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MODULAR CONTROL SYSTEM

In oil and gas fields, controls, sensors and valve actuators are conventionally spread over the whole structure of, for example, a subsea production tree. A previously accepted disadvantage of such an arrangement is that if any part of this equipment should fail, the tree has to be pulled for the damage to be corrected and this involves extensive workover operations and loss of production time, with the commensurate expense.

According to the present invention, an assembly of equipment for use in a gas or oil field comprises a hydrocarbon module containing fluid flow passages which are controlled by moving valve parts, and a separate control module which contains valve actuators, and which is arranged to be brought into juxtaposition with and fixed with respect to the hydrocarbon module whereby moving parts of the valve actuators are engageable with the moving valve parts across an interface between the modules to enable operation of the valves by the actuators.

The control module may be fixed to the hydrocarbon module, or both modules may be fixed to a common base.

The hydrocarbon module could take many forms such as a production tree, a manifold, a separator or a pumping head. The valves in this module may be flow valves, chokes or connectors but without their actuators, the actuators being provided separately in the control module. Most simply the moving actuator parts are rods which, at the interface between the modules, are arranged to abut end to end with respective rods forming the moving valve parts. Preferably the valves are fail safe closed and the valves rods are pushed by extension of the actuator rods to open the respective valves.

The actuators may be hydraulically or pneumatically operated pistons, or electrical actuators and a control module designed to be operated by one mode could be changed to one operated by different mode, e.g. an electric module

could be replaced by an hydraulic module, without any modification to the hydrocarbon module.

In case one of the actuators should become stuck in a position in which it extends across the interface, it is desirable that the control module is coupled to the hydrocarbon module in such a way that to disengage the control module from the hydrocarbon module, the control module undergoes a first movement to disengage the actuators from the moving valve parts to allow the valves to close, while the control module and hydrocarbon module are still engaged, and a second movement to disengage the control module from the hydrocarbon module. This ensures that the control module can be safely removed after the valves have closed, even if the actuators are stuck.

In addition to containing the valve actuators, the control module may incorporate valve actuation monitoring equipment and data gathering systems. In this case the control module may be connected via a hub to a part of the hydrocarbon module which has connections downhole or by umbilical to other stations.

The advantages which stem from the invention are numerous. The central activation of all the valves in a tree structure or other hydrocarbon module by actuators in the separate control module, obviously avoids the need to locate such actuators in the tree so that if, for example, an actuator should stick, it is only necessary to release and retrieve the control module, without plugging the well and pulling the tree. A central location of controls, transmitters and actuators in the control module eliminates the need for pipe work in the tree or other hydrocarbon module and eliminates the need for many hydraulic couplings and electrical connectors.

An example of a subsea wellhead constructed in accordance with the present invention is illustrated in the accompanying drawings, in which:-

Fig. 1 is a side view of an example of a wellhead;

Fig. 2 is a plan view of the wellhead as shown in Fig. 1;

Figs 3A, B and C show a side elevation, an end elevation and a plan of an example of a control module for use with the wellhead;

Fig. 4 is a diagrammatic sectional view of a conventional wellhead;

Fig. 5 is a diagrammatic sectional view of a wellhead constructed in accordance with the present invention; and

Fig. 6 is a sectional view of a valve for use with the wellhead shown in open and closed configurations.

As illustrated in Fig. 1 the subsea wellhead at the mud line 3 comprises the usual wellhead housing 4 containing concentric casings and, coupled to the top of the wellhead housing by a connector 5, a tree 6 within a framework 7. The tree may be of the kind known as a "spool tree", in which the production tubing hanger has a lateral port in alignment with a flow port in the tree, the arrangement being such that after the completion has been pulled, through a BOP, full bore access is provided to the well through the spool tree without the need to remove the spool tree.

In the context of the present invention, the spool tree 6 provides a hydrocarbon module through which the flow of fluids into and out of the well is controlled.

In Fig. 2 the spool tree 6 forming the hydrocarbon module is shown to contain several parallel valves 8, which may include an annular cross over valve, an annular master valve, a production master valve, a service wing valve, a production wing valve and chokes 9. These are all provided with mutually parallel operating rods 10 which are shown in Fig. 2 provided with extension rods 10′ so that they all terminate adjacent to the edge of the framework 7. Each of the valves is operated against spring action by depression of the respective operating rod 10.

Fig. 1 shows a control actuation module 11 coupled to one side of the tree 6. The control actuation module 11 is

provided with four T-pieces 11′, which, in plan, have a T-shape cross section. These are arranged to slide vertically into V-boxes 6′ on the side of the tree 6 which are provided with correspondingly shaped slots. In use, the control actuation module 11 is lowered on a suspension connection 12 and brought, with the aid of a ROV into proximity with the tree 6. The control actuation module 11 is guided by the framework 7 until the T-pieces 11′ slot into the V-boxes 6′. The control actuation module 11 is further lowered onto a base 13 of the tree 6 so that it is clamped into position on the side of the tree. The control actuation module 11 also interfaces with valve actuation monitoring equipment and data gathering systems via a hub 14 or a connector which is provided with electrical and hydraulic quick connect mechanisms.

As shown particularly in figures 3A and 3B, the control actuation module 11 incorporates actuators 15, each having a projecting actuating rod 16 ending in a mushroom head 16′. Each rod, when the modules are interconnected, is aligned end to end with a respective one of the valve actuating rods 10. The actuators may be electrical actuators provided with an electric motor and gear drive, similar to that shown in US-A-4920811, or hydraulic actuators provided with a double acting cylinder arrangement. Any one of the valves can then be opened by operation of the respective actuator in the control module, causing the respective rod 16 to be extended and hence the respective rod 10 to be retracted.

The principle of the invention is best illustrated by a comparison of the conventional arrangement as shown in Fig. 4 with the inventive arrangement shown in Fig. 5. In Fig. 4 the actuators 15A are provided within the tree 6. A separate control module 17 which has numerous hydraulic and electrical lines is provided for the control of the valves. A separate umbilical connection 18 is provided for the source of hydraulic and/or electrical power. By contrast, in Fig. 5, the actuators 15 and associated

controls are provided in the separate control module 11 with the actuating rods 16 engaging with the respective valve operating rods 10 across the interface between the control module 11 and tree 6. An umbilical connection 19 for the source of hydraulic and/or electrical power is provided directly to the control module 11.

The valve actuators could operate vertically instead of horizontally and the control module could be landed in a different attitude relative to the hydrocarbon module, subject to an appropriate interface between the valve moving parts, such as the rods 10, and the actuator moving parts, such as the rods 15.

A valve suitable for use in the tree 6 is shown in Fig. 6. The closure element is provided by a gate 20 which is shown in an open position in the top half of Fig. 6 and in a closed position in the bottom half of Fig. 6. The gate is connected to a stem 21 which extends out through the opposite end of the valve to the gate 20 where it terminates in a mushroom head 22 which, in use, is engaged by an actuating rod 16. The stem can be provided with any extension rod, for example as shown in Fig. 2 so that it extends to the edge of the tree 6. A spring 23 is provided in a spring cartridge 24 and is arranged to bias the valve into a closed position as shown in the bottom of Fig. 6. The spring is surrounded by a sleeve 25 which is telescopic so that it does not project beyond the stopper 22 when the valve is open. Thus, when the actuating rod 16 is retracted, the spring provides a fail safe closed operation.

In the event of malfunction, the least reliable parts are in the control module 11, and this can be readily disconnected and raised to the surface for repair without disturbing the tree 6, or having to break any hydrocarbon interface.

If an actuating rod 16 should become stuck in a position in which it extends across the interface between the hydrocarbon 16 and control module 11, the control

module 11 has first to be moved vertically so that the stuck actuator rod 16 is no longer in alignment with the respective operating rod 10, while the module 11 still remains fixed against horizontal movement away from the tree 6 by virtue of the engagement between T-pieces 11′ and V-boxes 6′. This vertical movement releases the actuating rod 10 and allows the spring 23 to force the valve into a closed position. The actuating rod 16 is now isolated from the tree, and the control module 11 can be removed safely by further vertical movement to bring the T-pieces 11′ out of the V-boxes 6′.

CLAIMS

1. An assembly of equipment for use in a gas or oil field comprising a hydrocarbon module (6) containing fluid flow passages which are controlled by moving valve parts (10), and a separate control module (11) which contains valve actuators (16), and which is arranged to be brought into juxtaposition with and fixed with respect to the hydrocarbon module whereby moving parts of the valve actuators (16) are engageable with the moving valve parts (10) across an interface between the modules to enable operation of the valves by the actuators.

2. An assembly accprdinc to claim 1, wherein the control module is fixed to the hydrocarbon module.

3. An assembly according to claim 1, wherein the control module and hydrocarbon module are fixed to a common base.

4. An assembly according to any one of the preceding claims, wherein the moving actuator parts are rods (16) which, at the interface between the modules (6,11), are arranged to abut end to end with respective rods forming the moving valve parts (10).

5. An assembly according to any one of the preceding claims, wherein the valves (8) are fail safe closed and the valves rods (10) are pushed by extension of the actuator rods (16) to open the respective valves.

6. An assembly according to any one of the preceding claims, wherein the control module (11) incorporates valve actuation monitoring equipment and data gathering systems.

7. An assembly according to claim 6, wherein the control module (11) is connected via a hub to a part of the

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hydrocarbon module (6) which has connections downhole or by umbilical to other stations.

8. An assembly according to any one of the preceding claims, wherein the control module (11) is coupled to the hydrocarbon module (6) in such a way that to disengage the control module from the hydrocarbon module, the control module undergoes a first movement to disengage the actuators (16) from the moving valve parts (10) to allow the valves to close, while the control module and hydrocarbon module are still engaged, and a second movement to disengage the control module from the hydrocarbon module.

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