Abstract: A tool (10) for testing pressure in a wellhead, having a stem (12) for insertion in the wellhead, the stem having an up position and a down position. The tool (10) further includes an energizing member (14) and an isolation seal (16), so that when the stem (12) is in the down position, the energizing member (14) energizes the isolation seal (16) so that it seals against the wellhead. In addition, the tool (10) includes a plug adapter (20) surrounding the stem (12) and having a variable inner diameter that selectively seals against the stem (12), so that when the stem (12) is in the up position the interface between the plug adapter (20) and the stem (12) is sealed, and when the stem (12) is in the down position, the interface between the plug adapter (20) and the stem (12) is not sealed.

Declarations under Rule 4.17:

- as to applicant’s entitlement to apply for and be granted a patent (Rule 4.1 7(H))
- as to the applicant’s entitlement to claim the priority of the earlier application (Rule 4.1 7(iii))

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MULTIFUNCTIONAL TEST TOOL FOR SUBSEA APPLICATIONS

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] This technology relates to oil and gas wells, and in particular to testing multiple pressure seals in wellhead assemblies of an oil and gas well with a single tool.

2. Brief Description of Related Art

[0002] Pressure testing of seals near the wellheads of subsea oil and gas wells is beneficial to ensure the integrity of the seals at certain interfaces. For example, a plug may be used to seal the inside of a casing hanger. Such a plug allows for pressure testing of the annulus seal between the casing hanger and the wellhead. Similarly, an isolation seal may be used to seal the wellhead itself, thereby allowing pressure testing of components above the wellhead, such as, for example, blow-out preventer (BOP) rams, or seals between the drilling connect and the wellhead.

[0003] Typically, such tests are run individually, requiring separate tools to complete each test. Thus, one tool is run with an annulus plug to test the annulus seal, which tool is removed subsequent to the test. Thereafter, another tool is run with an isolation seal to perform the isolation test, and is then removed from the well. Of course, the tests may be run in the opposite order as well, with the isolation test first, and the plug test second.

SUMMARY OF THE INVENTION

[0004] Disclosed herein is an example of a tool for testing pressure in a wellhead having a high pressure housing with a casing hanger inserted therein. The tool includes a longitudinal stem for insertion in the wellhead, the longitudinal stem having an up position and a down position. The tool also includes an energizing member in mechanical communication with an isolation seal, so that when the longitudinal stem is in the down position, the energizing
member compresses the isolation seal, and the isolation seal seals against the wellhead. In addition, the tool includes a plug adapter surrounding the longitudinal stem and having a variable inner diameter that selectively seals against the longitudinal stem, so that when the stem is in the up position the interface between the plug adapter and the longitudinal stem is sealed, and when the stem is in the down position, the interface between the plug adapter and the longitudinal stem is not sealed.

[0005] Also disclosed herein is a method for pressure testing components in a well. The method includes the steps of inserting a tool having an isolation seal and a plug adapter into a well so that the isolation seal is disposed adjacent a high pressure wellhead and the plug adapter is disposed adjacent a casing hanger, and sealing the casing hanger so that fluid above the plug adapter is contained above the plug adapter. The method also includes increasing the pressure of fluid above the plug adapter, and monitoring the pressure above the plug adapter to determine the integrity of the seal between the casing hanger and the high pressure wellhead. The method further includes adjusting the tool to open the plug adapter and allow fluid to flow past the plug adapter to a portion of the well below the plug adapter, sealing the interface between the isolation seal and the high pressure wellhead, increasing the pressure of fluid above the isolation seal, and monitoring the pressure above the isolation seal to determine the integrity of components above the isolation seal.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The present technology will be better understood on reading the following detailed description of nonlimiting embodiments thereof, and on examining the accompanying drawings, in which:

[0007] Fig. 1 is cross-sectional side view of a pressure testing tool according to an embodiment of the present technology;
[0008] Fig. 2 is cross-sectional side view of a plug adapter of a pressure testing tool according to an embodiment of the present technology;

[0009] Fig. 3 is perspective view of a stem of a pressure testing tool according to an embodiment of the present technology;

[0010] Fig. 4A is an enlarged cross-sectional side view of a pressure testing tool according to an embodiment of the present technology, where the stem is in the up position;

[0011] Fig. 4B is an enlarged cross-sectional side view of a pressure testing tool according to an embodiment of the present technology, where the stem is in the down position;

[0012] Fig. 5A is an enlarged cross-sectional side view of a pressure testing tool according to an alternate embodiment of the present technology, where the stem is in the up position; and

[0013] Fig. 5B is an enlarged cross-sectional side view of a pressure testing tool according to an alternate embodiment of the present technology, where the stem is in the down position.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0014] The foregoing aspects, features, and advantages of the present technology will be further appreciated when considered with reference to the following description of preferred embodiments and accompanying drawings, wherein like reference numerals represent like elements. In describing the preferred embodiments of the technology illustrated in the appended drawings, specific terminology will be used for the sake of clarity. However, the technology is not intended to be limited to the specific terms used, and it is to be understood that each specific term includes equivalents that operate in a similar manner to accomplish a similar purpose.

[0015] Fig. 1 is side cross-sectional view of a pressure testing tool 10 according to an embodiment of the present technology. The pressure testing tool 10 includes an elongate longitudinal stem 12, portions of which are surrounded by an energizing sleeve 14, an
isolation seal 16, an adjustment sleeve 18, and a plug adapter 20. The pressure testing tool 10 further includes a set of stem isolation seals 24, a set of upper plug seals 26, a set of lower plug seals 28, and a set of stem plug seals 30. Although the embodiment shown includes pairs of seals 24, 26, 28, and 30, it is possible that each pair of seals could be replaced with a single seal, or with more than two seals. Seals 24, 26, 28, and 30 circumscribe tool 10 at axially spaced apart locations.

Fig. 2 shows an example of the plug adapter 20 in a sectional view, including its variable diameter and a portion of its inner surface. The inner diameter of the plug adapter 20 is relatively smaller at a plug upper section 32 than at a plug lower section 34. When the stem 12 is in its upper position, as shown in Fig. 4A, the stem plug seals 30 seal against the inner surface of the plug upper section 32. When the stem 12 is in its lower position as shown in Fig. 4B, an annulus is defined between the stem plug seals 30 and the inner surface of the plug lower section 34 that allows fluid to pass between the stem plug seals 30 and the inner surface of the plug lower section 34. The plug adapter 20 is configured to surround the stem 12, and may be held in place on the stem 12 with a tool landing ring 35 while the pressure testing tool 10 is deployed.

Fig. 3 shows a perspective view of the stem 12 with all other components of the pressure testing tool 10 removed. The J-slot mechanism includes a slot 36 having a vertical portion 38 and a horizontal portion 40. The slot 36 is arranged on the surface of the stem 12 to interact with a protrusion (not shown) that may extend from another part of the tool 10, such as, for example, the adjustment sleeve 18. When the protrusion extends into the horizontal portion 40 of the slot 36, the stem 12 is held in the upper position shown in Fig. 4A. Upon rotation of the stem 12, however, the protrusion can be made to leave the horizontal portion 40 of the slot 36 and enter the vertical portion 38 of the slot 36. When this happens, the stem 12 drops downward until it lands in the position shown in Fig. 4B. Thus,
the stem 12 can be moved from the upper to the lower position by twisting and dropping the stem 12, and can be moved from the lower to the upper position by lifting and twisting the stem 12 in the opposite direction. In Fig. 3, the slot 36 is oriented so that rotation of the step is to the right (clockwise) in order to drop the stem. Of course, the slot 36 could be oriented in any configuration, including so that the stem 12 is rotated to the left (counter clockwise) to drop the stem 12.

[0018] Referring now to Figs. 4A and 4B, there is shown the pressure testing tool 10 inserted into a wellhead assembly that includes a high pressure housing 42, a casing hanger 44, and an annulus seal 46 between housing 42 and hanger 44. In Fig. 4A, the pressure testing tool 10 is shown with the stem 12 in an up position, so as to allow pressure testing of the annulus seal 46. To accomplish this testing, the stem 12 is positioned relative to the plug adapter 20 so that the stem plug seals 30 seal the interface between the stem 12 and the plug adapter 20 by contacting the inner surface of the plug upper section 32. Upper plug seals 26 in turn seal the interface between the plug adapter 20 and the casing hanger 44. In this configuration, the pressure testing tool 10 isolates the area within the casing hanger 44 below the plug adapter 20.

[0019] With the pressure testing tool arranged as shown in Fig. 4A, the annulus seal 46 can be tested. To accomplish this, the pressure in the well above the plug adapter 20 is raised to a predetermined level. In some embodiments, the pressure above the plug adapter 20 may be raised to about 15,000 psi or more. With the inner diameter of the casing hanger 44 sealed as shown in Fig. 4A, the operator can verify that no fluid leaks past the annulus seal 46 located between the casing hanger 44 and the high pressure housing 42.

[0020] As shown in Fig. 4B, the pressure testing tool 10 can next be adjusted to conduct isolation testing of the well. To accomplish this, the stem 12 is lowered until the stem plug seals 30 come out of contact with the inner surface of the plug adapter 20. This occurs when
the stem plug seals 30 move from the plug upper section 32 to the plug lower section 34. As the stem 12 moves downward, the compression ring 13 also moves downward. This is because the compression ring 13 is longitudinally fixed relative to the stem 12. As the stem 12 lowers, the compression ring 13 contacts and pushes the energizing sleeve 14 downward. As the energizing sleeve 14 moves downward, it energizes the isolation seal 16 by compressing it against the high pressure housing 42. Thus, the isolation seal 16 seals the interface between the pressure testing tool 10 and the high pressure housing 42. As the stem 12 reaches its down position, in which the isolation seal 16 is energized, the stem isolation seals 24 internally engage components of the tool 10, thereby sealing internal leak paths in the tool 10. Thus, the pressure testing tool 10 isolates the area above the isolation seal 16.

[0021] With the pressure testing tool arranged as shown in Fig. 4B, components above the isolation seal 16 (e.g., blowout preventer (BOP) rams, or seals in the subsea connectors), can be tested. To accomplish this, the pressure above the isolation seal 16 is raised to a predetermined level. In some embodiments, the pressure above the seal 16 may be raised to about 15,000 psi or more. With the inner diameter high pressure housing 42 sealed by the isolation seal 16 as shown in Fig. 4B, the operator can verify that no fluid leaks are present in areas to be tested.

[0022] Figs. 5A and 5B depict the pressure testing tool 10 inserted into a wellhead assembly that includes the components shown in Figs. 4A and 4B, except that instead of casing hanger 44 located in a first position, there is shown an alternate casing hanger 144 shown in a second position. In Fig. 5A, the pressure testing tool 10 is shown with the stem 12 in an up position, so as to allow pressure testing of the annulus seal 46. To accomplish this testing, the stem 12 is positioned relative to the plug adapter 20 so that the stem plug seals 30 seal the interface between the stem 12 and the plug adapter 20 by contacting the inner surface of the plug upper section 32. Lower plug seals 28 in turn seal the interface between the plug adapter 20 and the
casing hanger 144. In this configuration, the pressure testing tool 10 isolates the area within the casing hanger 144 above the plug adapter 20.

[0023] With the pressure testing tool arranged as shown in Fig. 5A, the annulus seal 46 can be tested. To accomplish this, the pressure in the well below the plug adapter 20 is raised to a predetermined level. In some embodiments, the pressure below the plug adapter 20 may be raised to about 15,000 psi or more. With the inner diameter of the casing hanger 144 sealed as shown in Fig. 5A, the operator can verify that no fluid leaks past the annulus seal 46 located between the casing hanger 144 and the high pressure housing 42.

[0024] As shown in Fig. 5B, the pressure testing tool 10 can next be adjusted to conduct isolation testing of the well. To accomplish this, the stem 12 is lowered until the stem plug seals 30 come out of contact with the inner surface of the plug adapter 20. This occurs when the stem plug seals 30 move from the plug upper section 32 to the plug lower section 34. As the stem 12 moves downward, a downward oriented face 48 on stem 12 contacts a corresponding upward oriented face 50 on the energizing member 18. As the stem 12 moves downward, the compression ring 13 also moves downward. This is because the compression ring 13 is longitudinally fixed relative to the stem 12. As the stem 12 lowers, the compression ring 13 contacts and pushes the energizing sleeve 14 downward. As the energizing sleeve 14 moves downward, it energizes the isolation seal 16 by compressing it against the high pressure housing 42. The isolation seal 16 seals the interface between the isolation sleeve 14 and the high pressure housing 42. As the stem 12 reaches its down position, in which the isolation seal 16 is energized, the stem isolation seals 24 internally engage components of the tool 10, thereby sealing internal leak paths in the tool 10. Thus, the pressure testing tool 10 isolates the area above the isolation seal 16.

[0025] With the pressure testing tool arranged as shown in Fig. 5B, components above the isolation seal 16, (e.g., BOP rams, or seals in the subsea connectors, such as between the
drilling connect and wellhead) can be tested. To accomplish this, the pressure above the isolation seal 16 is raised to a predetermined level. In some embodiments, the pressure above the seal 16 may be raised to about 15,000 psi or more. With the inner diameter high pressure housing 42 sealed by the isolation seal 16 as shown in Fig. 5B, the operator can verify that no fluid leaks are present in areas to be tested.

[0026] One advantage of the presently described pressure testing tool is the ability to conduct both plug and isolation tests in a well in one run. Known systems require running plug and isolation tests in series, because each test requires a separate tool. As a result of the one-run capability to conduct multiple tests, the number of trips necessary to pressure test is reduced, which saves time and money, and increases efficiency.

[0027] While the technology has been shown or described in only some of its forms, it should be apparent to those skilled in the art that it is not so limited, but is susceptible to various changes without departing from the scope of the invention. Furthermore, it is to be understood that the above disclosed embodiments are merely illustrative of the principles and applications of the present invention. Accordingly, numerous modifications may be made to the illustrative embodiments and other arrangements may be devised without departing from the spirit and scope of the present invention as defined by the appended claims.
What is claimed is:

1. A tool for testing pressure in a wellhead bore, comprising:
   a longitudinal stem;
   an energizing member circumscribing the stem and in communication with an isolation seal, the isolation seal capable of expanding into sealing contact with an inner surface of the bore when the stem is in a down position; and
   a plug adapter surrounding the longitudinal stem and having a variable inner diameter that selectively seals against the longitudinal stem, so that when the stem is in the up position the interface between the plug adapter and the longitudinal stem is sealed, and when the stem is in the down position, the plug adapter is set back from the longitudinal stem.

2. The tool of claim 1, wherein the plug adapter has at least first and second plug seals circumscribing the plug adapter on an outer surface thereof for sealing against the inner surfaces of a first position casing hanger and a second position casing hanger, respectively, the first plug seal located at a first position for sealing the interface between the plug adapter and the first position casing hanger, and the second plug seal located at a second position for sealing the interface between the plug adapter and the second position casing hanger.

3. The tool of claim 1 further comprising an adjustment member, wherein the position of the longitudinal stem is determined by a slot that engages a portion of the adjustment member, the slot having a horizontal portion and a vertical portion, and the longitudinal stem adjusted between up and down positions by rotating the stem until the portion of the adjustment member that engages the slot is aligned with the vertical portion, thereby allowing the stem to rise and fall as the portion of the adjustment member tracks the vertical portion of the slot.
4. The tool of claim 1, wherein the variable inner diameter of the plug adapter includes an upper section having a first diameter, and a lower section having a second diameter, and wherein the second diameter is larger than the first diameter.

5. The tool of claim 4, wherein the outer surface of the longitudinal stem has a stem plug seal positioned to seal against the upper section of the inner diameter of the plug adapter when the longitudinal stem is in the up position, and to be separated from the lower section of the inner diameter of the plug adapter when the longitudinal stem is in the down position.

6. An apparatus for testing pressure in a wellhead having a high pressure housing with a casing hanger inserted therein, the apparatus comprising:

   a longitudinal stem for insertion in the wellhead and circumscribed by a compression ring that is fixedly attached to the stem in a longitudinal direction, the stem having an up position and a down position;

   an energizing sleeve surrounding the longitudinal stem, the energizing sleeve in an upper position when the stem is in the up position, and pushed by the compression ring into a lower position when the stem is in the down position;

   an isolation seal positioned between the apparatus and the high pressure housing so that when the energizing sleeve is in the down position, the isolation seal is energized and seals the interface between the apparatus and the high pressure housing;

   a plug adapter surrounding the longitudinal stem below the isolation sleeve proximate to the casing hanger, the plug adapter having a variable inner diameter, and a hanger seal that seals the interface between the plug adapter and the casing hanger;

   a plug seal attached to and circumventing an outer diameter of the longitudinal stem so that when the stem is in the up position, the plug seal seals the interface between the longitudinal stem and the plug adapter, and when the stem is in the down position, the plug
seal does not contact the plug adapter, thereby allowing fluid to pass between the plug adapter and the longitudinal stem.

7. The apparatus of claim 6, wherein the plug adapter has at least first and second seals circumscribing the plug seal on an outer surface thereof for sealing against the inner surfaces of a first position casing hanger and a second position casing hanger, respectively, the first seal located at a first position for sealing the interface between the plug adapter and the first position casing hanger, and the second seal located at a second position for sealing the interface between the plug adapter and the second position casing hanger.

8. The apparatus of claim 6, wherein the longitudinal stem includes a slot having a horizontal portion and a vertical portion, and the apparatus further comprises an adjustment sleeve aligned adjacent the slot, the longitudinal stem adjusted between up and down positions by rotating the stem until the portion of the adjustment sleeve that engages the slot is aligned with the vertical portion of the slot, thereby allowing the stem to rise and fall as the portion of the adjustment member tracks the vertical portion of the slot.

9. The apparatus of claim 6, wherein the variable inner diameter of the plug adapter includes an upper section having a first diameter, and a lower section having a second diameter, and wherein the second diameter is larger than the first diameter.

10. The apparatus of claim 9, wherein the outer surface of the longitudinal stem has a stem plug seal positioned to seal against the upper section of the inner diameter of the plug adapter when the longitudinal stem is in the up position, and to be separated from the lower section of the inner diameter of the plug adapter when the longitudinal stem is in the down position.

11. A method for pressure testing components in a well, the method comprising:
inserting a tool having an isolation seal and a plug adapter into a well so that the isolation seal is disposed adjacent a high pressure housing and the plug adapter is disposed adjacent a casing hanger;

sealing the casing hanger so that fluid above the plug adapter is contained above the plug adapter;

increasing the pressure of fluid above the plug adapter;

monitoring the pressure above the plug adapter to determine the integrity of the seal between the casing hanger and the high pressure housing;

adjusting the tool to open the plug adapter and allow fluid to flow past the plug adapter to a portion of the well below the plug adapter;

sealing the interface between the isolation seal and the high pressure housing;

increasing the pressure of fluid above the isolation seal;

monitoring the pressure above the isolation seal to determine the integrity of components above the isolation seal.

12. The method of claim 11, further comprising:

monitoring the pressure in a blow-out preventer (BOP) above the isolation seal to determine the integrity of the BOP rams.

13. The method of claim 11, further comprising:

monitoring the pressure in the drilling connect or high pressure housing to determine the integrity of the seal between the drilling connect and high pressure housing.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

**INV. E21B23/01 E21B33/04**

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

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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  "O" document referring to an oral disclosure, use, exhibition or other means
  
  "P" document published prior to the international filing date but later than the priority date claimed

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