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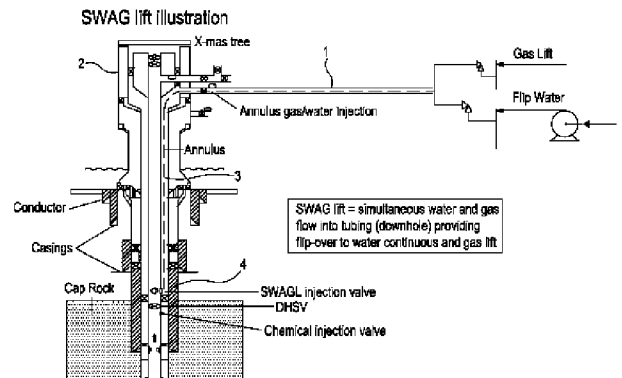
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(54) Title **ARTIFICIAL LIFT METHOD**
 (57) Abstract

An artificial lift method is provided which is suitable for use in heavy oil reservoirs. The method comprises injecting a combination of water and gas into a well to create artificial lift.



Artificial lift method

5 Production wells are used to produce fluid from reservoirs in the geological subsurface. In particular, fluids in the form of oil and gas are produced through wells, as is routinely the case in the oil and gas industry. The production fluid is typically received in the well from the subsurface reservoir due to the natural pressure conditions, and then flows out of the well inside a dedicated production tubing disposed in the well. The flow of gas and liquids in a production well takes place as a result of pressure in the reservoir. The naturally occurring pressure may be sufficient to lift the fluids to the surface. In addition to the natural flow of fluids, an artificial pressure may be added to increase the flow, or create a flow if the naturally occurring pressure is not sufficient to lift the fluids to the surface. The artificial pressure is also referred to as artificial lift. An electric submersible pump (ESP) is a downhole pump which can be used to create artificial lift. A system of multiple EPS lifted wells may be used, wherein the wells are connected to a common manifold. The production fluid from the well is then transported along pipelines to a downstream facility, for example a floating production platform (in the case of an offshore well) where the fluid may be processed further. Additional booster pumps may be provided in the production system at the surface, for example on the seabed, to help pump the production fluid from the well along the pipeline to the downstream facility at a suitable rate.

Existing methods for creating artificial lift for a high production rate, for example over 1000 standard cubic metre per day, are: gas lift for conventional oil wells, ESP mainly for heavy oils, HSP (hydraulic submersible pumps) mainly for heavy oils, rod pumps and hydraulic jet pumps.

The main problems with the current technology ESP are: a limited life time (0.5-1.5 years) before they have to be changed; high cost of changing the ESP (need a drilling rig to change the pump); loss of production when the ESP is down; higher well cost due to down hole equipment (in addition to the ESP itself); high OPEX of the ESP pump; cost, weight and space of the topside equipment to control the pump (mainly VSD); down hole diluent may be required to reduce the viscosity of the fluid in the well. The diluent is expensive and uses some of the available surface process capacity

35 The invention provides a method and system as defined in the accompanying claims.

Some embodiments of the invention will now be described by way of example only and with reference to the accompanying drawing, in which:

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Fig.1 illustrates schematically a system;

Fig.2 illustrates a method.

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The method described herein may be used as an artificial lift method for heavy oil reservoirs where gas-lift cannot be applied due to high viscosity of the reservoir oil.

The method described herein provides for a method of injecting a combination of water and gas into a well. This method may be used to create artificial lift. The water and gas may be injected simultaneously into the well.

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The water and gas may be injected into the well through holes in the production tubing, optionally as deep as possible such that injection takes place close to a lower completion section. The holes in the production tubing may be provided with valves to control the inflow of water and gas.

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The water and gas may be transported down in the annular space between the tubing and the smallest casing. Alternatively, the water and gas may be transported down in a single shared tubing which is provided inside or outside the production tubing. Alternatively, the water and gas may be transported down in separate tubing inside or outside the production tubing, wherein a first tube is provided for the water and a second tubing for the gas. With separate tubing, water can be provided at any position upstream the gas injection. Water can also be provided by extending the well or a well branch into an aquifer.

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An advantage of adding or injecting water to the produced reservoir fluid is to generate a flow regime inside the production tubing with a low apparent viscosity, when compared to reservoir fluid without water, to reduce the frictional pressure loss. An advantage of adding or injecting gas to the produced reservoir fluid is to generate a fluid mixture in the tubing with low apparent density, when compared to reservoir fluid without gas.

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Consequently, by adding, injecting and/or mixing water and gas down hole in the well with the produced reservoir fluid, the fluid mixture in the tubing will have both low viscosity and low density, thereby combining the advantages of water and gas.

5 The amount of water and gas injected into the production tubing down hole can be regulated continuously to maximize the production of reservoir fluid. The amount of water and gas injected into the well may be varied depending on the composition of the produced fluid, such as water cut and gas liquid ratio of the produced reservoir fluid. Addition of water with continuous flow conditions can be one solution to secure low
10 apparent viscosity of the fluid in the production tubing.

Injection of both water and gas simultaneously reduces pressure losses both due to friction and gravity. Without adding further pressure, the well pressure itself may be sufficient to transport the production fluids to the surface in combination with the
15 reduction of pressure losses after injection of water and gas.

The added water to reduce friction pressure loss may also be used in connection with transportation of heavy oil outside the well, such as in pipeline transportation of oil.

20 Further advantages of the method disclosed herein are: reduction of cost (CAPEX and OPEX), improved well regularity (avoid replacement of ESP's, expensive rig time), reduced weight (mainly VSD's), improvement of the utilization of the surface processing capacity (avoid injection of diluent before it is needed in the surface process). An ESP is sensitive to gas, and the use an ESP will influence the position of the wells in a
25 reservoir with a gas cap. Using gas lift can increase the flexibility of where to position the well path, thereby enhancing the production from the field. An ESP limits the well paths (e.g. maximum dog leg), while the present method does not put any restrictions on the well path which may allow for a more optimum placement of wells with respect to recovery and production rate. Addition of water will influence the amount of water which
30 generates water continuous conditions, which improves oil/water and gas/liquid separation downstream of the wellhead.

Figure 1 illustrates a specific implementation for SWAGL (simultaneous water and gas injection lift). The gas and water are mixed above the sea bed and combined in a single
35 tube (1). The tube extends through the Christmas tree (2) into an annulus (3), which is

provided outside the innermost tubular extending towards the bottom of the well. The tube terminates at a valve (4) provided at an opening in the tubular. The opening is provided below the water, below the seafloor and below the cap rock. Other alternatives are injection of water and gas in single or separate tubings inside or outside the production tubing, or controlled water production from the aquifer combined with conventional gas lift.

Figure 2 illustrates a method of combining gas and water (S1), and injecting the combination of water and gas into a well to create artificial lift (S2).

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Although the invention has been described in terms of preferred embodiments as set forth above, it should be understood that these embodiments are illustrative only and that the claims are not limited to those embodiments. Those skilled in the art will be able to make modifications and alternatives in view of the disclosure which are contemplated as falling within the scope of the appended claims. Each feature disclosed or illustrated in the present specification may be incorporated in the invention, whether alone or in any appropriate combination with any other feature disclosed or illustrated herein.

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Claims

1. An artificial lift method suitable for use in heavy oil reservoirs; the method comprising:
5 injecting a combination of water and gas into a well to create artificial lift.
2. The method of claim 1, wherein the water and gas are injected simultaneously into the well.
- 10 3. The method of claim 1 or 2, wherein the water and gas are injected into the well through one or more openings in the production tubing,
4. The method of any preceding claim, wherein the water and gas are injected deep in the well such that injection takes place close to a lower completion section.
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5. The method of claim 3, wherein the one or more openings in the production tubing are provided with valves to control the inflow of water and gas.
6. The method of any preceding claim, wherein the water and gas are transported
20 downhole in an annular space between the tubing and the casing.
7. The method of any one of claims 1 to 5, wherein the water and gas are transported downhole in a single shared tubing which is provided inside or outside the production tubing.
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8. The method of any one preceding claim, wherein the water and gas are transported down in separate tubing inside or outside the production tubing, wherein a first tube is provided for the water and a second tubing for the gas.
- 30 9. The method of claim 8, wherein water is provided at a position upstream the gas injection.
10. The method of any preceding claim, wherein water is provided by extending the well or a well branch into an aquifer.
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11. A system for providing artificial lift suitable for use in heavy oil reservoirs; the system comprising:

5 a combined tube extending through a Christmas tree into an annulus of the well and terminating at a valve provided at an opening in a tubular, wherein the tube is arranged to provide a combination of gas and water at the opening in the tubular.

12. The system of claim 11, wherein the opening is provided below the water, below the seafloor and below the cap rock.

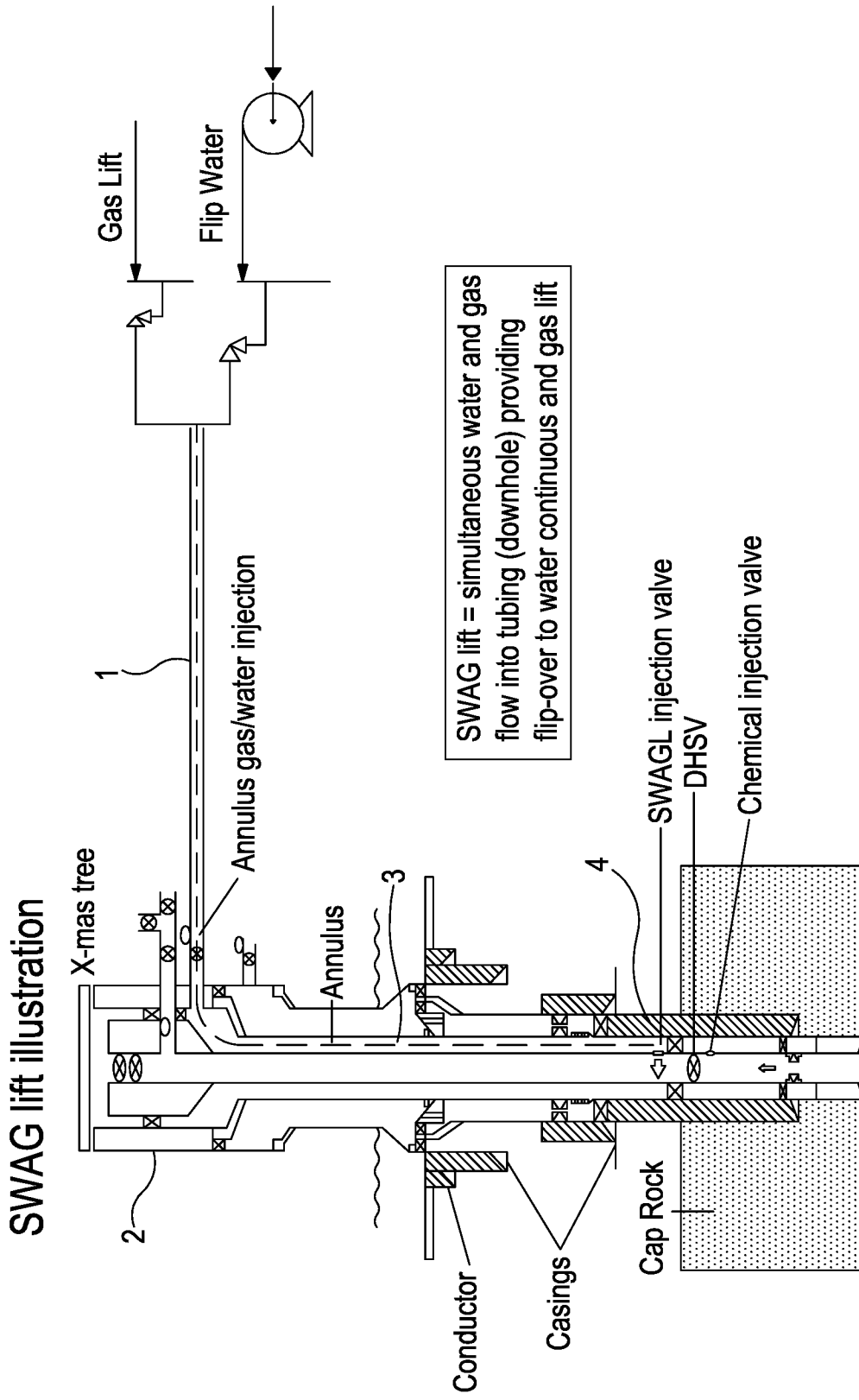


Fig. 1

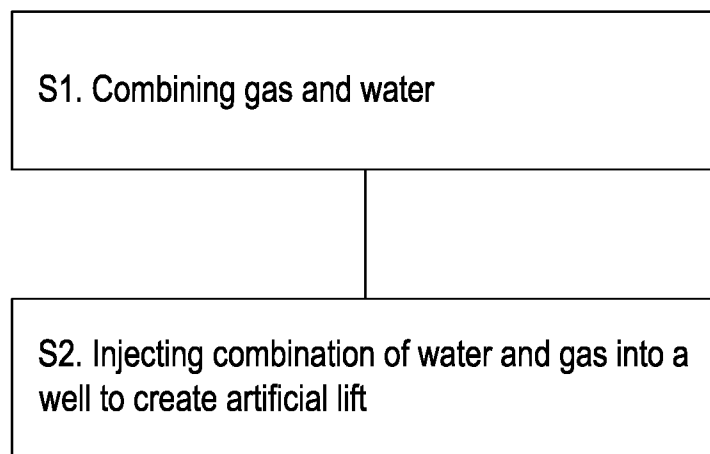


Fig. 2