

Conformance Screen Assembly

Field of Invention

The invention relates to the use of conformance screen assemblies used to extract liquid
5 from a well bore.

Background

Swellable rubber is used in a downhole pipe to prevent formation sand from entering the
10 pipe. It does this by sealing around a filter ensuring all fluid flow is subject to the filter.

Typically, the swellable rubber is an elongate band arranged to push the filter, usually
held within a screen assembly, against the well bore wall on contacting liquid within the
well bore.
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The depth of a well bore, typically several hundred metres, prevents easy removal of the
screen assembly on failure, and so the reliability of the screen assembly is paramount to
prevent the ingress of sand.

20 However, the contact area between the screen assembly and well bore wall in prior art
systems is relatively low.

Expandable systems according to the prior art, include the whole screen (including pipe)
being expandable using a purpose built expansion tool. With the prior art method, the

expanded OD is limited to the expansion tool and this may not contact the well bore.

Further, expanding the base pipe and screen, weakens the whole assembly, resulting in premature failures

- 5 It would therefore be desirable to provide a conformance screen assembly which overcomes or alleviates the above disadvantages, or which at least provides a useful alternative.

10 **Summary of Invention**

In a first aspect, the invention provides a conformance screen assembly in a wellbore, comprising: a base pipe; a plurality of expandable sections mounted on the base pipe, each of the expandable sections further including a swellable rubber segment mounted
15 to the base pipe and at least one screen assembly coupled to the swellable rubber segment; and; an annular ring coupled to the screen assembly, wherein the annular ring, the base pipe and adjacent expandable sections define at least one flow space, said flow space arranged to receive a fluid flow from the wellbore via the screen assembly and direct said fluid flow into the base pipe.

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It follows that the invention accommodate the greater flow rate into the base pipe by providing the flow space into which the water ingress can be collected, and

consequently avoid a bottle neck caused by limited cross sectional portions of the flow path.

5 **Brief Description of Drawings**

It will be convenient to further describe the present invention with respect to the accompanying drawings that illustrate possible arrangements of the invention. Other arrangements of the invention are possible, and consequently the particularity of the
10 accompanying drawings is not to be understood as superseding the generality of the preceding description of the invention.

Figure 1 shows a cross-sectional view of a conformance screen assembly in an unexpanded configuration according to one embodiment of the present invention;
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Figure 2 shows a cross-sectional view of the conformance screen assembly in an expanded configuration according to one embodiment of the present invention;

Figure 3 shows a close up view of a screen assembly according to one embodiment of
20 the present invention;

Figure 4 shows an isometric view of the conformance screen assembly in an unexpanded configuration according to one embodiment of the present invention;

Figure 5 shows an isometric view of the conformance screen assembly in an expanded configuration according to one embodiment of the present invention;

Figures 6a to 6c shows various views of an annular ring in an unexpanded configuration
5 according to one embodiment of the present invention;

Figures 7a to 7c shows various views of the annular ring in an expanded configuration according to one embodiment of the present invention;

10 Figure 8 shows a cross-sectional view of the conformance screen assembly in an expanded configuration according to one embodiment of the present invention;

Figure 9 shows a cross sectional view of the conformance screen assembly according to one embodiment of the present invention;

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Figures 10A and 10B are isometric vies of an annular ring according to one embodiment of the present invention;

Figures 11A to 11D are various views of the annular ring of Figures 10A and 10B;

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Figure 12 is an isometric view of a conformance screen according to a further embodiment of the present invention, and;

Figure 13 is a cross sectional view of a conformance screen assembly according to a further embodiment of the present invention.

Detailed Description

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Figures 1 and 2 depict cross-sectional views of a segment of a conformance screen assembly in the longitudinal direction according to an embodiment of the present invention. As shown, the conformance screen assembly 10 broadly comprises a base pipe 12, a plurality of expandable sections 22 mounted on the base pipe 12, each of the expandable sections 22 further includes a swellable rubber segment 20 mounted to the base pipe 12 and at least one screen assembly 25 coupled to the swellable rubber segment 20, and an annular ring 30 coupled to the screen assembly 25, wherein the annular ring 30, the base pipe 12 and adjacent expandable sections 22 defines at least one flow space 40 through which a fluid flows. The base pipe 12 further comprises a plurality of pipe apertures 15 that allow formation fluids to enter a bore 5 of the base pipe 12.

In the illustrated embodiment of the present invention, the expandable sections 22 comprises a swellable rubber segment 20 and at least one screen assembly 25 coupled to the swellable rubber segment. The expandable sections 22 are arranged to be spaced apart along the longitudinal axis of the base pipe 12, such that each of the plurality of expandable sections 22 is discrete and not in contact with the adjacent expandable sections. The expandable sections 22 are further positioned such that they do not block

the plurality of pipe apertures 15 on the base pipe 12, therefore providing a flow space 40 in between the expandable sections 22 for formation fluids to flow through.

In an embodiment of the present invention, the swellable rubber segment 20 of the
5 expandable section 22 is disposed on the base pipe 12, and is further held in place by a plurality of weld rings 45. In the illustrated embodiment, the weld rings 45 are preferably positioned between adjacent expandable sections 22, and arranged to prevent the swellable rubber segments 20 from expanding in the longitudinal direction of the base pipe 12. This ensures that the swellable rubber segments 20 do not enter the flow
10 space 40. In one embodiment, the swellable rubber segments may be made of ethylene propylene diene monomer (EPDM), or other forms of elastomers that swell upon exposure to oil, water, or a mixture of both.

One or more screen assemblies 25 are further coupled to the swellable rubber segments
15 20. As illustrated in Figure 3, the screen assembly 25 typically comprises a sintered mesh 60 sandwiched between inner and outer drainage layers 50, 55, and enclosed lengthwise by a retainer 65. In alternative embodiments, the sintered mesh may be replaced by a single layer mesh or, wire wrap screen segments. If wire wrap is used, inner and outer drainage may not be required.

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The retainer 65 further defines a flow path along the longitudinal axis of the base pipe 12 for formation fluids to flow there through within the retainer 65. In an embodiment, the inner and outer drainage layer may be a commercially available material such as a

wire mesh. Drainage mesh may be made of welded wire mesh or woven wire mesh. The number of wires per inch may differ depending on the flow rate required. Furthermore, the retainer 65 may be constructed from a non-permeable material, such as a formed metal sheet.

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The screen assembly 25 further comprises a shroud 70 disposed above the outer drainage layer 55. As illustrated in Figures 4 and 5, the shroud may include a plurality of perforations 75 dimples or louvres, which may be arranged to allow formation fluids to flow through the shroud, and then into the flow path defined by the retainer 65. The
10 shroud may comprise a mechanical screening element comprising stainless steel and made from spiral welded tube or longitudinally welded tube. The shroud is primarily used for protection while run in hole.

Referring now to Figures 6a to 7c, coupled to the screen assembly 25 and in between
15 adjacent expandable sections 22 is an annular ring 30. In an embodiment of the present invention, the annular ring 30 may further include a plurality of ring segments 80, wherein each of the ring segments 80 are moveable circumferentially relative to the adjacent ring segments. In one embodiment, the ring segments are in sliding engagement with adjacent ring segments. The ring segments 80 are further arranged to
20 be hollow so as to allow fluids to flow there through. As shown in Figures 6b and 7b, the ring segments 80 are connected with each other by a splice joint 90. The splice joint 90 is arranged to maintain a seal between the ring segments such that unfiltered

formation fluids will not flow there through. The annular ring helps to move the screen assembly to expand simultaneously.

As seen in Figures 11A and 11C, and the respective detailed views Figures 11B and
5 11D, the ring segments 80 further includes lugs 184, 186. Ring segments 80 are locked with two surfaces, defined as a seal 180 on one side and polished seal bore 175 on the other segment. This allows less friction when moving the segments circumferentially. The surfaces may be substantially parallel, or inclined to each other as shown in Figures 11A to 11D. Ease of manufacturing may be an advantage provided by parallel surfaces,
10 with the inclined surfaces allowing the annular ring to expand, but maintain a continuous circumferential shape, as the ring segments move relative to each other.

The ring segments may be locked with a T junction, which stops it from getting out of the seal bore. It will be appreciated that the ring segments 80 may be connected by a
15 range of different joint types, as long as the joint allows the ring segments 80 to be circumferentially moveable relative to each other. The lugs act as a final stop to prevent further expansion of the annular ring which may otherwise lead to disassembly passed a certain point of expansion. The annular ring will, within specific circumstances, be designed to full expand within the downhole before the lugs 184, 186, and thus they
20 exists primarily to act as a safety block to prevent damage.

Each ring segment 80 is preferably in sealing engagement with at least one screen assembly 25 so as to prevent unfiltered formation fluid from bypassing the screen

assembly 25 and flowing directly into the flow space 40. Examples of the sealing engagement include welding, bonding or other suitable technique. As best seen in Figures 6a and 7a, each of the ring segments 80 further includes at least one ring aperture 85 disposed on an inner surface of the ring segment 80, thereby providing a
5 direct pathway for production fluids to flow from the screen assembly 25, through the ring segments 80 and the ring aperture 85 and finally into the flow path 40 in between the expandable sections 22. Preferably, the annular ring 30 may be constructed from a non-permeable material such as stainless steel, coated steel or alloy and machined to size. Alternatively, the annular ring may be an engineering plastic capable of resisting
10 the temperature range experienced in a downhole environment

Referring back to Figures 1 and 2, the operation of the conformance screen assembly 10 will now be described in further detail. After coming into contact with an activating fluid, the swellable rubber segments 20 will expand radially from an unexpanded
15 configuration, as shown in Figure 1, to an expanded configuration, as shown in Figure 2. Accordingly, screen assembly 25 will move in the radial direction and engage the surface of the wellbore (not shown). Consequently, the ring segments 80 of the annular ring 30 will also move in the circumferential direction relative to each other, resulting in an expansion of the annular ring 30 in the radial direction.

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Referring now to Figure 8, formation fluids will first flow into the shroud 70 through perforations 75 and into the sintered mesh and the drainage layers of the screen segment 25 where it will undergo filtration. The formation fluid will then flow in the longitudinal

direction of the base pipe through the drainage layers in the retainer 65 (not shown) and into the ring segments 80, before flowing through the ring apertures 85 into the flow space 40 in between the expandable sections 22. Finally, the formation fluid will flow through the pipe apertures 15 into the bore 5 of the base pipe 12. Below the annular ring, there may be another wire wrap screen, serving as a back-up screen. Should a screen segment fail and unfiltered fluid starts to get in to the annular ring, the back-up screen is arranged to filter them out.

Accordingly, the present invention maximizes the contact between the conformance screen assembly 10 and the surface of the wellbore. In particular, the contact area between the screen assembly 25 and the wellbore will be greater than that of the prior art. This allows for a more efficient production as formation fluids will have more ingress routes into the bore 5 of the base pipe 12.

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Furthermore, the conformance screen assembly of the present invention will also maintain sand control integrity. In particular, the annular ring 30 prevents formation fluids from bypassing the screen assembly 25 and flowing directly into the bore 5.

Furthermore, the arrangement of the ring segments 80 allows the entire annular ring 30 to expand radially and contact the surface of the wellbore while ensuring that unfiltered formation fluids do not bypass the filtration system in the screen assembly. Therefore, sand control integrity is maintained.

In addition, as the swellable rubber segments are discrete and spaced apart along the longitudinal axis of the base pipe, redundancies will be introduced into the system. In particular, in the event that one swellable rubber segment fails to work as expected, the other swellable rubber segments will still expand as per normal. As a result, the wellbore will still be sufficiently supported, thereby preventing its collapse while at the same time maintaining the seal against the walls of the wellbore.

Several techniques may be used for contacting the swellable rubber segments with the activating fluid. Swellable rubbers can be activated, depending on the well bore condition. In the case of a high flow well, swellable rubber may not need any external fluids to activate. In cases where flow rate is low or for any other reasons, oil can be pumped from surface to activate the rubber.

In an embodiment, the activating fluid may be circulated through the well after installation of the conformance screen assembly. In a further embodiment, the activating fluid may already be present in the well, and in this case, the conformance screen assembly may include a mechanism for delaying the expansion so as to prevent it from expanding during installation. In a further alternative, the swell time for the rubber used for the swellable rubber segments is well known. Accordingly, the rate of insertion of the conformance screen assembly, and time to swell after contacting the activating fluid may be precisely determined.

In another embodiment of the present invention, as shown in Figure 13 biasing members 200, 210 may be positioned in the swellable rubber segments 13 such that one end of the biasing member is attached to the base pipe and the other end of the biasing member is embedded in the swellable rubber segments. Preferably, the biasing members 200, 210 may be positioned adjacent to the weld ring 145. The biasing members 200, 210 may be any elastic material that stores energy, such as mechanical energy, in a compressed state, such as a spring. The biasing members may be in a compressed state when the conformance screen assembly is in the unexpanded configuration. During expansion, the biasing members 200, 210 will release the stored mechanical energy and exert a force on the swellable rubber segments, thereby aiding in the expansion of the swellable rubber segments.

Accordingly, such a mechanism ensures uniform expansion of the swellable rubber segments. Furthermore, it also acts as a fail-safe mechanism in the event that a portion of the swellable rubber fails to expand as required. In this case, the biasing members will push the rubber out, forcing it to expand and contact the surface of the wellbore. Hence, the biasing member may function as an additional safety mechanism to ensure adequate support of the wellbore so as to prevent formation collapse.

In embodiments of the present invention and as shown in Figure 9, a filter assembly 105 may be further provided in the flow space 140 between the swellable rubber segments 120 of the expandable sections 122. In the illustrated embodiment, the filter assembly 105 may include a drainage layer, and a filter element. In this embodiment, the second

screen assembly is fixed and welded in relation to the base pipe, and preferably at the weld rings 145.

Figures 10A and 10B show an alternative arrangement of the annular ring in the retracted 150 and expanded 155 positions. The added feature of this arrangement as compared to those previously described is the addition of the inflow control device having vents 160, 165. The inflow control device permits the selective opening of the vents based on a specific event. That event may be selective engagement by an operator, triggering based upon output from sensors (not shown) and expansion under particular conditions. By placing the inflow control device within the annular ring, assembly becomes a relatively easy matter, as well as placing the inflow control device at the required location within the well screen assembly.

Figure 12 shows an isometric view of the conformance screen 190, having an inflow control device 195, according to one embodiment of the present invention. In this view, the embedment of sensors 192 and communication cables 185 within the expandable section can be seen. The expandable section, particularly when made from an expandable rubber, ensures the rubber maintains a protective seal around the communication cables 185. The sensors 192 may be used for a variety of reasons including temperature sensors, pressure sensors and/or moisture sensors. In this way, the conformance screen can provide one or more environmental outputs to be read by an operator, providing real time, location specific data, as well as a longitudinal profile of conditions within the downhole, based upon the data received by sensors located at each

annular ring. In an alternative arrangement, the sensors may be located along the full length of the pipe, so as to provide a more detailed profile of environmental conditions, such as temperature.

- 5 Such an arrangement provides for a secondary filtration system and ensures that the formation fluid is properly filtered before entering into the bore of the base pipe. Hence, this minimizes the amount of sand entering into the base pipe, thereby reducing the cost of midstream and downstream processing.
- 10 The invention has been described herein by way of example only and that various modifications in design and/or detail may be made without departing from the spirit and scope of this invention.

Claims

1. A conformance screen assembly in a wellbore, comprising:
 - a base pipe;
 - a plurality of expandable sections mounted on the base pipe, each of the
 - 5 expandable sections further include a swellable rubber segment mounted to the
 - base pipe and at least one screen assembly coupled to the swellable rubber
 - segment; and
 - an annular ring coupled to the screen assembly,
 - wherein the annular ring, the base pipe and adjacent expandable sections
 - 10 defines at least one flow space, said flow space arranged to receive a fluid flow
 - from the wellbore via the screen assembly and direct said fluid flow into the base
 - pipe.
2. A conformance screen assembly according to claim 1, wherein the annular ring
- 15 further comprises a plurality of ring segments, each of the plurality of ring
- segments being circumferentially moveable relative to the adjacent ring segments.
3. The conformance screen assembly according to claim 2, wherein each of the
- plurality of ring segments is slidably engaged with the adjacent ring segment.
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4. The conformance screen assembly according to any one of claim 2 or claim 3,
- wherein each of the plurality of ring segments is in sealing engagement with the at
- least one screen assembly.

5. The conformance screen assembly according to any one of claims 2 to 4, wherein each of the plurality of ring segments is arranged to allow fluid to flow there through.

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6. The conformance screen assembly according to any one of the preceding claims, further comprising at least one biasing member coupled to the base pipe and embedded in the swellable rubber segment, said biasing member arranged to apply a radial force to the screen assembly.

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7. The conformance screen assembly according to any one of the preceding claims, wherein the at least one biasing member includes a spring.

8. The conformance screen assembly according to any one of the preceding claims, wherein the plurality of expandable sections are spaced apart along the longitudinal axis of the base pipe, and arranged to expand radially.

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9. The conformance screen assembly according to any one of the preceding claims, further comprising at least one weld ring adjacent to the base pipe and between adjacent expandable sections.

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10. The conformance screen assembly according to any one of the preceding claims, further comprising a filter assembly disposed between adjacent expandable sections.