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Reinforced compression plate split for slip hanger

Abstract

A compression plate to be used with a slip hanger is disclosed in at least one embodiment along with embodiments of methods to prepare and use such a compression plate. The compression plate includes at least one bolt hole and includes at least one split in the at least one bolt hole.

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Background/Summary

BACKGROUND

1. Field of Invention

(1) This invention relates in general to slip hangers to be used around casing, and, in particular, to a compression plate that includes at least one bolt hole and includes at least one split in the at least one bolt hole to improve pre-loading of a seal in the slip hanger.

2. Description of the Prior Art

(2) A wellhead may be provided in an oil and gas drilling operation to suspend casings or strings, to seal annulus between such casings and strings, and to provide interfaces for aspects of the wellhead, such as a blow-out preventer ("BOP"). In a drilling operation, concentric casings may be delivered downhole of a well to support a borehole. Such casings can also isolate a borehole from different fluid producing zones. The wellhead may be used to support casing hangers that in turn support a weight of the casings. A slip hanger includes a seal and may be provided to prevent well fluid from escaping through a head of a casing. Furthermore, a force may be necessary to energize a seal of the slip hanger.

SUMMARY

(3) In at least one embodiment, a compression plate to be used with a slip hanger is disclosed. The compression plate includes at least one bolt hole and includes at least one split in the at least one bolt hole.

(4) In at least one embodiment, a method for preparing a compression plate to be used with a slip hanger is disclosed. The method includes machining the compression plate according to predetermined dimensions. A further step in the method includes drilling at least one bolt hole in the compression plate. A splitting is performed for the compression plate to be split at the at least one bolt hole.

(5) In at least one embodiment, a method for a compression plate to be used with a slip hanger is disclosed. The method includes providing the compression plate in multiple sections to be associated together around a casing. The multiple sections join to form at least one split that is within at least one bolt hole of the compression plate. The method includes assembling the compression plate with at least one bolt through the at least one bolt hole.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) Various embodiments in accordance with the present disclosure will be described with reference to the drawings, in which:

(2) FIG. **1** illustrates a section view of a casing and associated slip hanger, in accordance with at least one embodiment.

(3) FIG. **2** illustrates a slip hanger, in part, that is subject to improvements of at least one embodiment herein.

(4) FIG. **3** illustrates a slip hanger of at least one embodiment.

(5) FIG. **4** illustrates cones of bolt influence during pre-loading of a slip hanger according to at least one embodiment.

(6) FIG. **5** illustrates a method to be used with the slip hanger in FIGS. **1**-**4**, in accordance with at least one embodiment.

(7) FIG. **6** illustrates another method to be used with the slip hanger in FIGS. **1**-**4**, in accordance with at least one embodiment.

DETAILED DESCRIPTION

(8) In the following description, various embodiments will be described. For purposes of explanation, specific configurations and details are set forth in order to provide a thorough understanding of the embodiments. However, it will also be apparent to one skilled in the art that the embodiments may be practiced without the specific details. Furthermore, well-known features may be omitted or simplified in order not to obscure the embodiment being described.

(9) Various other functions can be implemented within the various embodiments as well as discussed and suggested elsewhere herein. In at least one embodiment, the present disclosure is to a compression plate to be used with a slip hanger, along with embodiments of methods to prepare and use such a compression plate, where the compression plate includes at least one bolt hole and

includes at least one split in the at least one bolt hole.
(10) In at least one embodiment, manually energized slip hangers may be installed around a section of a casing by wrapping the slip hanger around the casing. A seal, such as a compression seal, may be split or cut in sections (such as two halves) and assembled with the compression plate that is over the seal and a slip bowl that is under the seal. The slip bowl may be also in sections with the sections joining at a gland split. This assembly is so that each section (such as a half) of the seal is aligned with a section (such as a half) of a slip bowl in the slip hanger. In at least one embodiment, each of such sections of a seal, of a slip bowl, or of a compression plate when used in conjunction with such features of a slip hanger may be referred to herein as halves with reference to each of such section of such features of a slip hanger, but may be referred to also as triples, quarters, when provided in more sections than the halves.
(11) In at least one embodiment, a seal bridge, which is an area of the seal that is between the halves of the slip bowl may be a weak point of the seal. This may be the case as a split on a top compression plate may be aligned with a seal split of the seal (or may be proximate to the seal split). Then, an end forming the split of the compression plate may be significantly less stiff than solid portions of the compression plate. As a result a compressive force, resulting from bolt preload may not be evenly applied through the compression plate to the seal during energization and operation and this may be evident in the split sections of the compression plate, the seal, and the slip bowl.
(12) In at least one embodiment, offsetting a split of a compression plate so that the split is within at least one bolt hole and overlaps a seal split (at the seal bridge) is described herein. The seal bridge may then come under the direct cones of influence from preloaded bolts, where the cones of influence reflect how a bolt tension clamping force extends on opposite sides of the seal split and the gland split. In at least one embodiment, therefore, the bolts on either side of a split of the compression plate can apply a clamping force subsequent to the bolt preload, through the compression plate, that covers the seal split. For example, the seal can be uniformly compressed across the seal bridge, as a result.
(13) In at least one embodiment, a section of the compression plate having the split in at least one bolt hole can enable such a section to evenly apply a bolt preload to the seal split of the seal, while maintaining a wrap-around functionality. The offsetting of the split of the compression plate to be within a bolt hole and under a bolt head of a bolt applied to the bolt hole enables the cone of influence to apply through the compression plate directly to either side of the compression plate split. The split area that includes the seal split and the gland split is fully supported, as a result. Therefore, a preload that is applied to the bolts can be evenly distributed through the compression plate and around the seal split. Moreover, the split end of the compression plate, that would otherwise be the least stiff section and unsupported if not split in at least one bolt hole, is now fully supported and directly compressed by the a bolt preload. This is advantageous as it allows for a more robust seal to be formed using the slip hanger, without compromising the wrap-around functionality.
(14) In at least one embodiment, the features herein address when the seal split is not offset from a gland split in the slip bowl that is below the seal and from the split of the compression plate that is above the seal. The features herein particularly address a weak point of the seal formed in this manner and that is supported by a weak part of the slip bowl (such as the gland split of the slip bowl). For example, an alignment (or proximate alignment) of the seal split, the gland split, and the split of the compression plate can result in a weak point of the slip hanger and particularly for the compression plate that is a least stiff section of the gland split and the compression plate. Further, a compression plate having a split and that is not fully supported at ends forming the split can behave as a cantilever beam that can deform as the seal is set. Such deformation can result in a lower seal compression load, which can weaken the seal and can result in an ineffective seal at the seal split region. A result from these issues is that a compression seal may not be fully energized along such

splits and can lead to leakage of well fluid.
(15) In at least one embodiment, providing a split within a bolt hole of a compression plate that is not proximate to the seal split of the seal is so that both ends of the split of the compression plate enable downward compression on the seal. In at least one embodiment, such a feature does not require in-field disassembly. Further, an advantage realized using features herein is that the slip hanger can be wrapped around the casing in the field without removing or installing any bolts or parts in the field.
(16) Features herein therefore also address requirements to assemble a slip hanger in the field. For example, such requirements may be to remove multiple fasteners, such as cap screws, from the slip hanger and to adjust the seal to overlap the gland split by at least one bolt hole. In at least one embodiment, doing so requires that at least two cap screws of the slip hanger are to be installed in the field, which can increase field time and can increases a risk associated with objects dropping into the well.
(17) FIG. **1** illustrates a section view **100** of a casing **102** and associated slip hanger **104**, in accordance with at least one embodiment. The slip hanger **104** may circumscribe an outer surface of a casing **102** and may be positioned between the outer surface **106** of the casing **102** and an inner surface **110** of a casing head **112**. The slip hanger **104** may include a compression plate that is bolted to an upper portion of a slip bowl, which further illustrated in FIG. **2**. The slip hanger **104** includes a seal **108**. In at least one embodiment, the seal **108** may be of an elastomeric material. However, other materials can be readily understood to be used in seals for a slip hanger based at least on the disclosure herein.
(18) FIG. **2** illustrates a slip hanger **200** that may be slip hanger **104** of FIG. **1**, in part, that is subject to improvements of at least one embodiment herein. In at least one embodiment, the seal hanger includes a compression plate **202** positioned over the seal **204**, which in turn may be positioned over a slip bowl **206**. Furthermore, a bottom plate may be positioned adjacent to or may be integral with the slip bowl **206**. A number of bolts/or fasteners **210** (also referred to herein as clamping members) may be provided for the bolt holes **208**. In at least one embodiment, the bolts **210** may include an elongated body to extend through the bolt holes **208**. The bolt holes **208** start from the compression plate **202** and extend through the seal **204**, and through at least part of the slip bowl **206**.
(19) The bolts **210** may rigidly connect the compression plate **202** to the slip bowl **206**. In at least one embodiment, therefore, the lower end of each bolt **210** independently connects to an upper portion of the slip bowl **206**. A washer stack and/or additional connectors may be provided individually or collectively, with the bolt **210**. The bolt **210** enables the compression plate **202** to apply a compression force on the seal **204** to put the seal **204** in a compressed state.
(20) In at least one embodiment, manually energized slip hangers, such as illustrated in FIG. **2**, may be installed around a section of a casing by wrapping the slip hanger **200** around the casing such as by wrapping individual sections **202**A, **204**A, **206**A, which are marked as one halves of the compression plate **202**, the seal **204**, and the slip bowl **206**, around a casing **102** (with their other halves that are not marked) before applying the bolts **210**.
(21) In at least one embodiment, therefore, the seal **204** may be split or cut in sections **204**A (such as two halves) and assembled with sections **202**A of the compression plate **202** that is over the seal **204** and with sections **206**A of the slip bowl **206** that is under the seal **204**. The slip bowl **206** that is in sections **206**A have the sections **206**A joining at a gland split **206**B. This assembly is so that each half **204**A of the seal **204** is aligned with a section (such as a half) **206**A of a slip bowl **206** in the slip hanger **200**.
(22) In at least one embodiment, a seal bridge **214** occurs in an area of the seal that is between the halves **206**A of the slip bowl **206**. The seal bridge **214** may be a weak point of the seal and subsequently of the slip hanger **200**. This may be the case as a split **202**B on a top compression plate **202** may be aligned with a seal split **204**B of the seal **204** (or may be proximate to the seal

split). Then, an end forming the split **202**B of the compression plate **202** may be significantly less stiff than solid portions of the compression plate **202**. As a result, a bolt preload may not be evenly applied through the compression plate **202** when a compressive force applied to the seal **204** by the bolts **210** and this is evident in the split sections **202**A, **204**A, **206**A of the compression plate **202**, the seal **204**, and the slip bowl **206**.

(23) In at least one embodiment, the features herein address when the seal split **204**B that is not offset from a gland split **206**B and split **202**B of a compression plate, and instead, may be coincidental with the gland split **206**B of the slip bowl **206** and the split **202**B of the compression plate **202**. The features herein particularly address a weak point of the seal formed in this manner and that is supported by a weak part of the slip hanger components (such as the gland split **206**B of the slip bowl **206** and the split **202**B of the compression plate **202**). For example, an alignment (or proximate alignment) of the seal split **204**B, the gland split **206**B, and the split **202**B of the compression plate **202** then results in a weak point of the slip hanger **200** that is a least stiff section of the gland split **206**B and the split **202**B of the compression plate **202**. A result from these issues is that a compression seal **202** may not be fully energized along such splits **202**B, **204**B, **206**B and can lead to leakage of well fluid.

(24) FIG. **3** illustrates a slip hanger **300** of at least one embodiment. In at least one embodiment, relative to FIG. **2**, a split **302**B of a compression plate **302** is so that the split **302**B is within at least one bolt hole **306**. Further, the split **302**B of the compression plate **302** overlaps a seal split **204**B (such as at or proximate to the seal bridge previously described) of a seal **204**. The seal bridge described herein may then come under a cone of influence from a preloaded bolt **210**. FIG. **4** illustrates cones **402**A, B of influence from a preloaded bolt **210** during energization of a slip hanger according to at least one embodiment. FIG. **4** omits the compression plate **302** through which the cones **402**A, B act on the seal **204** and the slip bowl **206**, only to illustrate the cones **402**A, B of influence overlapping the seal split **204**B and a gland split **206**B.

(25) Further, the cones **402**A, B of influence diagrammatically illustrate how a bolt preload extends on opposite sides of the seal split **204**B and the gland split **206**B. In at least one embodiment, therefore, the bolts **210** on either side of a split **302**B of the compression plate **302** can apply a clamping force subsequent to the bolt preload, through the compression plate **302**, that covers the seal split **204**B. For example, the seal **204** can be uniformly compressed across the seal bridge, as a result.

(26) In at least one embodiment, a section **302**A of the compression plate **302** having the split **302**B in at least one bolt hole **306** enables each section **302**A to evenly apply a bolt preload to the seal split of the seal **204**, while maintaining a wrap-around functionality. An offsetting **304** of the split **302**B of the compression plate **302** to be within a bolt hole **306** and under a head of a bolt **210** applied to the bolt hole **306** enables the cone **402**A,B of influence to apply through the compression plate **302**. The split area that includes the seal split **204**B and the gland split **206**B is fully supported, as a result. Therefore, a preload that is applied to the bolts **210** can be evenly distributed through the compression plate **302** and around the seal split **204**B, relative to FIG. **2**. This is advantageous as it allows for a more robust seal to be formed using the slip hanger **300**, without compromising the wrap-around functionality or the removal and/or installation of cap screws in the field.

(27) In at least one embodiment, therefore, disclosed herein is a compression plate **302** to be used with a slip hanger **300**. The compression plate **302** includes at least one bolt hole **306** and includes at least one split **302**B in the at least one bolt hole **306**. In at least one embodiment, further, the compression plate **302** includes the split **302**B being tangential to the at least one bolt hole **306**. In at least one embodiment, if the compression plate is split into two halves, the ends of each half can include part of a bolt hole to be assembled together with the seal and the slip bowl.

(28) In at least one embodiment, a compression plate **302** can therefore include a number of sections, one of which is marked **302**A, and not just two halves. The sections of the compression

plate are located over a seal **204**. The seal **204** includes a number of sections, one which is marked **204**A, to be located over a slip bowl **206**. In at least one embodiment, the number of sections of a compression plate **302** may be determined based in part on the number of sections of a seal **204**. Further, the slip bowl **206** may also include sections, one of which is marked **206**A. The compression plate **302**, the seal **204**, and the slip bowl **206** are to be assembled together around a casing **102**.

(29) The compression plate **302** herein includes at least one bolt hole **306** that is adapted to receive at least one bolt **210**. The at least one bolt **210** is adapted to receive a force, such as a preloading force. The compression plate **302** is adapted to compress at individual sections, such as a section **302**A illustrated, of the compression plate, to compress, energize, and reinforce a seal **204** that is underlying the compression plate **302** by at least the split **302**B of the compression plate **302**. Therefore, the compression plate **302** is a reinforced compression plate with a split **302**B for a slip hanger. In at least one embodiment, a compression plate **302** is adapted to assert uniform downward clamping pressure, at least represented in part via the cones **402**A, B of influence, through the individual sections, such as a section **302**A, of the compression plate **302**.

(30) In at least one embodiment, a compression plate **302** herein supports a seal **204** that is associated with the compression plate **302**, where the seal **204** includes a seal split **204**B that is between two bolt holes **306**, **308** and that include the at least one bolt hole **306** having the split **302**B of the compression plate. In at least one embodiment, a compression plate **302** herein includes a number of sections, one section **302**A is illustrated, where individual ends of such individual sections can be assembled together to form the at least one split **302**B.

(31) In at least one embodiment, a compression plate **302** herein includes individual ones of a number of sections, of which one section **302**A is referenced in each of the FIGS. **3** and **4**. The number of sections can include part of the at least one bolt hole **306** in at least one of its respective ends, such as an end forming the split **302**B of the compression plate **302**. In at least one embodiment, a compression plate **302** herein is so that individual ones of the number of sections of the compression plate **302** can be assembled together over a seal **204** to include at least one split **302**B in an offset **304** position relative to a seal split **204**B of the seal **204**.

(32) FIG. **5** illustrates a method **500** to be used with the slip hanger in FIGS. **1**-**4**, in accordance with at least one embodiment. In at least one embodiment, the method **500** is for preparing a compression plate **302** to be used with a slip hanger **300**. The method **500** includes machining (**502**) the compression plate according to predetermined dimensions. The method **500** includes drilling (**504**) at least one bolt hole in the compression plate. In at least one embodiment, the method **500** includes determining (**506**) a number of sections for the compression plate, such as based in part on a number of section of a seal to be used with the compression plate. The method **500** includes splitting (**508**) the compression plate at the at least one bolt hole to provide the sections. Further holes in the compression plate may be provided by step **504** herein.

(33) In at least one embodiment, the method **500** herein may include a step or a sub-step for splitting of the compression plate by providing a split, in the at least one bolt hole, that is tangential to the at least one bolt hole, as described at least with respect to FIG. **3**. In at least one embodiment, the method **500** herein may include a step or a sub-step for splitting of the compression plate to provide a number of sections for the compression plate to be associated together around a casing of the at least one bolt hole. In at least one embodiment, the method **500** herein may include a step or a sub-step for threading the at least one bolt hole in a body of the slip hanger to enable the at least one bolt hole to receive at least one bolt. The at least one bolt may be adapted to receive a force and the compression plate may be adapted to compress individual sections of the compression plate to energize, compress, and reinforce a seal underlying the compression plate.

(34) FIG. **6** illustrates another method **600** to be used with the slip hanger in FIGS. **1**-**4**, in accordance with at least one embodiment. In at least one embodiment, the method **600** herein is for a compression plate **302** to be used with a slip hanger **300**. The method **600** includes providing

(**602**) the compression plate in a number of sections to be associated together around a casing. The number of sections join to form at least one split that is within at least one bolt hole of the compression plate. The method **600** includes enabling (**604**) the sections from step **602** to be associated together around a casing. The method **600** includes verifying (**606**) that the sections are ready to be assembled. This step may include verifying the alignment of the underlying seal and slip bowl. The method **600** includes assembling (**608**) the compression plate with at least one bolt through the at least one bolt hole.

(35) In at least one embodiment, the method **600** herein may include a step or a sub-step for providing a seal over a lip of a slip bowl. In at least one embodiment, the method **600** herein may include a step or a sub-step for adjusting the seal so that a seal split is offset or coincidental over a gland split. Further, the method **600** herein may include a step or a sub-step for providing the compression plate over the seal. The at least one split is offset relative to the seal split.

(36) In at least one embodiment, the method **600** herein may be performed so that the at least one split is tangential to the at least one bolt hole. In at least one embodiment, the method **600** herein may include a step or a sub-step for providing a preload to the at least one bolt to cause the compression plate to compress individual ones of the plurality of sections of the compression plate to energize, compress, and reinforce a seal underlying the compression plate. In at least one embodiment, the method **600** herein may be performed so that the compression plate is adapted to assert uniform downward clamping pressure through the plurality of sections of the compression plate. In at least one embodiment, the method **600** herein may be performed so that a seal is associated with the compression plate and the seal includes a seal split that is between two bolt holes that include the at least one bolt hole. In at least one embodiment, the method **600** herein may be performed so that individual ends of individual ones of the number of sections form the at least one split and include at least part of the at least one bolt hole.

(37) The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense. It will, however, be evident that various modifications and changes may be made thereunto without departing from the broader spirit and scope of the invention as set forth in the claims. Further, any of the many embodiments disclosed here may be combined by a person of ordinary skill using the present disclosure to understand the effects of such combinations.

Claims

1. A compression plate associated with a seal and a slip bowl of a slip hanger, the compression plate comprising at least one bolt hole and comprising at least one split in the at least one bolt hole, wherein the compression plate is arranged with the at least one split in an offset position relative to a seal split of the seal and with the seal and the slip bowl being under the compression plate, and wherein the seal split is coincidental with a gland split of the slip bowl.

2. The compression plate associated with the seal and the slip bowl of the slip hanger of claim 1, wherein the at least one split being through the at least one bolt hole to provide two halves for the compression plate.

3. The compression plate associated with the seal and the slip bowl of the slip hanger of claim 1, wherein the compression plate comprises a plurality of first sections to be located over the seal, wherein the seal comprises a plurality of second sections to be located over the slip bowl, wherein the slip bowl comprises a plurality of third sections, and wherein the compression plate, the seal, and the slip bowl are to be assembled together around a casing.

4. The compression plate associated with the seal and the slip bowl of the slip hanger of claim 1, wherein the at least one bolt hole is adapted to receive at least one bolt, wherein the at least one bolt is adapted to receive a force and wherein the compression plate is adapted to compress at individual sections of the compression plate and is adapted to compress the seal underlying the compression plate.

5. The compression plate associated with the seal and the slip bowl of the slip hanger of claim 4, wherein the compression plate is adapted to assert uniform downward clamping pressure through the individual sections of the compression plate.
6. The compression plate associated with the seal and the slip bowl of the slip hanger of claim 1, wherein the at least one bolt hole that is between two further bolt holes, individual ones of the two further bolt holes being on either side of the at least one bolt hole.
7. The compression plate associated with the seal and the slip bowl of the slip hanger of claim 1, further comprising: a plurality of sections, wherein individual ends of individual ones of the plurality of sections assembled together form the at least one split.
8. The compression plate associated with the seal and the slip bowl of the slip hanger of claim 7, wherein individual ends of individual ones of the plurality of sections comprise at least part of the at least one bolt hole.
9. The compression plate associated with the seal and the slip bowl of the slip hanger of claim 7, wherein individual ones of the plurality of sections of the compression plate are assembled together over the seal, and wherein the at least one split of the bolt hole is in the offset position relative to the seal split of the seal.
10. A method for preparing a compression plate used with a seal and a slip bowl of a slip hanger, the method comprising: machining the compression plate according to predetermined dimensions; and drilling at least one bolt hole in the compression plate; and splitting the compression plate at the at least one bolt hole, wherein the splitting provides at least one split in the at least one bolt hole, the at least one split being predetermined to enable arrangement of the compression plate with the at least one split in an offset position relative to a seal split of the seal and with the seal and the slip bowl being under the compression plate, and wherein the seal split is coincidental with a gland split of the slip bowl.
11. The method of claim 10, wherein the splitting of the compression plate further comprises: providing the at least one split through the at least one bolt hole to provide two halves for the compression plate.
12. The method claim 10, wherein the splitting of the compression plate provides a plurality of sections for the compression plate to be associated together around a casing.
13. The method of claim 10, further comprising: threading the at least one bolt hole of a body of the slip hanger to enable the at least one bolt hole to receive at least one bolt, wherein the at least one bolt is adapted to receive a force and wherein the compression plate is adapted to compress individual sections of the compression plate to compress the seal underlying the compression plate.
14. A method for a compression plate used with a seal and with a slip bowl of a slip hanger, the method comprising: providing the compression plate in a plurality of sections and associated together around a casing, wherein the plurality of sections join to form at least one split that is within at least one bolt hole of the compression plate; arranging the at least one split of the compression plate in an offset position relative to a seal split of the seal, wherein the seal split is coincidental with a gland split of the slip bowl and assembling the compression plate with at least one bolt through the at least one bolt hole.
15. The method of claim 14, further comprising: providing the seal over a lip of the slip bowl; and providing the plurality of sections of the compression plate over the seal and over the slip bowl.
16. The method claim 14, wherein the at least one split is through the at least one bolt hole to provide two halves for the compression plate, the two halves of the compression plate forming the plurality of sections.
17. The method of claim 14, further comprising: providing a preload to the at least one bolt to cause the compression plate to compress individual ones of the plurality of sections of the compression plate and to compress the seal underlying the compression plate.
18. The method of claim 14, wherein the compression plate is adapted to assert uniform downward clamping pressure through the plurality of sections of the compression plate.

19. The method of claim 14, wherein the at least one bolt hole that is between two further bolt holes, individual ones of the two further bolt holes being on either side of the at least one bolt hole.
20. The method of claim 14, wherein individual ends of individual ones of the plurality of sections comprise at least part of the at least one bolt hole.