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Retaining backup system for frac plugs

Abstract

A backup ring for a frac plug. The backup ring may include a plurality of segments defined by a plurality of slots, where each segment is defined by a sequential pair of the plurality of slots. The backup ring may also include a plurality of buttons, wherein at least one button is disposed on each segment. The backup ring creates a backup anchor for the sealing element and reduces or prevents extrusion of the sealing element.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) Any and all applications for which a foreign or domestic priority claim is identified in the Application Data Sheet as filed with the present application are hereby incorporated by reference under 37 CFR 1.57. The present application claims priority benefit of U.S. Provisional Application No. 63/376,452 filed Sep. 21, 2022, the entirety of which is incorporated by reference herein and should be considered part of this specification.

BACKGROUND

(1) In the field of hydrocarbon production, hydraulic fracturing or “fracing” is a process of stimulating a hydrocarbon producing well by fracturing the surrounding rock with a hydraulically pressurized fluid of water, sand and chemicals. During fracing it is commonly necessary to isolate each zone so as to only provide the pressurized fluid and sand to the desired location within the well. This is due to the potential for the well to be quite long and therefore the pumping and material required to therefore frac the entire well string would be too large.

(2) In a variety of well fracturing applications, a wellbore is initially drilled and cased. the frac plug is then pumped down and actuated to form a seal with the surrounding casing. One common method of splitting the well up into the manageable zones is to provide a plug below the zone to be fractured. Once the casing is perforated, the frac plug is used to prevent fracturing fluid from flowing farther downhole, thus forcing the fracturing fluid out through the perforations and into the surrounding formation. In some applications, multiple frac plugs may be deployed to enable fracturing at different well zones. Each frac plug comprises a sealing element which is deformed into sealing engagement with the surrounding casing. The sealing element may be formed of an elastomeric material or metal material which is deformed in a radially outward direction until forming a permanent seal with the inside surface of the casing. To ensure sealing, the frac plug tends to be formed with relatively precise and expensive components. In addition to the expense, the construction of such a frac plug also can lead to difficulties associated with milling out the frac plug after completion of the fracturing operation.

SUMMARY
(3) According to one or more embodiments of the present disclosure, a backup ring includes a plurality of segments defined by a plurality of slots, wherein each segment is defined by a sequential pair of the plurality of slots, and a plurality of buttons, wherein at least one button is disposed on each segment.
(4) According to one or more embodiments of the present disclosure, a frac plug for use within a cased well includes a mandrel, a sealing element disposed around the mandrel, a backup ring disposed around the mandrel and adjacent to the sealing element, a cone disposed around the mandrel and adjacent to the backup ring, and a slip assembly that, when the frac plug is set within the cased well, travels along the cone and expands radially to allow buttons disposed in slips of the slip assembly to engage the casing of the well. The backup ring includes a plurality of segments defined by a plurality of slots, wherein each segment is defined by a sequential pair of the plurality of slots, and a plurality of buttons, wherein at least one button is disposed on each segment.
(5) According to one or more embodiments of the present disclosure, a method of fracturing a well includes disposing a frac plug within a bore of the well. The method also includes setting the frac plug to engage buttons disposed in slips of a slip assembly of the frac plug with an inner surface of a casing within the well and to engage buttons disposed in segments of a backup ring of the frac plug with the inner surface of the casing to retain the frac plug within the casing.
(6) 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.
(2) FIG. **1** is a schematic illustration of an example of a downhole tool deployed in a wellbore according to one or more embodiments of the present disclosure.
(3) FIG. **2** is a cross-sectional view of a frac plug according to one or more embodiments of the present disclosure.
(4) FIG. **3** is an isometric view of the frac plug of FIG. **2**.
DETAILED DESCRIPTION
(5) 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 apparatus and/or method may be practiced without these details and that numerous variations or modifications from the described embodiments may be possible.
(6) In the specification and appended claims: the terms “connect,” “connection,” “connected,” “in connection with,” “connecting,” “couple,” “coupled,” “coupled with,” and “coupling” are used to mean “in direct connection with” or “in connection with via another element.” As used herein, the terms “up” and “down,” “upper” and “lower,” “upwardly” and “downwardly,” “upstream” and “downstream,” “uphole” and “downhole,” “above” and “below,” and other like terms indicating relative positions above or below a given point or element are used in this description to more clearly describe some embodiments of the disclosure.
(7) Referring generally to FIG. **1**, an embodiment of a downhole tool **20** is illustrated deployed in a well **21**. According to one or more embodiments of the present disclosure, the downhole tool **20** is a frac plug. For example, the frac plug **20** may be deployed in a wellbore **22** to facilitate a

fracturing operation. In the example illustrated, the frac plug **20** is deployed in the wellbore **22** to isolate a zone of the wellbore **22** so that fracturing fluid **24** may be directed through perforations **26** and into a surrounding formation **28** uphole of the frac plug **20** for fracturing of the surrounding formation **28**. It should be noted that the frac plug **20** according to one or more embodiments of the present disclosure may be used in many types of wellbores, such as deviated, e.g., horizontal, wellbores to facilitate fracturing of desired well zones along the horizontal or otherwise deviated wellbore.

(8) Still referring to FIG. **1**, the wellbore **22** may be lined with a casing **30**, and each frac plug **20** may be actuated to grip into and seal against the casing **30**, thereby sealing or substantially restricting flow of the fracturing fluid **24** downhole of the frac plug **20** in the wellbore **22**. As a result, during a fracturing operation, the fracturing fluid **24** is directed through the perforations **26** into the surrounding formation **28** while the frac plug **20** remains anchored to the casing **30**. Once the fracturing operation is completed and a given frac plug **20** is no longer of use, the frac plug **20** may be milled and removed from the wellbore **22**.

(9) Referring now to FIG. **2** is a cross-sectional view of a frac plug **200** according to one or more embodiments of the present disclosure is shown. Specifically, FIG. **2** shows the frac plug **200** in an unset position. According to one or more embodiments, the frac plug **200** may include a mandrel **202**, a slip assembly **204**, a cone **206**, a sealing element **208**, bottom sub **214** and a backup ring **210** disposed around the mandrel **202**. The frac plug **200** is held together in a run-in-hole unset position by shear pins **220**. When a set force is applied to the frac plug **200**, the shear pins **220** are sheared allowing the various parts of the shear plug **200** to move relative to each other. In one or more embodiments, the backup ring **210** is disposed adjacent the sealing element **208** and the backup ring **210**, which may radially expand against an inner wall of the casing **30** and create a circumferential barrier to keep the sealing element **208** from extruding. Additionally, the backup ring **210** may be integrally formed with the cone **206**. In other embodiments, the backup ring **210** may be separate from the cone **206**. The frac plug **200** also includes an internal locking mechanism **212**, such as a lock rings or a ratcheting mechanism. The internal locking mechanism **212** consists of an inner locking ring **216** and an outer locking ring **218**. The inner locking ring **216** is positioned in a groove in an outer surface of the mandrel **202**. The outer locking ring **218** is positioned in a groove in an inner surface of the cone **206**. The inner locking ring **216** and outer locking ring **218** both have a ratchet mechanism that will overlap and help keep the frac plug **200** energized and pressed into the casing **30**. The internal locking mechanism **212** keeps the sealing element **208** axially compressed and retains the backup ring **210** and slip assembly **204** against the casing **30** after the frac plug **200** is set within the casing **30**, as described in more detail below.

(10) Turning now to FIG. **3**, FIG. **3** is an isometric view of the frac plug **200** of FIG. **2**. As shown in FIG. **3**, the slip assembly **204** of the frac plug **200** may include a plurality of slips **300**. Further, each slip **300** may include one or more buttons **302** disposed in the slip **300**. Similarly, the backup ring **210** includes multiple segments **304** that each include at least one button **306** disposed therein. The multiple segments **304** on the backup ring **210** For example, a plurality of slanted slots (not labeled) may be formed circumferentially between the multiple segments **304**. The slots may not extend across the entire axial length of the multiple segments **304**. The slots will cause the multiple segments **304** to rotate when energized.

(11) When the frac plug **200** is compressed from the run-in-hole unset position to a set position, the slip assembly **204** travels along the cone **206**, causing the slip assembly **204** to radially expand. The radial expansion of the slip assembly **204** causes the buttons **302** disposed in the slips **300** to grip and bite into the inner surface of the casing **30**. Further, when the frac plug **200** is in the set position, the sealing element **208** is deformed into sealing engagement with the surrounding casing **30**. Additionally, the transition from the unset position to the set position, the segments **304** of the backup ring **210** break apart, rotate, and extend radially into the casing to create a backup anchor for the sealing element **208** that reduces or prevents extrusion of the sealing element **208**. The

buttons **306** on one or more segments **304** also grip and bite into the inner surface of the casing **30**. The buttons **306** on the one or more segments **304** prevent uphole movement.

(12) According to one or more embodiments of the present disclosure, the sealing element **208** may be formed of an elastomeric material or metal material, which is deformed in a radially outward direction until forming a permanent seal with the inside surface of the casing **30**. Due to the gripping and biting of the buttons **302**, **306** and the sealing of the sealing element **208**, the frac plug **200** is able to be effectively anchored to the inside surface of the casing **30** when the frac plug **200** is in the set position. The frac plug **200** may remain anchored to the inside surface of the casing **30** during a fracturing operation, and after the fracturing operation, the frac plug **200** may be drilled out, as previously described.

(13) 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 pos sible 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 backup ring for use with a sealing element, comprising: a plurality of segments defined by a plurality of slots, wherein each segment is defined by a sequential pair of the plurality of slots; and a plurality of buttons, wherein at least one button is disposed on each segment, wherein the backup ring is configured to break apart, rotate, and extend radially into a casing of a cased well to create a backup anchor for the sealing element.
2. The backup ring of claim 1, wherein the backup ring is disposed around a mandrel of a frac plug and adjacent to the sealing element.
3. The backup ring of claim 2, wherein the backup ring prevents extrusion of the sealing element when radially extended into the casing.
4. The backup ring of claim 2, wherein the least one button disposed on each segment of the backup ring engages with the casing when the frac plug is set.
5. A frac plug for use within a cased well, the frac plug comprising: a mandrel; a sealing element disposed around the mandrel; a backup ring disposed around the mandrel and adjacent to the sealing element, the backup ring comprising: a plurality of segments defined by a plurality of slots, wherein each segment is defined by a sequential pair of the plurality of slots, and wherein the plurality of segments is configured to break apart, rotate, and extend radially into a casing of the cased well to create a backup anchor for the sealing element; and a plurality of buttons that, when the frac plug is set within the cased well, engage with the casing of the cased well, wherein at least one button is disposed on each segment; a cone disposed around the mandrel and adjacent to the backup ring; shear pins to help the frac plug in a run-in-hole unset position; and a slip assembly that, when the frac plug is set within the cased well, travels along the cone and expands radially to allow buttons disposed in slips of the slip assembly to engage the casing of the well.
6. The frac plug of claim 5, wherein the backup ring is integrally formed with the cone.
7. The frac plug of claim 5, further comprises an internal locking mechanism.
8. The frac plug of claim 7, wherein the locking mechanism further comprises an inner locking ring with a ratchet surface and an outer locking ring with a ratchet surface; and wherein the ratchet surface of the inner locking ring engages the ratchet surface of the outer locking ring to lock the frac plug in a set position.
9. The frac plug of claim 5, wherein the plurality of slots does not extend across an entire axial length of the plurality of segments.
10. The frac plug of claim 5, wherein the sealing element is formed of an elastomeric material or a metal material.
11. The frac plug of claim 5, wherein the buttons of the segments and the buttons of the slips grip

and bite into an inner surface of the casing.

12. The frac plug of claim 5, wherein the backup ring prevents extrusion of the sealing element when radially extended into the casing.

13. A method of setting a frac plug in a well, the method comprising: disposing a frac plug within a bore of the well; setting the frac plug to engage buttons disposed in slips of a slip assembly of the frac plug with an inner surface of a casing within the well and to engage buttons disposed in segments of a backup ring of the frac plug with the inner surface of the casing to retain the frac plug within the casing, wherein when setting the frac plug, the segments of the backup ring break apart, rotate, and extend radially into the casing to create a backup anchor for a sealing element that reduces or prevents extrusion of the sealing element; and performing a fracturing operation.

14. The method of claim 13, further comprising compressing the sealing element disposed around a mandrel of the frac plug creating an engagement with the surrounding casing.

15. The method of claim 13, further comprising locking the frac plug in a set position with an internal locking mechanism.

16. The method of claim 13, wherein the frac plug is drilled out after the fracturing operation.