A wellhead isolation tool includes a lower mandrel sized and shaped for insertion through a wellhead into a length of wellbore tubing. The wellhead isolation tool includes an improved sealing assembly connected to the lower end of the mandrel. The sealing assembly includes a conventional elastomeric cup deployed about a cup carrier for sealingly engaging an inner surface of the tubing. The sealing assembly further includes an abrasive cleaning ring deployed below the cup (e.g., between the cup carrier and the bull nose). Corrosion products, scale, and/or other debris may be advantageously removed from the tubing via the abrasive action of the cleaning ring, thereby promoting a better seal between the cup and the tubing.
WELLHEAD ISOLATION TOOL INCLUDING AN ABRASIVE CLEANING RING

RELATED APPLICATIONS

[0001] None.

FIELD OF THE INVENTION

[0002] The present invention relates generally to wellhead isolation tools for isolating sensitive wellhead components during fracturing operations. More particularly, this invention relates to an improved wellhead isolation tool including an abrasive cleaning ring deployed below the sealing cup.

BACKGROUND OF THE INVENTION

[0003] Well fracturing operations are well known in the oil and natural gas drilling industries for increasing the flow capacity of a well. During a typical well fracturing operation, large volumes of abrasive and/or acidic fluids (e.g., slurries of sand, water, and various chemicals) are pumped through a frac head and down into the well by high-pressure pumps. The high-pressure fluids (and sometimes gels) are intended to fracture the formation, thereby improving the permeability and flow capacity of the hydrocarbons. Owing to the abrasive (and often corrosive) nature of the fracturing fluids and to the erosion sensitive nature of certain wellbore components, a wellhead isolation tool is often deployed between the frac head and the wellhead. Conventional isolation tools are typically mounted directly above the wellhead and include a lower mandrel that is inserted through the wellhead into the casing wellbore (or production tubing). The mandrel is intended to bypass sensitive wellhead components (valves, hangers, etc.), thereby isolating them from the fracturing fluids.

[0004] Commercially utilized wellhead isolation tools typically include a sealing mechanism deployed on the lower end of the mandrel to prevent wellbore pressure from escaping through the annular region between the mandrel and the casing (or other tubing into which the mandrel is inserted). Known sealing mechanisms typically include one or more elastomeric cups (also referred to in the art as sealing nipples or packers) sealingly deployed about the mandrel. The cups are typically configured to expand radially under back pressure to seal against the inner wall of the production tubing or well casing. Various sealing mechanisms are described in U.S. Pat. Nos. 4,023,814 to Pitts, 4,111,261 to Oliver, 4,601,494 to McLeod, 5,261,487 to McLeod et al., and 6,918,441 to Dallas.

[0005] While isolation tools employing sealing mechanisms of various types have been utilized commercially for many years, there is yet room for further improvement. For example, the presence of corrosion products, scale, sand, and/or other debris on the inner surface of the tubing can sometimes degrade the quality of the seal. In such instances, damage to the sealing cup is often observed (e.g., tearing and/or cutting of the cup). Typically, the damaged cup is replaced on the job site and the mandrel reinserted into the tubing. Sometimes it is necessary to replace the cup multiple times prior to achieving an adequate seal. Such a repetitive process is known to waste valuable rig time.

[0006] Back flow of the fracturing fluids is also known to force sand and other debris upwards into the sealing cup (e.g., between the cup and the tubing during the fracturing operation). The presence of such debris is known to sometimes hinder the release of the seal between the cup and the tubing when pressure is removed from the well. As such, commercial isolation tools are known to sometimes maintain a tight seal on the tubing even after pumping of the fracturing fluids has ceased. This can cause severe difficulty in removing the isolation tool from the wellhead after the completion of the fracturing operation. Damage to the wellhead and/or the isolation tool has been known to occur in such instances.

[0007] Therefore, there is a need for an improved wellhead isolation tool, and in particular, a wellhead isolation tool including a mandrel with an improved sealing mechanism.

SUMMARY OF THE INVENTION

[0008] The present invention addresses the above-described drawbacks of prior art wellhead isolation tools. Aspects of this invention include a wellhead isolation tool of conventional construction including a lower mandrel sized and shaped for insertion through a wellhead into a length of wellbore tubing such as conventional production tubing or well casing. The wellhead isolation tool includes an improved sealing assembly connected to the lower end of the mandrel. The sealing assembly includes a conventional elastomeric cup deployed about a cup carrier for sealingly engaging an inner surface of the tubing. The sealing assembly further includes an abrasive cleaning ring deployed below the cup (e.g., between the cup carrier and the bull nose). The abrasive outer surface of the cleaning ring is intended to abrade the inner surface of the tubing upon insertion of the sealing assembly therein. Corrosion products, scale, and/or other debris may be advantageously removed from the tubing via the abrasive action of the cleaning ring, thereby promoting a better seal between the cup and the tubing.

[0009] Exemplary embodiments of the present invention may advantageously provide several technical advantages. For example, sealing assemblies in accordance with this invention tend to provide an improved seal with the tubing due to the removal of debris from the inner surface thereof. Moreover, damage to the cup (from such debris) tends to be minimized. The need to remove and replace the cup at the job site tends to be obviated, thereby saving valuable rig time. Exemplary cleaning ring embodiments also tend to restrict sand and other fracturing fluid solids from flowing upwards to the cup. As such the seal between the cup and the tube may be more reliably released upon completion of a fracturing operation.

[0010] In one aspect the present invention includes a wellhead isolation tool. The tool includes a main body portion and a mandrel deployed in the main body portion, the mandrel having an external end extending outward from main body portion. A sealing assembly is connected to a lower end of the mandrel and includes a cup carrier having an elastomeric cup deployed thereabout, the cup disposed to move axially on the cup carrier. A tube cleaner is deployed distal from the mandrel as compared to the cup. The tube cleaner includes an abrasive outer surface disposed to abrade an inner surface of a tube into which the mandrel is deployed.

[0011] In another aspect this invention includes a sealing assembly configured to be coupled to a mandrel on a wellhead isolation tool. The sealing assembly includes a cup carrier having an elastomeric cup deployed thereabout and a tube cleaner deployed distal from the mandrel as compared to the cup. The tube cleaner includes an abrasive outer surface disposed to abrade an inner surface of a tube into which the mandrel is deployed.
In yet another aspect this invention includes a wellhead isolation tool. The tool includes a main body portion, a mandrel having an external end extending outward from the main body portion, and a sub connected to the external end of the mandrel. The tool further includes a cup carrier connected to the sub and an elastomeric cup deployed about the cup carrier. The cup is disposed to slide axially on the cup carrier between a shoulder on the sub and an enlarged diameter portion of the cup carrier. The tool still further includes a bull nose connected to the cup carrier and a cleaning ring deployed between the cup carrier and the bull nose. The cleaning ring includes an abrasive outer surface.

The foregoing has outlined rather broadly the features and technical advantages of the present invention in order that the detailed description of the invention that follows may be better understood. Additional features and advantages of the invention will be described hereinafter, which form the subject of the claims of the invention. It should be appreciated by those skilled in the art that the conception and the specific embodiment disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present invention. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention, and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

FIG. 1 depicts a perspective view of one exemplary embodiment of a wellhead isolation tool in accordance with the present invention deployed between a conventional frac head and a conventional wellhead.

FIG. 2A depicts a cross-sectional view of one exemplary embodiment of a sealing arrangement in accordance with this invention for use in a wellhead isolation tool.

FIG. 2B depicts the sealing arrangement shown on FIG. 2A deployed in a length of tubing.

FIG. 3 depicts a perspective view of one exemplary embodiment of a cleaning ring in accordance with this invention.

DETAILED DESCRIPTION

Referring to FIGS. 1 through 3, it will be understood that features or aspects of the embodiments illustrated may be shown from various views. Where such features or aspects are common to particular views, they are labeled using the same reference numeral. Thus, a feature or aspect labeled with a particular reference numeral on one view in FIGS. 1 through 3 may be described herein with respect to that reference numeral shown on other views.

Referring now to FIG. 1, one exemplary embodiment of a wellhead isolation tool 100 in accordance with the present invention is shown deployed on a wellhead 50. Wellhead isolation tool 100 is shown deployed below a conventional frac head 75 and above the wellhead 50 (only a lower portion of the frac head is shown on FIG. 1). During a typical fracturing operation abrasive fluids are pumped under high pressure into the frac head 75, through the isolation tool 100, and down into the well. The isolation tool includes an inner mandrel 120 (shown on FIGS. 2A and 2B) that extends downward from the main body portion of the isolation tool 100, through the wellhead 50, and into the wellbore (e.g., into the well casing or production tubing deployed in the wellbore, which is shown and denoted at 200 on FIG. 2B).

Turning now to FIGS. 2A and 2B, the mandrel 120 and sealing assembly 150 are shown in more detail. FIG. 2A shows the mandrel 120 and sealing assembly 150 in isolation, while FIG. 2B shows the mandrel 120 and sealing assembly 150 deployed in and sealed with length of tubing 200. In the exemplary embodiment shown, sealing assembly 150 includes a cup carrier 160 deployed between a lower bull nose 180 and an upper sub 170 (which is threadably coupled with the mandrel 120). At least one cup 165 is slidably deployed about the cup carrier 160. The cup 165 is disposed to slide axially on the cup carrier between shoulder 164 and shoulder 172 of sub 170. As is known to those of ordinary skill in the art, the cup 165 is typically fabricated from an elastomeric (rubber) material and is sized and shaped for sealingly engaging both the cup carrier 160 and the tubing 200. Under elevated fluid pressure (e.g., as shown on FIG. 2B) the cup 165 is urged upwards (under the influence of the high pressure fracturing fluid) into contact with shoulder 172 of sub 170. The lower portion 168 of the cup is also urged radially outward (as also shown on FIG. 2B), thereby forming a pressure-tight seal with the inner surface of the tubing 200.

With continued reference to FIGS. 2A and 2B, sealing assembly 150 further includes a cleaning ring 190 deployed between a lower face 162 of the cup carrier 160 and a shoulder portion 182 of the bull nose 180. In the exemplary embodiment shown, the cleaning ring 190 is sized and shaped such that tightening bull nose 180 to the cup carrier 160 secures the cleaning ring 190 between face 162 and shoulder 182. The cleaning ring 190 is further sized and shaped such that an abrasive outer surface 192 thereof contacts an inner surface of tubing 200 (FIG. 2B). In the exemplary embodiment shown, cleaning ring 190 includes a plurality of abrasive (cutting) teeth 195 (FIG. 3) formed in outer surface 192. The teeth 195 are intended to abrade the inner surface of the tubing 200 upon insertion therein such that corrosion products and/ or other debris are at least partially removed from the tubing.

With reference now to FIG. 3, one exemplary embodiment of sealing ring 190 is shown in perspective view. A stated above with respect to FIGS. 2A and 2B, sealing ring 190 includes at least one thread 195 (also referred to as teeth) formed in and circumferentially about an outer surface 192 thereof. In the exemplary embodiment shown, it will be appreciated that the threads are wickered (i.e., shaped with a cutting edge facing downward) such that abrasive action is promoted when the assembly 150 is urged downward in the tube 200. Conversely, there is typically very little abrasive action upon removal of the assembly 150 from the tube, thereby advantageously facilitating easy removal of the sealing assembly from the tube upon completion of the fracturing operation.

It will be appreciated that cleaning rings 190 in accordance with this invention may include substantially any suitable number of threads 195 (i.e., one or more) provided at substantially any suitable longitudinal spacing. The exemplary embodiment shown on FIG. 3 includes approximately 8 threads per inch (a pitch of 8). The invention is, of course, not limited in this regard. Moreover, the invention is not limited to cleaning ring embodiments including threads 195 (or teeth) as shown on FIGS. 2A, 2B, and 3. Rather, substantially any
other suitable abrasive surface may be utilized. For example, the cleaning ring may be alternatively fabricated from a reinforced composite material. In such an embodiment, the reinforcing material (e.g., carbide chips) may provide for suitable abrasive action with the inner surface of tube 200. Moreover, the outer surface of the cleaning may alternatively be embedded with an abrasive material.

[0025] Cleaning ring 190 may be fabricated from substantially any suitable material including metallic materials, elastomers, and plastics. In such exemplary embodiments, teeth 195 may be formed via conventional machining techniques. Alternatively, elastomeric or plastic cleaning ring 190 embodiments may be formed, for example, via conventional injection molding processes, which tends to advantageously reduce fabrication costs. Molded plastic cleaning rings 190, being inexpensive, may be advantageously discarded and replaced when worn or damaged.

[0026] It will be further appreciated that the invention is not limited by the exemplary embodiments shown on FIGS. 2A and 2B. For example, cleaning ring 190 may be deployed substantially anywhere on the tool, provided that it is below cup 165 (i.e., distal from the mandrel as compared to the cup). Moreover, the cleaning ring 190 may be formed integrally with another component of the sealing assembly 150. For example, an integral cleaning ring may be fabricated by forming a plurality of raised threads (teeth) in an outer surface of the bulb nose 180 or in an outer surface of the enlarged diameter section of the cup carrier 160.

[0027] With reference again to FIGS. 2A and 2B, it will be appreciated that sealing assembly 150, including cleaning ring 190, tends to advantageously improve the pressure-tight seal between the cup 165 and the inner surface of the tube 200. In particular, removal of corrosion products and other debris from the inner wall of the tube 200 (via the abrasive action of the cleaning ring 190) typically provides a smoother surface for sealing with the cup 165. Moreover, removal of various debris from the inner wall of the tube 200 also tends to reduce cup damage and wear. As such, an adequate seal is typically achieved the first time the sealing assembly 150 is inserted into the tubing 200. A significant savings in rig time can thus be achieved (especially in applications in which the inner surface of the tube 200 is heavily loaded with scale and/or other debris).

[0028] Cleaning ring 190 also tends to advantageously provide a filtering-like functionality. Since the abrasive teeth 192 are in contact (or near contact) with the inner surface of the tube 200, sand and other solids in the fracturing fluid are restricted (or even prevented) from moving upward through the annular region between the sealing assembly 150 and the tube 200. However, the cleaning ring 190 is not sealingly engaged with the inner surface of the tube 200 and is not intended to provide a pressure tight seal (as is provided by the cup 165). The cleaning ring 190 therefore typically allows pressurized liquid to move upwards towards the cup 165 such that a tight seal is achieved via expansion of the cup 165 against the tube 200 (as described above). Since the cup 165 is kept substantially free from sand and other solids (due to the filtering action of the cleaning ring 190), the seal may also be quickly and reliably released upon removal of the pressure (e.g., when the fracturing fluid pumps are turned off).

[0029] Although the present invention and its advantages have been described in detail, it should be understood that various changes, substitutions and alternations can be made herein without departing from the spirit and scope of the invention as defined by the appended claims.

1. A wellhead isolation tool comprising:
   a mandrel deployed in the main body portion, the mandrel having an external end extending outward from the main body portion; and
   a sealing assembly connected to a lower end of the mandrel, the sealing assembly including a cup carrier having an elastomeric cup deployed thereabout, the cup disposed to move axially on the cup carrier;
   a tube cleaner deployed distal from the mandrel as compared to the cup, the tube cleaner including an abrasive outer surface disposed to abrade an inner surface of a tube into which the mandrel is deployed.

2. The wellhead isolation tool of claim 1, wherein the abrasive outer surface comprises at least one raised thread.

3. The wellhead isolation tool of claim 2, further comprising a bull nose connected to the cup carrier, the at least one thread being formed on an outer surface of the bull nose.

4. The wellhead isolation tool of claim 1, wherein:
   the wellhead isolation tool further comprises a bull nose connected to the cup carrier; and
   the tube cleaner includes a cleaning ring deployed between the cup carrier and the bull nose.

5. The wellhead isolation tool of claim 4, wherein the cleaning ring includes at least one wickered thread formed on an outer surface thereof.

6. The wellhead isolation tool of claim 4, wherein the cleaning ring is fabricated from a material selected from the group consisting of elastomeric materials and plastic materials.

7. The wellhead isolation tool of claim 4, wherein the cleaning ring is fabricated from a material selected from the group consisting of elastomeric materials and plastic materials.

8. A sealing assembly configured to be coupled to a mandrel on a wellhead isolation tool, the sealing assembly comprising:
   a cup carrier having an elastomeric cup deployed thereabout, the cup disposed to move axially on the cup carrier;
   a tube cleaner deployed distal from the mandrel as compared to the cup, the tube cleaner including an abrasive outer surface disposed to abrade an inner surface of a tube into which the mandrel is deployed.

9. The wellhead isolation tool of claim 8, wherein the abrasive outer surface comprises at least one raised thread.

10. The wellhead isolation tool of claim 9, further comprising a bull nose connected to the cup carrier, the at least one thread being formed on an outer surface of the bull nose.

11. The wellhead isolation tool of claim 8, wherein:
   the wellhead isolation tool further comprises a bull nose connected to the cup carrier; and
   the tube cleaner includes a cleaning ring deployed between the cup carrier and the bull nose.

12. The wellhead isolation tool of claim 11, wherein the cleaning ring includes at least one wickered thread formed on an outer surface thereof.

13. The wellhead isolation tool of claim 11, wherein the cleaning ring includes at least one wickered thread formed on an outer surface thereof.
14. The wellhead isolation tool of claim 11, wherein the cleaning ring is fabricated from a material selected from the group consisting of elastomeric materials and plastic materials.

15. A wellhead isolation tool comprising:
   a main body portion;
   a mandrel having an external end extending outward from the main body portion;
   a sub connected to the external end of the mandrel;
   a cup carrier connected to the sub;
   an elastomeric cup deployed about the cup carrier, the cup disposed to slide axially on the cup carrier between a shoulder on the sub and an enlarged diameter portion of the cup carrier;
   a bull nose connected to the cup carrier; and
   a cleaning ring deployed between the cup carrier and the bull nose, the cleaning ring including an abrasive outer surface.

16. The wellhead isolation tool of claim 15, wherein the abrasive outer surface of the cleaning ring comprises a plurality of raised threads.

17. The wellhead isolation tool of claim 15, wherein the abrasive outer surface of the cleaning ring comprises a plurality of wickered threads.

18. The wellhead isolation tool of claim 15, wherein the cleaning ring is fabricated from a material selected from the group consisting of elastomeric materials and plastic materials.

19. In a wellhead isolation tool including a sealing assembly connected to an external end of a mandrel, the sealing assembly operative to form a substantially pressure tight seal with an inner surface of a tube, the sealing assembly including a bull nose connected to a cup carrier, the sealing assembly further including an elastomeric cup deployed about the cup carrier, the cup disposed to sealingly engage the inner surface of the tube, an improvement comprising:
   a cleaning ring deployed between the cup carrier and the bull nose, the cleaning ring including at least one thread formed on an outer surface thereof, the at least one thread disposed to abrade an inner surface of the tube upon insertion of the mandrel in the tube.

20. The improvement of claim 19, wherein the at least one thread is wickered such that the thread is not disposed to abrade the inner surface of the tube upon removal of the mandrel from the tube.

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