

Description

The development of weak spots or leaks in tubular members in locations not accessible to repair, such as in subsea wellheads, creates serious repair problems. When such repairs are needed in a well casing string, it has been the practice to cut the casing in the well bore below the bad spot, removing the upper cut portions of the casing string, installing a packer type of patch by slipping it over the permanent part of the casing string and securing it to the casing string and then reconnecting good casing to the patch to complete the casing string.

Another method includes removing the casing above the damaged or bad area, lowering an over-shot type of casing patch having a lower bowl carrying a spiral grapple into surrounding relation to the upper portion of the casing in the well bore, and engagement of the patch with the casing is followed by lifting the string to compress the lead to form a highly effective seal between the casing and the patch.

Another solution which has been proposed is to provide an internal steel tubing covered with a glass mat and epoxy resin. When set, the corrugated patch expands radially to conform symmetrically to the casing bore. Also, it is claimed that the epoxy resin extrudes into cavities in the tubing or casing wall to act as a gasket and sealing agent.

Still another solution which is disclosed in U. S. Patent No. 2,495,352 is to remove the string above a break and lower another string which has an enlarged lower end into surrounding relationship to the upper end of the broken string in the well. A plastic material is pumped down the new string with a plug set into the top of the broken string so that the plastic is diverted into the annulus between the enlarged lower end and the upper end of the broken string and also around the exterior of the enlarged lower end. The setting of the plastic provides an uninterrupted bore extending through the lower broken string, through the set plastic and into the upper string.

It has been known to utilize internal pressure to form a first tubular member placed within a second tubular member having internal grooves so that the first tubular member is deformed into such grooves to provide a positive seal and also to join the two tubular members. Examples of this type of joint forming are shown in U. S. Patent Nos. 4,388,752; 4,330,144; 2,438,529; 2,477,676; 3,432,916, EP-A-0122099 and BE-A-715505. U.S. Patent No. 4,593,488 discloses the use of half rings of collapsible material positioned within the grooves of the outer members when the forming is to be done under water. The function of the material is to

permit forming which would otherwise be limited or prevented by the entrapment of water in the grooves. Also, it avoids the obvious solution of porting the grooves to the exterior of the second tubular member which avoids entry of water or other materials which could limit the useful life of the formed joint.

An object of the present invention is to provide an improved connector which may be quickly and easily connected to the upper end of a well casing within a well bore.

According to one aspect of the present invention there is provided a well casing repair connector comprising:

a tubular housing having means at its upper end for connecting to a string extending upwardly from its upper end, internal rib locating means below said connecting means and internal sealing and gripping profiles below said rib locating means, and

a tubular guide connected to the lower end of said tubular housing to guide said housing in locating it in surrounding relationship to the upper end of the casing to be repaired,

said tubular housing being sufficiently strong to withstand deformation of the upper end of the casing into gripping and sealing engagement with the interior of said tubular housing.

According to another aspect of the present invention there is provided a method of repairing a damaged casing within a well bore including the steps of:

preparing the upper end of the damaged casing,

lowering a casing repair connector into surrounding relationship to the upper end of the prepared casing,

said casing repair connector having internal sealing and gripping means immediately surrounding the exterior of the upper end of the casing,

lowering a pressure forming tool into the upper interior of said prepared casing,

delivering fluid under pressure to said pressure forming tool to pressure form the casing into sealing and gripping engagement with said internal sealing and gripping means within said casing repair connector, and

recovering said pressure forming tool.

The invention will be described now by way of example only, with particular reference to the accompanying drawings. In the drawings:

FIGURE 1 is a sectional view of the well casing within a well bore that has been severed below an imperfection.

FIGURE 2 is a sectional view of the well casing with the improved connector landed on the upper end of the well casing and with the setting tool positioned therein.

FIGURE 3 is another sectional view illustrating the forming of the casing into the connector.

FIGURE 4 is another sectional view of the connector after the removal of the forming tool and with the casing connecting into the connector.

As shown in FIGURE 1, well casing 10 has been severed at a point below the defect and has been prepared so that it is ready to receive its repair parts. The improved repair connector 12 is lowered on string 14 into engagement with the upper end of casing 10 and with guide 16 and annular housing 18 positioned in surrounding relation to casing 10. Repair connector 12 includes guide 16 and annular housing 18 with guide 16 threaded into the lower end of annular housing 18 and string 14 which is threaded into the upper end of annular housing 18 for the running repair connector 12 into its desired repair position.

Guide 16 includes groove 20 on its inner surface near the lower end of annular housing 18 with packing ring 22 positioned therein. Also, guide 16 includes lower tapered entrance 21 which assists in the landing of repair connector 12 on the upper end of the well casing. Annular housing 18 is a high strength tubular member having upper internal threads 24 into which string 14 connects, rib 26 immediately below threads 24 with groove 28 therein, internal sealing section 30 including a plurality of internal grooves 32 at least partially filled with pressure compensating material, such as microspheres in a matrix of epoxy or syntactic foam, and gripping section 34 including concave recess 36 lined with a plurality of serrations 38. External groove 40 in annular housing 18 is filled with a brittle material 42, such as a thermosetting resin or a ceramic material for reasons hereinafter explained.

Forming tool 44 is lowered through string 14 and landed with its locator in engagement with rib 26 and its groove 28 to ensure proper location. With tool 44 within the upper end of casing 10, pressure is delivered through tool 44 and exerted uniformly on the interior of casing 10. The level of pressure is to be sufficient to deform casing into both sealing section 30 and gripping section 34 into tight engagement within grooves 32 and within serrations 38 within concave recess 36. When sufficient deformation has occurred, sufficient hoop tension will develop in annular housing 18 to cause cracking of brittle material 42. Brittle material 42 is preselected so that it cracks at the yield in the exterior of annular housing 18 which ensures that casing 10 has been sufficiently pressure formed into sealing and gripping sections 30 and 34 to provide a pressure tight joint in casing which is sufficiently strong for the requirements of a casing joint. The cracking or other failure of brittle material 42 creates sufficient noise that it can be detected

at the upper end of string 14 so that the operator knows that the joining of casing 10 into annular housing 18.

5 Claims

1. A well casing repair connector comprising;
 - a tubular housing (18) having means (24) at its upper end for connecting to a string extending upwardly from its upper end, internal rib locating means (26) below said connecting means and internal sealing and gripping profiles (32, 36) below said rib locating means, and
 - a tubular guide (16) connected to the lower end of said tubular housing (18) to guide said housing in locating it in surrounding relationship to the upper end of the casing to be repaired,
 - said tubular housing (18) being sufficiently strong to withstand deformation of the upper end of the casing into gripping and sealing engagement with the interior of said tubular housing.
2. A casing repair connector according to claim 1, wherein said sealing and gripping profiles include:
 - annular grooves (32) in the interior of said tubular housing, and
 - an annular shallow recess (36) lined with serrations.
3. A casing repair connecting according to claim 1 or claim 2, including
 - an annular groove (20) in the interior of said tubular guide (16), and
 - resilient packing means (22) positioned within said annular groove in said tubular guide for sealing against the exterior of said casing.
4. A casing repair connector according to any one of claims 1 to 3 including:
 - a groove (40) around the exterior of said tubular housing (18) at the level slightly below the level of the internal locating means (26), and
 - a brittle material (42) filling said external groove in said tubular housing, said brittle material being selected to fail at a preselected hoop tension to produce an audible noise.
5. A casing repair connector according to claim 4, wherein
 - said brittle material (42) is selected from the group consisting of a thermosetting resin and a ceramic.

FIGURE 3 is another sectional view illustrating the forming of the casing into the connector.

FIGURE 4 is another sectional view of the connector after the removal of the forming tool and with the casing connecting into the connector.

As shown in FIGURE 1, well casing 10 has been severed at a point below the defect and has been prepared so that it is ready to receive its repair parts. The improved repair connector 12 is lowered on string 14 into engagement with the upper end of casing 10 and with guide 16 and annular housing 18 positioned in surrounding relation to casing 10. Repair connector 12 includes guide 16 and annular housing 18 with guide 16 threaded into the lower end of annular housing 18 and string 14 which is threaded into the upper end of annular housing 18 for the running repair connector 12 into its desired repair position.

Guide 16 includes groove 20 on its inner surface near the lower end of annular housing 18 with packing ring 22 positioned therein. Also, guide 16 includes lower tapered entrance 21 which assists in the landing of repair connector 12 on the upper end of the well casing. Annular housing 18 is a high strength tubular member having upper internal threads 24 into which string 14 connects, rib 26 immediately below threads 24 with groove 28 therein, internal sealing section 30 including a plurality of internal grooves 32 at least partially filled with pressure compensating material, such as microspheres in a matrix of epoxy or syntactic foam, and gripping section 34 including concave recess 36 lined with a plurality of serrations 38. External groove 40 in annular housing 18 is filled with a brittle material 42, such as a thermosetting resin or a ceramic material for reasons hereinafter explained.

Forming tool 44 is lowered through string 14 and landed with its locator in engagement with rib 26 and its groove 28 to ensure proper location. With tool 44 within the upper end of casing 10, pressure is delivered through tool 44 and exerted uniformly on the interior of casing 10. The level of pressure is to be sufficient to deform casing into both sealing section 30 and gripping section 34 into tight engagement within grooves 32 and within serrations 38 within concave recess 36. When sufficient deformation has occurred, sufficient hoop tension will develop in annular housing 18 to cause cracking of brittle material 42. Brittle material 42 is preselected so that it cracks at the yield in the exterior of annular housing 18 which ensures that casing 10 has been sufficiently pressure formed into sealing and gripping sections 30 and 34 to provide a pressure tight joint in casing which is sufficiently strong for the requirements of a casing joint. The cracking or other failure of brittle material 42 creates sufficient noise that it can be detected

at the upper end of string 14 so that the operator knows that the joining of casing 10 into annular housing 18.

5 Claims

1. A well casing repair connector comprising:
 - a tubular housing (18) having means (24) at its upper end for connecting to a string extending upwardly from its upper end, internal rib locating means (26) below said connecting means and internal sealing and gripping profiles (32, 36) below said rib locating means, and
 - a tubular guide (16) connected to the lower end of said tubular housing (18) to guide said housing in locating it in surrounding relationship to the upper end of the casing to be repaired,
 - said tubular housing (18) being sufficiently strong to withstand deformation of the upper end of the casing into gripping and sealing engagement with the interior of said tubular housing.
2. A casing repair connector according to claim 1, wherein said sealing and gripping profiles include:
 - annular grooves (32) in the interior of said tubular housing, and
 - an annular shallow recess (36) lined with serrations.
3. A casing repair connecting according to claim 1 or claim 2, including
 - an annular groove (20) in the interior of said tubular guide (16), and
 - resilient packing means (22) positioned within said annular groove in said tubular guide for sealing against the exterior of said casing.
4. A casing repair connector according to any one of claims 1 to 3 including:
 - a groove (40) around the exterior of said tubular housing (18) at the level slightly below the level of the internal locating means (26), and
 - a brittle material (42) filling said external groove in said tubular housing, said brittle material being selected to fail at a preselected hoop tension to produce an audible noise.
5. A casing repair connector according to claim 4, wherein
 - said brittle material (42) is selected from the group consisting of a thermosetting resin and a ceramic.



6. A casing repair connector according to any one of claims 2 to 5 including:
pressure compensating material in said annular grooves (32).

7. A casing repair connector according to claim 6, wherein:

said pressure compensating material includes microspheres in a matrix selected from the group of epoxy and syntactic foam.

8. A method of repairing a damaged casing within a well bore including the steps of:

preparing the upper end of the damaged casing (10),

lowering a casing repair connector (12) into surrounding relation to the upper end of the prepared casing,

said casing repair connector having internal sealing and gripping means (32, 36) immediately surrounding the exterior of the upper end of the casing,

lowering a pressure forming tool (44) into the upper interior of said prepared casing,

delivering fluid under pressure to said pressure forming tool (44) to pressure form the casing (10) into sealing and gripping engagement with said internal sealing and gripping means (32, 36) within said casing repair connector (12), and

recovering said pressure forming tool.

9. A method according to claim 8, including the step of:

detecting the completion of the forming step by sensing the noise generated by the fracturing of a brittle band of material carried in the exterior of the casing repair connector.

Patentansprüche

1. Bohrlochverrohrungsreparaturkupplung, die umfaßt:
ein röhrenförmiges Gehäuse (18), das an seinem oberen Ende eine Einrichtung (24) zur Verbindung mit einem Strang, der sich von seinem oberen Ende aus nach oben erstreckt, eine innere Rippenpositionierungseinrichtung (26) unterhalb der Verbindungseinrichtung und innere Dichtungs- und Eingreifprofile (32, 36) unterhalb der Rippenpositionierungseinrichtung, und
eine röhrenförmige Führung (16), die mit dem unteren Ende des röhrenförmigen Gehäuses (18) verbunden ist, um das Gehäuse bei der Anordnung um das obere Ende der zu reparierenden Verrohrung herum zu führen, wobei das röhrenförmige Gehäuse (18) fest

genug ist, um Verformung des oberen Endes der Verrohrung in eingreifenden und abdichtenden Kontakt mit der Innenseite des röhrenförmigen Gehäuses auszuhalten.

2. Verrohrungsreparaturkupplung nach Anspruch 1, wobei die Dichtungs- und Eingreifprofile enthalten:

Ringnuten (32) an der Innenseite des röhrenförmigen Gehäuses, und
eine flache, ringförmige Aussparung (36), die von Zacken durchzogen ist.

3. Verrohrungsreparaturkupplung nach Anspruch 1 oder Anspruch 2, die enthält:

eine Ringnut (20) an der Innenseite der röhrenförmigen Führung (16), und
eine elastische Dichtungseinrichtung (20), die in der Ringnut in der röhrenförmigen Führung angeordnet ist und zur Außenseite der Verrohrung hin abdichtet.

4. Verrohrungsreparaturkupplung nach einem der Ansprüche 1 bis 3, die enthält:

eine Nut (40) um die Außenseite des röhrenförmigen Gehäuses (18) herum, die sich etwas unterhalb der inneren Positionierungseinrichtung (26) befindet, und
ein sprödes Material (42), das die Außennut im röhrenförmigen Gehäuse ausfüllt, wobei das spröde Material so ausgewählt ist, daß es bei einer vorgegebenen Ringzuspannung zerstört wird und dabei ein hörbares Geräusch erzeugt.

5. Verrohrungsreparaturkupplung nach Anspruch 4, wobei

das spröde Material (42) aus der Gruppe ausgewählt wird, die sich aus einem wärmehärtbarem Harz und einem keramischen Stoff zusammensetzt.

6. Verrohrungsreparaturkupplung nach einem der Ansprüche 2 bis 5, die enthält:

druckausgleichendes Material in den Ringnuten (32).

7. Verrohrungsreparaturkupplung nach Anspruch 6, wobei das druckausgleichende Material Mikrokugeln in einer Matrix enthält, die aus der Gruppe von Epoxidharz und syndiotaktischem Schaum ausgewählt wird.

8. Verfahren zur Reparatur einer beschädigten Verrohrung, das die folgenden Schritte umfaßt:
Vorbereitung des oberen Endes der beschädigten Verrohrung (10),
Absenken einer Verrohrungsreparaturkupplung (12) um das obere Ende der vorbereiteten Ver-



rohrung herum,

wobei die Verrohrungsreparaturkupplung innere Dichtungs- und Eingreifvorrichtungen (32, 36) hat, die sofort die Außenseite des oberen Endes der Verrohrung umschließen,

Absetzen einer Druckformungsvorrichtung (44) in die obere Innenseite der vorbereiteten Verrohrung,

Einleiten von Fluid unter Druck in die Druckformungsvorrichtung (44), um die Verrohrung (10) durch Druckformen in abdichtenden und eingreifenden Kontakt mit den inneren Dichtungs- und Eingreifvorrichtungen (32, 36) in der Verrohrungsreparaturkupplung (12) zu bringen, und

Entnahme der Druckformungsvorrichtung.

9. Verfahren zur Reparatur einer beschädigten Verrohrung nach Anspruch 8, das den folgenden Schritt umfaßt:

Feststellung der Beendigung des Formungsschrittes durch Wahrnehmung des Geräusches, das durch das Brechen eines Bandes aus sprödem Material, das an der Außenseite der Verrohrungsreparaturkupplung gelagert ist, entsteht.

Revendications

1. Connecteur de réparation de tubage de puits comprenant :

une enveloppe tubulaire (18) munie d'un moyen (24) au niveau de son extrémité supérieure pour se connecter à une barre s'étendant vers le haut à partir de son extrémité supérieure, un moyen de positionnement en forme de nervure interne (26) situé en-dessous dudit moyen de connexion et des profils internes d'étanchéité et d'ancrage (32, 36) situés en-dessous dudit moyen de positionnement en forme de nervure, et

un guide tubulaire (16) connecté à l'extrémité inférieure de ladite enveloppe tubulaire (18) afin de guider ladite enveloppe pour la positionner autour de l'extrémité supérieure du tubage à réparer,

ladite enveloppe tubulaire (18) étant suffisamment résistante pour supporter une déformation de l'extrémité supérieure du tubage afin que cette extrémité vienne en contact d'ancrage et d'étanchéité avec l'intérieur de ladite enveloppe tubulaire.

2. Connecteur de réparation de tubage selon la revendication 1, dans lequel lesdits profils d'étanchéité et d'ancrage comprennent :

des gorges annulaires (32) disposées à l'intérieur de ladite enveloppe tubulaire, et

un évidement annulaire (36) profilé de façon à comporter des crénelures.

3. Connecteur de réparation de tubage selon la revendication 1 ou la revendication 2, incluant :
une gorge annulaire (20) située à l'intérieur du guide tubulaire (16), et

un moyen de garniture d'étanchéité élastique (22) disposé à l'intérieur de ladite gorge annulaire ménagée dans ledit guide tubulaire afin de réaliser une étanchéité vis-à-vis de l'extérieur dudit tubage.

4. Connecteur de réparation de tubage selon l'une quelconque des revendications 1 à 3, comprenant :

une gorge (40) située autour de l'extérieur de ladite enveloppe tubulaire (18) en un niveau situé légèrement en-dessous du niveau du moyen de positionnement interne (26), et

un matériau cassant (42) remplissant ladite gorge externe ménagée dans ladite enveloppe tubulaire, ledit matériau cassant étant choisi de façon à se rompre pour une tension périphérique prédéterminée afin de produire un bruit audible.

5. Connecteur de réparation de tubage selon la revendication 4, dans lequel ledit matériau cassant (42) est choisi dans le groupe constitué par une résine thermodurcissante et une céramique.

6. Connecteur de réparation de tubage selon l'une quelconque des revendications 2 à 5, comprenant :

un matériau de compensation de pression disposé dans lesdites gorges annulaires (32).

7. Connecteur de réparation de tubage selon la revendication 6, dans lequel :

ledit matériau de compensation de pression comprend des microsphères situées dans une matrice choisie dans le groupe formé par une résine époxy et une mousse synthétique.

8. Procédé de réparation d'un tubage endommagé situé à l'intérieur d'un trou de forage, comprenant les étapes suivantes :

préparation de l'extrémité supérieure du tubage endommagé (10),

descente d'un connecteur de réparation de tubage (12) jusqu'à venir entourer l'extrémité supérieure du tubage préparé,

ledit connecteur de réparation de tubage comprenant un moyen interne d'étanchéité et d'ancrage (32, 36) entourant immédiatement l'extérieur de l'extrémité supérieure du tubage,



descente d'un outil de déformation par pression (44) à l'intérieur de la partie supérieure dudit tubage préparé,

envoi d'un fluide sous pression dans l'outil de déformation par pression (44) afin de déformer par pression le tubage (10) pour l'amener en contact d'étanchéité et d'ancrage avec ledit moyen interne d'étanchéité et d'ancrage (32, 36) situé à l'intérieur dudit connecteur de réparation de tubage (12), et

récupération dudit outil de déformation par pression.

9. Procédé selon la revendication 8, incluant l'étape de détection de la fin de l'étape de déformation en détectant le bruit généré par la rupture d'une bande de matériau cassant supportée au niveau de l'extérieur du connecteur de réparation de tubage.

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