the main riser (2) is connected to a storage tank (4), the secondary riser (3) is for gas transport and is connected to a gas scrubber (6), the flow restriction means (7) is a controlled regulating valve, and in that there is a control means (8) in the pipeline between the risers and responsive to the position of the liquid/gas interface along the pipeline so as to control the setting of the regulating valve (7) to maintain the position of the said interface constant.

2. A system according to Claim 1 wherein the controlling means includes sensing means K^1 to K^5 located at least along the pipeline between the main riser (2) and the T-junction (5) connecting the secondary riser (3) to the pipeline.

3. A system according to Claim 2 wherein the sensing means comprises a sequence of capacitive detectors K^1-K^5 in the pipeline, each responsive to the proximity of the gas/liquid interface.

4. A system according to Claim 2 wherein the sensing means comprise pressure sensors and the latter are arranged also in the scrubbing means (6) and in tank storage means (4), both of which means are within the separation plant.

5. A system according to any preceding claim wherein the distance between the T-junction (5) which connects the secondary riser (3) to the pipeline (1) and the main riser (2) is at least twice

the height of the main riser.

6. A system according to any preceding claim wherein the portion of the main pipeline situated between the two risers is inclined upward away from the T-junction.

7. A system according to Claim 6 wherein the angle of inclination is 2°.

Patentansprüche

1. System zur Phasentrennung eines Flüssigkeitsgemisches unter Wasser, das wenigstens zwei Phasen hat, wie Öl und Gas, von einem Meeresbodenölbohrloch, wobei das System eine Unterwasserpipeline einschliesst, ein an die Pipeline angeschlossenes Steigrohr, und ein Nebensteigrohr, das mit Stromeinschränkungsmitteln versehen ist, und an die Pipeline mittels eines T-Gliedes angeschlossen ist, das stromauf von dem Hauptsteigrohr angeordnet ist, dadurch gekennzeichnet, dass das Hauptsteigrohr (2) an einen Speichertank (4) angeschlossen ist, das Nebensteigrohr (3) zum Gastransport vorhanden ist und an einen Gaswäscher (6) angeschlossen ist, das Stromeinschränkungsmittel (7) ein kontrolliertes Regelventil ist, und dass ein Kontrollmittel (8) in der Pipeline zwischen den Steigrohren vorhanden ist, und auf die Stellung der Flüssigkeits/Gasgrenzfläche entlang der Pipeline reagiert, um die Einstellung des Regelventils (7) zu kontrollieren, um die Stellung der Grenzfläche konstant zu halten.

2. System nach Anspruch 1, worin das Kontrollmittel Abtastmittel K^1 bis K^5 einschliesst, die wenigstens entlang der Pipeline zwischen dem Hauptsteigrohr (2) und dem T-Glied (5), das das Nebensteigrohr (3) an die Pipeline anschliesst, angeordnet sind.

3. System nach Anspruch 2, worin das Abtastmittel eine folge von kapazitiven Messfühlern K^1-K^5 in der Pipeline umfasst, wobei jeder auf die Nähe der Gas/Flüssigkeitsgrenzfläche reagiert.

4. System nach Anspruch 2, worin die Abtastmittel Druckgeber umfassen, und die letztgenannten auch in dem Waschmittel (6) und dem Tankspeichermittel (4) angeordnet sind, wobei beide Mittel innerhalb der Trennanlage liegen.

5. System nach einem der vorhergehenden Ansprüche, worin die Entfernung zwischen dem T-Glied (5), das das Nebensteigrohr (3) an die Pipelinie (1) und das Hauptsteigrohr (2) anschliesst, wenigstens zweimal so hoch wie das Hauptsteigrohres ist.

6. System nach einem der vorhergehenden Ansprüche, worin das Teil der Hauptpipeline, das zwischen den beiden Steigrohren angeschlossen ist, nach oben, von dem T-Glied weg, geneigt ist.

7. System nach Anspruch 6, worin der Neigungswinkel 2° ist.

Revendications

1. Système de séparation sous-marine de phases d'un débit de fluide comportant un minimum de deux phases, telles que l'huile et le gaz, à partir d'un puits de pétrole au fond de la mer, le système comportant un oléo-gazoduc sous-marin, un montant principal raccordé à l'oléo-gazoduc sous-marin et un montant secondaire comportant des moyens d'étranglement du débit et raccordé à l'oléo-gazoduc, caractérisé en ce que, le montant principal (2) est raccordé à un réservoir (4), le montant secondaire (3) prévu pour transporter le gaz est raccordé à un épurateur de gaz (6), les moyens d'étranglement (7) consistent d'un robinet régulateur, et en ce que des moyens de commande (8) sont prévus dans l'oléo-gazoduc entre les montants et répondent à la position de l'interface liquide/gaz le long de l'oléo-gazoduc de manière à ajuster le réglage du robinet régulateur (7) de manière à maintenir constante la position de la dite interface.

2. Système selon la revendication 1 dont les moyens régulateurs comportent des moyens capteurs K^1 à K^5 situés au minimum le long de l'oléo-gazoduc entre le montant principal (2) et le raccord en Té (5) raccordant le montant secondaire (3) à l'oléo-gazoduc.

3. Système selon la revendication 2 dont les moyens capteurs comportent une série de capteurs capacitifs K^1-K^5 situés dans l'oléo-gazoduc, chacun répondant à la proximité de l'interface du gaz/liquide.

4. Système selon la revendication 2 dont les moyens capteurs comportent des capteurs de pression, ces derniers étant également agencés dans l'épurateur de gaz (6) et le réservoir (4), tous deux étant situés dans le matériel de séparation.

5. Système selon l'une des revendications précédentes selon lesquelles la distance entre le raccord en Té (5) reliant le montant secondaire (3) à

l'oléo-gazoduc (1) et au montant principal (2) mesure au minimum deux fois la hauteur du montant principal.

6. Système selon l'une des revendications précédentes dont le tronçon d'oléo-gazoduc situé entre les deux montants est incliné pour s'éloigner du raccord en Té.

7. Système selon la revendication 6 dont l'angle d'inclinaison est de 2°.

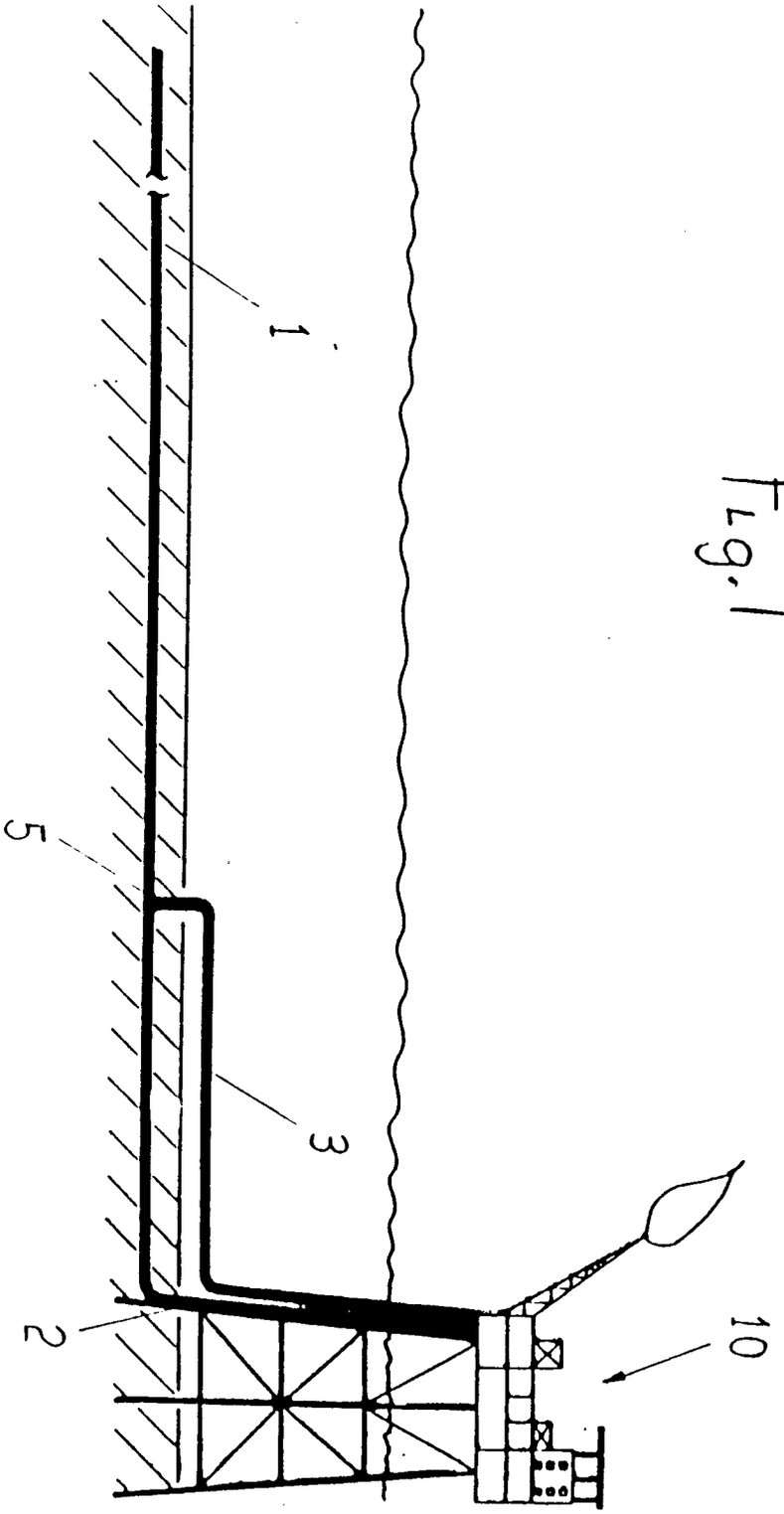

Fig. 1

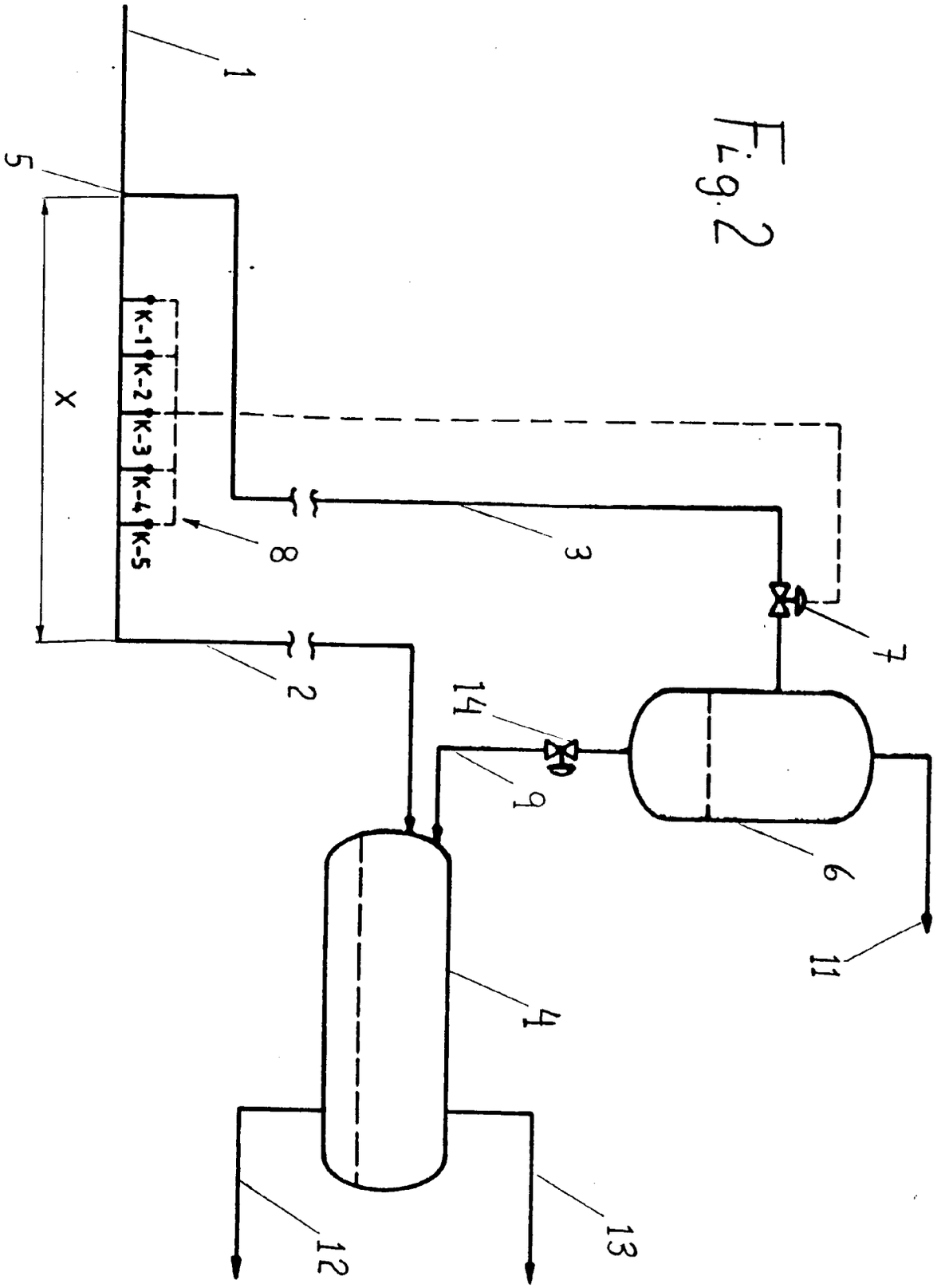

Fig. 2