

HIGH TEMPERATURE BACK PRESSURE VALVE

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] This invention relates generally to back pressure valves for use in sealing oil and gas wells. More particularly, this invention relates to back pressure valves that seal wells using high temperature-resistant metal sealing surfaces.

2. Brief Description of Related Art

[0002] Back pressure valves are useful for plugging oil and gas wells to temporarily contain the wells during, for example, removal of a pressure control adapter (e.g., a blowout preventer, and installation of other equipment, such as a production tree). Typically, back pressure valves are configured to fit into the opening of the tubing hanger at the wellhead, and are equipped with elastomeric or other non-metal seals. Such seals prevent the flow of fluid out of the top of the well by sealing the interface between the back pressure valve and the production tubing.

[0003] In general, the elastomeric or other non-metal seals used in back pressure valves are adequate for applications having relatively low temperatures, such as about 250 degrees Fahrenheit or below. However, problems arise with such seals when temperatures exceed about 450 degrees Fahrenheit or more. For example, in wells where steam assistance gravity drained (SAGD) methods are used, temperatures often reach levels higher than 450 degrees Fahrenheit or more. Under such high heat conditions, elastomeric or other non-metal seals may fail.

[0004] Attempts have been made to improve the durability of elastomeric seals under high heat conditions by, for example, designing elastomers with higher heat tolerance, or coating the elastomeric seals with a heat resistant material. Such attempts, however, have met with limited success. Alternatively, attempts have been made to cool the wellhead prior to installation of valves having elastomeric seals, such as, for example, by pumping cold water into the well. The downside to this approach, however, is that the cooling process can be time consuming and expensive. What is needed, therefore, is a back pressure valve that can effectively seal the wellhead and that is resistant to high temperature applications.

SUMMARY OF THE INVENTION

[0005] Disclosed herein is a back pressure valve for sealing a wellbore that has a cylindrical body configured for insertion into the opening in a tubing hanger, and that has tapered metal sealing surfaces. The surfaces taper inwardly in a downward direction. The back pressure valve also has a threaded portion that corresponds to a threaded portion of the tubing hanger so that when the threads of the valve engage the threads of the tubing hanger, the tapered metal sealing surface is brought into sealing engagement with the tubing hanger. Thus configured, the wellbore is sealed because fluid is prevented from flowing between the tubing hanger and the metal sealing surfaces of the back pressure valve.

[0006] Optionally, the back pressure valve includes a poppet assembly having a moveable poppet valve with a poppet valve flange. When the poppet valve flange contacts and seals against the cylindrical body, the poppet valve is closed and no fluid can pass between the poppet valve flange and the cylindrical body. Conversely, when the poppet valve is removed away from the cylindrical body, the poppet valve is opened, and fluid is allowed to pass between the poppet valve flange and the cylindrical body. A spring may surround at least part of the poppet valve and, absent external forces, is configured to urge the poppet valve flange into contact with the cylindrical body. In one embodiment, both the cylindrical body and the poppet valve flange are made of metal, and when they contact one another they form a metal to metal seal.

[0007] Also disclosed is a method of sealing a well using a back pressure valve as disclosed herein. The method includes the steps of inserting the back pressure valve through a pressure control adapter on the well (such as a blowout preventer) so that the metal sealing surfaces of the back pressure valve seal against the tubing hanger, thereby sealing the well. Thereafter, the

pressure control adapter is removed and a production tree may be installed. After installation of the production tree, the back pressure valve may be removed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The present invention will be better understood on reading the following detailed description of nonlimiting embodiments thereof, and on examining the accompanying drawings, in which:

[0009] Fig. 1 is a side cross sectional view of a back pressure valve according to one possible embodiment of the present invention;

[0010] Fig. 2 is a side cross sectional view of a back pressure valve according to the embodiment shown in Fig. 1, with the poppet valve in an open position;

[0011] Fig. 3 is a side cross sectional view of the back pressure valve of Fig. 1 inserted into a tubing hanger that has a blowout preventer mounted to the top thereof; and

[0012] Fig. 4 is an enlarged cross sectional view of the interface between sealing surfaces of the back pressure valve and the opening in the tubing hanger according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0013] The foregoing aspects, features, and advantages of the present invention will be further appreciated when considered with reference to the following description of preferred embodiments and accompanying drawings, wherein like reference numerals represent like elements. In describing the preferred embodiments of the invention illustrated in the appended drawings, specific terminology will be used for the sake of clarity. However, the invention is not intended to be limited to the specific terms used, and it is to be understood that each specific term includes equivalents that operate in a similar manner to accomplish a similar purpose.

[0014] Referring to Fig. 1, there is shown a back pressure valve 2 according to one example embodiment of the present technology. The back pressure valve 2 has a cylindrical body 4 configured to be inserted into the opening 6 in the tubing hanger 8 of a wellbore (shown in Fig. 3). The cylindrical body 4 may have internal shoulders 22. The back pressure valve 2 also includes a metal sealing surface 10 that in an example tapers inwardly from an upper end 12 to a lower end 14 thereof. In one example embodiment, the sealing surface 10 may be tapered at an angle of about 3 to 10 degrees relative to the longitudinal axis 16 of the back pressure valve 2. In certain embodiments, such as that shown in Fig. 1, the back pressure valve 2 may also have a hydraulic sealing groove 13 that circumscribes the back pressure valve 2 and bisects the metal sealing surface 10.

[0015] The back pressure valve 2 additionally has means for attachment of the valve 2 to the tubing hanger 8, as well as means for energizing the metal sealing surface 10 into sealed engagement with surfaces of the tubing hanger 8 (shown in Fig. 3). For example, with respect to the means for attachment, in the embodiment shown in Fig. 1 the back pressure valve 2 includes threads 18 that may be configured to correspond to threads 42 (shown in Fig. 3) in the opening of

the tubing hanger 8. Furthermore, with respect to the means for energizing, the back pressure valve 2 may have internal threads 20 positioned on an inner surface 21 of the back pressure valve 2. These internal threads 20 may be configured for engagement with an installation tool (not shown). Once the installation tool is engaged with the internal threads 20, the installation tool can rotate the back pressure valve 2 until threads 18 fully engage the corresponding threads 42 in the opening of the tubing hanger 8.

[0016] Fig. 1 also shows a poppet valve 24 that may be included in the back pressure valve 2. The poppet valve 24 may include a poppet valve flange 26, and an elongate member 31 that extends from the poppet valve flange 26 to at or near the bottom end 38 of the back pressure valve 2. In addition, the poppet valve 24 may include a spring 28, or other biasing mechanism. The poppet valve flange 26 may have a seal 30 that prevents fluid from passing between the poppet valve flange 26 and shoulders 22 on the cylindrical body 4 when the poppet valve is closed, as shown in Fig. 1, and as further described below.

[0017] A spring 28 may surround at least a portion of the elongate member 31 of the poppet valve 24 to help control the movement of the poppet valve 24. The spring 28 is bounded at a bottom end by a spring retention shelf 40 in the cylindrical body 4, and at an upper end by protrusions 33 extending outwardly from an upper end of the elongate member 31. Alternatively, the protrusions 33 may be omitted, and the upper end of the spring 28 may be bounded by the poppet valve flange 26. The spring 28 is biased so that, in the absence of external forces, it urges the at least one flange 26 of the poppet valve 24 into engagement with the shoulders 22 on the cylindrical body 4.

[0018] Thus configured, the poppet valve 24 has at least a closed position and an open position. The closed position is the position shown in Fig. 1, with the poppet valve flange 26 contacting

the shoulders 22 on the cylindrical body 4. When in the closed position, the at least one poppet valve flange 26 forms a seal with the shoulders 22, and fluid is prevented from flowing between the poppet valve flange 26 and the shoulders 22. In an example embodiment, both the flange 26 and the shoulders 22 are metal, so that the seal between them is a metal to metal seal. Seals 30 may supplement this seal and may be made of an elastomer or any other suitable material.

[0019] Application of an external force may cause the poppet valve 24 to move into an open position, as shown in Fig. 2. For example, an axial pressure differential on poppet valve 24 may exert a force on the poppet valve 24 in a downward direction D. When the magnitude of this downward force exceeds the upward force exerted on the poppet valve flange 26 by the spring 28 and well bore pressure, the poppet valve 24 will move downward relative to the cylindrical body 4. As this happens, the poppet valve flange 26 will move downward into an open position, away from the shoulders 22 on the cylindrical body 4, and fluid will be able to flow therebetween. Hence, the back pressure valve assembly can be removed from inside the hanger with a lubricator tool.

[0020] Referring now to Fig. 3, there is shown a back pressure valve 2 according to an embodiment of the invention, inserted into an opening 6 of a tubing hanger 8. Also shown is a blowout preventer 46 mounted above the tubing hanger 8. In this embodiment, the opening 6 includes threads 42 that are configured for engagement with the threads 18 of the back pressure valve 2. In addition, an upper portion 44 of the walls of opening 6 is tapered outwardly, from a smaller diameter at a downward position toward the lower portion of the tubing hanger 8 to a larger diameter at an upward position toward the upper portion of the tubing hanger 8. As the back pressure valve 2 enters the opening 6, the threads 18 of the back pressure valve 2 engage the threads 42 of the opening 6. An installation tool (not shown) then continues to provide

torque to the internal threads 20 until the back pressure valve 2 is fully threaded into the opening 6 and the metal sealing surface 10 of the valve 2 contacts the tapered upper portion 44 of the walls of the opening 6. With the back pressure valve 2 fully in place, the contact between the metal sealing surface 10 and the walls of the opening 6 in the tubing hanger 8 form a seal. In embodiments having a hydraulic sealing groove 13, the hydraulic sealing groove 13 may serve to enhance the seal and clean the tapered sealing surface, when the metal sealing surface 10 fully contacts the walls of the opening 6. With the back pressure valve 2 in place in the tubing hanger 8 as shown in Fig. 3, the opening 6 of the tubing hanger 8 is sealed and blocks fluid flow between the walls of the opening 6 and the metal sealing surface 10 of the back pressure valve 2.

[0021] Fig. 4 show an enlarged view of an example interface between the metal sealing surface 10 of the back pressure valve 2 and the tubing hanger 8. In Fig. 4, an example of the taper of the metal sealing surface 10 can clearly be seen. As discussed above, in one example embodiment, the metal sealing surface is tapered at an angle of about 3 to 9 degrees.

[0022] One advantage to the back pressure valve disclosed herein is that the seal between the valve 2 and the tubular hanger 8 is metal to metal. This means that no elastomeric or other type of seal is required to seal the interface between the components. The elimination of elastomers or other non-metal seals is beneficial because many of those materials cannot withstand high heat applications. In fact, elastomeric and other non-metal seals are generally not adapted for use in applications where temperatures reach 450 degrees Fahrenheit or more. Moreover, while some specialized elastomeric seals may be able to withstand higher temperatures, such seals often cannot be used because of economic or other considerations.

[0023] Some wellhead applications, however, do generate high heat. For example, steam assistance gravity drained (SAGD) wellhead applications can generate temperatures of up to 650

degrees Fahrenheit or more. Therefore, to use elastomeric or non-metal seals in those applications requires time-consuming cooling processes, such as pumping cold water through the wellhead. Because the seals of the valves disclosed herein are made of metal, and can therefore withstand much higher temperatures, the cooling processes are unnecessary.

[0024] In addition to the apparatus and assembly shown in Figs. 1-4, another embodiment of the invention provides a method of sealing a well with the back pressure valve described above. In practice, the back pressure valve of the present embodiments may be used to plug a well during the transition of wellhead operations to production operations, when the pressure control adapter such as a blowout preventer (shown in Fig. 3) is removed from the wellhead, and a production tree (not shown) is installed.

[0025] Initially, the back pressure valve is introduced to the tubing hanger at the wellhead by attaching the valve to an installation tool and inserting the valve through the pressure control adapter. For example, referring to Fig. 3, if the pressure control adapter is a blowout preventer 46 or lubricator adapter, the back pressure valve 2 is inserted through the opening 48 that provides access from the top of the blowout preventer 46 to the opening 6 in the tubing hanger 8. During this step, the installation tool may engage the internal threads 20 on the inner surface 21 of the back pressure valve 2, and may turn the back pressure valve 2 so that the threads 18 of the back pressure valve 2 engage corresponding threads 42 in the tubing hanger 8. The tool will continue to turn the back pressure valve 2, thereby further engaging the threads, until the metal sealing surfaces 10 of the valve 2 contact the tubing hanger 8.

[0026] Once the back pressure valve 2 is in place and a seal is achieved, the pressure control adapter may be removed and a production tree may be installed without fluid leaking from the

well. After the installation of the production tree, the back pressure valve 2 may be removed by reversing the above process to allow oil or gas to flow out of the wellhead.

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

What is claimed is:

1. A back pressure valve for sealing a wellbore, the back pressure valve designed for installation in a tubing hanger at a wellhead, the tubing hanger having an upper end and a lower end, and defining an opening having a threaded portion and walls that taper outwardly from a smaller diameter at a downward position toward the lower end to a larger diameter at an upward position toward the upper end, the back pressure valve comprising:

a substantially cylindrical body having a threaded portion configured to engage the threaded portion of the tubing hanger when the valve enters the opening defined by the tubing hanger; and

a tapered metal sealing surface on the cylindrical body configured to contact the tapered walls of the opening in the tubing hanger when the threaded portion of the valve is engaged with the threaded portion of the opening so as to form a seal between the valve and the tubing hanger.

2. The back pressure valve of claim 1, wherein the tapered metal sealing surface is tapered at an angle of from 3 to 10 degrees.

3. The back pressure valve of claim 1, further comprising:

internal threads configured for engagement with an installation tool, and through which the installation tool can provide a torque to the cylindrical body to engage the threads of the cylindrical body with the threads of the opening in the tubing hanger until a seal is formed between the tapered metal sealing surface of the cylindrical body and the walls of the opening in the tubing hanger.

4. The back pressure valve of claim 1, further comprising:

a sealing groove that circumscribes the cylindrical body and bisects the tapered metal sealing surface.

5. The back pressure valve of claim 1, further comprising:

a poppet valve having a poppet valve flange and movably contained within the cylindrical body, the poppet valve having an open position and a closed position;

wherein when the poppet valve is in the open position, the poppet valve flange is substantially disengaged from the cylindrical body so that fluid can pass between the poppet valve flange and the cylindrical body, and when the poppet valve is in the closed position, the poppet valve flange forms a seal between the poppet valve flange and the cylindrical body to prohibit fluid from passing between the poppet valve flange and the cylindrical body.

6. The back pressure valve of claim 5, further comprising:

a spring surrounding at least a portion of the poppet valve and biased to urge the poppet valve flange into sealed contact with the cylindrical body.

7. The back pressure valve of claim 5, wherein the cylindrical body is composed of metal, and the poppet valve flange is composed of metal, so that when the poppet valve is in a closed position, the cylindrical body and the poppet valve flange form a metal to metal seal.

8. A wellhead assembly including a back pressure valve, comprising:

a tubing hanger mounted to a wellhead and defining an opening having walls, the walls of the opening tapering outwardly from a smaller diameter within the tubing hanger to a larger diameter at the top end thereof; and

a back pressure valve having a substantially cylindrical body and a tapered metal sealing surface;

wherein the substantially cylindrical body is configured to releasably engage the walls of the opening when the back pressure valve is inserted into the opening; and

wherein the tapered metal sealing surface of the back pressure valve seals against the tapered walls of the opening when the cylindrical body engages the walls of the opening.

9. The wellhead assembly of claim 8, wherein the opening of the tubing hanger has a threaded portion and the substantially cylindrical body has a threaded portion, and wherein the threaded portions of the opening and the cylindrical body are configured for releasable engagement when the cylindrical body is inserted into the opening.

10. The wellhead assembly of claim 8, wherein the tapered metal sealing surface of the back pressure valve is tapered at an angle of from 3 to 10 degrees.

11. The wellhead assembly of claim 9, wherein the back pressure valve further comprises:
internal threads configured for engagement with an installation tool, and through which the installation tool can provide a torque to the cylindrical body to engage the threads of the cylindrical body with the threads of the opening in the tubing hanger until a seal is formed between the tapered metal sealing surface of the cylindrical body and the walls of the opening in the tubing hanger.

12. The wellhead assembly of claim 8, wherein the back pressure valve has a sealing groove that circumscribes the cylindrical body and bisects the tapered metal sealing surface.

13. The wellhead assembly of claim 8, wherein the back pressure valve further comprises:
a poppet valve having a poppet valve flange and movably contained within the cylindrical body, the poppet valve having an open position and a closed position;

wherein when the poppet valve is in the open position, the poppet valve flange is substantially disengaged from the cylindrical body so that fluid can pass between the poppet valve flange and the cylindrical body, and when the poppet valve is in the closed position, the

poppet valve flange forms a seal between the poppet valve flange and cylindrical body to prohibit fluid from passing between the poppet valve flange and the cylindrical body.

14. The wellhead assembly of claim 13, wherein the back pressure valve further comprises:

a spring surrounding at least a portion of the poppet valve and biased to urge the at least one poppet valve flange into sealed contact with the cylindrical body.

15. The wellhead assembly of claim 13, wherein the cylindrical body is composed of metal, and the at least one poppet valve flange is composed of metal, so that when the poppet valve is in a closed position, the cylindrical body and the poppet valve flange form a metal to metal seal.

16. A method of sealing a well with a back pressure valve having metal sealing surfaces while removing a pressure control adapter and installing a production tree, the method comprising:

inserting the back pressure valve into the wellhead through the pressure control adapter so that the metal sealing surfaces of the back pressure valve sealingly engage metal surfaces of the wellhead;

removing the pressure control adapter from the wellhead;

installing the production tree on the wellhead; and

removing the back pressure valve from the wellhead.

17. The method of claim 16, further comprising:

providing a tubing hanger in the wellbore defining an opening with threaded surfaces;

providing threads on at least a portion of the surface of the back pressure valve; and

energizing the metal sealing surfaces of the back pressure valve by engaging the back pressure valve with an installation tool that provides torque to the back pressure valve so that the threaded surfaces of the opening engage with the threaded surfaces of the back pressure valve.