INSTALLATION FOR USING CONTROL FLUID AS BARRIER FLUID FOR ELECTRIC MOTORS COUPLED TO SUBSEA PUMPS

Field of the Invention

[0001] The present invention relates to an installation for using control fluid as barrier fluid for electric motors coupled to subsea pumps. The present invention refers to the use of hydraulic control fluid for hydrocarbon producing equipment as barrier fluid for electric motors coupled to subsea pumps.

Background of the Invention

[0002] Up to now, the use of subsea pumps has presented very positive results for increasing the oil and gas production in subsea fields in Brazil and in the world.

[0003] This technology started to be used for producing hydrocarbons in onshore fields and with the development of offshore fields, its application was extended to subsea wells.

[0004] Besides using pumps as a tool for pumping hydrocarbons, these pumps are also used for water injection in a production or discard reservoir.

[0005] Submerged Centrifugal Pumps (SCP) are the type of centrifugal pumps most used for producing petroleum. These pumps were initially designed for operating inside wells and for this reason are constructively long and slim. For operating, they do not need external supply of barrier fluid for the motor, since the barrier fluid is isolated and compensated regarding the process through a set of seals, isolating the pump motor.

[0006] With the demand increase of pumps for subsea use, new concepts of pumping systems were developed, more suitable for using on the seabed.

[0007] In surface pumps applications, generally the electric motor housing is in communication with the surrounding environment, such that the internal cavity of the motor is filled with air. When the motor is coupled to a pump, this pump has a sealing system in the shaft to avoid pumped fluid (process fluid) leakage to the environment.

[0008] This seal is known as a mechanical, dynamic or rotating seal. For being a seal needing to seal between two surfaces with relative movement between them, the seal is not completely efficient, allowing a small leakage of the process fluid outside the pump housing.

[0009] In general, there is an open housing between the motor and the pump, ensuring that any leakage of the process fluid is collected and forwarded to proper discard. In subsea applications however, the escape of any amount of process fluid to the environment is unacceptable, since this would mean sea water contamination.

[0010] A method commonly used for controlling seal leakage is to eliminate the open space between the pump seal and the motor seal, in such way that leakages of process fluid resulting from the pump are obliged to enter into the motor housing. The motor itself is totally sealed from sea water surrounding the static seals. In order that the process fluid does not enter into the motor, its internal cavity is filled with another fluid, called barrier fluid.

[0011] In SCP pumps, the barrier fluid is separated from the process fluid by a set of seals that aims to equalize the pressures between the process and the barrier fluid, allows the expansion and contraction of the barrier fluid due to temperature variation and isolates the process fluid from the barrier fluid. In this case, the motor housing is filled with dielectric oil before installing the pump in its operation location and the continuous supply of a barrier fluid from an external source is not necessary. In addition, it is not necessary to control the pressure in active manner, neither is the consumption of barrier fluid allowed

for. This arrangement simplifies the operation, however it tends to reduce the equipment life.

[0012] In pumps designed to operate on the seabed, the most common solution is to use a single seal separating the process fluid from the barrier fluid; a solution significantly more compact than that used for SCP. However, with this arrangement, it is not possible to ensure that contamination (leakage through the seal) of the barrier fluid by the process fluid will not occur.

[0013] To prevent contamination of the barrier fluid, this same is kept at a higher pressure than the process fluid in the pump side. Thus, any leakage through the shaft seal will occur only in the motor to the pump direction. In general, such leakages are small and do not significantly impact the subsea equipment´s operation.

[0014] In this case, as there is a small but constant consumption of barrier fluid, there is a requirement for an external source to supply this fluid and also to provide the necessary pressure to ensure overpressure in the motor housing.

[0015] The barrier fluid has also the objective of lubricating the pump and motor bearings, besides aiding in the thermal management of the equipment.

[0016] Since the motor winding is exposed to this barrier fluid, generally a fluid with dielectric properties is chosen. Thus, the winding insulation is preserved, even if there are small detects in the enamel insulation of the wires – a problem that does not exist for conventional motors with air inside.

[0017] The dielectric fluid is typically a mineral oil with low viscosity. The low viscosity is desirable for reducing losses resulting from the drag caused by the presence of the liquid in the space between the rotor and the stator. Mineral oil is chosen due to its good dielectric properties.

[0018] By being a specific fluid, not used in other functions present in the subsea equipment, it is necessary to create an infrastructure dedicated to supply this fluid, from the logistics for supply to the platform, to equipment that is installed in the platform and in the subsea environment for directing barrier fluid to the pump.

[0019] Problems and difficulties for using barrier fluid start in the characteristics and properties required by the same. To maintain the dielectric properties and ensure motor integrity, strict control of contamination by water, even in small proportions, is necessary. Furthermore, this oil has a great tendency to absorb atmospheric moisture which requires periodic testing to evaluate the water content of the stored fluid.

[0020] The supply of barrier fluid to the submerged motor involves several aspects as described in the following:

[0021] The fluid is specially purchased - there is no other use for this fluid in petroleum production platforms environment. In the case of Brazilian platforms this fluid is imported, since there is no domestic production. It is carried in drums to the platform to which the pump is connected, being stored until required to refill the reservoir of the ressurization unit.

[0022] The pressurization unit, or hydraulic power unit (HPU) is installed on this platform and dedicated to supply the barrier fluid, which is pressurized via electric pumps and accumulators. Control valves allow directing the fluid into the umbilical which in turn conducts the fluid to the subsea pump.

[0023] Beside the purchase cost of the fluid, and acquisition and installation of the hydraulic unit, there are major operational inconveniences in monitoring the supply of the fluid in a timely manner, since storage of a large quantity of this fluid is not feasible, due to lack of space in the platform. This lack of space is also critical for hydraulic unit installation.

[0024] Another technical limitation is the fluid path through the "*swivel*", in case of the platform with *"turret"*, requiring the availability of a dedicated path.

[0024a] It is generally desirable to overcome or ameliorate one or more of the above described difficulties, or to at least provide a useful alternative.

Summary of the Invention

In accordance with the present invention, there is provided an installation for using control fluid as barrier fluid for electric motors coupled to subsea pumps, comprising a platform (10) in which is installed a single hydraulic power unit (HPU) (5), provided with hydraulic control fluid and connected by an umbilical (6) to the umbilical termination unit (9), where a control module (8) and valves and *"chokes"* (11) are interconnected through hydraulic coupling plates (MQC) (7), wherein the said umbilical termination unit (9) is provided with a hose (HFL) (12) interconnecting it with the electric motor (2) of the pump (1) via one of the hydraulic coupling plates (MQC) (7), in such way that the hydraulic control fluid is also used as barrier fluid in the said motor (2) and centrifugal pump (1) assembly.

Brief Description of the Drawings

[0025] Preferred embodiments of the invention are hereafter described, by way of non-limiting example only, with reference to the accompanying drawings in which:

Figure 1 is a schematic view of the installations for using barrier fluid in electric motors coupled to subsea pumps, according to the state of the art; and

Figure 2 is a schematic view of the installation for using control fluid as barrier fluid for electric motors coupled to subsea pumps, according to the present invention.

[0026] The use of barrier fluid according to the state of the art represented in Figure 1 comprises an installation composed of two hydraulic power units (HPU), two independent umbilicals and two independent connections to the platform, for the management of barrier fluid for electric motors coupled to subsea pumps and for the control fluid for the subsea system, respectively.

[0027] The installation represented in the Figure 2, object of the present invention, comprises a single hydraulic power unit (HPU), a single umbilical and, consequently, a single interface with the platform, for barrier fluid and for control fluid, using the same fluid for both purposes.

Detailed Description of Embodiments of the Invention

[0028] In offshore systems, the control of the subsea production equipment is typically hydraulic. For this, a hydraulic power unit (HPU) is installed on the platform providing, through an umbilical, pressurized fluid for he subsea system. The distribution of this fluid for several consumers – valves, "*chokes"* and control module – is done via hoses (HFL) and hydraulic couplings (MQC).

[0029] Advantageously, embodiments of the present invention provide means of using the control fluid as barrier fluid for the motors of subsea pumps using the infrastructure already available on the platform and in the subsea environment. The implementation and use of the present invention comprises, notably, the reconfiguration of the subsea hydraulic distribution system. In specific cases, some modification to the HPU of the platform may be necessary, as for example, increases of the reservoirs, accumulators and pump flow rates.

[0030] The pressure regulation inside the motor housing is performed by a set of regulating valves mounted on the pump, with the control HPU responsible for providing a constant pressure of fluid that is routed to the pump.

[0031] The installation, may be well understood by the detailed description of Figure 2, where the same numeric references identify the same elements illustrated in Figure 1.

[0032] In a platform (10) there is a single hydraulic power unit (HPU) (5), provided with water-based hydraulic control fluid, which is connected by an umbilical (6) to the umbilical termination unit (9), where normally a control module (8) and valves and *"chokes"* (11) are interconnected via hydraulic coupling plates (MQC) (7). A hose (HFL) (12) is provided in such way as to perform the connection between the umbilical termination unit (9) and the electric motor (2) of the pump (1) via the plates (MQC) (7), in such manner that the water-based hydraulic control fluid may be also used as barrier fluid in the motor and centrifugal pump unit. This installation allows achieving an overpressure of the barrier fluid relative to the inlet (3) of the process fluid.

[0033] It must be noted that the hydraulic circuit originating from the hydraulic power unit (5) is enough for simultaneously performing the hydraulic control of the subsea system (8, 11) and the supply of the barrier fluid for electric motor (2) of the subsea pump (1).

[0034] It must be noted for those skilled in the art that the adoption of the installation according to the present invention, when sharing the same fluid for subsea control as for the barrier fluid, will provide among other advantages:

From the constructive point of view:

- the possibility of utilization of existing infrastructure on the platform, eliminating the need for more than one hydraulic control unit (HPU) and,

therefore, optimizing the space available on the floating unit, without barrier fluid reservoir tanks, accumulators, etc., in the pressurization unit;

- the possibility of taking advantage of the control umbilical, without needing extra lines to supply fluid to the pump motor since the redistribution will come to be done subsea;

- the economy of hydraulic paths in the *"swivel"*, in the case of platforms with *"turret"*;

From the logistics point of view:

- the use of already existing fluids and offshore supply logistics, it not being necessary to insert a new product into the supply contracts;

From qualitative point of view:

- the cleanliness specification for the control fluid is the same as that required for operating the pump; that is, it will not be necessary to change the quality requirements of the fluid to use it as barrier fluid.

[0035] As can be also noted, the application of this installation according to the present invention will substantially reduce the cost and the implantation and operation complexity of a subsea pumping system. In addition, since the electric motor was already designed to work immersed in a water based-fluid, contamination of barrier fluid by the process fluid or seawater will not result in motor failure due to short circuit.

Claims defining the Invention:

1. Installation for using control fluid as barrier fluid for electric motors coupled to subsea pumps, comprising a platform (10) in which is installed a single hydraulic power unit (HPU) (5), provided with hydraulic control fluid and connected by an umbilical (6) to a umbilical termination unit (9), where a control module (8) and valves and *"chokes"* (11) are interconnected through hydraulic coupling plates (MQC) (7), wherein the said umbilical termination unit (9) is provided with a hose (HFL) (12) interconnecting it with the electric motor (2) of the pump (1) via one of the hydraulic coupling plates (MQC) (7), in such way that the hydraulic control fluid is also used as barrier fluid in the said motor (2) and centrifugal pump (1) assembly.

2. Installation for using control fluid as barrier fluid for electric motors coupled to subsea pumps, according to claim 1, wherein the said installation provides the achievement of an overpressure of the barrier fluid relative to the inlet (3) of the process fluid.

3. Installation for using control fluid as barrier fluid for electric motors coupled to subsea pumps, according to claim 1, wherein the hydraulic circuit originating from the hydraulic power unit (5) is enough to perform simultaneously the hydraulic control of the subsea system (8, 11) and supply of the barrier fluid for electric motor (2) of the subsea pump (1).

4. Installation for using control fluid as barrier fluid for electric motors coupled to subsea pumps, according to claim 1, wherein the fluid used for control and for barrier fluid is a water based-fluid.

5. Installation for using control fluid as barrier fluid for electric motors coupled to subsea pumps, according to any claims 1 to 4, wherein the utilization of infrastructure generally existent on the platform is allowed.

6. Installation for using control fluid as barrier fluid for electric motors coupled to subsea pumps, according to any claims 1 to 4, wherein utilization of a control umbilical is allowed, with the fluid redistribution totally performed in the subsea environment.

7. Installation for using control fluid as barrier fluid for electric motors coupled to subsea pumps, according to any claims 1 to 4 wherein in the case of platforms with *“turret”*, the hydraulic paths in the *“swivel”* are used for distributing fluid.

8. Installation for using control fluid as barrier fluid for electric motors coupled to subsea pumps, according to any claims 1 to 4, wherein the logistics of fluids and offshore supplies already existing on the platform are used.

9. Installation for using control fluid as barrier fluid for electric motors coupled to subsea pumps, according to any claims 1 to 4, wherein there is no need to change quality requirements of the control fluid for use as barrier fluid.