NON-CARCASSED, COLLAPSE RESISTANT, CONTROL LINE FOR USE SUBSEA AND METHOD OF USE

PRIORITY

This application claims priority from United States Provisional Application 60/660,085 filed March 9, 2005.

FIELD OF INVENTION

[0001] The invention relates generally to the field of subsea conduits. More specifically, embodiments of the invention relate to a flexible conduit and associated valve components capable of maintaining a minimum internal pressure at predetermined subsea depths for the purpose of preventing collapse of the conduit while maintaining the ability to vent fluid, if necessary, downstream of an associated flexible conduit valve located subsea.

BACKGROUND OF THE INVENTION

[0002] In existing subsea conduits, multi-layer conduits are used for fluid flow delivery subsea to prevent collapse of the flexible conduit. Problems with such multi-layer conduits, e.g. collapse resistant hoses (HCR) with an inner support structure surrounded by one or more outer pressure barrier members, include that they are either not flexible enough for certain subsea applications or sufficient to withstand internal delivery pressures as required subsea.

[0003] Certain thermoplastic type HCR, e.g. aramid fiber reinforced thermoplastic hoses such as MULTIFLEX®, do not have acceptable burst pressure characteristics for a range of delivery capable HCR hoses, e.g. 3/8" x 15000 PSI HCR hoses.

[0004] Allowing an end component such as a valve to shift to a "fail closed" position is a typical requirement for subsea well control to minimize possibility of personnel, environment and equipment endangerment. However, current fluid conduits used at depths

subsea still require multi-conduit hoses to ameliorate against collapse and do not keep fluid pressures within predetermined ranges in the fluid carrying portion of the multi-conduit hose.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] **Fig. 1** is a view in partial perspective of an embodiment;

[0006] **Fig. 2** and **Fig. 3** are partial cutaway views in partial perspective of embodiments;

[0007] **Fig. 4** is a schematic view of an embodiment in use; and

[0008] **Fig. 5** is a flowchart of an exemplary method of use.

BRIEF DESCRIPTION OF EMBODIMENTS OF THE INVENTIONS

[0009] Referring to **Fig. 1**, in exemplary embodiments described herein below, flexible conduit 10 is a single conduit, e.g. a non-carcassed, collapse resistant control line, which may comprise a reinforcing carcass, e.g. a steel or other metal carcass, as will be familiar to those of ordinary skill in the subsea arts.

[0010] First valve 12 is disposed at a first end of flexible conduit 10. First valve 12 may be of a nature and kind as are currently used for such purposes and may include a spring whose force must be overcome to introduce pressure into flexible conduit 10, e.g. a check valve as are known in the art. In certain preferred embodiments, first valve 12 is a backpressure valve as is known in the art. Upon a drop of fluid pressure within flexible conduit 10 to predetermined value, first valve 12 will shut off, thereby capturing a known residual pressure in the conduit.

[0011] Second valve 16 is disposed at a second end of flexible conduit 10, the second end being disposed at depths subsea. In a currently preferred embodiment, these depths may range up to maximum water depths currently being explored for recovery of natural resources. For example, in current configurations, this depth may be as deep as around 8000 feet. Second valve 16 may be a relief valve of a nature and kind as are currently used for

enhancing valve actuator closing time. In a currently preferred embodiment, second valve 16 are of a class of valves known by those skilled in the art of production control as Quick Dump valves.

[0012] Second valve 16, a relief valve, is similar in function to first valve 12 in that a known pressure must be introduced to overcome the restraint of second valve 16, e.g. overcome a spring force which maintains second valve 16 in a closed position, thus allowing fluid delivery through flexible conduit 10 to a desired location. Second valve 16 has additional functionality in that, upon fluid pressure in flexible conduit 20 falling to a predetermined value, second valve 16 will shift to its closed position, blocking the supply pressure, but through relief port 12 in second valve 16 allow venting of internal fluid pressure downstream of second valve 16.

[0013] Referring now to **Figs. 2** and **3**, in currently preferred embodiments, core 20 is surrounded by one or more sheaths such as sheath 24 and sheath 23. In an embodiment, sheath 23 may comprise multiple sheaths 23 made of an appropriate material such as ARAMID® fibers. Reinforcing fibers 26 may be present as well, as will be understood by one of ordinary skill in these arts. Some reinforcing fibers may further comprise other fibers or conduits as shown at 28. These fibers 28 may comprise electrical, optical, and/or hyrdraulic conduits, or the like.

[0014] **In the operation of an exemplary embodiment,** both first valve 12 and second valve 16 may be selectively engaged or disengaged to maintain a predetermined pressure of fluid inside flexible conduit 10. For example, both first valve 12 and second valve 16 may in their closed positions when fluid pressure inside flexible conduit 10 drops to a predetermined level. Maintaining at least a minimum pressure in this manner aids in preventing a collapse of all or portions of flexible conduit 10 due to ambient pressures to which flexible conduit 10 is exposed.

[0015] If a situation arises in which fluid pressure builds to a level above a second predetermined value, second valve 16 may be controlled or otherwise automatically move from its current open or closed position to a position which allows fluid inside flexible conduit 10 to be vented subsea, downstream of second valve 16. (See **Fig. 4**)

[0016] The sequence described herein allows trapping a fluid at a desired pressure within flexible conduit 10, preventing the collapse of flexible conduit 10. By venting the downstream pressure permissible to an end component being served by flexible conduit 10, typically a valve actuator or a valve actuator control valve, flexible conduit 10, using second valve 16, can thus shift to a "fail closed" position.

[0017] One or both of first valve 12 and second valve 16 may be connected to a Christmas tree, as that term is understood by those of ordinary skill in the subsea hydrocarbon arts.

[0018] Using first valve 12 and second valve 16, a fluid maybe maintained at a predetermined range of at least minimum pressure within flexible conduit 10 to prevent the collapse of flexible condition 10 at depth while maintaining the ability to vent pressure downstream of a subsea valve, e.g. valve 30. This may further allow a Christmas tree or tree control module valves to shift to their fail closed position. This step, i.e. failing followed by closing using venting the supply pressure, is a final safety function to shut in the tree such as might occur in the presence of an electrical or hydraulic failure in the umbilical.

[0019] Use of flexible conduit 10 may further allow use of standard multiflex hoses in deepwater applications rather than requiring use of a collapse resistant hose (HCR).

[0020] It is understood that though embodiments may comprise embodiments with some carcasses, such are not the preferred structure as the invention described herein may be used to eliminate the need for a carcass, in part because a carcass may impair an ability to get high pressure ratings on the products.

[0021] It will be understood that various changes in the details, materials, and arrangements of the parts which have been described and illustrated above in order to explain the nature of this invention may be made by those skilled in the art without departing from the principle and scope of the invention.

CLAIMS

What is claimed is:

1. A flexible conduit for use subsea, comprising:
   a. a non-carcassed, collapse resistant control line further comprising a reinforcing carcass;
   b. a first valve, comprising an open position and a close position, disposed at a first end of the control line; and
   c. a second valve, comprising an open position and a close position, disposed at a second end of the control line, the second end adapted to be disposed at a predetermined subsea depth.

2. The flexible conduit of claim 1 wherein the reinforcing carcass comprises a metal carcass.

3. The flexible conduit of claim 1 wherein the flexible conduit is a single conduit.

4. The flexible conduit of claim 1 wherein the first valve is a check valve.

5. The flexible conduit of claim 1 wherein the first valve comprises a spring whose force must be overcome to introduce pressure into flexible conduit.

6. The flexible conduit of claim 1 wherein the second valve is a relief valve, further comprising a vent port.

7. The flexible conduit of claim 7 wherein the second valve comprises a spring whose force must be overcome to introduce pressure into flexible conduit, the second valve comprising:
   a. an open position at which pressure overcomes the second valve's restraint to allow fluid delivery to the desired location; and
   b. a closed position, operative upon fluid pressure in the flexible conduit falling to a predetermined value, wherein supply pressure is blocked.

8. The flexible conduit of claim 1, wherein the first valve and the second valve are adapted to connect to a Christmas tree.

9. The flexible conduit of claim 1 wherein the predetermined subsea depth defines a maximum water depth of around 8000 feet.

10. A method of providing fluid through a flexible conduit subsea, comprising:

a. providing a flexible conduit for use subsea, the flexible conduit comprising a non-carcassed, collapse resistant control line further comprising a reinforcing carcass, a first valve disposed at a first end of the control line, and a second valve disposed at a second end of the control line;

b. disposing the second end at a predetermined depth subsea; and

c. selectively engaging or disengaging the first valve and the second valve to maintain a predetermined pressure of fluid inside the flexible conduit.

11. The method of claim 10, further comprising placing the first valve and the second valve into a closed position when fluid pressure inside the flexible conduit drops to a predetermined level.

12. The method of claim 10, wherein the predetermined pressure is sufficient to maintain a minimum fluid pressure within the flexible conduit.

13. The method of claim 12, wherein the minimum fluid pressure is sufficient to prevent a collapse of predetermined portion of the flexible conduit which might otherwise occur in the presence of an ambient pressure to which the flexible conduit is exposed.

14. The method of claim 10, further comprising:

a. providing the second valve with a vent port;

b. detecting a fluid pressure within the flexible conduit; and

c. enabling the second valve, at the detected fluid pressure, to move to a predetermined position which allows fluid inside the flexible conduit to be vented subsea, downstream of the second valve, through the vent port.

15. The method of claim 14, wherein the second valve is enabled either automatically or under a control directive from a controller operatively in communication with the second valve.

16. The method of claim 14, further comprising:

a. connecting at least one of the first valve or the second valve to a Christmas tree;

b. maintaining the fluid at a predetermined range having at least a minimum fluid pressure within the flexible conduit to prevent a collapse of the flexible condition at a depth while maintaining the ability to vent pressure downstream of a subsea valve.

17. The method of claim 16, wherein the subsea valve is the second valve.

18. The method of claim 16, further comprising:

a. upon detecting a predetermined pressure, shifting to a fail closed position of at least one of (i) a Christmas tree or (ii) tree control module valves; and

b. closing the flexible conduit by venting the supply pressure.