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(54) Title: AN ARRANGEMENT AND METHOD FOR WATER SHUT-OFF IN AN OIL AND/OR GAS WELL

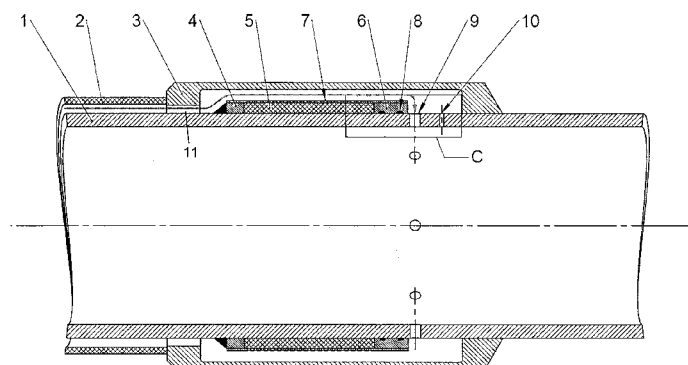


Fig. 1

(57) Abstract: The present invention relates to an arrangement and method for water shut-off in an oil and/or gas well. The arrangement comprises: a hydrocarbon production pipe (1) having a pipe wall with at least one opening (9); a swellable element (5) adapted to expand when subjected to water; and a shut-off element (6), wherein the swellable element is arranged to come into contact with fluid from the well or an associated reservoir and to actuate the shut-off element when expanded so that the shut-off element at least partly closes the at least one opening in the pipe wall.

An arrangement and method for water shut-off in an oil and/or gas well

The present invention relates to an arrangement and method for water shut-off in an oil and/or gas well.

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WO 2008004875 A1 (NORSK HYDRO ASA) discloses method for flow control and a self-adjusting valve or flow control device, in particular useful in a production pipe for producing oil and/or gas from a well in an oil and/or gas reservoir, which production pipe includes a lower drainage pipe preferably being divided into at least
10 two sections each including one or more inflow control devices which communicates the geological production formation with the flow space of the drainage pipe. The fluid flows through an inlet and further through a flow path of the control device passing by a movable disc or movable device which is designed to move relative to the opening of the inlet and thereby reduce or increase the flow-through area by exploiting the
15 Bernoulli effect and stagnation pressure created over the disc, whereby the control device, depending on the composition of the fluid and its properties, automatically adjusts the flow of the fluid based on a pre-estimated flow design. The flow control device in WO 2008004875 A1 may for instance be used to reduce inflow of water. However, a problem with the flow control device in WO 2008004875 A1 is that it may
20 not be completely closed if the fluid contains water.

Further, WO 2005080750 A1 (NORSK HYDRO ASA) discloses a method and a device in connection with an actuator intended for use in connection with a fluid flow or fluid reservoir, in particular an actuator that is designed to be used in connection with a drainage pipe for the production of oil and/or gas in an oil and/or gas reservoir. An
25 osmotic cell is used to operate the actuator. The osmotic cell is placed in the fluid flow, whereby the necessary force and motion for the actuator to adjust or drive a fluid control device or valve are achieved by utilising the osmotic pressure difference between the solution in the cell and the external fluid flow/reservoir in relation to the cell. The method and device in WO 2005080750 A1 supposedly keep water production
30 to a minimum level. However, a problem with the device in WO 2005080750 A1 is that it is not reversible in case the (pressure) drawdown is high.

It is an object of the present invention to at least partly overcome the above-mentioned problems, and to provide an improved water shut-off arrangement and
35 method.

This object, and other objects that will be apparent from the following description, is achieved by a water shut-off arrangement and method according to

the appended independent claims. Embodiments are set forth in the appended dependent claims.

According to an aspect of the present invention, there is provided an arrangement for water shut-off in an oil and/or gas well, the arrangement comprising: a hydrocarbon production pipe having a pipe wall with at least one opening; a swellable element adapted to expand when subjected to water; and a shut-off element, wherein the swellable element is arranged to come into contact with fluid from the well or an associated reservoir and to actuate the shut-off element when expanded so that the shut-off element at least partly closes the at least one opening in the pipe wall.

The present invention allows for automatic shut-off of the (inlet) opening should the fluid from the well/reservoir contain water, whereby the yield of the oil/gas production may be increased. Further, the present arrangement can cope with high drawdown.

The arrangement may further comprise a sleeve fitted over a section of the hydrocarbon production pipe, wherein the swellable element is interposed between the hydrocarbon production pipe and the sleeve such that it is forced to expand mainly in the longitudinal or axial direction of the hydrocarbon production pipe.

The sleeve may be perforated to allow fluid from the well or associated reservoir to come into contact with the swellable element.

Further, the shut-off element may include a sliding ring provided around the hydrocarbon production pipe, wherein one end of the swellable element is fixed and the other end is directly or indirectly in contact with the sliding ring, for pushing the sliding ring along the hydrocarbon production pipe to a position where the sliding ring covers the at least one opening in the pipe wall when the swellable element is expanded.

The arrangement may further comprise a housing adapted to accommodate at least the swellable element and the shut-off element, wherein the housing has an inlet for fluid from the well or associated reservoir.

The arrangement may further comprise a sand screen arranged upstream of the swellable element with respect to the fluid from the well or associated reservoir.

An additional opening out of reach for the shut-off element may be provided in the pipe wall of the hydrocarbon production pipe.

The swellable element may include a hygroscopic material.

The swelling or expansion of the swellable element may be reversible.

The sensitivity of the water shut-off function may be set by selecting at least one of: the type or material of the swellable element; the dimension(s) of the swellable element; and the initial distance between the shut-off element and the at least one opening in the pipe wall.

According to another aspect of the present invention, there is provided a method for water shut-off in an oil and/or gas well in which a hydrocarbon production pipe having a pipe wall with at least one opening is provided, wherein the method comprises: providing a swellable element adapted to expand when subjected to water; and
5 providing a shut-off element, wherein the swellable element is arranged to receive fluid from the well or an associated reservoir and to actuate the shut-off element when expanded so that the shut-off element closes the at least one opening in the pipe wall. This aspect may exhibit the same or similar features and technical effects as the previously described aspect of the invention.

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These and other aspects of the present invention will now be described in more detail, with reference to the appended drawings showing a currently preferred embodiment of the invention.

Fig. 1 is a cross-sectional side view of an embodiment of the present invention.

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Figs. 2a-2b are detailed views of a portion C of Fig. 1.

Fig. 1 shows an arrangement for water shut-off in an oil and/or (natural) gas well according to an embodiment of the present invention. The present application may be applied onshore or offshore (subsea).

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The arrangement comprises a pipe 1. The pipe 1 may be a hydrocarbon production pipe, and it is placed in the oil and/or (natural) gas well.

The pipe 1 comprises at least one opening or hole 9 in the pipe wall. For instance, several holes 9 may for instance be arranged in a "ring" around the pipe 1. The holes 9 are generally adapted to allow fluid from a reservoir associated with the well
25 into the pipe 1. The fluid from the reservoir typically includes oil, gas, and/or water.

The arrangement further comprises a swellable element 5. The swellable element 5 is adapted to expand when subjected or exposed to water, but not to expand when subjected to oil or gas. The swellable element 5 may include a hygroscopic material. The swellable element 5 can for instance be made of or include one or more polymers
30 that swell under the influence of water. Further, the swelling or expansion of the swellable element 5 may be reversible. That is, the swellable element 5 may return to an initial state from an expanded state if it no longer is subjected to water. Also, the swellable element 5 may be sub-divided in several smaller swellable elements.

The swellable element 5 is interposed between the pipe 1 and a perforated sleeve
35 7 fitted over a section of the pipe 1. To this end, the swellable element 5 may have the form of a cylinder provided around the pipe 1. The sleeve 7 may for instance be made of steel, and its perforations allow fluid from the well or the associated reservoir to

moisten or wet the swellable element 5. Further, the sleeve 7 may protect the swellable element 5 from bending and buckling. Also, the sleeve 7 serves to limit the direction of expansion of the swellable element 5, as will be explained further below.

One end of the swellable element 5 (to the left in fig. 1) is clamped by a retaining ring 4. The retaining ring 4 may for instance be made of steel. The other free end (to the right in fig. 1) of the swellable element 5 is connected to a shut-off element forming part of the present arrangement. The shut-off element includes a sliding ring 6 and optional O-rings 8. The sliding ring 6 may slide along the pipe 1 from the position shown in fig. 2a to the position shown in fig. 2b. In this working area of the sliding ring 6, the outer surface of the pipe 1 may be smoothed to facilitate the sliding.

The arrangement may further comprise a housing 3. The housing 3 accommodates the retaining ring 4, the swellable element 5, the sliding ring 6, the sleeve 7, the hole 9, and also an additional opening or hole 10 to the pipe 1. The housing 3 has an inlet 11 for allowing fluid from the well/reservoir into the housing 3, whereby the fluid received in the housing 3 may moisten or wet the swellable element 5. An optional sand screen 2 may also be included in the arrangement. The sand screen 2 is arranged before the inlet 11, upstream of the swellable element 5 with respect to the fluid from the well/reservoir. The sand screen 2 may prevent sand erosion in the hole 9.

Upon operation, fluid from the well/reservoir passes the sand screen 2 and enters the housing 3 through the inlet 11. The fluid comes into contact with the swellable element 5 via the perforations of the sleeve 7. Initially, the swellable element 5 may be in a non-swelled state, as shown in fig. 1 and fig. 2a. In this state, the sliding ring 6 does not cover the hole 9. If the fluid mainly contains oil and/or gas, and no water or just a small amount of water, the swellable element 5 will remain in this state. Hence, the fluid (i.e. mainly oil/gas) may pass through the hole 9 into the pipe 1. However, if the amount of water in the fluid increases, the swellable element 5 will start to expand (swell). The sleeve 7 forces the swellable element 5 to expand mainly in the longitudinal or axial direction of the pipe 1. Further, since one end of the swellable element 5 (to the left in fig. 1) is clamped by a retaining ring 4, the other free end (to the right in fig. 1) of the swellable element 5 will move to the right in fig. 1 and push the sliding ring 6 along the pipe 1. When the swellable element 5 has expanded sufficiently, the sliding ring 6 with the O-rings 8 will be positioned over the hole 9 (see fig. 2b), completely closing the hole 9, whereby the inflow of fluid (which contains a significant amount of water) to the pipe 1 through the hole 9 is stopped. Hence, if the amount of water in the incoming fluid (suddenly) increases, e.g. due to a water break through or irruption, the inflow into the pipe 1 through hole(s) 9 will automatically be shut-off, and unwanted "water production" is avoided.

The additional hole 10, which is out of reach for the sliding ring 6 even when the swellable element 5 is fully expanded, provides for the reversibility of the arrangement. Namely, the additional hole 10 allows a small flow of fluid over the swellable element 5, even when the hole 9 is closed. If the incoming fluid again contains more oil/gas and less or no water, the swelled element 5 will contract or shrink back towards the initial state and pull back the sliding ring 6 so that the hole 9 is opened.

The sensitivity of the water shut-off function may be set or controlled in various ways. By 'the sensitivity of the water shut-off function' is basically meant the swellable element's sensitivity to water or at what amount or percentage of water in the fluid that the hole 9 should be closed/opened. This can be controlled e.g. by selecting a particular type or material of the swellable element 5. Also, dimensions, in particular the length, of the swellable element 5 may be selected accordingly. Also, the initial distance between the sliding ring 6 and the hole 9 influences the water shut-off function and may be set accordingly: a longer distances makes the shut-off function less sensitive to water while a shorter distance makes it more sensitive.

The person skilled in the art will realize that the present invention by no means is limited to the embodiment(s) described above. On the contrary, many modifications and variations are possible within the scope of the appended claims.

Also, the swellable element could in at least some embodiments be replaced by an osmotic cell or another element adapted to expand when exposed to water.

C l a i m s

1. An arrangement for water shut-off in an oil and/or gas well, the arrangement comprising:
5 a hydrocarbon production pipe (1) having a pipe wall with at least one opening (9);
a swellable element (5) adapted to expand when subjected to water; and
a shut-off element (6),
wherein the swellable element is arranged to come into contact with fluid from
10 the well or an associated reservoir and to actuate the shut-off element when expanded so that the shut-off element at least partly closes the at least one opening in the pipe wall.
2. An arrangement according to claim 1, further comprising a sleeve (7) fitted over a section of the hydrocarbon production pipe, wherein the swellable element is
15 interposed between the hydrocarbon production pipe and the sleeve such that it is forced to expand mainly in the longitudinal or axial direction of the hydrocarbon production pipe.
3. An arrangement according to claim 2, wherein the sleeve is perforated to allow
20 fluid from the well or associated reservoir to come into contact with the swellable element.
4. An arrangement according to any preceding claim, wherein the shut-off element includes a sliding ring provided around the hydrocarbon production pipe, and wherein
25 one end of the swellable element is fixed and the other end is directly or indirectly in contact with the sliding ring, for pushing the sliding ring along the hydrocarbon production pipe to a position where the sliding ring covers the at least one opening in the pipe wall when the swellable element is expanded.
- 30 5. An arrangement according to any preceding claim, further comprising a housing (3) adapted to accommodate at least the swellable element and the shut-off element, wherein the housing has an inlet (11) for fluid from the well or associated reservoir.
6. An arrangement according to any preceding claim, further comprising a sand
35 screen (2) arranged upstream of the swellable element with respect to the fluid from the well or associated reservoir.

7. An arrangement according to any preceding claim, wherein an additional opening (10) out of reach for the shut-off element is provided in the pipe wall of the hydrocarbon production pipe.
- 5 8. An arrangement according to any preceding claim, wherein the swellable element includes a hygroscopic material.
9. An arrangement according to any preceding claim, wherein the swelling or expansion of the swellable element is reversible.
- 10 10. An arrangement according to any preceding claim, wherein the sensitivity of the water shut-off function is set by selecting at least one of:
- the type or material of the swellable element;
 - the dimension(s) of the swellable element; and
 - 15 the initial distance between the shut-off element and the at least one opening in the pipe wall.
11. A method for water shut-off in an oil and/or gas well in which a hydrocarbon production pipe (1) having a pipe wall with at least one opening (9) is provided,
- 20 wherein the method comprises:
- providing a swellable element (5) adapted to expand when subjected to water; and
 - providing a shut-off element (6),
 - wherein the swellable element is arranged to receive fluid from the well or an
 - 25 associated reservoir and to actuate the shut-off element when expanded so that the shut-off element closes the at least one opening in the pipe wall.

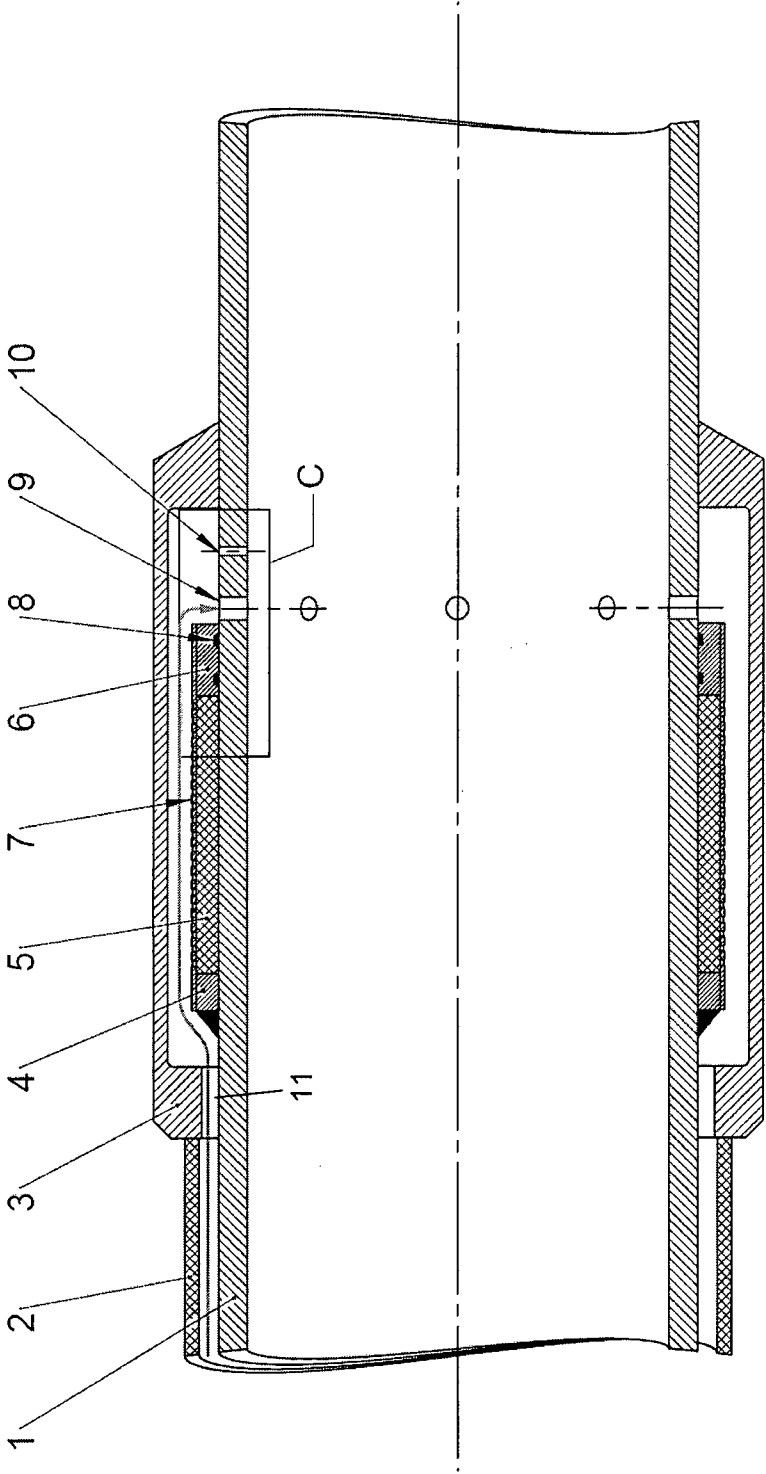
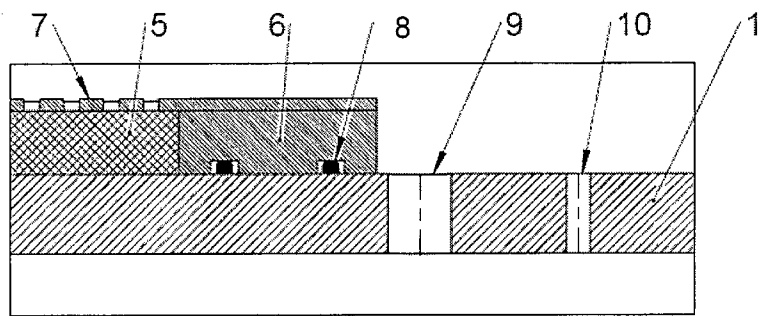


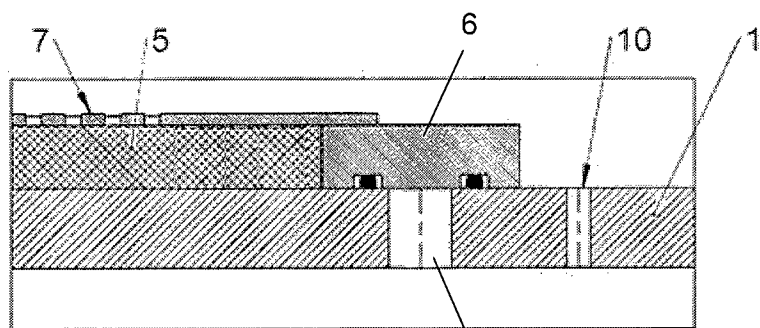
Fig. 1

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C

Fig. 2a



C

Fig. 2b

INTERNATIONAL SEARCH REPORT

International application No

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A. CLASSIFICATION OF SUBJECT MATTER

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ADD.

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, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	WO 2010/062417 A1 (SCHLUMBERGER SERVICES PETROL [FR]; SCHLUMBERGER CA LTD [CA]; SCHLUMBER) 3 June 2010 (2010-06-03) claims 9,10,16,35 the whole document	1,5-11
X	US 2009/283275 A1 (HAMMER AARON C [US]) 19 November 2009 (2009-11-19) paragraph [0036]; figures 6,6E the whole document	1,2,4-8, 10,11
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No
PCT/N02010/000469

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2008/143784 A2 (HALLIBURTON ENERGY SERV INC [US]; RICHARDS WILLIAM MARK [US]; HAILEY T) 27 November 2008 (2008-11-27) page 7, line 15 - page 17, line 25; claims 10,20; figures 2-7 the whole document	1,5-10
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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