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(54) Open hole packer and seal

(57) A sealing system for open hole sections of reservoirs comprising; an annular sealing element arranged to extend around and being fixed to a conduit; a mechanical packer arranged to expandably deform said seal element, wherein said sealing element swells in the presence of a fluid.

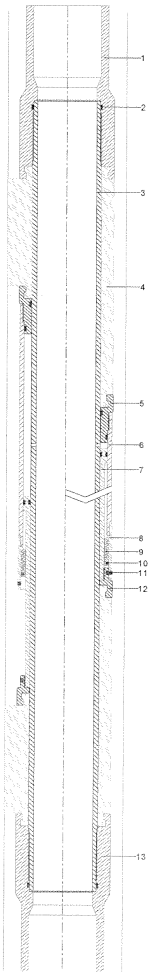

Fig. 2

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Description

[0001] The present invention relates to the field of open-hole mechanical packers for use in relation to the recovery of fluids such as oil or gas.

[0002] After drilling and casing the reservoir, open hole sections of the reservoirs must be completed to enable recovery of gas or oil. The completion process requires that sections of oil or gas reservoirs be compartmentalised such that the flow of the fluids from the reservoir into the production tubing can be controlled and managed, thereby allowing for efficient recovery of the oil or gas present in the reservoirs.

[0003] To compartmentalise the open hole sections, mechanical packers are known to be used to isolate adjacent portions of the open hole external to the production tubing. Such compartmentalisation serves to help control the flow of fluid external to, and into, the production tubing.

[0004] With oil wells for example, the packers are fitted to, and sealed around, a completion liner and then inserted into the well. Existing mechanical open-hole packer seal technology uses packers formed of a seal of deformable elastomer material. After the completion section is placed in the reservoir, the packers are set against the open-hole section of the reservoir by pressurising a piston seal assembly which serves to drive a mechanism which transversely deforms the packer seal along the direction of the completion liner. Actuating the packer in this manner causes it to deform in a transverse/radial direction forming a seal between the completion liner and the open-hole section of the reservoir.

[0005] It is also known for packers to be formed of a material which is arranged to expand, i.e. swell, as a result of contact with, for example, a liquid found in, or in the vicinity of, the reservoir, so that the packer expands to seal the space between the completion liner and the well wall. One example of such a known arrangement is US Patent 7143832.

[0006] Such known arrangements are disadvantageously limited since during the lifetime of the reservoir, the shape and dimensions of the open-hole section may vary as a result of the drilling process, or prior acid stimulation jobs, which initially prepare and stimulate the reservoir rock to optimally produce hydrocarbons into the open hole section. Also variations in the initial overburden rock stresses due to depletion of oil or gas from the reservoir can cause changes in the open hole shape and configuration. These variations in shape, dimension and configuration can result in loss of seal between the packer and the inner surface of the open hole section which can result in micro-leaks between the packer and the open-hole section of the reservoir.

[0007] The present invention seeks to provide for an open-hole seal arrangement having advantages over known such open-hole seals.

[0008] According to a first aspect of the present invention there is provided a sealing arrangement for open hole sections of reservoirs comprising: a mechanical packer associated with a conduit to be located within the open hole section and arranged to urge a sealing element into engagement with the surface of the hole section, wherein at least part of said sealing element has a capability for expansion due to contact with fluid.

[0009] According to a further aspect of the invention there is provided a method of sealing open hole sections of reservoirs using the arrangement according to the first aspect of the invention, and comprising the steps of; inserting said sealing arrangement into said open hole section; urging the sealing element into engagement with the surface of the hole section by means of the mechanical packer, and allowing the sealing element to expand further following contact with fluid.

[0010] Advantageously therefore, if the shape or dimensions of the open-hole change over time, the seal element can further expand to conform to the new shape or dimension of the open-hole. This allows for maintenance of a fluid tight seal between the sealing element and the open-hole walls of a reservoir even after a change in dimensions/configuration of the open hole. This therefore advantageously serves to prevent micro-leaks between the sealing element and open-hole walls of a reservoir which could result in loss of fluid contained in the reservoir.

[0011] Furthermore, maintenance of the seal allows for the flow of fluids from the reservoir to be controlled or managed in a manner serving to maintain efficient recovery of fluids from the reservoir.

[0012] It should also be appreciated that the invention provides for a sealing element for an open hole section of a reservoir, the sealing element being arranged to be deformed by a mechanical packer so as to urged into engagement with the surface of the hole section, and further having at least one part that is capable of expansion upon fluid contact.

[0013] The present invention is described further hereinafter, by way of example only, with reference to the accompanying drawing in which:

Fig. 1 provides a schematic illustration of a current sealing configuration and the limitations thereof;

Fig. 2 illustrates a cross-section view of the open-hole mechanical packer embodying the present invention and including swellable elastomer sealing element; and

Fig. 3 is an expanded view of the mechanical packer arrangement of Fig. 2.

[0014] Fig. 1 shows a schematic of prior art open hole completions 25 and seal elements 22, 24 deployed in a well 21. When the completion 25 is initially set across the reservoir section, the mechanical open-hole packers are set by pressuring up a piston seal assembly, which is an integral part of the mechanical packer, which in turn

drives a mechanism to deform the seal elements 22, 24 and hence make a seal between the completion liner and the open section of the well 21. An example of a bad seal 24 is shown.

[0015] In overview of Figs. 2 and 3, there is provided an open hole completion 18 and a mechanical packer 17. A swellable elastomer seal element 3 is disposed around the completion 18 and between the mechanical packer 17 and an abutment 1. The abutment 1 is generally the point where the completion 18 is sealably connected or coupled to the production tubing which allows for recovery of the fluid in the reservoir and further comprises a top sub 2.

[0016] The completion 18 is formed of a pipe or conduit, and is suitable for being placed in open-holes of fluid reservoirs for recovering fluids such as oil from the reservoir in question. The completion 18 is generally circular in cross-section however, any suitable cross-section can be employed. The seal element 3 is arranged to extend in a transverse/radial direction along a length of the completion and also to provide a radial fit around the circumference of the completion 18. The seal element 3 includes an annular internal surface to provide a fluid tight seal with the completion 18. The annular surface of the seal element 3 can be any appropriate shape determined by the cross-sectional shape of the completion 18.

[0017] The seal element 3 is formed of a elastomer material such as Hydrogenated Nitrile Butadiene Rubber (HNBR) or Nitrile elastomeric compounds with the presence of swellable elastomer which can be deformed under mechanical load, so that it increases diameter, but is reduced in transverse length whilst maintaining a fluid tight seal with the completion 18.

[0018] A further requirement of the elastomer material is that it increases in volume or swells in the presence of fluids such as oil gas or water which would be normally present in the reservoir, but whilst maintaining a fluid tight seal with the completion 18.

[0019] The mechanical packer arrangement 17 is arranged to deform the seal element. The packer 17 is arranged to receive the completion 18, such that the packer 17 can travel in a transverse direction along the length of completion 18, towards or away from the abutment 1. The packer 17 has a cross-sectional dimension to substantially match the cross-sectional dimensions of the seal element 3, thereby allowing the seal element 3 to be deformed against the abutment 1 under mechanical pressure applied by the packer 17. The packer assembly further comprises a piston element 4, which is arranged to deform the seal element 3. The piston will drive the seal element in a deformed fashion using applied pressure from the inside. The arrangement in an un-deformed state is shown in the upper half (above line x-x) of Fig.3. O ring seals 5, 6 are provided on the piston element 4. Also provided is a piston insert 7, a retainer ring 8, a cylinder 9, a lock ring 10, a garter spring 11, shear pins 12, a snap ring 13, a guide 14 and a mandrel 15.

[0020] In operation, the completion 18, seal element 3 and mechanical packer 17 as described above, are inserted or run-in to an open-hole of the reservoir prior to removal of the fluid therefrom. When the completion 18 is in place, the mechanical packer 17 is pressured-up using a piston seal assembly, so that it is urged to travel along the completion 18 towards the abutment 1. As the seal is forced against the abutment 1 by the mechanical packer, the seal element 3 is transversely loaded so that it deformably expands in a radial direction, to meet the walls of the open-hole 16, as shown in the lower half (below line x-x) of Fig.3.

[0021] During this deformation stage, the fluid tight seal between the seal element 3 and the completion 18 is maintained. Deformation of the seal element 3 can continue until an adequate fluid tight seal is formed between the seal element 3 and the walls of the open-hole, and deformation of the seal element 3 is complete when it forms a fluid tight seal with the walls of the open-hole 16. Compression of the seal is continued until the seal element is fully packed off, that is compressed, against the wall of the open hole formation.

[0022] In addition to the above mechanical deformation of the seal element 3, the seal element can also undergo further expansive deformation against the walls 16 of the reservoir. Once the mechanical deformation has taken place, further expansive deformation is caused by the presence of fluids in the reservoir which results in an increase in volume of the seal element 3, whilst maintaining a fluid tight seal with the completion 18. This process of expansive deformation results from of chemical absorption of the fluid in the reservoir in the seal element 3. In this regard the walls 16 of the open hole prevent the seal element 3 from undergoing further expansion, and the seal element is said to have redundancy in its ability to expand.

[0023] Therefore, if the shape or dimensions of the open-hole varies in any way, the seal element 3 can undergo further expansion so as to maintain the fluid tight seal between the seal element 3 and the walls 16 of the open-hole.

Claims

1. A sealing arrangement for open hole sections of reservoirs comprising: a mechanical packer associated with a conduit to be located within the open hole section and arranged to urge a sealing element into engagement with the surface of the hole section, wherein at least part of said sealing element has a capability for expansion due to contact with fluid.

2. The sealing system according to Claim 1, wherein said sealing element is formed of an elastomer material such as Hydrogenated Nitrile Butadiene Rubber (HNBR) or Nitrile elastomeric compounds.

3. The sealing system according to any one of Claims

1 and 2, wherein the sealing element is arranged to form a fluid tight seal around said conduit, said conduit being arranged to be inserted in said open hole section of said reservoir.

4. The sealing system according to any one or more of Claims 1 to 3, wherein the sealing element is arranged to form a seal between said conduit and walls of said open hole section following deformable expansion.

5. The sealing system according to Claim 4, wherein the seal element is further arranged to form a seal between said conduit and walls of said open hole section upon contact with a fluid and absorbtion of it to increase in volume.

6. A method of sealing open hole sections of reservoirs using the system according to Claims 1 to 5, and comprising the steps of; inserting said sealing arrangement into said open hole section; urging the sealing element into engagement with the surface of the hole section by means of the mechanical packer, and allowing the sealing element to expand further following contact with fluid.

7. A well bore completion assembly including a sealing system according to Claims 1 to 5.

8. A sealing element for an open hole section of a reservoir, the sealing element being arranged to be deformed by a mechanical packer so as to urged into engagement with the surface of the hole section, and further having at least one part that is capable of expansion upon fluid contact.

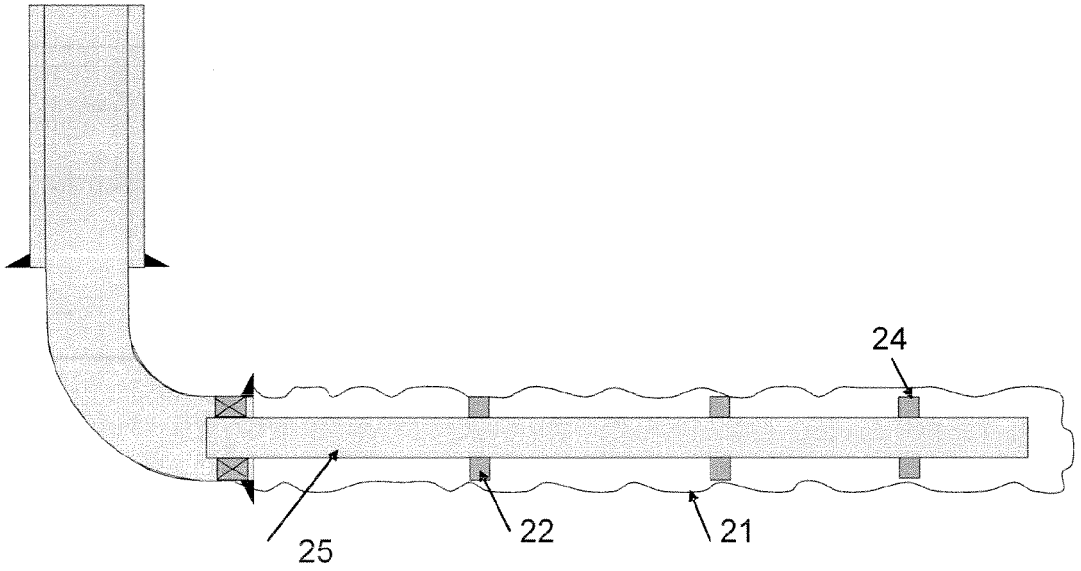

Fig.1

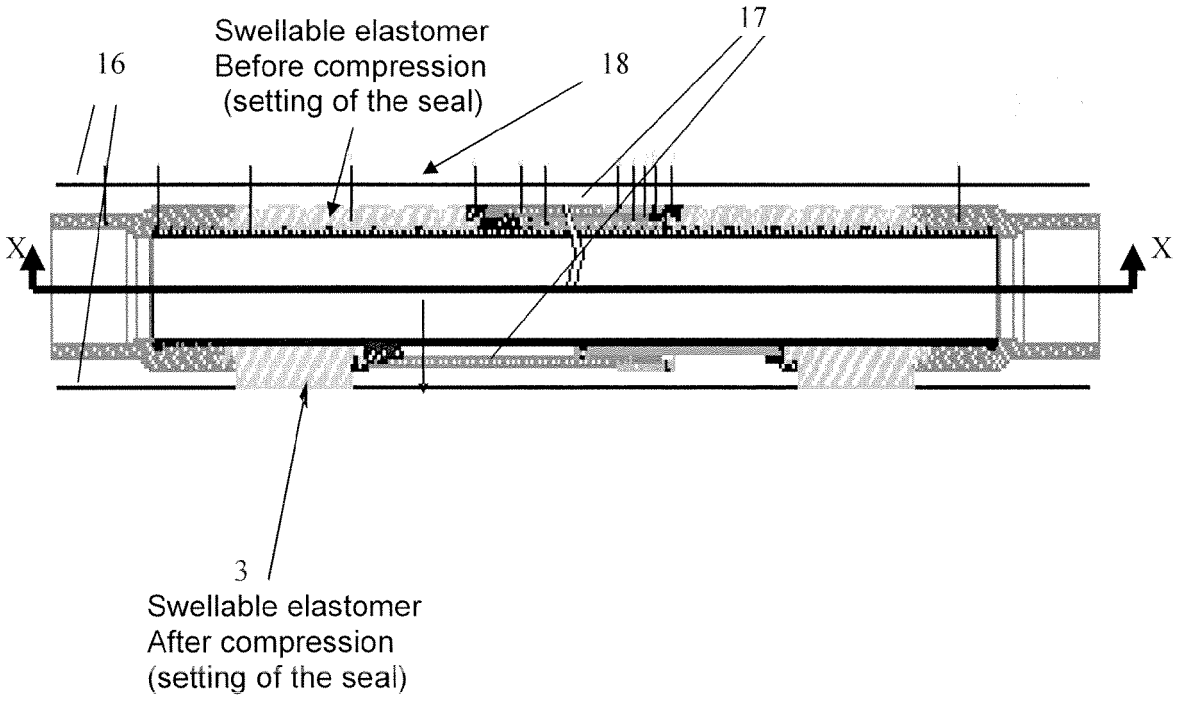
Swellable elastomer
Before compression
(setting of the seal)
16
17
18
X
X
3
Swellable elastomer
After compression
(setting of the seal)

Fig.3

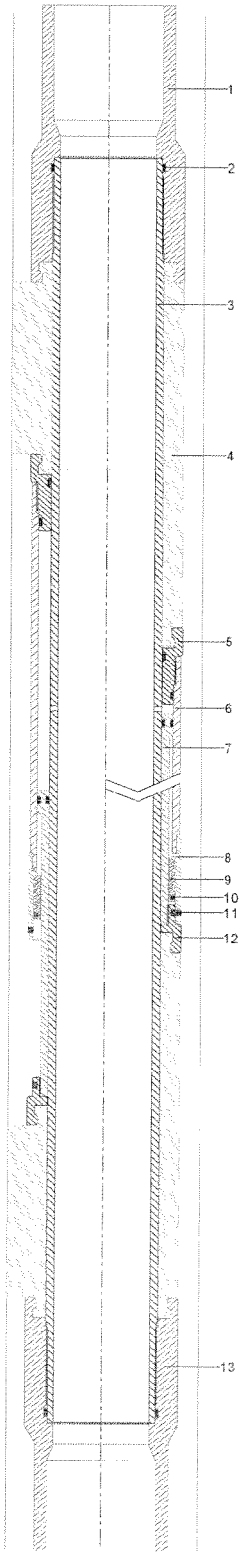

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 08 10 4394

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2007/114016 A1 (BREZINSKI MICHAEL M [US] ET AL BREZINSKI MICHAEL M [US] ET AL) 24 May 2007 (2007-05-24) * paragraphs [0054], [0062], [0130] * * figures 2-4 * -----	1-8	INV. E21B33/12
X	GB 2 406 593 A (SCHLUMBERGER HOLDINGS [VG]) 6 April 2005 (2005-04-06) * page 4, paragraph 7 * * figures 2a,2b * -----	1,3,5-8	
			TECHNICAL FIELDS SEARCHED (IPC) E21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	29 October 2008	Schouten, Adri

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 08 10 4394

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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29-10-2008

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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