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(54) **Universal backup for swellable packers**

(57) A universal backup member is provided for use on packers and other downhole tools that use members selected for expansion upon exposure to a wellbore fluid. The backup member prevents axial extrusion of the swellable member. An elastomer portion of the backup member is selected for expansion in wellbore fluids that include both aqueous solutions and hydrocarbons, without regard to the fluid in the wellbore.

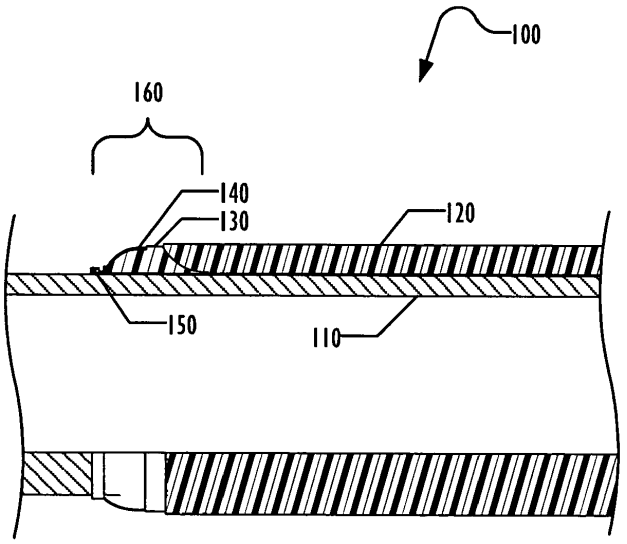

FIG. 1

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Description

TECHNICAL FIELD

[0001] The present invention relates to the field of downhole apparatus, and in particular to downhole apparatus for use with swellable materials.

BACKGROUND ART

[0002] In the field of hydrocarbon exploration and production, various tools are used to provide fluid seals between two components in a wellbore. Annular barriers have been designed for preventing undesirable flow of wellbore fluids in the annulus between a wellbore tubular and the inner surface of a surrounding tubular or the borehole wall. In many cases, the annular barriers provide a fluid seal capable of holding a significant pressure differential across its length. In one application, a wellbore packer is formed on the outer surface of a completion string that is run into an outer casing in a first condition having a particular outer diameter. When the packer is in its desired downhole location, it is inflated or expanded into contact with the inner surface of the outer casing to create a seal in the annulus. Similar wellbore packers have been designed for use in openhole environments, to create a seal between a tubular and the surrounding wall of the wellbore.

[0003] Conventional packers are actuated by mechanical or hydraulic systems. A force or pressure is applied from the wellhead to move a mechanical packer element radially into contact with the surrounding surface. In an inflatable packer, fluid is delivered from the wellhead to inflate a chamber defined by a bladder around the tubular body.

[0004] More recently, wellbore packers have been developed which include a mantle of swellable material formed around the tubular. The swellable material is selected to increase in volume on exposure to at least one predetermined fluid, which may be a hydrocarbon fluid or an aqueous fluid or brine. The swellable packer may be run to a downhole location in its unexpanded state, where it is exposed to a wellbore fluid and caused to increase in volume. The design, dimensions, and swelling characteristics are selected such that the swellable packer element expands to create a fluid seal in the annulus to isolate one wellbore section from another. Swellable packers have several advantages over conventional packers, including passive actuation, simplicity of construction, and robustness in long-term isolation applications.

[0005] In addition, swellable packers may be designed for compliant expansion of the swellable mantle into contact with a surrounding surface, such that the force imparted on the surface prevents damage to a rock formation or sandface, while still creating an annular barrier or seal. Swellable packers therefore lend themselves well to openhole completions in loose or weak formations.

[0006] The materials selected to form a swellable element in a swellable packer vary depending on the specific application. Swellable materials are elastomeric (i.e. they display mechanical and physical properties of an elastomer or natural rubber). Where the swellable mantle is designed to swell in hydrocarbons, it may comprise a material such as an ethylene propylene diene monomer (EPDM) rubber. Where the swellable mantle is required to swell in aqueous fluids or brines, the material for example may comprise an N-vinyl carboxylic acid amide-based cross-linked resin and a water swellable urethane in an ethylene propylene rubber matrix. In addition, swellable elastomeric materials may be designed to increase in volume in both hydrocarbon fluids and aqueous fluids.

[0007] Expandable metal backups are used to prevent extrusion on swellable packer elements. Since the swellable elements are manufactured using a variety of materials designed to swell in oil, water, or both, there is a need to develop these backup systems for each of the various elastomers. This also requires manufacturing to stock the various types of back-up units, which adds extra cost to the manufacturing process and creates a situation where mistakes can be made and the wrong type of back up assembled onto packers.

SUMMARY OF INVENTION

[0008] In one embodiment, an apparatus for use with a downhole tool having a swellable element is disclosed. The apparatus comprises an attachment portion, configured for attachment of the apparatus to the downhole tool; a ring portion, connected to the attachment portion, having an expanded condition and an unexpanded condition; and an elastomer portion, disposed radially inwardly of the ring portion, composed of a first elastomer selected to expand upon exposure to both aqueous solutions and hydrocarbons, wherein expansion of the elastomer portion upon exposure to an aqueous solution or a hydrocarbon urges the ring portion radially outwardly from the unexpanded condition to the expanded condition.

[0009] In another embodiment, a downhole tool is disclosed. The downhole tool comprises a body; a swellable element, disposed about the body, composed of a first elastomer selected to expand upon exposure to a predetermined wellbore fluid; a backup unit, disposed about the body at an end of the swellable element. The backup unit comprises an attachment portion, attached to the body; a ring portion, connected to the attachment portion, having an expanded condition and an unexpanded condition; and an elastomer portion, disposed between the ring portion and the body, composed of a second elastomer selected to expand upon exposure to both aqueous solutions and hydrocarbons regardless of the predetermined wellbore fluid, wherein expansion of the elastomer portion urges the ring portion radially outwardly from the unexpanded condition to the expanded condi-

tion.

In yet another embodiment, a method for assembling a downhole tool is disclosed. The method comprises selecting a swellable element for a downhole tool responsive to a fluid in a wellbore; disposing the swellable element on a body member of the downhole tool; disposing a backup unit on the body member adjacent an end of the swellable element, and attaching the universal backup unit to the body, where the backup unit comprises a ring portion having an expanded condition and an unexpanded condition; and an elastomer portion, disposed between the ring portion and the body, composed of a second elastomer selected without regard to the fluid in the wellbore.

BRIEF DESCRIPTION OF DRAWINGS

[0010] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate an implementation of apparatus and methods consistent with the present invention and, together with the detailed description, serve to explain advantages and principles consistent with the invention. In the drawings,

[0011] Figure **1** is a cutaway view of a downhole tool according to one embodiment.

DESCRIPTION OF EMBODIMENTS

[0012] In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the invention. It will be apparent, however, to one skilled in the art that the invention may be practiced without these specific details. In other instances, structure and devices are shown in block diagram form in order to avoid obscuring the invention. References to numbers without subscripts or suffixes are understood to reference all instance of subscripts and suffixes corresponding to the referenced number. Moreover, the language used in this disclosure has been principally selected for readability and instructional purposes, and may not have been selected to delineate or circumscribe the inventive subject matter, resort to the claims being necessary to determine such inventive subject matter. Reference in the specification to "one embodiment" or to "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiments is included in at least one embodiment of the invention, and multiple references to "one embodiment" or "an embodiment" should not be understood as necessarily all referring to the same embodiment.

[0013] FIG. **1** is a cutaway view of a portion of a swellable packer **100** according to one embodiment. Some common features of the swellable packer known to the art are omitted for clarity of the drawing. The swellable packer **100** comprises a central body **110**, such as a tubular or mandrel, about which is disposed a swellable elastomer mantle **120**. The swellable mantle **120** may be formed of one or more sections as desired, using any known technique for forming a swellable mantle about a central body. In one embodiment, the swellable mantle **120** may be bonded or otherwise attached to the body **110**. In one embodiment, the swellable mantle **120** is formed of an elastomer designed to swell when exposed to an aqueous solution such as water or brine. In another embodiment, the swellable mantle **120** is formed of an elastomer designed to swell when exposed to a hydrocarbon fluid. In yet another embodiment, the swellable mantle is formed of a hybrid elastomer that is designed to swell when exposed to either an aqueous solution or a hydrocarbon fluid.

[0014] Upon insertion into the well, the elastomer of the mantle **120** swells upon exposure to the fluid surrounding the packer **100** in the wellbore. As the elastomer of the mantle **120** swells, it expands radially outwardly, engaging a surrounding casing or open hole wellbore (not shown in FIG. **1**) sealing the packer **100** to the casing or wellbore. The elastomer of the mantle **120** may also swell axially, and if not prevented from doing so, may extrude axially around the other elements disposed at the ends of the mantle **120**, reducing the pressure that is exerted by the expanded mantle **120** on the surrounding casing or wellbore.

[0015] To prevent this extrusion, backup unit 160 is disposed at least one end of the mantle **120**, according to one embodiment. Although only one end of the swellable mantle **120** is illustrated in FIG. **1**, similar elements may be disposed at both ends of the mantle 120.

[0016] In one embodiment, the backup unit **160** comprises three elements: an attachment portion **150**, designed for attaching the backup unit **160** to the body **110**, a backup ring portion **140**, typically made of metal, and an elastomer backup element **130**. Axial pressure on the elastomer backup element **130** urges the backup portion **140** of the backup unit **160** radially outwardly, while the attachment portion **150**, secured to the body **110**, presents axial or rotational movement of the backup unit **160** relative to the body **110**. The backup element 130 also exerts force on the mantle **120**, contributing to the prevention of axial extrusion of the mantle **120**.

[0017] In addition to force generated by the axial expansion of the mantle **120**, in one embodiment, the elastomer backup element **130** is also formed of a swellable material. Although the elastomer forming the mantle **120** is typically selected based on the types of fluids found in the well, the elastomer backup element **130** is formed of a hybrid swellable material that is selected for expansion on exposure to both aqueous solutions and hydrocarbon fluids. Thus, the same backup unit **160** may be used regardless of the composition of the mantle **120**, in wells with any type of wellbore fluid suitable for a downhole tool with a swellable member.

[0018] Such hybrid elastomers are known to the art, but have not previously been used for constructing the backup elastomer element **130**. For example, one type of hybrid swellable elastomer is an elastomeric matrix

material such as EPDM, impregnated with super absorbent polymer (SAP) particles. The SAPs have hydrophilic characteristics. In another example, the hybrid swellable elastomer comprises the reaction product of linear or branched polymers having residual ethylenic unsaturation with an unsaturated organic monomer having at least one reactive moiety. Other examples of hybrid swellable elastomers are known and may be used.

[0019] By using a hybrid elastomer as the elastomer backup element **130**, regardless of the wellbore fluid, instead of one designed specifically for aqueous solutions or hydrocarbon fluids, a universal backup unit may be manufactured and used on packers intended for use in the presence of either type of fluid, thus reducing manufacturing and inventory costs, as well as reducing the risk that a packer **100** may be assembled with a backup unit **160** that is designed for the wrong type of solution.

[0020] As the packer **100** is exposed to wellbore fluids, expansion of the backup elastomer 130 resists axial expansion of the mantle **120**, and also swells radially outwardly, causing the backup ring portion **140** to deform and expand radially outwardly, further preventing extrusion of the mantle **120** axially.

[0021] In some embodiments, the backup ring portion **140** is a solid unit. In other embodiments, the backup ring portion **140** may be divided into a plurality of sections or fingers that separate as the mantle **120** and backup elastomer **130** swell and expand. Multiple layers of fingers may be provided in some embodiments, disposed so that expansion of the layers of fingers maintains an overlap, preventing extrusion of the elastomer of the mantle **120** between adjacent fingers of the backup ring portion.

[0022] Although the above description is written in terms of a packer, the universal backup unit **160** may be used in other downhole tools that incorporate swellable members.

[0023] It is to be understood that the above description is intended to be illustrative, and not restrictive. For example, the above-described embodiments may be used in combination with each other. Many other embodiments will be apparent to those of skill in the art upon reviewing the above description. The scope of the invention therefore should be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. In the appended claims, the terms "including" and "in which" are used as the plain-English equivalents of the respective terms "comprising" and "wherein."

Claims

1. An apparatus (160) for use with a downhole tool (100) having a swellable element, (120) comprising:

an attachment portion (150), configured for attachment of the apparatus (160) to the downhole tool (100);

a ring portion (140), connected to the attachment portion (150), having an expanded condition and an unexpanded condition; and

an elastomer portion (130), disposed radially inwardly of the ring portion (140), composed of a first elastomer selected to expand upon exposure to both aqueous solutions and hydrocarbons,

wherein expansion of the elastomer portion (130) upon exposure to an aqueous solution or a hydrocarbon urges the ring portion (140) radially outwardly from the unexpanded condition to the expanded condition.

2. The apparatus of claim 1, wherein the swellable element (120) of the downhole tool is composed of a second elastomer, selected to expand upon exposure to aqueous solutions.

3. The apparatus of claim 1 or 2, wherein the swellable element (120) of the downhole tool is composed of a second elastomer, selected to expand upon exposure to hydrocarbons.

4. The apparatus of claim 1, 2 or 3, wherein the elastomer portion (130) urges the ring portion (140) radially outwardly from the unexpanded condition to the expanded condition responsive to axial pressure on the elastomer portion (130) by the swellable element (120) of the downhole tool.

5. The apparatus of any preceding claim, wherein the first elastomer is an elastomeric matrix of ethylene propylene diene monomer rubber impregnated with a super absorbent polymer.

6. The apparatus of any preceding claim, wherein the first elastomer is a reaction product of linear or branched polymers having residual ethylenic unsaturation with an unsaturated organic monomer having at least one reactive moiety.

7. A downhole tool (100), comprising:

a body (110);

a swellable element (120), disposed about the body (110), composed of a second elastomer selected to expand upon exposure to a predetermined wellbore fluid;

a backup unit in the form of the apparatus of any preceding claim, disposed about the body (110) at an end of the swellable element. (120)

8. The downhole tool of claim 7, wherein the swellable element (120) axially expands upon exposure to the predetermined wellbore fluid, exerting axial pressure upon the elastomer portion (130), and

wherein the elastomer portion (130) urges the ring

portion (140) radially outwardly from the unexpanded condition to the expanded condition responsive to axial pressure upon the elastomer portion (130) by the swellable element (120).

9. The downhole tool of claim 7 or 8, wherein the predetermined wellbore fluid is an aqueous solution.

10. The downhole tool of claim 7, 8 or 9, wherein the predetermined wellbore fluid is a hydrocarbon.

11. The downhole tool of any of claims 7 to 10, wherein the first elastomer is an elastomeric matrix of ethylene propylene diene monomer rubber impregnated with a super absorbent polymer.

12. The downhole tool of any of claims 7 to 11, wherein the first elastomer is a reaction product of linear or branched polymers having residual ethylenic unsaturation with an unsaturated organic monomer having at least one reactive moiety.

13. A method of assembling a downhole tool (100), comprising:

selecting a swellable element (120) for the downhole tool (100) responsive to a fluid in a wellbore;
disposing the swellable element (120) on a body member (110) of the downhole tool (100);
disposing a backup unit (160) on the body member (110) adjacent an end of the swellable element (120), the backup unit (160) comprising:

a ring portion (140) having an expanded condition and an unexpanded condition; and
an elastomer portion (130), disposed between the ring portion (140) and the body member (110), composed of a second elastomer selected without regard to the fluid in the wellbore; and

attaching the backup unit (160) to the body member (110).

14. The method of claim 13, wherein the act of selecting a swellable element (120) comprises:

selecting a swellable element (120) designed to swell upon exposure to a hydrocarbon.

15. The method of claim 13 or 14, wherein the act of selecting a swellable element (120) comprises:

selecting a swellable element (120) designed to swell upon exposure to an aqueous solution.

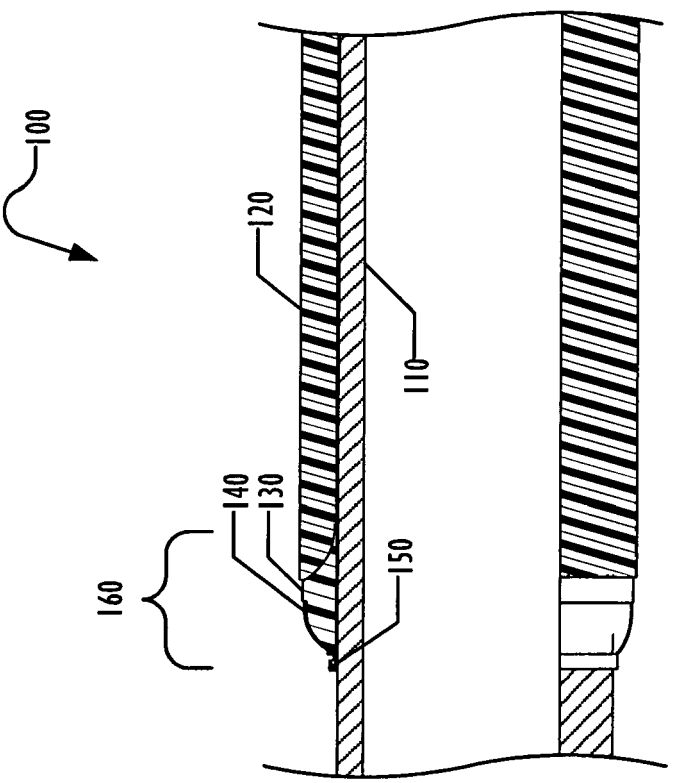

FIG. 1