SPHERICAL BLOWOUT PREVENTER WITH ENERGIZEABLE PACKER SEAL AND METHOD OF USING SAME

CROSS-REFERENCE TO RELATED APPLICTIONS

[0001] The application claims priority to US Non-Provisional Application No. 14/229,268, filed on March 28, 2014, the entire contents of which is hereby incorporated by reference herein.

BACKGROUND

[0002] The present disclosure relates generally to techniques for performing wellsite operations. More specifically, the present invention relates to techniques, such as sealing and/or severing a tubular at the wellsite, for preventing blowouts.

[0003] Oilfield operations may be performed to locate and gather valuable downhole fluids. Oil rigs are positioned at wellsites, and downhole tools, such as drilling tools, are deployed into the ground to reach subsurface reservoirs. Once the downhole tools form a wellbore (or borehole) to reach a desired reservoir, casings may be cemented into place within the wellbore, and the wellbore completed to initiate production of fluids from the reservoir. Tubulars may be positioned in the wellbore to enable the passage of subsurface fluids to the surface.

[0004] Leakage of subsurface fluids may pose an environmental threat if released from the wellbore. Equipment, such as blow out preventers (BOPs), may be positioned about the wellbore to form a seal about a wellbore to prevent leakage of fluid therefrom. Various types of BOPs, such as ram, spherical, annular, etc., may be used. For example, BOPs may have rams with blades to sever and/or seal the wellbore, or employ a spherical configuration. Some examples of BOPs are provided in U.S. Patent/Application Nos. 5588491 and 5662171, the entire contents of which are hereby incorporated by reference herein.

SUMMARY

[0005] According to a first aspect, there is provided a seal assembly of a blowout preventer for sealing a wellbore penetrating a subsurface formation, the blowout preventer comprising a housing with a fluid path therethrough in fluid communication with the wellbore, the seal assembly comprising: a piston slidably positionable in the housing, the piston having a hole therethrough in fluid communication with the fluid path and further comprising a substantially planar portion that is substantial normal to a longitudinal axis of the seal assembly; and a packer element comprising a plurality of fingers and a packer seal, wherein each of the plurality of fingers comprises a housing portion and a piston portion comprising at least one substantially planar portion, wherein the housing portion is slidably movable along the housing and the at least one substantially planar portion of the piston portion is slidingly movable along the substantially planar portion of the piston, wherein the plurality of fingers are engageable by the piston to

slidingly move (1) the piston portion of the plurality of fingers radially toward the fluid flow path through the housing of the blowout preventer and (2) the housing portion of the plurality of fingers along a curved surface of the housing to selectively energize the packer seal to form a fluid tight seal about the blowout preventer.

[0006] The housing portion may be pivotally connectable to the piston portion. A movement portion of the piston may be slidably positionable in a piston cavity of the housing. The piston portion may be slidably engageable with a sliding surface of the piston. The housing portion may include an elongate body with a pointed tip at an end thereof. The fingers may have at least one inlet extending therein, and the packer seal may be extrudable about the at least one inlet. The fingers may have a variable gap therebetween. The packer seal may be extrudable about the fingers to form a seal with the housing and the piston. The packer seal may be molded about the fingers. The packer seal may have an inner surface convergable to form a seal with one of itself and a tubular of the wellbore.

[0007] According to a second aspect, there is provided a blowout preventer for sealing a wellbore penetrating a subsurface formation, the blowout preventer comprising: a housing having a flow path therethrough in fluid communication with the wellbore; and a sealing assembly positionable in the housing about the flow path, the sealing assembly comprising: a piston slidably positionable in the housing, the piston having a hole therethrough in fluid communication with the fluid path and further comprising a substantially planar portion that is substantially normal to a longitudinal axis of the seal assembly; and a packer element comprising a plurality of fingers and a packer seal, wherein each of the plurality of fingers comprises a housing portion and a piston portion comprising at least one substantially planar portion, wherein the housing portion is slidably movable along the housing and the at least one substantially planar portion of the piston portion is slidingly movable along the substantially planar portion of the piston, wherein the plurality of fingers are engageable by the piston to slidingly move (1) the piston portion of the plurality of fingers radially towards the fluid flow path through the housing of the blowout preventer and (2) the housing portion of the plurality of fingers along a curved surface of the housing to energize the packer seal to form a fluid tight seal about the blowout preventer.

[0008] The housing may include a wellbore portion operatively connectable to a wellhead and a riser portion operatively connectable to a riser. The housing may include a riser portion, a wellbore portion, and a housing ring. The housing may have a cavity therein to receive at least a portion of the seal assembly. The housing may have a curved inner surface engageable by the housing portion. The housing may be positionable about a tubing of the wellbore. The blowout preventer may also include a pressure source to drive the piston. The seal assembly may be operatively connectable to a controller.

[0009] According to a third aspect, there is provided a method of forming a seal about a wellbore penetrating a subsurface formation, the system comprising: disposing a blowout preventer about the wellbore, the blowout preventer comprising: a housing having a flow path therethrough in fluid communication with the wellbore and a sealing assembly positionable in the housing about the flow path, the sealing assembly comprising: a piston slidably positionable in the housing, the piston comprising a substantially planar portion that is substantially normal to a longitudinal axis of the sealing assembly, and a packer element comprising a plurality of fingers and a packer seal, wherein each of the plurality of fingers comprise a housing portion and a piston portion, the piston portion comprising at least one substantially planar portion; slidingly engaging the piston portion of the plurality of fingers with the piston; slidingly moving (1) the piston portion of the plurality of fingers radially toward the fluid flow path through the housing of the blowout preventer with the at least one substantially planar portion of the piston portion slidingly moving along the substantially planar portion of the piston and (2) the housing portion of the plurality of fingers along a curved surface of the housing; and energizing the packer seal to form a fluid tight seal about the blowout preventer .

[0010] The method may also involve retracting the packer seal to a retracted portion defining a desired diameter therein. The energizing may involve closing the flow path by compressing the packer seal with the fingers, supporting the packer seal by extending the piston portion towards the flow path a distance beyond an inner surface of the piston, converging tips of the housing portion of the fingers and/or tips of the piston portion of the fingers to define a reduced a diameter therebetween, supporting the packer seal in the sealed position by compressing the packer seal between the housing portion and the piston portion with the fingers, supporting the packer seal in an unsealed position by retracting the fingers, compressing the packer seal against an inner surface of the housing, compressing the packer seal between the piston portion and the piston, and/or self-sealing the packer seal by converging an inner surface of the packer seal together to close an inner diameter thereof.

[0011] The method may also involve disposing the tubular through the flow path, forming a seal about the blowout preventer by forming a seal about the tubular, and/or establishing fluid communication between a riser and the wellbore via the fluid path. The energizing may also involve slidably moving the housing portion along the housing and the piston portion along the piston, engaging the fingers with the piston, moving the fingers to a sealed position about the flow path, and/or moving the piston by selectively applying pressure to the piston. The disposing may involve operatively connecting a wellbore end of the housing to the wellbore and a riser end of the housing to a riser.

BRIEF DESCRIPTION DRAWINGS

[0028] The sealing assembly 122 includes a piston 231 and a packer element 233. The housing 228 includes a wellbore portion 232 and a riser portion 234 with a housing ring 236 therebetween. The wellbore portion 232 has a body with a channel 238 to receive tubing 118 therethrough. A flange 240 extends from a seafloor end of the body and a housing cavity 242 extends into an opposite surface end. The flange 240 is operatively connectable to subsea equipment 104, such as wellhead 110 (Figure 1). The housing cavity 242 is configured to receive the riser portion 234 and the housing ring 236 therein.

[0029] The wellbore portion 232 has a piston shoulder 246 extending from the wellbore portion 232 into the housing cavity 242 about channel 238. A piston cavity 248 is defined in the wellhead portion 232 between the housing ring 236 and the piston shoulder 246. The piston cavity 248 is shaped to receivingly engage a portion of the piston 231 of the sealing assembly 122. The housing ring 236 is supported in the wellbore portion 232 between the riser portion 234 and the piston 231.

[0030] The riser portion 234 is disposable in the housing cavity 242 with a portion extending from a surface end of the wellbore portion 232. An outer surface of the riser portion 234 is receivably supportable in the cavity 242 of the wellbore portion 232. The riser portion 234 has a body with a passage 250 in fluid communication with the channel 238 to define a flow path 251 through the BOP 116 for receiving the tubing 118 therethrough. The riser portion 234 has a cavity 252 with a curved inner surface 258 therein. The cavity 252 extends from the passage 250 and is configured to receive the packer element 233 therein.

[0031] A surface end of the riser portion 234 is operatively connectable to riser 117 and the flange 240 is operatively connectable to the wellbore 112 such that fluid may pass between the wellbore 112 and the platform 106. Fluid may flow between the tubular 118 and the riser 117 when the sealing assembly is in the unsealed position.

[0032] The sealing assembly 122 is movably positionable in the housing 228 to selectively seal the passage 250 therethrough. The piston 231 has an engagement portion 254 and a movement portion 256. The movement portion 256 is slidably positoinable in the cavity 248 along curved surface 258 of the wellhead portion 232 of the housing 228 as indicated by the arrows. The engagement portion 254 has a tubular body extending from the movement portion 256 and a sliding surface 259 engageable with the packer element 233. The engagement portion 254 has a hole 255 therethrough forming part of the flow path 251.

[0038] As also shown in Figure 2B, the BOP 116 may be subject to various forces and/or pressures. A wellbore pressure Pw may extend from the wellbore 106 into the flow path 251 as indicated by the upward arrow. In some cases, a surface pressure Ps may also apply to the BOP 116 as indicated by the downward arrow. An activation pressure Pa may be inserted into the piston cavity 248 to hydraulically activate movement of the piston 231 toward the sealed position.

[0039] Packer seal 262 is energized by movement of the fingers 260 to the sealed position of Figure 2B. The housing portion 266 of the fingers 260 converge about flow path 251 to compress the packer seal 262 therebetween. The housing portion 266 supports the packer seal 262 against the curved surface 258 of the riser portion 234 to provide a seal thereabout to prevent leakage that may result, for example, from the surface pressure Ps. A portion of the packer seal 262 may be enclosed between the housing portions 266. A portion of the packer seal 262 may also extend between the fingers 260 and against the curved surface 258 to form a seal about the riser portion 234.

[0040] The piston portion 264 of the fingers 260 slide to a converged position along the sliding surface 259 of the piston 231. The piston portion 264 supports the packer seal 262 about the sliding surface 259 of the piston 231 to provide a seal thereabout to prevent leakage between the fingers 260 and piston 231 that may result, for example, from the wellbore pressure Pw.

[0041] When moved to the sealed position of Figure 2B, the packer seal 262 may press towards the piston 231. As indicated by the curved arrows about the tip 268, the packer seal 262 may attempt to extend around the engagement portion 254 of the piston 231. The piston portion 264 may have a tip 268 that extends a distance D beyond an inner surface of the engagement portion 254 of the piston 231 along the flow path 251 to support the packer seal 262. Tips 268 of the piston portions 264 encircle the flow path 251 and define a sealing ring about the flow path 251 adjacent the piston 231. The tips 268 may support the packer seal 262 to prevent wellbore pressure Pw from acting on the piston 231 and/or to prevent fluid from passing between the packer assembly 233 and the piston 231.

[0042] Referring to Figures 3A-5, various views depicting the operation and structure of the fingers 260 are provided. Figures 3A and 3B show the fingers 260 in the unsealed and sealed positions, respectively. Figures 4A and 4B show views of the packer element 233 removed from

the BOP 116 with the fingers 260 in the unsealed position. Figure 5 shows a portion of the packer element 233 adjacent piston 231 with the packer seal 262 removed therefrom.

[0043] As shown in Figures 4A-5, the housing portion 266 of the fingers 260 each have an elongated body 470 with a pointed (or tapered) tip 472 at a convergence end thereof. The tips 472 may optionally engage the tubular 118 to pierce, rake, sever, and/or otherwise cause damage to the tubular 118 to facilitate sealing about the BOP. A variable gap 473 is defined between the fingers 260. The elongated body 470 of the housing portion is pivotally connected to the piston portion 264 of the fingers 260.

[0044] As shown in Figure 5, elongated body 470 has the curved outer surface with an inlet 574 extending therein. The elongated body 470 also has a rounded end 576 pivotable about the piston portion 264. The piston portion 264 has a pivot end 578 pivotally connectable to the rounded end 576 with the tip 268 extending therefrom. The tip 268 has a slider surface 577 engageable with the sliding surface 254 of piston 231. An inlet 579 extends into the slider surface 577. The gap 473, the inlet 574 of the housing portion, and the inlet 579 may provide for expansion of the packer seal 262 therein.

[0045] Referring to Figures 2A-2B, 4A-4B, and 6, various views depicting the operation and structure of the packer seal 262 are provided. Figures 2A and 2B show the packer seal 262 in the unsealed and sealed positions, respectively. Figures 4A and 4B show views of the packer element 233 removed from the BOP 116 with the packer seal 262 in the unsealed position. Figure 6 shows a portion of the packer seal 262 with the finger 260 removed therefrom.

[0046] As shown in Figures 4A and 4B, in the unsealed (or uncompressed position), the packer seal 262 includes a ring shaped body 480 with fingers 260 embedded therein. The packer seal 262 may be molded about the fingers 260. The packer seal 262 may be compressible and/or energizable by movement of the fingers 260 as shown in Figures 2A and 2B. The packer seal 262 may be of an elastomeric (e.g., rubber) materials with a stiffness defined to provide desired sealing capabilities in the BOP 116.

[0047] The packer seal 262 has a curved outer surface 481 receivable in the housing 228 along the curved inner surface 258 of the riser portion 234 and/or the housing ring 236. As shown in Figures 4A, 4B and 6, the ring shaped body 480 terminates at vertical segments 482 adjacent the tips 472 of the fingers 260. An inner surface 484 of the packer seal 262 defines a path in fluid communication with flow path 251 for fluid flow therethrough when in the unsealed position.

CLAIMS

1. A seal assembly of a blowout preventer for sealing a wellbore penetrating a subsurface formation, the blowout preventer comprising a housing with a fluid path therethrough in fluid communication with the wellbore, the seal assembly comprising:

a piston slidably positionable in the housing, the piston having a hole therethrough in fluid communication with the fluid path and further comprising a substantially planar portion that is substantial normal to a longitudinal axis of the seal assembly; and

a packer element comprising a plurality of fingers and a packer seal, wherein each of the plurality of fingers comprises a housing portion and a piston portion comprising at least one substantially planar portion, wherein the housing portion is slidably movable along the housing and the at least one substantially planar portion of the piston portion is slidingly movable along the substantially planar portion of the piston, wherein the plurality of fingers are engageable by the piston to slidingly move (1) the piston portion of the plurality of fingers radially toward the fluid flow path through the housing of the blowout preventer and (2) the housing portion of the plurality of fingers along a curved surface of the housing to selectively energize the packer seal to form a fluid tight seal about the blowout preventer.

2. The seal assembly of Claim 1, wherein the housing portion is pivotally connectable to the piston portion.

3. The seal assembly of Claim 1, wherein the housing portion comprises an elongate body with a pointed tip at an end thereof.

4. The seal assembly of Claim 1, wherein the plurality of fingers has at least one inlet extending therein, the packer seal extrudable about the at least one inlet.

5. The seal assembly of Claim 1, wherein the packer seal is extrudable about the plurality of fingers to form a seal with the housing and the piston.

6. The seal assembly of Claim 1, wherein the packer seal is molded about the plurality of fingers.

7. The seal assembly of Claim 1, wherein the packer seal has an inner surface convergable to form a seal irrespective of a tubular of the wellbore disposed in the fluid flow path.

8. A blowout preventer for sealing a wellbore penetrating a subsurface formation, the blowout preventer comprising:

a housing having a flow path therethrough in fluid communication with the wellbore; and

a sealing assembly positionable in the housing about the flow path, the sealing assembly comprising:

a piston slidably positionable in the housing, the piston having a hole therethrough in fluid communication with the fluid path and further comprising a substantially planar portion that is substantially normal to a longitudinal axis of the seal assembly; and

a packer element comprising a plurality of fingers and a packer seal, wherein each of the plurality of fingers comprises a housing portion and a piston portion comprising at least one substantially planar portion, wherein the housing portion is slidably movable along the housing and the at least one substantially planar portion of the piston portion is slidingly movable along the substantially planar portion of the piston, wherein the plurality of fingers are engageable by the piston to slidingly move (1) the piston portion of the plurality of fingers radially towards the fluid flow path through the housing of the blowout preventer and (2) the housing portion of the plurality of fingers along a curved surface of the housing to energize the packer seal to form a fluid tight seal about the blowout preventer.

9. The blowout preventer of Claim 8, wherein the housing comprises a wellbore portion operatively connectable to a wellhead and a riser portion operatively connectable to a riser.

10. A method of forming a seal about a wellbore penetrating a subsurface formation, the system comprising:

disposing a blowout preventer about the wellbore, the blowout preventer comprising: a housing having a flow path therethrough in fluid communication with the wellbore and a sealing assembly positionable in the housing about the flow path, the sealing assembly comprising: a piston slidably positionable in the housing, the piston comprising a substantially planar portion that is substantially normal to a longitudinal axis of the sealing assembly, and a packer element comprising a plurality of fingers and a packer seal, wherein each of the plurality of fingers comprise a housing portion and a piston portion, the piston portion comprising at least one substantially planar portion;

slidingly engaging the piston portion of the plurality of fingers with the piston;

slidingly moving (1) the piston portion of the plurality of fingers radially toward the fluid flow path through the housing of the blowout preventer with the at least one substantially planar portion of the piston portion slidingly moving along the substantially planar portion of the piston and (2) the housing portion of the plurality of fingers along a curved surface of the housing; and

energizing the packer seal to form a fluid tight seal about the blowout preventer .

11. The method of Claim 10, further comprising retracting the packer seal to a retracted position defining a desired diameter therein.

12. The method of Claim 10, wherein the energizing comprises closing the flow path by compressing the packer seal with the plurality of fingers.

13. The method of Claim 10, wherein the energizing comprises supporting the packer seal by extending the piston portion towards the flow path a distance beyond an inner surface of the piston.

14. The method of Claim 10, wherein the energizing comprises converging one of the tips of the housing portion of the plurality of fingers and tips of the piston portion of the plurality of

fingers to define a reduced diameter between the tips of the housing portion and a reduced diameter between the tips of the piston portion.

15. The method of Claim 10, wherein the energizing comprises supporting the packer seal in the sealed position by compressing the packer seal between the housing portion and the piston portion with the plurality of fingers.

16. The method of Claim 10 wherein the energizing comprises supporting the packer seal in an unsealed position by retracting the plurality fingers.

17. The method of Claim 10, wherein the energizing comprises compressing the packer seal against an inner surface of the housing.

18. The method of Claim 10, wherein the energizing comprises compressing the packer seal between the piston portion and the piston.

19. The method of Claim 10, wherein the energizing comprises slidably moving the housing portion along the housing and the piston portion along the piston.

20. The method of Claim 10, wherein the energizing comprises engaging the plurality of fingers with the piston and moving the plurality of fingers to a sealed position about the flow path.