Title: SLIP-DEPLOYED ANTI-EXTRUSION BACKUP RING

Abstract: Arrangements and packer devices having anti-extrusion backup rings that are expanded radially outwardly by a setting mechanism that lies proximate the elastomeric packer element that is being protected against extrusion. The setting mechanism can be a slip assembly that has a radially expandable slip element.
SLIP-DEPLOYED ANTI-EXTRUSION BACKUP RING

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Application No. 13/471900, filed on May 15, 2012, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The invention relates generally to the design of packer devices.

2. Description of the Related Art

[0002] Anti-extrusion backup rings are used to prevent or reduce extrusion of deformable elastomeric packer elements for packer devices in wellbores. Other backup rings partially encase an end portion of the elastomeric packer element and are therefore, expanded radially outwardly as the packer element expands radially during setting. Backup rings of this type are discussed in U.S. Patent No. 8,083,001 issued to Conner et al. which is owned by the assignee of the present invention and is herein incorporated by reference.

SUMMARY OF THE INVENTION

[0003] The invention provides packer devices having one or more anti-extrusion backup rings that are expanded radially outwardly by the radial expansion of a setting mechanism that lies proximate the elastomeric packer element that is being protected against extrusion. In certain embodiments, the setting mechanism is a slip assembly that has a radially expandable slip element. In particular embodiments, the slip assembly is set by axial movement of the slip element over a setting cone. In a described embodiment, the anti-extrusion backup ring has an interior portion that extends along the end wall of the packer element and an exterior portion that is substantially perpendicular to the interior portion. In the described embodiment, the exterior portion overlies a portion of the slip element. The slip element urges the backup ring into mechanical or intimate contact with a surrounding tubular when the slip element is set against the surrounding tubular. Outward radial expansion of the slip element will urge the exterior portion of the backup ring radially outwardly. In a described embodiment, the exterior portion of the backup ring is urged into contact with the surrounding tubular by the slip element. When so set, the backup ring prevents or reduces...
axial extrusion of the packer element past the backup ring in the direction of the slip assembly.

[0004] In another described embodiment, the backup ring takes the form of an annular spring that radially surrounds the cone of the slip assembly. During setting of the packer device, the slip element urges the spring into a wedged position between the cone and the surrounding tubular so that the wedged spring acts as backup ring to prevent extrusion of the packer element.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The advantages and further aspects of the invention will be readily appreciated by those of ordinary skill in the art as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings in which like reference characters designate like or similar elements throughout the several figures of the drawing and wherein:

[0006] Figure 1 is a one-quarter side cross-sectional view of an unset exemplary packer device having an anti-extrusion backup ring in accordance with the present invention.

[0007] Figure 2 is a one-quarter side cross-sectional view of the packer device of Figure 1, now in a set position.

[0008] Figure 3 is a one-quarter side cross-sectional view of an unset packer device having an exemplary alternative anti-extrusion backup ring in accordance with the present invention.

[0009] Figure 4 is a one-quarter side cross-sectional view of the packer device of Figure 3, now in a set position.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] Figure 1 illustrates an exemplary compression-set packer device 10 that includes an interior cylindrical mandrel 12 that defines an interior flowbore 14 having central axis 16 along its length. As the general construction and operation of a compression-set packer device is well known, it will not be discussed in detail here.

[0011] A compressible, or compression-set, packer element 18 radially surrounds the mandrel 12. The packer element 18 is preferably formed of a deformable elastomer, as is known in the art. An anti-extrusion backup ring 20 is located adjacent the packer element 18. The backup ring 20 has an interior portion 22 that extends radially outwardly from the
mandrel 12 and along the end wall 24 of the packer element 18. The backup ring 20 also has 
an exterior portion 26 that, in the depicted embodiment, is substantially perpendicular to the 
interior portion 22. In particular embodiments, the backup ring 20 is formed of metal. A 
suitable metal for this application is annealed 8620 steel. In other particular embodiments, the 
backup ring 20 is formed of a non-metallic material such as carbon epoxy and other 
composites. In preferred embodiments, the backup ring 20 has a rigidity that allows it to be 
deployed with a setting force that is usual and customary for setting of the packer element 18. 
In accordance with other embodiments, the setting force would be in the range of 5,000 - 15,000 lbs. In 
accordance with other embodiments, the backup ring 20 could be a non-metallic petal-style 
backup ring that is not flexible, but has a designated break point.

[0012] In accordance with other particular embodiments of the present invention, the 
exterior portion 26 of the backup ring 20 is slotted so that the backup ring 20 is of the petal 
variety. Also in certain embodiments, this petal-style ring is formed of non-metallic material.

[0013] A slip assembly, generally shown at 28, radially surrounds the mandrel 12 and 
includes a cone 30 that is axially slidable upon the mandrel 12. The cone 30 presents a ramped 
outer radial setting surface 32. The slip assembly 28 also includes a slip element 34. The slip 
element 34 is typically radially segmented, but need not be so. The slip element 34 preferably 
has teeth 36 to create a biting engagement with a surrounding tubular member 38 when set. 
The slip element 34 presents a radially inwardly-facing slanted surface 40 that is 
complimentary to the surface 32 of the cone 30. The slip element 34 is located so that the 
slanted surface 40 is in contact with the surface 32 of the cone 30. It is noted that, in the 
unset position, shown in Figure 1, an end portion 42 of the slip element 34 is disposed radially 
within the exterior portion 26 of the backup ring 20.

[0014] A ring 44 also radially surrounds the mandrel 12 and is affixed to the mandrel 
12 by threaded or bonded connection 46. The ring 44 contacts the slip element 34.

[0015] In order to set the packer device 10, the components surrounding the mandrel 
12 are axially compressed against the ring 44 as is known in the art. As Figure 2 illustrates, 
the packer element 18 will expand radially outwardly and into sealing contact with the 
surrounding tubular 38. As the cone 30 is moved axially toward the ring 44, the slip element 
34 is moved radially outwardly due to sliding movement of the slip element 34 upon the 
ramped surface 32 of the cone 30. The slip element 34 is moved radially outwardly until its 
teeth 36 bitingly engage the surrounding tubular 38.
[0016] The radial outward movement of the slip element 34 also energizes the backup ring 20. The interior portion 24 of the backup ring 20 is urged against the packer element 18. The exterior portion 26 of the backup ring 20 is also preferably brought into contact with the surrounding tubular 38 by the slip element 34. The backup ring 20 now functions as an anti-extrusion barrier which will prevent extrusion of the packer element 18 axially toward the slip assembly 28. Although only a single backup ring 20 is depicted associated with a single axial end wall 24 of the packer element 18, it should be understood that a similar backup ring and setting arrangement could be used for the opposite axial end of the packer element 18.

[0017] It will be understood that the invention provides an arrangement for preventing axial extrusion of a packer element that is set within a surrounding tubular. This arrangement includes the anti-extrusion backup ring 20 as well as the setting mechanism that is provided in certain embodiments by the slip assembly 28.

[0018] In addition, it should be understood that the invention provides methods for establishing an anti-extrusion backup seal for a packer element 18 in a packer device 10 to be set within a surrounding tubular 38. In accordance with these methods, an anti-extrusion backup ring 20 is placed proximate an end wall 24 of the packer element 18. The backup ring 20 is then energized to prevent extrusion by a setting mechanism other than the packer element 18. In particular embodiments, the setting mechanism is a slip assembly 28 and energizes the backup ring 20 by urging a slip element 34 radially outwardly to cause the backup ring 20 to be urged against the packer element 18. In certain embodiments, the slip element 34 urges a portion of the backup ring 20 into engagement with the surrounding tubular 38.

[0019] The inventors have found that the arrangements and methods of the present invention provide for positive energizing of the backup ring 20. Since the slip element 34 is formed of a rigid material or assemblage of rigid materials, it will provide for a rigid anchoring of the backup ring 20 against the surrounding tubular 38.

[0020] Figures 3 and 4 illustrate an alternative compression-set packer device 50 having a packer element 18 that radially surrounds mandrel 12. The packer device 50 is constructed and operates in the manner as the packer device 10 described previously except where indicated otherwise. The inclined outer surface 32 of cone 30 preferably includes an annular recess 52. An annular spring 54 is disposed on the outer surface 32 of the cone 30. Preferably, the spring 54 resides within the recess 52. In one embodiment, the spring 54 is
formed of a non-metallic ceramic material, such as carbon fiber reinforced PEEK (polyether ether ketone). Suitable annular springs for use as the spring 54 are available commercially from a number of manufacturers, including Automated Dynamics of Schenectady, New York.

[0021] When the packer device 50 is moved from the unset position (Figure 3) to the set position (Figure 4) by compression, the end portion 42 of the slip element 34 will contact the spring 54 and urge it over the cone 30. The spring 54 is then wedged between the cone 30 and the surrounding tubular 38 so that the spring 54 functions as an anti-extrusion backup member that will prevent extrusion of the packer element 18 axially within the surrounding tubular 38. It is noted that the spring 54 may deform (flatten) cross-sectionally as it is wedged.

[0022] The foregoing description is directed to particular embodiments of the present invention for the purpose of illustration and explanation. It will be apparent, however, to those skilled in the art that many modifications and changes to the embodiment set forth above are possible without departing from the scope and the spirit of the invention.
CLAIMS
What is claimed is:
1. An arrangement for preventing axial extrusion of a compression-set packer element of a packer device set within a surrounding tubular, the arrangement comprising:
   an anti-extrusion backup ring radially surrounding a central mandrel and located proximate the packer element;
   a setting mechanism for energizing the backup ring to prevent axial extrusion of the packer element within the surrounding tubular.
2. The arrangement of claim 1 wherein the setting mechanism comprises a slip assembly that is used to create an anchoring engagement between the packer device and the surrounding tubular.
3. The arrangement of claim 1 wherein the anti-extrusion backup ring further comprises:
   a radially interior portion that lies along an end wall of the packer element; and
   a radially exterior portion that lies radially outside of the setting mechanism.
4. The arrangement of claim 1 wherein:
   the anti-extrusion backup ring further comprises an annular spring; and
   the backup ring is energized by the setting mechanism by being wedged between a portion of the setting mechanism and the surrounding tubular.
5. The arrangement of claim 4 wherein the annular spring resides within a recess on a cone in the setting mechanism prior to being energized.
6. The arrangement of claim 1 wherein the backup ring is formed of metal.
7. The arrangement of claim 1 wherein the backup ring is formed of a non-metallic material.
8. A packer device that is to be set within a surrounding tubular, the packer device comprising:
   a central mandrel;
   a compression-set packer element radially surrounding the mandrel;
   an anti-extrusion backup ring radially surrounding the mandrel and located adjacent the packer element; and
   a setting mechanism for energizing the backup ring to prevent axial extrusion of the packer element within the surrounding tubular.
9. The packer device of claim 8 wherein the setting mechanism comprises a slip assembly that creates an anchoring engagement between the packer device and the surrounding tubular.

10. The packer device of claim 8 wherein the anti-extrusion backup ring further comprises:

   a radially interior portion that lies along an end wall of the packer element; and
   a radially exterior portion that lies radially outside of the setting mechanism.

11. The packer device of claim 8 wherein:

   the anti-extrusion backup ring further comprises an annular spring; and
   the backup ring is energized by the setting mechanism by being wedged between a portion of the setting mechanism and the surrounding tubular.

12. The arrangement of claim 11 wherein the annular spring resides within a recess on a cone in the setting mechanism prior to being energized.

13. The packer device of claim 8 wherein the backup ring is formed of metal.

14. The packer device of claim 8 wherein the backup ring is formed of a non-metallic material.

15. A method of establishing an anti-extrusion backup seal for a packer element in a packer device to be set within a surrounding tubular, the method comprising the steps of:

   radially surrounding a central mandrel with the packer element;
   placing an anti-extrusion backup ring proximate an end wall of the packer element;
   locating a setting mechanism proximate the backup ring; and

   the setting mechanism energizing the backup ring against the end wall of the packer element as the packer element is set against the surrounding tubular.

16. The method of claim 15 wherein the setting mechanism comprises a slip assembly, and the setting mechanism energizes the backup ring by urging a slip member radially outwardly to cause the backup ring to be urged against the packer element.

17. The method of claim 16 wherein the slip element further urges a portion of the backup ring into engagement with the surrounding tubular.

18. The method of claim 15 wherein the setting mechanism comprises a slip assembly, and the setting mechanism energizes the backup ring by urging the backup ring into a wedged position between the slip assembly and the surrounding tubular.

19. The method of claim 18 wherein the backup ring comprises an annular spring.
A. CLASSIFICATION OF SUBJECT MATTER

E21B 33/122(2006.01)i, E21B 33/124(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E21B 33/122; E21B 23/06; E21B 3312; E21B 33/12; E21B 33/129; E21B 33/124

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: packer, backup ring, slip assembly, annular spring, and setting mechanism

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Relevant to claim No.</th>
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<td>US 7762323 B2 (FRAZIER, W. LYNN) 27 July 2010 See column 4, lines 30-42, column 5, line 26 - column 8, line 22, and figures 4-5.</td>
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<td>US 6840328 B2 (MCKEE, L. MICHAEL et al.) 11 January 2005 See column 4, line 30 - column 5, line 64 and figures 2-4.</td>
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Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be of particular relevance
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