

MODULAR SAFETY VALVE SYSTEM, VALVE MODULE AND METHOD OF SETTING PARAMETERS OF A VALVE SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

- 5 [0001] This application claims the benefit of U.S. Application No. 16/892807, filed on June 4, 2020, which is incorporated herein by reference in its entirety.

BACKGROUND

- 10 [0002] In the resource recovery industry downhole safety valves are employed to prevent unwanted flow through a string. Due to the operational importance of such valves they must be certified in an API 14A facility before they are approved for use in the field. The number of API 14A facilities and their locations can cause delays in acquiring the certification. As such, the industry is receptive to ideas that can lessen these delays.

15 SUMMARY

[0003] Disclosed is an embodiment of a modular downhole safety valve system comprising a plurality of valve modules being selectable in the field, the valve modules being connectable to one another in the field to define a modular safety valve having desired parameters and is ready for downhole deployment without additional certification.

[0004] Disclosed is an embodiment of a plurality of valve modules for a modular downhole safety valve ready for downhole deployment comprising at least a first valve module and a second valve module both being selected from the plurality of valve modules such that assembly of the first valve module to the second valve module defines the modular downhole safety valve having selected parameters and being ready for downhole deployment without additional certification.

- 20 [0005] Disclosed is an embodiment of a method of setting parameters of a downhole safety valve in the field comprising configuring a plurality of valve modules, each of the valve modules being connectable to others of the valve modules such that assembly of a first of the valve modules to a second of the valve modules defines the downhole safety valve having selected parameters and being ready for downhole deployment without additional certification; and providing the plurality of the valve modules for selection in the field.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The following descriptions should not be considered limiting in any way.

With reference to the accompanying drawings, like elements are numbered alike:

[0007] Figure 1A-1C depict embodiments of a downhole safety valve system

5 disclosed herein; and

[0008] Figure 2 depicts an embodiment of a downhole safety valve disclosed herein.

DETAILED DESCRIPTION

[0009] A detailed description of one or more embodiments of the disclosed apparatus
10 and method are presented herein by way of exemplification and not limitation with reference to the Figures.

[0010] Parameters for downhole safety valves, such as biasing forces that determine setting loads, and control mechanisms for valve operation are often selected by well operators for each specific application. Once these parameters are established the valves are
15 constructed then sent to an API 14A facility for certification before being delivered to the well where they are ultimately deployed. Embodiments disclosed herein provide an alternate approach to this procedure. The embodiments allow final assembly of downhole safety valves in the field that meet certification without requiring the valves to be tested and certified after their final assembly.

[0011] Referring to Figures 1A-1C, a downhole safety valve system disclosed herein is identified by reference character 10. The valve system 10 includes a plurality of valve modules 16 connected together end-to-end in a daisy-chain fashion to define a complete downhole safety valve 18. Each of the valve modules 10 is tested and certified in an API 14A facility prior to being delivered to the field. As such, no further certification testing is
25 required when the separate valve modules 10 are assembled together in the field to form the completed valve 18. This alleviates bottlenecks and costs associated with shipping completed valves to and from certification facilities, as well as time lost while waiting for shipping and testing to be done.

[0012] These pre-certified valve modules 16 can be provided to the field and stored
30 there near to where they will ultimately be deployed. Then when an operator needs a new safety valve 18 and has established the parameters for it, he can simply select the specific valve modules 16 that together will define the downhole safety valve 18 desired, retrieve them from storage, assemble them together, and proceed with well operations.

[0013] The downhole safety valve 18A in Figure 1A, consists of three of the valve modules 16. One is a flapper module 16A, the second is a spring module 16B, and the third is a control module 16C. This valve 18A may be configured to operate at a depth of 500 to 1500 feet, for example based on a biasing force of the spring module 16B.

5 [0014] The safety valve 18B of Figure 1B is configured to operate at a depth of 2,000 to 3,000 feet. It differs from the valve 18A in that it has an additional spring module 16D. A spring force of the spring module 16D is additive to the spring force of the spring module 16B thereby accounting for the difference in operating depth. This modularity allows for any practical number of the spring modules to be added. For example, the safety valve 18C
10 shown in Figure 1C has a third spring module 16E added to the spring modules 16B and 16D, thereby increasing the operational depth of the valve 18C to a range of 3,500 to 4,500 feet.

[0015] The valve modules 16A-16D all use a common connection scheme so that they are interchangeable. For example, in one embodiment, the valve modules 16A-16D each had a male thread 22 on one end and a female thread 26 on the opposing end. This
15 allows any of the valve modules 16A-16D to connect to any other of the valve modules 16A-16D.

[0016] The safety valve 18D of Figure 2 has five valve modules; a bottom sub module 16F, a flapper module 16G, a spring module 16H, a control module 16J, and a nipple adapter module 16K. The nipple adapter module 16K and bottom sub module 16F configure
20 the safety valve 18D to be easily incorporated into a larger production string. The various valve modules 16A-16J can alter various functional parameters of the safety valve 18D. For example, the valve modules 16A-16J can determine a closure mechanism and/or an operating mechanism of the downhole safety valve 18. This can determine whether the valve 18 has an equalizing or a non-equalizing option. Similarly, this can determine whether the
25 valve operating mechanism includes a standard or a deep-set variant.

[0017] Set forth below are some embodiments of the foregoing disclosure:

[0018] Embodiment 1: A modular downhole safety valve system comprising a plurality of valve modules being selectable in the field, the valve modules being connectable to one another in the field to define a modular safety valve having desired parameters and is ready for downhole deployment without additional certification.

[0019] Embodiment 2: The modular safety valve system of any prior embodiment, wherein more than one of a same type of the valve modules can be employed to define the desired parameters.

[0020] Embodiment 3: The modular safety valve system of any prior embodiment, wherein the valve modules are spring modules, and biasing forces of the more than one spring modules are additive.

[0021] Embodiment 4: The modular safety valve system of any prior embodiment, wherein each of the modules includes a first threaded end and a second threaded end, the first threaded end and the second threaded end of one of the valve modules being configured to threadably engage with threaded ends of other of the valve modules in a daisy-chain fashion.

[0022] Embodiment 5: The modular safety valve system of any prior embodiment, wherein the valve modules are selectable from the group comprising: a nipple adapter module, a control module, a spring module, a flapper module, and a bottom sub module.

[0023] Embodiment 6: The modular safety valve system of any prior embodiment, wherein the desired parameters including at least one of a valve closure mechanism and a valve operating mechanism.

[0024] Embodiment 7: The modular safety valve system of any prior embodiment, wherein the valve closure mechanism includes at least one of an equalizing mechanism and a non-equalizing mechanism.

[0025] Embodiment 8: The modular safety valve system of any prior embodiment, wherein the valve operating mechanism includes at least one of a standard and a deep-set variant.

[0026] Embodiment 9: A plurality of valve modules for a modular downhole safety valve ready for downhole deployment comprising at least a first valve module and a second valve module both being selected from the plurality of valve modules such that assembly of the first valve module to the second valve module defines the modular downhole safety valve having selected parameters and being ready for downhole deployment without additional certification.

[0027] Embodiment 10: The valve module of any prior embodiment, wherein the first valve module and the second valve module each include a first threaded end and a second threaded end, the first threaded end and the second threaded end being configured to threadably engage with threaded ends of other module in a daisy-chain fashion.

[0028] Embodiment 11: The valve module of any prior embodiment, wherein the first valve module is a first spring module configured to be connected in the field to the second valve module that is a second spring module to define a total valve biasing force.

[0029] Embodiment 12: The valve module of any prior embodiment, wherein at least one of the first valve module and the second valve module determines whether a valve closure mechanism is an equalizing mechanism and a non-equalizing mechanism.

[0030] Embodiment 13: The valve module of any prior embodiment, wherein at least one of the first valve module and the second valve module determines whether the valve operating mechanism is a standard or a deep-set variant.

[0031] Embodiment 14: The valve module of any prior embodiment, wherein at least one of the first valve module and the second valve module determine a valve closure mechanism and a valve operating mechanism of the modular downhole safety valve.

[0032] Embodiment 15: A method of setting parameters of a downhole safety valve in the field comprising configuring a plurality of valve modules, each of the valve modules being connectable to others of the valve modules such that assembly of a first of the valve modules to a second of the valve modules defines the downhole safety valve having selected parameters and being ready for downhole deployment without additional certification; and providing the plurality of the valve modules for selection in the field.

[0033] Embodiment 16: The method of setting parameters of a safety valve of any prior embodiment, further comprising certifying each of the plurality of valve modules in an API 14A facility.

[0034] Embodiment 17: The method of setting parameters of a safety valve of any prior embodiment, further comprising configuring the plurality of valve modules to be connectable to others of the valve modules in an end-to-end daisy-chain fashion.

[0035] Embodiment 18: The method of setting parameters of a safety valve of any prior embodiment, further comprising configuring the plurality of valve modules to be connectable to others of the valve modules such that an operating parameter of the safety valve is determined by a number of a same type of the valve modules assembled.

[0036] Embodiment 19: The method of setting parameters of a safety valve of any prior embodiment, further comprising configuring the plurality of valve modules to be connectable to others of the valve modules such that at least one of a valve closure mechanism and a valve operating mechanism of the downhole safety valve is defined by which of the valve modules are assembled in the field.

[0037] The use of the terms “a” and “an” and “the” and similar referents in the context of describing the invention (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. Further, it should be noted that the terms “first,” “second,”

and the like herein do not denote any order, quantity, or importance, but rather are used to distinguish one element from another. The modifier “about” used in connection with a quantity is inclusive of the stated value and has the meaning dictated by the context (e.g., it includes the degree of error associated with measurement of the particular quantity).

5 [0038] The teachings of the present disclosure may be used in a variety of well operations. These operations may involve using one or more treatment agents to treat a formation, the fluids resident in a formation, a wellbore, and / or equipment in the wellbore, such as production tubing. The treatment agents may be in the form of liquids, gases, solids, semi-solids, and mixtures thereof. Illustrative treatment agents include, but are not limited to, 10 fracturing fluids, acids, steam, water, brine, anti-corrosion agents, cement, permeability modifiers, drilling muds, emulsifiers, demulsifiers, tracers, flow improvers etc. Illustrative well operations include, but are not limited to, hydraulic fracturing, stimulation, tracer injection, cleaning, acidizing, steam injection, water flooding, cementing, etc.

 [0039] While the invention has been described with reference to an exemplary 15 embodiment or embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to 20 the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the claims. Also, in the drawings and the description, there have been disclosed exemplary embodiments of the invention and, although specific terms may have been employed, they are unless otherwise stated used in a generic and descriptive sense only and not for purposes 25 of limitation, the scope of the invention therefore not being so limited.

What is claimed is:

1. A modular downhole safety valve system (10) characterized by a plurality of valve modules (16) being selectable in the field, the valve modules (16) being connectable to one another in the field to define a modular safety valve (18) having desired parameters and is ready for downhole deployment without additional certification.

2. The modular safety valve system (10) of claim 1, wherein more than one of a same type of the valve modules (16) can be employed to define the desired parameters.

3. The modular safety valve system (10) of claim 2, wherein the valve modules (16) are spring modules (16A, 16D, 16E, 16H), and biasing forces of the more than one spring modules (16A, 16D, 16E, 16H) are additive.

4. The modular safety valve system (10) of claim 1, wherein each of the modules (16) includes a first threaded end and a second threaded end, the first threaded end and the second threaded end of one of the valve modules (16) being configured to threadably engage with threaded ends of other of the valve modules (16) in a daisy-chain fashion.

5. The modular safety valve system (10) of claim 1, wherein the valve modules (16) are selectable from the group comprising: a nipple adapter module (16K), a control module (16C, 16J), a spring module (16B, 16D, 16E, 16H), a flapper module (16A, 16G), and a bottom sub module (16F).

6. The modular safety valve system (10) of claim 1, wherein the desired parameters including at least one of a valve closure mechanism and a valve operating mechanism.

7. The modular safety valve system (10) of claim 6, wherein the valve closure mechanism includes at least one of an equalizing mechanism and a non-equalizing mechanism.

8. A plurality of valve modules (16) for a modular downhole safety valve (18) ready for downhole deployment comprising at least a first valve module and a second valve module both being selected from the plurality of valve modules (16) such that assembly of the first valve module to the second valve module defines the modular downhole safety valve (18) having selected parameters and being ready for downhole deployment without additional certification.

9. The valve module (16) of claim 8 wherein the first valve module and the second valve module each include a first threaded end and a second threaded end, the first threaded end and the second threaded end being configured to threadably engage with threaded ends of other module in a daisy-chain fashion.

10. The valve module (16) of claim 8 wherein the first valve module is a first spring module (16B) configured to be connected in the field to the second valve module that is a second spring module (16D) to define a total valve biasing force.

11. A method of setting parameters of a downhole safety valve (18) in the field characterized by:

configuring a plurality of valve modules (16), each of the valve modules (16) being connectable to others of the valve modules (16) such that assembly of a first of the valve modules to a second of the valve modules defines the downhole safety valve having selected parameters and being ready for downhole deployment without additional certification; and providing the plurality of the valve modules (16) for selection in the field.

12. The method of setting parameters of a safety valve (18) of claim 11, further comprising certifying each of the plurality of valve modules (16) in an API 14A facility.

13. The method of setting parameters of a safety valve (18) of claim 11, further comprising configuring the plurality of valve modules (16) to be connectable to others of the valve modules (16) in an end-to-end daisy-chain fashion.

14. The method of setting parameters of a safety valve (18) of claim 11, further comprising configuring the plurality of valve modules (16) to be connectable to others of the valve modules (16) such that an operating parameter of the safety valve (18) is determined by a number of a same type of the valve modules (16) assembled.

15. The method of setting parameters of a safety valve (18) of claim 11, further comprising configuring the plurality of valve modules (16) to be connectable to others of the valve modules (16) such that at least one of a valve closure mechanism and a valve operating mechanism of the downhole safety valve (18) is defined by which of the valve modules (16) are assembled in the field.