

A SAFETY VALVE ASSEMBLY FOR A PRODUCTION TUBING

FIELD OF INVENTION

[0001] The present invention relates broadly, but not exclusively, to a safety valve assembly for a production tubing and a method for operating it.

BACKGROUND

[0002] During wellbore completion operations, subsurface safety valves, such as tubing retrievable safety valves (TRSVs), are commonly installed as part of a production tubing string within oil and gas wells, controlled either hydraulically or electronically from the surface. These valves act as downhole safety devices to control fluid flow and provide a critical safety mechanism in emergencies.

[0003] TRSVs are often subjected to years of service in harsh operating conditions. Factors contributing to TRSV malfunctions include valve leakage, control line failure, and valve damage. These malfunctions can pose significant safety hazards to wellbore operations. Since the valves are integral to the completion process, retrieving a malfunctioning valve requires a workover, which is a difficult and costly operation. In such instances, a secondary method for controlling fluid flow through the tubing string is typically necessary.

[0004] For example, wireline retrievable safety valves (WRSVs) may be inserted inside a malfunctioning TRSV to assume its function. Conventionally, before installing a WRSV, wireline service tools are used to lock the TRSV in the open position and create a communication path for hydraulic fluid to reach the WRSV. However, this process has several drawbacks. A key drawback is that the process can be complicated, time-consuming, and costly, often requiring multiple trips down the tubing string.

[0005] A need therefore exists to address at least one of the problems above or to provide a useful alternative.

SUMMARY OF INVENTION

[0006] According to a first aspect of the present invention, there is provided a safety valve assembly for a production tubing, the safety valve assembly comprising:

a flow tube configured to move between an open position, in which fluid flow into the production tubing is allowed, and a closed position, in which fluid flow into the production tubing is restricted;

a piston installed along the production tubing uphole from the flow tube, wherein the piston is operable to move the flow tube from the closed position to the open position and to retain the flow tube in the open position; and

a piston actuator operatively connected to the piston, wherein the piston actuator is configured to operate the piston.

[0007] The piston actuator may comprise a piston hydraulic control line which uses hydraulic fluid to actuate the piston.

[0008] The piston may comprise a communication path configured to establish fluid communication between the piston hydraulic control line and a retrievable safety device installed within the safety valve assembly, enabling the transfer of the hydraulic fluid to the retrievable safety device.

[0009] The piston may comprise securing means on an outer surface of the piston for attachment to an inner surface of a housing of the safety valve assembly, thereby preventing the piston and the flow tube from shifting uphole.

[0010] According to a second aspect of the present invention, there is provided a method for operating a safety valve assembly as claimed in claim 1, the method comprising:

activating the piston actuator to move the piston downhole, thereby moving the flow tube downhole from the closed position to the open position; and

securing the piston in the safety valve assembly to retain the flow tube in the open position.

[0011] Activating the piston actuator may comprise transmitting hydraulic fluid through a piston hydraulic control line to apply hydraulic pressure to the piston, thereby moving the piston downhole.

[0012] The method may further comprise transferring the hydraulic fluid from the hydraulic control line to a retrievable safety device installed within the safety valve assembly through a communication path inside the piston.

[0013] Securing the piston in the safety valve assembly may comprise attaching securing means on an outer surface of the piston to an inner surface of a housing of the safety valve assembly, thereby preventing the piston and the flow tube from shifting uphole.

BRIEF DESCRIPTION OF DRAWINGS

[0014] Embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

[0015] Figure 1 illustrates a tubing retrievable safety valve (TRSV) in an open position, in accordance with an example embodiment.

[0016] Figure 2 illustrates the TRSV assembly of Figure 1 in a closed position.

[0017] Figure 3 illustrates the TRSV assembly of Figures 1 and 2 in a locked open position.

[0018] Figure 4 illustrates an enlarged view of a communication path inside the TRSV assembly of Figures 1 to 3.

DETAILED DESCRIPTION

[0019] Embodiments of the present invention will be described, by way of example only, with reference to the drawings. Like reference numerals and characters in the drawings refer to like elements or equivalents.

[0020] Figure 1 illustrates a safety valve assembly (exemplified by a tubing retrievable safety valve (TRSV) assembly 100) in an open position, in accordance with an example embodiment. Figure 2 illustrates the TRSV assembly 100 of Figure 1 in a closed position. The TRSV assembly 100 is part of a production tubing and includes, but not limited to, a flow tube actuator (exemplified by a flow tube hydraulic control line 112 in Figure 1), a flow tube 114, a piston actuator (exemplified by a piston hydraulic control line 122 in Figure 1), and a piston 124.

[0021] A person skilled in the art would understand the remaining components of a TRSV assembly 100, and therefore, they are not discussed in detail in this description. For example, the movement of flow tube 114 is controlled by another piston. When hydraulic pressure from the flow tube hydraulic control line 112 pushes this piston, it causes the flow tube 114 to move downwards, allowing the valve to open. This enables fluid to flow through the production tubing. A loss of hydraulic pressure reverses the movement of the flow tube 114 and closes the valve, thereby restricting fluid flow.

[0022] As illustrated in Figure 1, the flow tube 114 is operatively connected to the flow tube hydraulic control line 112, which controls the movement of the flow tube 114. The flow tube 114 is configured to move between an open position, in which fluid flow into the production tubing is allowed, and a closed position, in which fluid flow into the production tubing is restricted. Under normal production conditions, the flow tube 114 is shifted to the open position shown in Figure 1 in response to hydraulic pressure from the flow tube hydraulic control line 112. In emergencies, the hydraulic pressure is released by the flow tube hydraulic control line 112, causing the flow tube 114 to shift to the closed position shown in Figure 2.

[0023] The piston 124 is installed along the production tubing uphole from the flow tube 114 and is operatively connected to the piston hydraulic control line 122, which is configured to operate the piston 124. Under normal circumstances, when the flow tube 114 functions correctly, the piston 124 remains in the uphole position shown in both Figures 1 and 2. However, there are circumstances where a retrievable safety device, such as a wireline retrievable safety valve (WRSV), may need to be installed inside the TRSV assembly, such as in the event of a malfunction of the flow tube 114 and valve closure mechanism. In such circumstances, the piston 124 is operable to move the flow tube 114 from the closed position to the open position, as explained in further detail below with respect to Figure 3. The piston 124 is also operable to retain the flow tube 114 in the open position. This allows the WRSV to be installed inside the TRSV assembly 100 to assume its function.

[0024] Figure 3 illustrates the TRSV assembly 100 of Figures 1 and 2 in a locked open position. When the flow tube 114 malfunctions, it may shift uphole and close the TRSV assembly 100. To install the WRSV inside the TRSV assembly 100, the TRSV assembly 100 must be manually open and held in the open position. In one embodiment, the piston hydraulic control line 122 is activated to apply hydraulic

pressure to the piston 124, moving the piston 124 downhole to push the flow tube 114 downwards. Subsequently, the piston 124 continues to retain the flow tube 114 in the open position.

[0025] The piston 124 may include securing means, such as angled teeth, constructed on its outer surface to secure it against the inner surface of the TRSV's housing, which may include a c-ring with mating teeth that correspond with the angled teeth of the securing means. Fixing the piston 124 against the inner surface of the housing prevents the piston 124 and flow tube 114 from shifting uphole while allowing the piston 124 to move downhole, thus locking the TRSV assembly 100 in the open position to allow for the installation of the WRSV inside the TRSV assembly 100.

[0026] Figure 4 illustrates an enlarged view of a communication path inside the piston 124 of Figures 1 to 3. When the flow tube 114 is held in the downhole position by the piston 124, a communication path 126 that establishes fluid communication between the piston hydraulic control line 122 and the WRSV is formed inside the TRSV assembly 100. The communication path 126 may include one or more grooves constructed on the inner surface of the piston 124. Conventionally, drilling a hole through the housing of the TRSV assembly 100 is required to create a communication path to transfer hydraulic fluid from the flow tube hydraulic control line 112 to the WRSV.

[0027] In the embodiments illustrated in Figures 1 to 4, the flow tube actuator and the piston actuator are both hydraulic control lines. It will be appreciated by a person skilled in the art that these control lines can be electronic control lines.

[0028] Embodiments of the present invention provide a safety valve assembly for a production tubing and a method for operating it. The flow tube 114 can be held in the locked open position by the piston 124 during the installation of the WRSV inside the TRSV assembly 100. Additionally, a communication path for hydraulic fluid to be transferred from the piston hydraulic control line 122 to the WRSV can be established when the flow tube 114 is in the locked open position.

[0029] Conventionally, wireline service tools are required for the installation of WRSVs to open then lock in position the flow tube 114 and to drill holes through the housing to create a communication path for transferring hydraulic fluid to the WRSV. Embodiments of the present invention may advantageously reduce or eliminate the need

for wireline service tools when installing a WRSV inside a malfunctioning TRSV assembly 100. Therefore, the workover process for a malfunctioning TRSV assembly 100 may be simplified, saving both cost and time.

[0030] It will be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

CLAIMS

1. A safety valve assembly for a production tubing, the safety valve assembly comprising:

a flow tube configured to move between an open position, in which fluid flow into the production tubing is allowed, and a closed position, in which fluid flow into the production tubing is restricted;

a piston installed along the production tubing uphole from the flow tube, wherein the piston is operable to move the flow tube from the closed position to the open position and to retain the flow tube in the open position; and

a piston actuator operatively connected to the piston, wherein the piston actuator is configured to operate the piston.

2. The safety valve assembly as claimed in claim 1, wherein the piston actuator comprises a piston hydraulic control line which uses hydraulic fluid to actuate the piston.

3. The safety valve assembly as claimed in claim 2, wherein the piston comprises a communication path configured to establish fluid communication between the piston hydraulic control line and a retrievable safety device installed within the safety valve assembly, enabling the transfer of the hydraulic fluid to the retrievable safety device.

4. The safety valve assembly as claimed in any one of the preceding claims, wherein the piston comprises securing means on an outer surface of the piston for attachment to an inner surface of a housing of the safety valve assembly, thereby preventing the piston and the flow tube from shifting uphole.

5. A method for operating a safety valve assembly as claimed in claim 1, the method comprising:

activating the piston actuator to move the piston downhole, thereby moving the flow tube downhole from the closed position to the open position; and

securing the piston in the safety valve assembly to retain the flow tube in the open position.

6. The method as claimed in claim 5, wherein activating the piston actuator comprises transmitting hydraulic fluid through a piston hydraulic control line to apply hydraulic pressure to the piston, thereby moving the piston downhole.

7. The method as claimed in claim 6, further comprising transferring the hydraulic fluid from the hydraulic control line to a retrievable safety device installed within the safety valve assembly through a communication path inside the piston.

8. The method as claimed in any one of claims 5 to 7, wherein securing the piston in the safety valve assembly comprises attaching securing means on an outer surface of the piston to an inner surface of a housing of the safety valve assembly, thereby preventing the piston and the flow tube from shifting uphole.