Title: WELL START-UP SYSTEM AND PROCESS

Abstract: A well start-up system consists of two boosting systems arranged in parallel. The system includes a fluid inlet line (4) for receiving inlet fluid from a well (1), a gas inlet line (8) connected to receive gas from the fluid inlet line (4), a multiphase inlet line (10) connected to receive multiphase fluid from the fluid inlet line (4), and a flow control system for controlling the flow of inlet fluid into the gas inlet line (8) and the multiphase inlet line (10). A gas-gas jet pump (16) is connected to receive inlet fluid from the gas inlet line (8), and high pressure gas from a supply (18). A multiphase pump (30) is connected to receive inlet fluid from the multiphase inlet line (10). A fluid outlet line (44) is connected to receive fluids from the gas pump outlet (24) and the multiphase pump outlet (38). The system is arranged such that during a first stage of a well start-up process when the inlet fluid is primarily gas, the inlet fluid is fed into the gas inlet line (8), and during a second stage of the well start-up process, when the inlet fluid is primarily multiphase fluid, the inlet fluid is fed into the multiphase inlet line (10).
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
WELL START-UP SYSTEM AND PROCESS

The present invention relates to a well start-up system and a process for re-starting dormant oil and gas wells.

5 In particular, but not exclusively, the invention relates to a system and a process for starting up wells where the produced fluid is gas or a mixture of gas and liquid, but where gas is the major component of the mixture. The invention therefore relates primarily to gas wells that also produce some liquid (oil or water), and oil wells that produce a mixture of gas and oil, where the proportion of gas to liquid is very high. For example, the ratio by volume of gas/liquid mixture at the operating pressure and temperature may have a value in excess of 9, although the invention is not limited to such situations.

When a well is shut down or remains shut for a period of time it is common for liquid (oil or water or both) to accumulate in the bottom of the well. Under certain circumstances, this can also happen while the well is producing if the velocity of the produced fluids is low.

15 The build-up of liquid results in an increase in the back pressure at the production zone, reducing the output of the well. When the back pressure generated by the column of liquid reaches the bottom hole shut-in pressure, production will cease. This column of liquid must then be removed in order to re-start the well. This means that during the well start-up process, the production from the well goes through two distinctly different stages: stage 1 when the produced fluid is pure gas and stage 2 when the produced fluid consists of a mixture of gas and liquid.

It is known that a jet pump (or eductor) can sometimes be used at the wellhead to reduce the back pressure on a dormant well and bring it back into production. However, as dormant wells are normally only partially filled with liquid, it is usually necessary to draw off a quantity of gas from the upper part of the column before the accumulated liquid can be removed. In general, jet pumps are designed for use either with liquid or gas as the motive fluid and the suction flow. A jet pump designed to operate efficiently with gas cannot therefore operate efficiently with both gas and liquid phases entering its suction side. Therefore, the usefulness of a single jet pump in starting up or re-starting dormant
wells is limited because of the changing conditions of the produced well fluids during the start-up process.

It is an object of the present invention to provide a well start-up system and process that mitigates at least some of the disadvantages discussed above. The term "well start-up" as used herein refers to any process or system that enables wells loaded with excessive liquid to be revived. Such systems are also sometimes referred to as "well kick-off" systems.

According to the present invention there is provided a well start-up system including: a fluid inlet line for receiving inlet fluid from a well; a gas inlet line connected to receive gas-rich fluid from the fluid inlet line; a multiphase inlet line connected to receive multiphase fluid from the fluid inlet line; a flow control system for controlling the flow of inlet fluid so that it flows either into the gas inlet line or the multiphase inlet line, depending on whether the inlet fluid is a gas or a multiphase fluid; a gas pump comprising a gas-gas jet pump having a low pressure inlet connected to receive gas-rich fluid from the gas inlet line, a high pressure inlet for connection to a high pressure gas supply and a gas pump outlet; a multiphase pump having a low pressure inlet connected to receive multiphase fluid from the multiphase inlet line, and a multiphase pump outlet; and a fluid outlet line connected to receive fluids from the gas pump outlet and the multiphase pump outlet; wherein the flow control system is constructed and arranged such that when the inlet fluid is a gas-rich fluid, the inlet fluid is fed into the gas pump via the gas inlet line, and when the inlet fluid is a multiphase fluid, the inlet fluid is fed into the multiphase pump via the multiphase inlet line.

In the present document, the term "gas-rich fluid" refers to an inlet fluid that consists primarily or wholly of gas, and more specifically that contains less than 5% liquid by volume at the operating pressure and temperature. A multiphase fluid is a fluid that includes a significant proportion of liquid, for example at least 5% liquid (oil and/or water) by volume at the operating temperature and pressure. The term "multiphase fluid" includes fluids that consist entirely of liquids. The system may also be of use with fluids falling outside the above ranges.

The system makes it possible to remove both gas and liquid from a dormant well in a continuous two-stage process, thereby re-starting the well and permitting continued production. The system is relatively inexpensive, requiring only simple jet pumps or
eductors, valves and flow control systems, and it can therefore be left in place for use on other similar wells or if production of the well ceases again. The system can also be automated, allowing a well to be re-started quickly as often as required, without human input.

The high pressure gas supply ideally has a pressure that is at least ten times that of the wellhead production pressure. The gas-gas jet pump is preferably constructed and arranged to provide a discharge pressure of at least twice the original wellhead pressure. The high pressure gas supply may be provided from a sustainable source, such as a supply of lift gas or export gas, or steam from geothermal wells, or it may be supplied by a compressor. A non-return valve may be connected to the outlet of the gas-gas jet pump, to prevent reverse flow through the jet pump. Alternatively, a non-return valve may be fitted to the low pressure inlet of the jet pump.

The multiphase pump may be a liquid-multiphase jet pump having a low pressure inlet connected to receive multiphase fluids from the multiphase inlet line, a high pressure inlet for connection to a high pressure liquid supply and an outlet. Advantageously, the high pressure liquid supply has a pressure of at least five times that of the wellhead production pressure. The high pressure liquid supply may for example be a supply of high pressure water used for injection into the reservoir (known as "injection water"). A non-return valve may be connected to the outlet of the multiphase jet pump, to prevent reverse flow through the jet pump.

Alternatively, the multiphase pump may be a mechanical multiphase pump, for example a positive displacement (PD) pump.

Advantageously, the multiphase pump is constructed and arranged to provide a discharge pressure of 2 to 3 times the flowing wellhead pressure.

The flow control system may include sensing means for sensing the phase of the inlet fluid, and flow control means for automatically feeding the inlet fluid into the gas inlet line when the inlet fluid is a gas-rich fluid, or the multiphase inlet line when the inlet fluid is multiphase fluid. The flow control system may include a separator device for separating the gas and liquid phases of the inlet fluid. The separator device may include a sensing device for sensing the quantity of liquid in the separator device.
According to a further aspect of the invention there is provided a well start-up process, the process including the steps of receiving inlet fluid from a well through a fluid inlet line, controlling the flow of inlet fluid so that it flows from the fluid inlet line into either a gas inlet line or a multiphase inlet line, depending on whether the inlet fluid is a gas-rich fluid or a multiphase fluid, the flow of inlet fluid being controlled such that when the inlet fluid is a gas-rich fluid, the inlet fluid is fed into the gas inlet line, the pressure of the fluid is increased using a gas-gas jet pump and the fluid is supplied to a gas pump outlet, and when the inlet fluid is a multiphase fluid, the inlet fluid is fed into the multiphase inlet line, the pressure of the fluid is increased using a multiphase pump and the fluid is supplied to a multiphase pump outlet, and the fluids from the gas pump outlet and the multiphase pump outlet are supplied to a fluid outlet line.

Advantageously, the gas-gas jet pump has a low pressure inlet that receives inlet fluid from the fluid inlet line, a high pressure inlet connected to a high pressure gas supply and a gas pump outlet. Preferably, the high pressure gas supply has a pressure of ideally 5 to 10 times that of the wellhead production pressure. The gas-gas jet pump preferably provides a discharge pressure of at least twice the wellhead production pressure. A non-return valve may be connected to the outlet of the gas-gas jet pump.

The multiphase pump may be a liquid-multiphase jet pump having a low pressure inlet that receives multiphase fluids from the multiphase inlet line, a high pressure inlet connected to a high pressure liquid supply and a multiphase outlet. Advantageously, the high pressure liquid supply has a pressure of at least twice, and preferably at least 5 times, that of the wellhead production pressure. A non-return valve may be connected to the outlet of the liquid-multiphase jet pump.

Alternatively, the multiphase pump may be a mechanical pump.

The main reason for and the advantage of using two jet pumps is that each is highly efficient only under a specific production condition. For example, if the produced well fluid is primarily gas a gas-gas jet pump is the most efficient way to reduce the back pressure on the well and withdraw gas from the well bore. In this case, high pressure gas is the motive flow, but when the accumulated liquids reach the wellhead and well fluids are liquid rich a liquid-multiphase jet pump is the best choice to reduce the back pressure on the well and withdraw the produced liquid-rich multiphase fluids from the well, in this case
the motive high pressure fluid is a liquid. It is worth noting that the two jet pumps have
different designs and motive flow and each during its use is at its optimum efficiency,
which is crucial in lowering the wellhead pressure and providing satisfactory well start-up.

Advantageously, the multiphase pump provides a discharge pressure of at least twice the
wellhead production pressure.

The process may include sensing the phase of the inlet fluid, and automatically feeding the
inlet fluid into the gas inlet line if the inlet fluid is a gas-rich fluid, or the multiphase inlet
line if the inlet fluid is a multiphase fluid.

The gas and liquid phases of the inlet fluid may be separated in a separator device. The
level of liquid in the separator device may be sensed.

Various embodiments of the invention will now be described, by way of example, with
reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic illustration of a first well start-up system, using two jet pumps;
Figure 2 is a diagrammatic illustration of a second well start-up system, using a jet pump
and a booster pump;

Figure 3 is a diagrammatic illustration of a third well start-up system, using two jet pumps
and a fluid separator, and

Figure 4 is a diagrammatic illustration of a fourth well start-up system, with a jet pump, a
booster pump and a separator vessel.

In the system shown in Figure 1, the well 1, which is partially blocked with a column of
liquid (oil and/or water) includes a number of valves 2,3. Fluid can be drawn off from the
well 1 through a fluid inlet line 4 that includes an on/off valve 5 and a pressure gauge or
pressure transmitter 6.

The fluid inlet line 4 is connected to a gas inlet line 8 for the gas phase of the inlet fluid and
a multiphase inlet line 10 for multiphase inlet fluid. The flow of fluid into the gas inlet line
8 and the multiphase inlet line 10 is controlled by a flow control system including a gas
isolation valve 12 in the gas inlet line 8 and an isolation valve 14 in the multiphase inlet
line 10. The flow control system may also optionally include a number of sensors and/or
transmitters (not shown) for monitoring the fluid flowing through the inlet lines 4, 8, 10 and motorised valve actuators for automatically operating the valves 14, 12 according to the detected phase of the fluid flowing through the inlet lines.

The gas inlet line 8 is connected to the low pressure inlet of a gas-gas jet pump 16. The high pressure inlet of the jet pump is connected through a line 18 to a high pressure gas supply, for example a lift gas supply, which is used as the motive flow for the jet pump. The high pressure gas inlet line includes a valve 20 for controlling the supply of gas to the jet pump and a pressure gauge or transmitter 22. The outlet of the jet pump 16 is connected to a gas outlet line 24 that includes a non-return valve 26 and a control valve 28.

The multiphase inlet line 10 is connected to the low pressure inlet of a multiphase jet pump 30. The high pressure inlet of the multiphase jet pump 30 is connected through a line 32 to a high pressure liquid source, which is used as the motive flow for the jet pump. The high pressure liquid inlet line 32 includes a valve 34 for controlling the supply of high pressure liquid to the jet pump, and a pressure gauge or transmitter 36. The outlet of the multiphase jet pump 30 is connected to a multiphase outlet line 38 that includes a non-return valve 40 and a control valve 42. If no high pressure liquid is available, high pressure gas can be used, although it would be less efficient in handling multiphase well fluids. In such a case this gas-multiphase jet pump will still be different from the gas-gas jet pump both in design and performance.

The gas outlet line 24 and the multiphase outlet line 38 are connected to a fluid outlet line 44 that includes a pressure gauge 46, and is connected to a manifold or header of a fluid supply line (not shown).

A process for operating the well start-up system to revive a well that is partially filled with liquid (oil or water) and that includes accumulated gas in the upper part of the well will now be described.

In the first stage of the operation, the multiphase isolation valve 14 is closed and the gas isolation valve 12 is opened. High pressure gas from a suitable source (e.g. lift gas) is supplied through the line 18 to the high pressure inlet of the gas-gas jet pump 16. This draws gas from the upper part of the well 1 through the fluid inlet line 4 and the gas inlet
line 8 into the low pressure inlet of the jet pump 16. The gas is then discharged from the outlet of the jet pump 16 through the gas outlet line 24 and the fluid outlet line 44.

As gas is drawn off, the gas pressure in the upper part of the well decreases and liquid that has collected in the lower part of the well starts to rise up the well and is mixed with produced gas or injected gas, forming a multiphase fluid. When the multiphase fluid reaches the well head, the multiphase isolation valve 14 is opened and high pressure motive liquid is supplied through the line 32 to the high pressure inlet of the multiphase jet pump 30. At the same time, the gas isolation valve 12 is closed to prevent further flow through the gas inlet line 8, and the supply of high pressure gas to the gas-gas jet pump 16 is shut off by closing the valve 20. The valve 28 in the gas outlet line 24 is also closed.

The supply of high pressure liquid to the multiphase jet pump 30 draws the multiphase fluid from the well 1 through the fluid inlet line 5 and the multiphase inlet line 10 to the low pressure inlet of the multiphase jet pump 30. The multiphase jet pump 30 expels the multiphase fluid through its outlet into the outlet line 38 and the fluid outlet line 44. This process continues until all the accumulated liquid has been removed from the well and normal production of gas or multi-phase fluids has been restored. If desired, the pressure of the gas can then be boosted by re-activating the gas-gas jet pump 16.

If the well becomes blocked again, the operation described above can be repeated as often as necessary, for as long as production is commercially viable. The process may be automated if required.

The non-return valves 26,40 are provided for safety reasons, to prevent any risk of the fluid flow reversing through the jet pumps 16,30.

The second well start system shown in Figure 2 is similar to the first well start system, except that the multiphase jet pump 30 is replaced by a mechanical booster pump 50. The system therefore includes a well 1 and a fluid inlet line 4 that includes a control valve 5 and a pressure gauge 6.

The fluid inlet line 4 is connected to a gas inlet line 8 for the gas phase of the fluid and a multiphase inlet line 10 for the liquid rich phase of the fluid. The flow of fluid into the gas inlet line 8 and the multiphase inlet line 10 is controlled by a flow control system including
a gas isolation valve 12 in the gas inlet line 8 and a liquid isolation valve 14 in the multiphase inlet line 10.

The gas inlet line 8 is connected to the low pressure inlet of a gas-gas jet pump 16 and the high pressure inlet of the jet pump 16 is connected through a line 18 to a high pressure gas supply. The outlet of the jet pump 16 is connected to a gas outlet line 24 via a non-return valve 26.

The multiphase inlet line 10 is connected to the inlet of a mechanical booster pump 50. The outlet of the booster pump 50 is connected to a multiphase outlet line 38 that includes a non-return valve 40 and a control valve 42. A bypass line 52 that includes a bypass valve 54 extends from the outlet to the inlet of the booster pump 50.

The gas outlet line 24 and the multiphase outlet line 38 are connected to a fluid outlet line 44 that includes a pressure gauge 46, and is connected to a manifold or header of a fluid supply line (not shown).

A process for operating the well start-up system shown in Figure 2 will now be described.

In the first stage of the operation, the multiphase isolation valve 14 is closed and the gas isolation valve 12 is opened. High pressure gas from a suitable source is supplied through the line 18 to the high pressure inlet of the gas-gas jet pump 16. This draws gas from the upper part of the well 1 through the fluid inlet line 4 and the gas inlet line 8 into the low pressure inlet of the jet pump 16. The gas is then discharged from the outlet of the jet pump 16 through the gas outlet line 24 and the fluid outlet line 44.

As gas is drawn off, the gas pressure in the upper part of the well decreases and liquid that has collected in the lower part of the well starts to rise up the well and may be mixed with the produced gas from the well, forming a multiphase fluid. When the multiphase fluid reaches the well head, the liquid isolation valve 14 is opened and the booster pump 50 is started. At the same time, the gas isolation valve 12 is closed to prevent further flow through the gas inlet line 8, and the supply of high pressure gas to the gas-gas jet pump 16 is shut off by closing the valve 20. The valve 28 in the gas outlet line 24 is also closed.

The booster pump 50 draws the multiphase fluid from the well 1 through the fluid inlet line 5 and the multiphase inlet line 10 and expels the fluid into the outlet line 38 and the fluid
outlet line 44. This process continues until all the accumulated liquid has been removed from the well and normal production of gas or multiphase fluids has been restored.

As at this stage the produced liquids may contain gas, the booster pump should be of a type that can also handle some gas. An example is a positive displacement or so called multiphase pump.

The third well start system shown in Figure 3 is similar to the first well start system, except that a separator device 60 is used to separate the gas and liquid phases of the fluid drawn from the well 1, and a liquid-liquid jet pump 30 is used to boost the outlet pressure of the liquid phase. The system therefore includes a well 1 and a fluid inlet line 4, which is connected to the gas inlet line 8 and a liquid inlet line 10 via the separator device 60. The flow of fluid into the gas inlet line 8 and the liquid inlet line 10 is controlled by a gas isolation valve 12 and a liquid isolation valve 14, which are operated automatically according to the phase of the fluid flowing into the separator device 60.

In the embodiment shown in Figure 3, the separator device 60 is a conventional knock-out vessel, comprising an elongated vertical chamber into which the inlet fluid flows approximately at or near the mid-point of its height. The gas and liquid phases of the inlet fluid are separated within the knock-out vessel, the gaseous part flowing upwards into the gas inlet line 8 and the liquid part falling to the bottom of the vessel and flowing out through the liquid inlet line 10. The knock-out vessel 60 could be a simple vertical vessel with no level of pressure control device. Alternatively, it may include a level sensing device 62 to detect the level of liquid in the vessel, and this is used to control the gas and liquid inlet valves 12,14 according to the phase of the inlet fluid. Therefore, when the inlet fluid is a gas-rich fluid and the knock-out vessel 60 contains little or no liquid, the gas inlet valve 12 will be opened so that gas is drawn off from the well by the gas-gas jet pump 16.

However, when the multiphase fluid reaches the top of the well head and starts to flow into the knock-out vessel 60, the liquid inlet valve 14 will be opened in response to the rising liquid level in the separator and the liquid will then be drawn off by a liquid-liquid jet pump 30. The flow of fluid into the gas inlet line 8 and the liquid inlet line 10 is therefore controlled according to whether the inlet fluid is a gas-rich fluid or a multiphase fluid.

In applications where high pressure liquid is not available, the motive flow to jet pump 30 could be high pressure gas and in this case jet pump 30 could be designed as gas-liquid jet
pump. This is not, however, the most efficient solution but is still beneficial if no high pressure liquid phase is available.

It should be noted that although a conventional knock-out vessel is shown in Figure 3, the separator device 60 may consist of any device that is suitable for separating the gas and liquid phases of the inlet fluid including, for example, a cyclonic separator.

The process for operating the well start-up system shown in Figure 3 therefore includes a first stage in which gas is drawn off from the upper part of the well 1 by the gas-gas jet pump 16, and a second stage in which liquid is drawn from the well 1 by the liquid-liquid jet pump 30 or a gas-liquid jet pump. The process may also include an intermediate stage in which the inlet fluid is a multiphase fluid, and the two phases are separated by the separator device 60 and drawn off simultaneously by the gas-gas and liquid-liquid jet pumps 16,30.

The fourth well start system shown in Figure 4 is similar to the third well start system shown in Figure 3, except that the liquid-liquid jet pump 30 is replaced by a mechanical booster pump 50. The method of operation is similar to that of the third system, except that the liquid phase of the inlet fluid is drawn off by the booster pump 50 instead of a liquid-liquid jet pump. This system is adopted when high pressure liquid phase is not available for the liquid jet pump as shown in figure 3.

In all options the key benefit gained is to have two separate boosting systems for well start-up so that a maximum possible drop in the well head pressure can be achieved during this operation. Such a big drop in the wellhead pressure is essential and crucial, without which the revival of the well may not be possible. By having the two separate boosting systems, one for the initial gas draw down phase and one for liquid rich phase, at both stages of well revival maximum drop in the wellhead pressure is achieved.
CLAIMS

1. A well start-up system including:
   • a fluid inlet line for receiving inlet fluid from a well;
   • a gas inlet line connected to receive gas-rich fluid from the fluid inlet line;
   • a multiphase inlet line connected to receive multiphase fluid from the fluid inlet line;
   • a flow control system for controlling the flow of inlet fluid so that it flows into the gas inlet line or the multiphase inlet line, depending on whether the inlet fluid is a gas-rich fluid or a multiphase fluid;
   • a gas pump comprising a gas-gas jet pump having a low pressure inlet connected to receive a gas-rich fluid from the gas inlet line, a high pressure inlet for connection to a high pressure gas supply and a gas pump outlet;
   • a multiphase pump having a low pressure inlet connected to receive multiphase fluid from the multiphase inlet line, and a multiphase pump outlet;
   • and a fluid outlet line connected to receive fluids from the gas pump outlet and the multiphase pump outlet;
   • wherein the flow control system is constructed and arranged such that when the inlet fluid is a gas-rich fluid, the inlet fluid is fed into the gas pump via the gas inlet line, and when the inlet fluid is a multiphase fluid, the inlet fluid is fed into the multiphase pump via the multiphase inlet line.

2. A well start-up system according to claim 1, wherein the high pressure gas supply has a pressure of at least twice, and preferably at least 5 times, the flowing wellhead pressure.

3. A well start-up system according to claim 1 or claim 2, wherein the gas pump is constructed and arranged to provide a discharge pressure of at least twice the flowing wellhead pressure.

4. A well start-up system according to any one of the preceding claims, wherein a non-return valve is connected to the outlet of the gas pump.

5. A well start-up system according to any one of the preceding claims, wherein the multiphase pump is a multiphase jet pump having a low pressure inlet connected
to receive multiphase fluid from the multiphase inlet line, a high pressure inlet for connection to a high pressure liquid supply, and a multiphase pump outlet.

6. A well start-up system according to claim 5, wherein a non-return valve is connected to the multiphase pump outlet.

7. A well start-up system according to any one of claims 1 to 4, wherein the multiphase pump is a mechanical pump.

8. A well start-up system according to any one of the preceding claims, wherein the multiphase pump is constructed and arranged to provide a discharge pressure of at least twice the flowing wellhead pressure.

9. A well start-up system according to any one of the preceding claims, wherein the flow control system includes sensing means for sensing the phase of the inlet fluid, and flow control means for automatically feeding the inlet fluid into the gas inlet line when the inlet fluid is a gas-rich fluid, or into the multiphase inlet line, when the inlet fluid is a multiphase fluid.

10. A well start-up system according to any one of the preceding claims, wherein the flow control system includes a separator device for separating the gas and liquid phases of the inlet fluid.

11. A well start-up system according to claim 10, wherein the separator device includes a sensing device for sensing the level of liquids in the separator device.

12. A well start-up process, the process including the steps of:
   • receiving inlet fluid from a well through a fluid inlet line;
   • controlling the flow of inlet fluid so that it flows from the fluid inlet line into a gas inlet line or a multiphase inlet line, depending on whether the inlet fluid is a gas-rich fluid or a multiphase fluid, the flow of inlet fluid being controlled such that;
   • when the inlet fluid is a gas-rich fluid, the inlet fluid is fed into the gas inlet line, the pressure of the fluid is increased using a gas-gas jet pump, and the fluid is supplied to a gas pump outlet;
when the inlet fluid is a multiphase fluid, the inlet fluid is fed into the multiphase inlet line, the pressure of the fluid is increased using a multiphase pump, and the fluid is supplied to a multiphase pump outlet;

and fluids from the gas pump outlet and the multiphase pump outlet are supplied to a common fluid outlet line.

13. A well start-up process according to claim 12, wherein the gas-gas jet pump has a low pressure inlet that receives gas-rich fluid from the fluid inlet line, a high pressure inlet connected to a high pressure gas supply and a gas pump outlet.

14. A well start-up process according to claim 12 or claim 13, wherein the high pressure gas supply has a pressure of at least 5 times the flowing wellhead pressure.

15. A well start-up process according to any one of claims 12 to 14, wherein the gas-gas jet pump provides a discharge pressure of at least twice the flowing wellhead pressure.

16. A well start-up process according to any one of claims 12 to 15, wherein a non-return valve is connected to the outlet of the gas-gas jet pump.

17. A well start-up process according to any one of claims 12 to 16 wherein the multiphase pump is a multiphase jet pump having a low pressure inlet that receives multiphase fluid from the multiphase inlet line, a high pressure inlet connected to a high pressure liquid supply, and a multiphase pump outlet.

18. A well start-up process according to claim 17, wherein the high pressure gas supply has a pressure of at least twice, and preferably at least 5 times, the flowing wellhead pressure.

19. A well start-up process according to claim 17 or claim 18, wherein a non-return valve is connected to the outlet of the multiphase jet pump.

20. A well start-up process according to any one of claims 12 to 16, wherein the multiphase pump is a mechanical pump.
21. A well start-up process according to any one of claims 12 to 20, wherein the multiphase pump provides a discharge pressure of at least twice the flowing wellhead pressure.

22. A well start-up process according to any one of claims 12 to 21, including sensing the phase of the inlet fluid, and automatically feeding the inlet fluid into the gas inlet line if the inlet fluid is a gas-rich fluid, or the multiphase inlet line if the inlet fluid is a multiphase fluid.

23. A well start-up process according to any one of claims 12 to 22, wherein the gas and liquid phases of the inlet fluid are separated in a separator device.

24. A well start-up process according to claim 23, wherein the level of liquid in the separator device is sensed.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

E21B43/34  E21B43/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and or where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
<td>Y</td>
<td>US 5 377 714 A (GIANNESENI ET AL) 3 January 1995 (1995-01-03) column 4, lines 22-38 column 6, lines 9-31 column 7, lines 48-51</td>
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<td>US 5 547 021 A (RADEN ET AL) 20 August 1996 (1996-08-20) column 4, lines 5-9 column 5, lines 24-26</td>
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Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents:
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Date of the actual completion of the international search

29 November 2005

Date of mailing of the international search report

06/12/2005

Name and mailing address of the ISA

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Tel. (+31-70) 340-2040, Tx. 31 651 app nl
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Garrido Garcia, M
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<th>Relevant to claim No.</th>
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<tr>
<td>A</td>
<td>US 6 296 690 B1 (CHARRON YVES) 2 October 2001 (2001-10-02) column 4, paragraph 14-29</td>
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<td>A</td>
<td>WO 03/033870 A (ALPHA THAMES LTD; APPLEFORD, DAVID, ERIC; LANE, BRIAN, WILLIAM) 24 April 2003 (2003-04-24) abstract</td>
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<td>A</td>
<td>GB 2 014 862 A (INST FRANCAISE DU PETROLE) 5 September 1979 (1979-09-05) abstract</td>
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