Description

This invention relates to tubing hanger seals. More particularly this invention relates to tubing hanger seals that utilize a drive sleeve to compress a metal to metal seal between the inside of a tubing head and the outside of a tubing hanger.

In oil field or natural gas production operations it is always essential to seal the annulus between the production tubing and the well casing. In high temperature environments, metal seal rings have been used in place of elastomeric or plastic seals. In most cases, the tubing string provided the weight to compress the metal seal between the hanger and the tubing head shoulder. The result was that seal integrity was determined by an ever changing tubing string weight and annular formation pressure against the projected surface area of the bottom of the hanger. In addition, the seal was uni-directional and offered little protection against a blowout situation.

It is therefore an object of this invention to provide a metal to metal tubing hanger seal that does not depend on the weight of the tubing string for its integrity.

It is a further object of this invention to provide a metal to metal seal that can be energized to a given load unaffected by the tubing string.

It is yet a further object of this invention to provide a metal to metal seal that will retain its integrity against upward as well as downward forces.

GB-A-2216965 discloses a wedge-type sealing device energised by applying compressive force in an axial direction to cause radial expansion. A housing is rotated by a running tool to a stop position and continued rotation causes sealing devices to be compressed into a gap.

US-A-4836579 discloses a subsea casing hanger in which the hanger is set within the casing by expansion of a split load ring.

GB-A-2221484 discloses two sleeves which are moved together axially until a first sleeve is stopped by a projecting shoulder, whereupon the second sleeve is moved further to energize a seal.

US-A-4501441 discloses a radially set tubing hanger, with no seal means disclosed.

US-A-4907812 discloses an axially energized seal assembly, with no hanger means disclosed.

According to the present invention, there is provided a tubing hanger sealing assembly comprising a substantially cylindrical tubing head having a flange at each end, a substantially vertical longitudinal bore therethrough and a groove in the upper portion of the inside diameter of the substantially vertical longitudinal bore; a substantially cylindrical tubing hanger with a longitudinal bore therethrough for communicating with a tubing string, the substantially cylindrical tubing hanger having a partially threaded upper portion with a plurality of anti-rotational knobs and a larger diameter lower portion, the upper and lower portions being separated by an outwardly sloping shoulder; a substantially cylindrical drive sleeve having threads on the lower inside portion thereof, the drive sleeve constructed and arranged to engage, in a threaded relationship, with the tubing hanger, the substantially cylindrical drive sleeve further having a larger upper outside diameter and a smaller lower, outside diameter, the outside diameters being separated by an inwardly sloping shoulder; a substantially circular load ring having a smaller upper inside diameter and a larger lower inside diameter, the diameters separated by an inverted shoulder, the inverted shoulder having a plurality of slots on the underside thereof, the slots constructed and arranged to engage the anti-rotational knobs on the lower diameter of the tubing hanger; a metal sealing ring having an inner surface, the inner surface defining a downwardly facing wedge and further defining an annular groove in the outer surface to form an upper and lower annular sealing surface; a split ring constructed and arranged to fit into the groove in the upper portion of the inside diameter of the tubing head, the outside diameter of the ring having an upper shoulder and a lower inverted shoulder corresponding to the inverted top shoulder and the lower shoulder of the groove; a bearing ring attached to the top of the load ring to reduce friction between the substantially circular load ring and the drive sleeve.

Preferably, the invention operates as follows.

As the sleeve moves down the hanger, it engages a split ring which it forces down and out into a groove in the inside of the tubing head. As the sleeve moves past the split ring, it engages a load transfer ring which in turn, energizes the metal sealing ring by compressing it between the tubing head and the frustro-conical profile of the tubing hanger. Once the seal is energized to a predetermined load, the running tool is removed and the drive sleeve holds the metal to metal seal in place at the set force while the split ring serves to prevent any vertical movement of the hanger and seal ring.

In the accompanying drawings:

Figure 1 is an elevation view, partly in section, of a wellhead component including a running tool, drive sleeve, split ring, load ring and metal sealing ring.

Figure 2 is an elevation view in section showing the elements of Figure 1 in greater detail.

Figure 3 is an elevation view of the elements of Figure 1 depicting the sealing assembly in an energized state.

Figure 4 is an exploded pictorial view showing the load ring, the metal sealing ring and the

tubing hanger.

Referring to the drawings in greater detail, Figure 1 shows a tubing head in partial section that utilizes a sealing assembly that is the subject of the present invention. The drive sleeve 1 fits between the inner wall of the tubing head and the outside of the tubing hanger and is threaded to the tubing hanger. The drive sleeve is energized or threaded by a removable landing tool 2 which is inserted and removed from above and utilizes a locking mechanism consisting of a mating J-slot 9 in the top of the drive sleeve and a J-pin 10 at the end of the landing tool 2.

The drive sleeve 1 includes two inwardly sloping shoulders 11, 12 between its upper and lower diameters. As the sleeve moves down, the lower shoulder 12 contacts the split ring 3 forcing it down against the load ring 4 and then out into a groove 8 in the tubing head. As the split ring moves into the groove, it is retained on the outside diameter between shoulders 11, 12. This allows the sleeve to move down and energize the load ring 4 through a bearing 13. Rotation of the load ring is prevented by castellations 15 on the load ring shown in Figure 4 and mating castellations 14 on the outside of the tubing hanger also shown on Figure 4. The load ring in turn, energizes the metal seal ring 5 by forcing it into a wedge shaped area formed between the outwardly sloped tubing hanger and the inside of the tubing head.

By applying a given amount of torque to the landing tool, a very precise amount of sealing pressure can be applied to the metal seal ring. The upper shoulder 11 prevents overloading of the seal. When the desired amount of torque has been applied, the running tool is removed and the metal sealing assembly remains energized by the drive sleeve. In addition, the split ring remains in the groove 8, preventing blowout.

Although the foregoing specifically describes one embodiment of the invention, it should be that the invention is not limited to a single embodiment and the inventive concepts could be utilized in a number of different ways.

As the foregoing demonstrates, the present invention overcomes the problems associated with relying on the weight of a tubing string to energize a metal to metal seal. In addition, the invention provides an effective way to guard against an upward surge of pressure from the well and the resulting blowout.

Claims

1. A tubing hanger sealing assembly comprising a substantially cylindrical tubing head having a flange at each end, a substantially vertical longitudinal bore therethrough and a groove (8) in the upper portion of the inside diameter of the substantially vertical longitudinal bore; a substantially cylindrical tubing hanger with a longitudinal bore therethrough for communicating with a tubing string, the substantially cylindrical tubing hanger having a partially threaded upper portion with a plurality of anti-rotational knobs (14) and a larger diameter lower portion, the upper and lower portions being separated by an outwardly sloping shoulder; a substantially cylindrical drive sleeve (1) having threads on the lower inside portion thereof, the drive sleeve constructed and arranged to engage, in a threaded relationship, with the tubing hanger, the substantially cylindrical drive sleeve further having a larger upper outside diameter and a smaller lower, outside diameter, the outside diameters being separated by an inwardly sloping shoulder (11,12); a substantially circular load ring (4) having a smaller upper inside diameter and a larger lower inside diameter, the diameters separated by an inverted shoulder, the inverted shoulder having a plurality of slots (15) on the underside thereof, the slots constructed and arranged to engage the anti-rotational knobs on the lower diameter of the tubing hanger; a metal sealing ring (5) having an inner surface, the inner surface defining a downwardly facing wedge and further defining an annular groove in the outer surface to form an upper and lower annular sealing surface; a split ring (3) constructed and arranged to fit into the groove in the upper portion of the inside diameter of the tubing head, the outside diameter of the ring having an upper shoulder and a lower inverted shoulder corresponding to the inverted top shoulder and the lower shoulder of the groove; a bearing ring (13) attached to the top of the load ring to reduce friction between the substantially circular load ring and the drive sleeve.

2. A tubing hanger sealing assembly according to claim 1, wherein the cylindrical drive sleeve (1) includes a J-slot (9) around its upper perimeter, the J-slots constructed and arranged to allow engagement with a removable energising tool.

3. A tubing hanger sealing assembly according to claim 1 or claim 2, wherein the cylindrical drive sleeve (1) includes a larger upper diameter and a smaller lower diameter, the larger and smaller diameters being separated by two inwardly sloping shoulders (11,12).

4. A method of installing a tubing hanger sealing assembly according to any one of the preced-

tubing hanger.

Referring to the drawings in greater detail, Figure 1 shows a tubing head in partial section that utilizes a sealing assembly that is the subject of the present invention. The drive sleeve 1 fits between the inner wall of the tubing head and the outside of the tubing hanger and is threaded to the tubing hanger. The drive sleeve is energized or threaded by a removable landing tool 2 which is inserted and removed from above and utilizes a locking mechanism consisting of a mating J-slot 9 in the top of the drive sleeve and a J-pin 10 at the end of the landing tool 2.

The drive sleeve 1 includes two inwardly sloping shoulders 11, 12 between its upper and lower diameters. As the sleeve moves down, the lower shoulder 12 contacts the split ring 3 forcing it down against the load ring 4 and then out into a groove 8 in the tubing head. As the split ring moves into the groove, it is retained on the outside diameter between shoulders 11, 12. This allows the sleeve to move down and energize the load ring 4 through a bearing 13. Rotation of the load ring is prevented by castellations 15 on the load ring shown in Figure 4 and mating castellations 14 on the outside of the tubing hanger also shown on Figure 4. The load ring in turn, energizes the metal seal ring 5 by forcing it into a wedge shaped area formed between the outwardly sloped tubing hanger and the inside of the tubing head.

By applying a given amount of torque to the landing tool, a very precise amount of sealing pressure can be applied to the metal seal ring. The upper shoulder 11 prevents overloading of the seal. When the desired amount of torque has been applied, the running tool is removed and the metal sealing assembly remains energized by the drive sleeve. In addition, the split ring remains in the groove 8, preventing blowout.

Although the foregoing specifically describes one embodiment of the invention, it should be that the invention is not limited to a single embodiment and the inventive concepts could be utilized in a number of different ways.

As the foregoing demonstrates, the present invention overcomes the problems associated with relying on the weight of a tubing string to energize a metal to metal seal. In addition, the invention provides an effective way to guard against an upward surge of pressure from the well and the resulting blowout.

Claims

1. A tubing hanger sealing assembly comprising a substantially cylindrical tubing head having a flange at each end, a substantially vertical longitudinal bore therethrough and a groove (8) in the upper portion of the inside diameter of the substantially vertical longitudinal bore; a substantially cylindrical tubing hanger with a longitudinal bore therethrough for communicating with a tubing string, the substantially cylindrical tubing hanger having a partially threaded upper portion with a plurality of anti-rotational knobs (14) and a larger diameter lower portion, the upper and lower portions being separated by an outwardly sloping shoulder; a substantially cylindrical drive sleeve (1) having threads on the lower inside portion thereof, the drive sleeve constructed and arranged to engage, in a threaded relationship, with the tubing hanger, the substantially cylindrical drive sleeve further having a larger upper outside diameter and a smaller lower, outside diameter, the outside diameters being separated by an inwardly sloping shoulder (11,12); a substantially circular load ring (4) having a smaller upper inside diameter and a larger lower inside diameter, the diameters separated by an inverted shoulder, the inverted shoulder having a plurality of slots (15) on the underside thereof, the slots constructed and arranged to engage the anti-rotational knobs on the lower diameter of the tubing hanger; a metal sealing ring (5) having an inner surface, the inner surface defining a downwardly facing wedge and further defining an annular groove in the outer surface to form an upper and lower annular sealing surface; a split ring (3) constructed and arranged to fit into the groove in the upper portion of the inside diameter of the tubing head, the outside diameter of the ring having an upper shoulder and a lower inverted shoulder corresponding to the inverted top shoulder and the lower shoulder of the groove; a bearing ring (13) attached to the top of the load ring to reduce friction between the substantially circular load ring and the drive sleeve.

2. A tubing hanger sealing assembly according to claim 1, wherein the cylindrical drive sleeve (1) includes a J-slot (9) around its upper perimeter, the J-slots constructed and arranged to allow engagement with a removable energising tool.

3. A tubing hanger sealing assembly according to claim 1 or claim 2, wherein the cylindrical drive sleeve (1) includes a larger upper diameter and a smaller lower diameter, the larger and smaller diameters being separated by two inwardly sloping shoulders (11,12).

4. A method of installing a tubing hanger sealing assembly according to any one of the preced-

* C L M S *

ing claims, the method comprising the steps of lowering a running tool (2) into the tubing head; engaging the drive sleeve (1) with the running tool; rotating the running tool until the sleeve exerts a desired amount of force on the split ring (3) driving it into the groove (8) in the upper portion of the inside diameter of the tubing head and engaging the bearing ring (13) which exerts a downward force on the metal seal (5); disengaging the running tool from the drive sleeve; and extracting the running tool.

Patentansprüche

1. Dichtungsanordnung für Bohrlochhänger, **dadurch gekennzeichnet, daß** sie gebildet ist aus:
einem im wesentlichen zylindrischen Bohrlochkopf mit einem Flansch an jedem Ende, einer durchgehenden, im wesentlichen vertikalen Längsbohrung und einer Nut (8) im oberen Teil der Innenseite der im wesentlichen vertikalen Längsbohrung;
einem im wesentlichen zylindrischen Bohrlochhänger mit einer durchgehenden Längsbohrung zur Verbindung mit einem Rohrstrang, wobei der im wesentlichen zylindrische Bohrlochhänger ein zum Teil mit Gewinde versehenes oberes Teil mit einer Vielzahl Drehungen verhindernder Vorsprünge (14) und einem unteren Teil mit größerem Durchmesser aufweist und die oberen und unteren Teile durch eine nach außen abgeschrägte Schulter voneinander getrennt sind;
einer im wesentlichen zylindrischen Antriebsbuchse (1) mit Gewinde an ihrem unteren Innenteil, wobei die Antriebsbuchse konstruiert und angeordnet ist, um unter Eingriff des Gewindes den Bohrlochhänger zu erfassen, und die im wesentlichen zylindrische Antriebsbuchse weiterhin einen größeren oberen Außendurchmesser und einen kleineren unteren Außendurchmesser aufweist und die Außendurchmesser durch eine nach innen abgeschrägte Schulter (11, 12) voneinander getrennt sind;
einem im wesentlichen runden Lastring (4), der einen kleineren oberen Innendurchmesser und einen größeren Innendurchmesser besitzt, und die Teile unterschiedlichen Durchmessers durch eine hängende Schulter voneinander getrennt sind und die hängende Schulter eine Vielzahl von Schlitzen (15) an ihrer Unterseite aufweist, die konstruiert und angeordnet sind, um mit den Drehungen verhindernden Vorsprünge am unteren Durchmesser des Bohrlochhängers zusammenzuwirken;
einem metallischen Dichtring (5) mit einer Innenfläche, wobei die Innenfläche einen nach unten weisenden Keil und weiterhin eine ringförmige Nut in der Außenfläche bildet, um eine obere und untere ringförmige Dichtfläche zu bilden;
einem Spaltring (3), der so konstruiert und angeordnet ist, daß er in die Nut im oberen Teil der Innenseite des Bohrlochkopfes paßt, und der Außendurchmesser des Ringes eine obere Schulter und eine untere, hängende Schulter aufweist, die mit der hängenden oberen Schulter und der unteren Schulter der Nut korrespondiert;
einem Tragring (13), der oben auf den Lastring aufgelegt ist, um die Reibung zwischen dem im wesentlichen runden Lastring und der Antriebsbuchse zu vermindern.

2. Dichtungsanordnung für Bohrlochhänger nach Anspruch 1, **dadurch gekennzeichnet, daß** die zylindrische Antriebsbuchse (1) einen J-förmigen Schlitz (9) um ihren oberen Umfang besitzt, der so konstruiert und angeordnet ist, daß er ein Zusammenwirken mit einem entfernbaren Kraftwerkzeug ermöglicht.

3. Dichtungsanordnung für Bohrlochhänger nach Anspruch 1 oder 2, **dadurch gekennzeichnet, daß** die zylindrische Antriebsbuchse (1) einen größeren oberen Durchmesser und einen kleineren unteren Durchmesser besitzt und die größeren und kleineren Durchmesser durch zwei nach innen abgeschrägte Schultern (11, 12) getrennt sind.

4. Verfahren zum Einbau einer Dichtungsanordnung für Bohrlochhänger nach jedem der vorhergehenden Ansprüche, **gekennzeichnet durch** folgende Verfahrensschritte:
Absenkung eines Betriebswerkzeugs (2) in dem Bohrlochkopf; Verbindung der Antriebsbuchse (1) mit dem Betriebswerkzeug; Drehen des Betriebswerkzeugs, bis die Antriebsbuchse eine bestimmte Kraft auf den Spaltring (3) ausübt und diesen in die Nut (8) im oberen Teil der Innenseite des Bohrlochkopfes drückt und mit dem Tragring (13) zusammenwirkt, welcher eine nach unten gerichtete Kraft auf den metallischen Dichtring (5) ausübt; Trennen des Eingriffes des Betriebswerkzeugs von der Antriebsbuchse; und Herausziehen des Betriebswerkzeugs.

Revendications

1. Ensemble d'étanchéité pour suspension de tubes de production comprenant une tête de colonne de production sensiblement cylindrique présentant une bride à chaque extrémité,

* C L M S *

un alésage longitudinal sensiblement vertical à travers ladite tête de colonne et une rainure (8) dans la partie supérieure du diamètre intérieur de l'alésage longitudinal sensiblement vertical; un collier de suspension de tubes de production sensiblement cylindrique avec un alésage longitudinal à travers celui-ci pour communiquer avec un train de tubage, le collier de suspension de tubes de production sensiblement cylindrique présentant une partie supérieure partiellement filetée avec une pluralité de créneaux d'antirotation (14) et une partie inférieure de diamètre plus grand, ces parties supérieure et inférieure étant séparées par un épaulement incliné vers l'extérieur; un manchon d'entraînement sensiblement cylindrique (1) présentant des filets sur l'intérieur de sa partie inférieure, ce manchon d'entraînement étant construit et disposé de façon à s'engager par filetage dans le collier de suspension de tubes, ce manchon d'entraînement sensiblement cylindrique présentant de plus un diamètre extérieur supérieur plus grand et un diamètre extérieur inférieur plus petit, ces diamètres extérieurs étant séparés par un épaulement incliné vers l'intérieur (11, 12); un anneau de charge sensiblement circulaire (4) présentant un diamètre intérieur supérieur plus petit et un diamètre intérieur inférieur plus grand, ces diamètres étant séparés par un épaulement inversé, cet épaulement inversé présentant une pluralité d'encoches (15) sur sa surface intérieure, ces encoches étant construites et disposées de façon à s'enclencher dans les créneaux d'antirotation sur le diamètre inférieur du collier de suspension de tubes; un anneau d'étanchéité métallique (5) présentant une surface intérieure qui définit un coin dirigé vers le bas, et définissant de plus une rainure annulaire dans sa surface extérieure pour former une surface d'étanchéité annulaire supérieure et inférieure; un anneau fendu 3 construit et disposé afin de s'adapter dans la rainure de la partie supérieure du diamètre intérieur de la tête de colonne, le diamètre extérieur de l'anneau présentant un épaulement supérieur et un épaulement inférieur inversé correspondant à l'épaulement supérieur inversé et à l'épaulement inférieur de la rainure; un coussinet (13) fixé sur la face supérieure de l'anneau de charge afin de réduire le frottement entre l'anneau de charge sensiblement circulaire et le manchon d'entraînement.

2. Ensemble d'étanchéité pour suspension de tubes de production selon la revendication (1), dans lequel le manchon d'entraînement cylindrique 1 comprend une rainure (9) en forme de J autour de son périmètre supérieur, cette rainure en forme de J étant construite et disposée afin de permettre l'accrochage avec un outil d'activation amovible.

3. Ensemble d'étanchéité pour suspension de tubes de production selon la revendication 1 ou 2, dans lequel le manchon d'entraînement cylindrique 1 comprend un diamètre supérieur plus grand et un diamètre inférieur plus petit, les grand et petit diamètres étant séparés par deux épaulements inclinés vers l'intérieur (11, 12).

4. Procédé d'installation d'un ensemble d'étanchéité pour suspension de tubes de production selon l'une quelconque des revendications précédentes, ce procédé comprenant les étapes consistant à faire descendre un outil de pose (2) dans la tête de colonne; accrocher le manchon d'entraînement 1 avec l'outil de pose; faire tourner l'outil de pose jusqu'à ce que le manchon exerce une force de valeur donnée sur l'anneau fendu (3), poussant celui-ci dans la rainure (8) située dans la partie supérieure du diamètre intérieur de la tête de colonne de production, puis poussant le coussinet (13) qui exerce sur le joint métallique (5) une force dirigée vers le bas; décrocher l'outil de pose du manchon d'entraînement; et extraire l'outil de pose.

* C L M S *