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Inventor(s)	Roselier; Samuel et al.

System and methodology for utilizing anchoring element with expandable tubular

Abstract

A technique facilitates improved anchoring of expandable well tools along a wellbore or other type of borehole. According to an embodiment, a well tool is sized for placement along a well string. The well tool comprises a tubing and an expandable tubular coupled to the tubing. The expandable tubular is plastically deformable in a radially outward direction when sufficient pressure is applied to an interior of the expandable tubular. The well tool also comprises at least one anchoring ring disposed circumferentially about the expandable tubular. The anchoring ring is constructed with at least one weak point which breaks during expansion of the expandable tubular. Breakage at this weak point enables movement of the anchoring ring in a radially outward direction without elongation of the anchoring ring.

Inventors:	**Roselier; Samuel (Bruz, FR), Neveu; Romain (Bruz, FR), Laupie; Robin (Bruz, FR), Tanguy; Gwenael (Bruz, FR)**
Applicant:	**Schlumberger Technology Corporation** (Sugar Land, TX)
Family ID:	**1000008765129**
Assignee:	**Schlumberger Technology Corporation (Sugar Land, TX)**
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Primary Examiner: Schimpf; Tara

Assistant Examiner: Quaim; Lamia

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS
(1) This application is a national stage entry under 35 U.S.C. 371 of International Application No. PCT/US2022/038264, filed Jul. 26, 2022 entitled "SYSTEM AND METHODOLOGY FOR UTILIZING ANCHORING ELEMENT WITH EXPANDABLE TUBULAR", which claims the benefit of European Patent Application No. 21306061.9, filed Jul. 29, 2021 entitled "SYSTEM AND METHODOLOGY FOR UTILIZING ANCHORING ELEMENT WITH EXPANDABLE TUBULAR," the disclosure of which is incorporated by reference in its entirety.
BACKGROUND
(2) In many oil and gas well applications, a wellbore is drilled into the earth and through a reservoir of a desired fluid, e.g. oil and/or gas. The wellbore may subsequently be completed with appropriate completion equipment having expandable well tools, e.g. packers, which may be expanded and anchored at desired locations along the wellbore. For example, packers may be disposed along the completion equipment and expanded into sealing engagement with a surrounding wellbore wall, e.g. a casing wall surface, to facilitate production of the desired fluids from the reservoir. Depending on the application, the packers or other expandable well tools may be mounted along production tubing and selectively expanded into anchored engagement with the surrounding wellbore wall.
SUMMARY
(3) In general, a system and methodology facilitate improved anchoring of expandable well tools along a wellbore or other type of borehole. According to an embodiment, a well tool is sized for placement along a well string. The well tool comprises a tubing and an expandable tubular, e.g. an expandable metal tubular, coupled to the tubing. The expandable tubular is plastically deformable in a radially outward direction when sufficient pressure is applied to an interior of the expandable tubular. The well tool also comprises at least one anchoring ring disposed circumferentially about the expandable tubular. The anchoring ring is constructed with at least one weak point which breaks during expansion of the expandable tubular. Breakage at this weak point enables movement of the anchoring ring in a radially outward direction without elongation of the anchoring ring.
(4) However, many modifications are possible without materially departing from the teachings of this disclosure. Accordingly, such modifications are intended to be included within the scope of this disclosure as defined in the claims.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) Certain embodiments of the disclosure will hereafter be described with reference to the accompanying drawings, wherein like reference numerals denote like elements. It should be understood, however, that the accompanying figures illustrate the various implementations described herein and are not meant to limit the scope of various technologies described herein, and:
(2) FIG. **1** is an illustration of an example of a well tool having an expandable tubular, e.g. an expandable metal tubular, with an anchoring element, according to an embodiment of the disclosure;

(3) FIG. **2** is a cross-sectional view of the well tool illustrated in FIG. **1**, according to an embodiment of the disclosure;
(4) FIG. **3** is a cross-sectional illustration of an example of an anchoring element disposed about an expandable metal tubular, according to an embodiment of the disclosure;
(5) FIG. **4** is an orthogonal view of an example of an anchoring element having gripping features oriented to engage and grip a surrounding wall, according to an embodiment of the disclosure;
(6) FIG. **5** is an orthogonal view of the anchoring element illustrated in FIG. **4** after expansion of the anchoring element and resultant breakage at a weak point of the anchoring element, according to an embodiment of the disclosure;
(7) FIG. **6** is an illustration of an anchoring element having a plurality of notches arranged to provide increased flexibility in the anchoring element, according to an embodiment of the disclosure;
(8) FIG. **7** is an illustration of the anchoring element of FIG. **6** after expansion of the anchoring element and resultant breakage at a weak point, according to an embodiment of the disclosure;
(9) FIG. **8** is an illustration of another example of an anchoring element having a different type of gripping features, according to an embodiment of the disclosure;
(10) FIG. **9** is an illustration of another example of an anchoring element having another type of gripping features, according to an embodiment of the disclosure;
(11) FIG. **10** is a cross-sectional illustration of an example of an anchoring element having a feature which helps hold the anchoring element against the expandable tubular during expansion, according to an embodiment of the disclosure;
(12) FIG. **11** is a cross-sectional illustration of another example of an anchoring element having a feature which helps hold the anchoring element against the expandable tubular during expansion;
(13) FIG. **12** is a cross-sectional illustration of a well tool in the form of a packer with an expandable tubular having a sealing element mounted thereon, according to an embodiment of the disclosure;
(14) FIG. **13** is a cross-sectional illustration of the well tool illustrated in FIG. **12** after sufficient expansion of the expandable tubular to move the sealing element and the anchoring elements into engagement with a surrounding wellbore wall;
(15) FIG. **14** is a cross-sectional illustration of another example of the well tool in the form of a packer with an expandable tubular having a sealing element mounted thereon, according to an embodiment of the disclosure; and
(16) FIG. **15** is a cross-sectional illustration of another example of the well tool in the form of a packer with an expandable tubular having a sealing element mounted thereon, according to an embodiment of the disclosure.

DETAILED DESCRIPTION

(17) In the following description, numerous details are set forth to provide an understanding of some embodiments of the present disclosure. However, it will be understood by those of ordinary skill in the art that the system and/or methodology may be practiced without these details and that numerous variations or modifications from the described embodiments may be possible.
(18) The disclosure herein generally involves a system and methodology which facilitate improved anchoring of expandable well tools along a wellbore or other type of borehole. According to an embodiment, a well tool is sized for placement along a well string. The well tool comprises a tubing and an expandable tubular, e.g. an expandable metal tubular, coupled to the tubing. The expandable tubular is plastically deformable in a radially outward direction when sufficient pressure is applied to an interior of the expandable tubular. The well tool also comprises at least one anchoring element disposed circumferentially about the expandable tubular. The anchoring element is constructed with at least one weak point which breaks during expansion of the expandable metal tubular. Breakage at this weak point enables movement of the anchoring element in a radially outward direction without elongation of the anchoring element.

(19) The construction and arrangement of each anchoring element enable the anchoring elements to be firmly held in position during the running-in-hole phase. Additionally, the construction limits the overpressure used for radially deforming the overall expandable tool. The anchoring element or elements can conform to the expandable tubular during expansion of the tool. Furthermore, each anchoring element is able to provide secure gripping with limited initial stress applied to the formation or tubular in which the anchoring element is expanded.
(20) According to an embodiment, the well tool comprises an anchoring element, e.g. an anchoring ring, mounted onto an expandable tubular. The anchoring element may be placed between stop rings attached to the expandable tubular. The stop rings may be formed of metal or another suitable material and attached to an outer surface of the expandable tubular or within grooves formed about the circumference of the expandable tubular. In a variety of applications, the anchoring element is formed of a harder material, e.g. a harder steel, then the expandable tubular and it also may be surface treated or hardened. Additionally, the anchoring element may be formed with a triangular or trapezoidal transverse cross-sectional shape captured between the stop rings. The triangular/trapezoidal surfaces may be formed at angles of between 10° and 45° with respect to the base surface(s).
(21) Prior to expansion of the expandable tubular and the anchoring element, e.g. during running-in-hole, the anchoring element is a single, one-piece element so that it cannot be moved or flushed. However, the anchoring element comprises a breakpoint which ruptures when radial expansion of the expandable tubular is initiated. In some embodiments, the anchoring element/ring may comprise a plurality of notches distributed circumferentially around the anchoring element/ring and which create reduced thickness areas in the anchoring element/ring. The notches provide the anchoring element/ring with increased flexibility and serve as hinges which allow the anchoring element/ring to conform during expansion of the expandable tubular. The anchoring element also may comprise a variety of gripping features to facilitate engagement and gripping of a surrounding wellbore wall, e.g. a surrounding casing surface. Furthermore, the anchoring element may comprise securing features, e.g. an elastomeric or polytetrafluoroethylene (PTFE) ring, a metallic ring, or other suitable features, which hold the anchoring element against the expandable tubular during expansion.
(22) Referring generally to FIGS. **1** and **2**, an example of a well tool **20** is illustrated as positioned along a well string **22** within a borehole **24**, e.g. a wellbore. In this example, the well tool **20** is in the form of an expandable packer **26**. However, the well tool **20** may comprise a variety of other types of expandable tools which are expanded into gripping engagement with a surrounding borehole wall/surface **28**, such as an inner surface of casing. In the illustrated example, the well tool **20** comprises a tubing **30** which may form part of the overall production tubing through which well fluid is produced to a desired collection location.
(23) The illustrated well tool **20** further comprises an expandable tubular **32** coupled to the tubing **30**. The expandable tubular **32** may be made from a variety of materials, but in many downhole environments the expandable tubular **32** is in the form of an expandable metal tubular as described below. By way of example, the expandable metal tubular **32** may be coupled with tubing **30** via end connection rings **34**. The expandable metal tubular **32** is plastically deformable in a radially outward direction when sufficient pressure is applied to an interior **36** of the expandable metal tubular to thus expand the tubular **32** in the radially outward direction. In some embodiments, expansion pressure may be directed to interior **36** via one or more expansion ports **38** formed radially through the tubing **30**, as illustrated in FIG. **2**. In the illustrated embodiment, the tubing **30** extends linearly through the expandable metal tubular **32** and may be concentrically positioned within tubular **32** as illustrated. However, other embodiments may be constructed which do not extend tubing **30** entirely through the expandable tubular **32**.
(24) Additionally, the well tool **20** comprises an anchoring element **40**, e.g. a plurality of anchoring elements **40**. In the specific example illustrated, the well tool **20** comprises four anchoring elements

40 although other numbers of anchoring elements **40** may be utilized. In a variety of applications, each anchoring element **40** is formed in the shape of a ring which is disposed circumferentially about the expandable metal tubular **32**.

(25) In the specific example illustrated, the well tool **20** is in the form of packer **26** which comprises a sealing element **42** mounted along an outer surface of the expandable metal tubular **32**. The packer **26** may be actuated by directing a sufficiently high pressure fluid down through an interior **43** of tubing **30**. This high pressure fluid flows through the one or more expansion ports **38** and into the interior **36** between tubing **30** and the surrounding expandable metal tubular **32**. The pressure is sufficient to radially expand and plastically deform the expandable metal tubular **32** so as to drive the anchoring elements/rings **40** and the sealing element **42** into secure engagement with the surrounding borehole surface **28**. It should be noted that other embodiments of the expandable well tool **20** may be constructed without use of sealing element **42**.

(26) Referring generally to FIG. **3**, a cross-sectional view of an example of anchoring ring **40** is illustrated as disposed circumferentially about the expandable metal tubular **32**. In this embodiment, each anchoring ring **40** is positioned between stop rings **44** which are arranged circumferentially about the expandable metal tubular **32**. The stop rings **44** may be welded to tubular **32**, machined as part of tubular **32**, or otherwise suitably attached to the expandable metal tubular **32**. According to an example, the anchoring ring **40** may be generally triangular or trapezoidal in shape and may comprise angled surfaces **46** disposed at a suitable angle, e.g. 10° to 45°, with respect to an outer base surface **48**. The stop rings **44** may have corresponding angular surfaces **50** positioned to secure the anchoring ring **40** therebetween. Additionally, the anchoring element/ring **40** may comprise a variety of gripping features **52**, e.g. teeth, spikes, inserts, oriented to engage the surrounding wall **28** when the expandable metal tubular **32** is expanded.

(27) As further illustrated in FIGS. **4-7**, each anchoring ring **40** may comprise a weak point **54** which breaks during expansion of the expandable metal tubular **32** (see FIGS. **5** and **7**). By providing one or more weak points **54**, the anchoring ring **40** is able to move radially outward during expansion of tubular **32** without being elongated. For example, the gripping features **52** may be moved radially outward into anchoring engagement with the surrounding wall **28** without having the anchoring ring **40** undergo elastic or plastic elongation. The weak point **54** may be formed via a variety of techniques, such as machining a thin section, connecting the ring ends via tack welding, or forming another suitable type of fracture/break point.

(28) In some embodiments, each anchoring ring **40** may be formed with a plurality of notches **56** located along, for example, an interior of the anchoring ring **40**. The notches **56** may be arranged circumferentially along the anchoring ring **40** to provide increased flexibility in the anchoring ring **40** relative to a ring without the notches. The flexibility afforded by notches **56** enables the anchoring ring **40** to adapt and conform to the shape and diameter of the expandable metal tubular **32** and the surrounding surface **28**. This ensures an improved anchoring engagement of the gripping features **52** with the surrounding wall surface **28**. It should be noted that gripping features **52** may comprise a variety of shapes and configurations, including circumferential ridges **58**, as illustrated in FIG. **8**, and rows of teeth **60**, as illustrated in FIG. **9**.

(29) Referring generally to FIGS. **10** and **11**, another embodiment of anchoring element **40** is illustrated. In this example, the anchoring element **40** is in the form of a ring having a securing feature **62** which helps hold the anchoring ring **40** against the expandable metal tubular **32** during expansion. By way of example, the securing feature **62** may be in the form of a PTFE or elastomeric ring **64** received in a corresponding circumferential groove **66** formed along an exterior surface of the anchoring ring **40**, as illustrated in FIG. **10**. In other embodiments, the securing feature **62** may be in the form of a metallic C-ring **68**, as illustrated in FIG. **11**.

(30) In FIG. **12**, an example of well tool **20** is illustrated in the form of expandable packer **26** deployed downhole into wellbore **24** via well string **22**. In this example, the expandable packer **26** is deployed to a desired downhole location within a surrounding casing **70** which establishes the

surrounding wall/surface **28**. While at the desired downhole location, fluid under pressure is directed downhole via, for example, interior **43** of tubing **30**. The fluid under pressure flows through expansion port **38** and into interior **36**, as indicated by arrows **72**, so as to radially expand the expandable metal tubular **32**, as illustrated in FIG. **13**. By applying sufficient pressure, the expandable metal tubular **32** is plastically deformed in a radially outward direction. Consequently, the anchoring rings **40**, as well as sealing element **42**, are moved into anchoring and sealing engagement, respectively, with the surrounding surface **28**.

(31) Anchoring performance may be increased in some applications by further increasing pressure within interior **36**. In some embodiments, the increased pressure within interior **36** may be trapped via a valve **74**, as illustrated in FIG. **14**. The valve **74** ensures that the relatively high pressure remains in interior **36** so as to maintain substantial force driving anchoring rings **40** into gripping engagement with the surrounding surface **28**. By way of example, the valve **74** may be a one-way check valve or other suitable valve placed in expansion port **38** or along the flow path through expansion port **38**.

(32) In some embodiments, the high-pressure fluid may be directed into interior **36** from an annulus **76** surrounding tubing **30**, as illustrated in FIG. **15**. A valve system **78** may be positioned on one side or both sides of the expandable packer **26** to compensate annulus pressure. As illustrated, for example, the valve system **78** may be positioned on a high pressure side of expandable packer **26** to allow high pressure on that side of the packer **26** to flow from the annulus **76** to the interior **36**. The high pressure fluid is able to energize interior **36** and thus help increase the anchoring performance of the anchoring element **40** on the opposite side of sealing element **42**. It should be noted the anchoring performance of the anchoring element **40** on the same side of sealing element **42** may not be increased as much due to the same high pressure being on the inside and outside of the expandable metal tubular **32**. Effectively, this type of system is self energized with annulus pressure.

(33) Depending on the parameters of a given operation and the environment in which such operation is conducted, the components of well tool **20** may be made from a variety of materials and in a variety of configurations. For example, a single anchoring element **40** or a plurality of anchoring elements **40** may be used to secure the well tool **20** with a surrounding wall. Additionally, the expandable tubular **32** may be in the form of an expandable metal tubular formed in a variety of sizes and with different types of metal materials or other materials which are able to plastically deform when exposed to sufficient internal pressure. The expandable metal tubular **32** may be combined with sealing element **42** to form expandable packer **26** which may be used to seal off sections of wellbore **24**. However, the expandable tubular **32** may be combined with a variety of anchoring elements **40** in other types of expandable anchoring tools.

(34) Although a few embodiments of the disclosure have been described in detail above, those of ordinary skill in the art will readily appreciate that many modifications are possible without materially departing from the teachings of this disclosure. Accordingly, such modifications are intended to be included within the scope of this disclosure as defined in the claims.

Claims

1. A system, comprising: a well tool sized for placement along a well string, the well tool comprising: a tubing; an expandable metal tubular coupled to the tubing with connection rings, the expandable metal tubular being plastically deformable in a radially outward direction when sufficient pressure is applied to an interior of the expandable metal tubular through one or more ports formed radially through the tubing to thus expand the expandable metal tubular; the tubing extends linearly through the expandable metal tubular such that the expandable metal tubular is positioned concentrically about the tubing; and an anchoring ring disposed circumferentially about the expandable metal tubular, the anchoring ring having a weak point which breaks during

expansion of the expandable metal tubular such that the anchoring ring is able to move radially outward without being elongated, wherein the anchoring ring comprises a plurality of notches located along an interior of the anchoring ring, such that a radial thickness of the anchoring ring is greater between adjacent notches than at each notch, and the anchoring ring remains intact at the plurality of notches following expansion of the expandable metal tubular into anchoring engagement with a surrounding surface.

2. The system as recited in claim 1, wherein the anchoring ring comprises a plurality of anchoring rings disposed circumferentially about the expandable metal tubular.

3. The system as recited in claim 1, wherein the anchoring ring comprises gripping features oriented to engage and grip a surrounding wall once the expandable metal tubular has been sufficiently expanded.

4. The system as recited in claim 1, wherein the anchoring ring has a triangular portion captured between stop rings secured to the expandable metal tubular and arranged circumferentially about the expandable metal tubular.

5. The system as recited in claim 1, wherein the anchoring ring is formed from a harder material than the expandable metal tubular.

6. The system as recited in claim 1, wherein the well tool is an expandable packer comprising a sealing element mounted on an outer surface of the expandable metal tubular.

7. The system as recited in claim 6, wherein a valve is provided on a side of the expandable packer, said valve is configured to compensate an annulus pressure.

8. The system as recited in claim 7, wherein an annulus differential pressure energizes an anchoring element opposite the annulus pressure.