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(54) Title: SUBSURFACE SAFETY VALVE FOR ELECTRIC SUBSEA TREE

(57) Abstract: An all electric subsea tree can be coupled with a hydraulic pressure unit that is fed off electrical and control lines that are in the umbilical from the surface. In that way hydraulic lines do not need to be separately run from the surface to the tree. Alternatively hydraulic pressure can be generated at a downhole tool using power and control lines running from the tree to the downhole equipment. As another alternative, the downhole equipment can be run by electric motor located downhole adjacent the downhole equipment and powered and controlled by lines running from the tree to the downhole location.



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APPLICATION FOR PATENT

Title: Subsurface Safety Valve for Electric Subsea Tree

Inventor: Walter S. Going

FIELD OF THE INVENTION

[0001] The field of the invention is subsurface equipment that responds to hydraulic control from the surface and more particularly when that equipment is coupled with an electric subsea tree.

BACKGROUND OF THE INVENTION

[0002] Downhole equipment such as subsurface safety valves (SSV) is typically controlled by a hydraulic control line that runs from a surface hydraulic power supply to the SSV housing. Application of pressure holds the valve open and removal or loss of applied pressure generally results in the valve going closed. In subsea systems, a tree is installed subsea at the mud line. The tree is connected to surface located hydraulic controls through a hydraulic umbilical so that pressure can be developed in the hydraulic system at the surface can be transmitted to the downhole equipment.

[0003] More recently, all electric subsea trees have been developed to save money in removing complexity of hydraulic switching circuits as well as other reasons. When these all electric trees are deployed the umbilical to the surface no longer has a need for hydraulic lines to operate the equipment located at the tree. However, downhole equipment such as SSVs are still provided with hydraulic control. Thus to still be able to team up traditional safety valves with the new all electric subsea tree, hydraulic lines still had to be run from the surface mounted pressure generating equipment to the subsea tree, a distance that could be thousands of feet and beyond to the SSV.

[0004] The present invention improves this situation by providing a module at the tree that receives power and signal input from the umbilical and generates hydraulic pressure at the subsea tree for use by an SSV or other downhole hydraulically operated equipment. Alternatively, the downhole component such as the SSV can be constructed

to receive electrical power and signal input from the tree and the hydraulic lines along the tubing can be eliminated in favor of local generation of hydraulic pressure at the housing of the downhole tool such as the SSV. Alternatively, the SSV can be reconfigured to open and close using an onboard electrically driven motor so that the hydraulic operating system can be replaced totally. These and other advantages of the present invention will be more readily understood by those skilled in the art from a review of the description of the preferred embodiment and the associated drawing while recognizing that the claims are the full measure of the invention.

SUMMARY OF THE INVENTION

[0005] An all electric subsea tree can be coupled with a hydraulic pressure unit that is fed off electrical and control lines that are in the umbilical from the surface. In that way hydraulic lines do not need to be separately run from the surface to the tree. Alternatively hydraulic pressure can be generated at a downhole tool using power and control lines running from the tree to the downhole equipment. As another alternative, the downhole equipment can be run by electric motor located downhole adjacent the downhole equipment and powered and controlled by lines running from the tree to the downhole location.

BRIEF DESCRIPTION OF THE DRAWING

[0006] FIG. 1 is a schematic of a subsea tree with a locally mounted hydraulic pressure generating unit for the safety valve downhole.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0007] FIG. 1 is a schematic representation that will be used to describe alternative design options. The variations revolve around an electric subsea tree **10** that is disposed near the mud line **12**. The wellbore **14** has a tubing string **16** in it and a subsurface safety valve (SSV) **18** mounted in the tubing string **16**.

[0008] A hydraulic pressure generating module **20** in one embodiment is mounted adjacent the tree **10**. A power line **22** and a control line **24** extend from a control module **26** that is a part of the subsea tree **10**. The umbilical **28** runs to surface at the waterline

and provides power and control signals from the surface such as from a platform or a vessel (not shown). Module 20 has an onboard controller 30 to power motor 32 which runs pump 34. A low pressure switch 36 set above the minimum pressure required to hold SSV 18 open is there to sound an alarm if the pressure declines below a preset value. Conversely, a high pressure switch 38 alarms if the operating pressure exceeds a predetermined maximum. A pressure compensated reservoir 40 is provided as well as a multi-position valve 42 to direct pressure back to the reservoir 40 in the position shown in FIG. 1 or alternatively out line 44 through a wet connector 46 which is a quick connection that can be automatically connected when the module 20 is placed on the tree 10 or by a remotely operated vehicle (ROV) not shown. Line 44 is a hydraulic line down to the SSV 18 that runs along string 16 in the known manner. A pressure transmitter 48 can be connected to the pump 34 discharge to transmit the operating pressure to the surface on a real time basis. The system can be closed or it can discharge hydraulic fluid when stroking the valve 18. If the system is not closed it can be periodically replenished by an ROV or by a line run to the reservoir 40. A closed system that retains hydraulic fluid is preferred.

[0009] With the above described arrangement, there doesn't need to be any hydraulic line from the waterline to the tree 10. This allows for a more economical umbilical while still allowing SSVs 18 now on the market that operate hydraulically to continue to be operated as before.

[0010] In an alternative embodiment, the components of module 20 can be integrated into SSV 18 or along the string 16 near it so that lines 22 and 24 can continue to run into the wellbore 14 to a now relocated module 20 that is now in the wellbore close to or integrated with the housing of the SSV 18. With this arrangement, hydraulic lines don't need to be run the length of string 16 while allowing the continued use of currently available hydraulically operated SSVs such as 18.

[0011] In yet another variation, the design of the SSV 18 can be reconfigured so that it needs no hydraulic power at all. Instead lines 22 and 24 run down the string 16 to a locally mounted electric motor M that directly or indirectly powers a flapper or other

closure device in the SSV 18. In this alternative, hydraulic pressure and a control system for it would not be needed. On the other hand, the currently available hydraulically operated valves could not be used and instead a different SSV design would be required for power and control input that would be all electrical.

[0012] The above description is illustrative of the preferred embodiment and many modifications may be made by those skilled in the art without departing from the invention whose scope is to be determined from the literal and equivalent scope of the claims below.

I claim:

1. A control system for a downhole tool, comprising:
an electric subsea tree;
a hydraulic pressure generating module mounted to or adjacent said tree
operatively connected to the downhole tool.
2. The system of claim 1, wherein:
said module is connected to the downhole tool by at least one hydraulic pressure
line run along a tubular string to the downhole tool.
3. The system of claim 2, wherein:
said tree provides at least one of power supply and control wire to said module.
4. The system of claim 3, wherein:
said module comprises a hydraulic pressure generating system further comprising
a pump and a reservoir and a regulation system to maintain pressure in said hydraulic
pressure line between predetermined values.
5. The system of claim 4, wherein:
said hydraulic pressure generating system is one of a vented system to the
surrounding sea and a non-vented system.
6. The system of claim 5, wherein:
said hydraulic pressure line further comprises a wet connect for rapidly hooking
up said pump to the downhole tool upon placement of said module on said tree.
7. The system of claim 1, wherein:
said downhole tool comprises a subsurface safety valve.
8. The system of claim 6, wherein:
said downhole tool comprises a subsurface safety valve.
9. A control system for a downhole tool, comprising:
an electric subsea tree;
a hydraulic pressure generating module mounted to or near the downhole tool.
10. The system of claim 9, wherein:
said tree provides at least one of power supply and control wire to said module.

11. The system of claim 10, wherein:
said module comprises a hydraulic pressure generating system further comprising a pump and a reservoir and a regulation system to maintain pressure in said hydraulic pressure line between predetermined values.
12. The system of claim 11, wherein:
said hydraulic pressure generating system is one of a vented system and a non-vented system.
13. The system of claim 12, wherein:
said hydraulic pressure generating module further comprises a wet connect for rapidly hooking up said pump to the downhole tool upon placement of said module near the downhole tool.
14. The system of claim 9, wherein:
said downhole tool comprises a subsurface safety valve.
15. The system of claim 13, wherein:
said downhole tool comprises a subsurface safety valve.
16. A control system for a downhole tool, comprising:
an electric subsea tree, said tree operatively electrically connected to a motor on the downhole tool for operation thereof.
17. The system of claim 16, wherein:
said tree provides at least one of power supply and control wire to the downhole tool.
18. The system of claim 17, wherein:
said motor directly or indirectly operates a valve member in the downhole tool between an open and a closed position.
19. The system of claim 18, wherein:
said valve member comprises a flapper on a subsurface safety valve.

