

A motor and pump barrier fluids pressure regulation system in a subsea motor and pump module

TECHNICAL FIELD OF THE INVENTION

5 The present invention relates generally to subsea equipment involved in the transport of process fluids generated in subsea hydrocarbon production. More specifically, the present invention is concerned with a system that is designed for management of barrier and lubrication fluid pressures in a subsea motor and pump module.

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BACKGROUND AND PRIOR ART

A process fluid in subsea hydrocarbon production is typically a multiphase fluid comprising oil and gas and eventually solid matter, which is extracted from an underground reservoir. A motor/pump module is arranged on the sea floor and configured for transport of the process fluid from the reservoir to a surface or land based host facility. The motor/pump module is frequently subjected to substantial variations in pressure in the pumped medium, as well as substantial transitional loads during pump start and stop sequences, e.g. The medium pressure at the suction side of the pump may be in the order of hundreds of bar, requiring corresponding measures in the motor/pump module to prevent process fluid and particulate matter from immigration from the pump interior into a motor housing via bearings and seals in the motor/pump module.

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Screw rotor pumps are often used for the purpose of pumping a multiphase fluid in subsea production. The screw rotor pump is a positive displacement type of pump having two screw shafts that are driven in rotation with intermeshing gears, between which a specific volume of fluid is displaced in the axial direction of the screws from a suction side of the pump to be discharged on the pressure side of the pump. The screws are journalled in bearings in a pump housing, and are drive-connected to a motor arranged in a motor housing. In case of a twin rotor screw pump, intermeshing timing gears carried on the screw shafts provide synchronization of the rotary motion. The motor housing is hydraulically separated from the pump by a seal arrangement, where the drive shaft is journalled to extend for connection with the pump rotor shaft. The pump bearings are separated from the pump medium by seal arrangements at both ends of the pump.

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For purposes of lubrication and cooling, as well as for preventing intrusion of sea water and pumped medium into the structures of a subsea motor and pump

module, hydraulic fluid needs to be supplied to the motor/pump module. In this connection, barrier fluid and lubrication fluid are basically different definitions of the same type of fluid applied to protect the internals of the motor/pump module.

- 5 Accordingly, a motor housing that protects the motor from the ambient sea and from the medium in the pump is to be maintained at a pressure above the internal pressure of the pump, this way acting also as a barrier which prevents intrusion of process fluid and particles into the motor housing via the seal and bearing arrangement. In result of the pressure difference, a leak flow of hydraulic fluid along
10 the drive shaft is unavoidable. The leakage rate is dependent on fluid properties, differential pressure, the transient operating conditions of the pump and the tightness of the seal(s). The leakage is compensated by refilling the motor housing from an external supply of hydraulic fluid.
- 15 Likewise, hydraulic fluid is typically supplied also to the pump for lubrication of its internal structure, such as pump rotor bearings, seals and timing gears. The pressure in the pump's lubrication fluid circuit is thus to be maintained above the pressure of the medium that is displaced through the pump, in order to prevent intrusion of process fluid and particles into pump bearings, seals and timing gears.
20 Leakage via the pump seals into the pumped medium is compensated by refilling from the external supply of hydraulic fluid.

The motor and pump can be drive-connected inside the motor housing, or outside the motor housing. For instance, the motor and pump can share one and the same
25 shaft with no separate coupling to connect them in a driving relationship. In other designs the pump shaft can be coupled to the motor shaft inside the motor housing. In still other designs, the motor and pump is drive-connected by means of a coupling located in a coupling chamber defined between the motor housing and the pump. However, in all alternatives it is desirable to maintain at all times a pressure
30 difference over the interfaces, i.e. between the motor housing, the coupling chamber when present, and the pumped medium, respectively.

Conventionally, motor barrier and pump barrier fluids are supplied via an umbilical, and leakage compensation as well as pressure control is managed from the host
35 facility. As subsea hydrocarbon production sites are increasingly installed and operated at increasing depths and step-out distances, the response times in lubrication and cooling systems increase correspondingly. As a consequence, there is a rising need for a motor and pump barrier fluids pressure regulation system that

operates with instant response to a change in pressures in the motor and pump module and which provides increased reliability in operation.

SUMMARY OF THE INVENTION

- 5 The present invention thus aims at providing a motor and pump barrier fluids pressure regulation system for a subsea motor and pump module which avoids the problems of prior art systems, and specifically those problems which are associated with long step-out distances and great water depths.
- 10 The present invention specifically aims at providing a motor and pump barrier fluids pressure regulation system in a subsea motor and pump module, the system having an inherent capability to adapt to pressure changes in the pumped medium. The present invention further aims at providing a motor and pump barrier fluids pressure regulation system having an inherent capability to compensate for loss of
- 15 hydraulic fluid caused by leakage via seals and bearings in the motor and pump module. Still another object of the present invention is to provide a motor and pump barrier fluids pressure regulation system wherein a preset pressure differential between a motor barrier fluid circuit and a pump barrier fluid circuit is automatically maintained at all times, and balanced towards the medium pressure.
- 20 The motor and pump barrier fluids pressure regulation system of the present invention may advantageously be applied to a subsea motor and pump module which comprises a pump motor disposed in a motor housing; a pump disposed in a pump housing having a pump inlet at a suction side and a pump outlet at a
- 25 discharge side of the pump, and a pump-rotor assembly arranged there between and journaled in bearings in the pump housing. The pump-rotor assembly is drive-connected to the motor through a drive-shaft that reaches between the motor and pump via a seal arrangement and is configured to displace a fluid medium from the pump inlet for discharge via the pump outlet.
- 30 Briefly, the object of the present invention is achieved by a motor and pump barrier fluids pressure regulation system for a subsea motor and pump module, comprising:
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- a motor barrier fluid circuit hydraulically separating the motor from the pump, comprising a barrier fluid supply section supplying barrier fluid to the motor from a hydraulic fluid supply, as well as a barrier fluid relief section discharging barrier fluid from the motor to the pumped medium;

- a pump barrier fluid circuit, hydraulically separating the internal structure of the pump from the pumped medium, and comprising a barrier fluid supply section supplying barrier fluid to the pump from a hydraulic fluid supply, as well as a barrier fluid relief section discharging barrier fluid from the pump to the pumped medium, wherein
- the fluid flow and pressure in each of the motor barrier fluid circuit and the pump barrier fluid circuit is controlled by pressure controlled on/off valves arranged in each circuit, said on/off valves being individually controllable in response to detected difference in pressure between the medium, on a suction side or on a discharge side of the pump, and the fluid in the motor and pump barrier fluid circuits, respectively.

A system according to the invention provides immediate response to any change in the pumped medium pressure, as well as a simple and robust solution which continuously maintains a predetermined pressure difference between the motor and pump barrier fluid circuits, and which at all times keeps the circuit pressures in balance with the pressure of the pumped medium.

Because the valves can be located close to the consumer, i.e. the motor/pump assembly, and without delay in operation, the pressure regulation system can be used without modification regardless of pump tie-back distance and water depth.

Another advantage provided by the pressure regulation system is that it enables the operator to maintain a steady supply pressure through an umbilical.

The present invention can be applied to a pressure regulation system wherein the motor barrier fluid is at all times maintained at a higher pressure than the pump barrier fluid, and the pump barrier fluid is at all times maintained at a higher pressure than the process medium in the pump. The pressure regulation system of the present invention is operative either for raising the pressure in the motor barrier fluid circuit or for lowering the pressure in the pump barrier fluid circuit. The pressure regulation system according to the present invention can also be extended to multiple pressure levels, i.e. by adding an intermediate pressure level between the motor barrier fluid and the pump barrier fluid.

Preferably, each pressure controlled on/off valve is arranged in series with a flow restriction of fixed orifice diameter which may be realized, alternatively, through a

manually controllable valve whose opening position is preset before installation
e.g.

5 The pressure regulation system is based on subsea on/off valves for supply and relief of barrier fluids. Suitable types of valves may be, but are not limited to, solenoid valves or directional control valves. Flow orifice downstream or upstream valve determines flow capacity when valve is open.

10 It is preferred that each of the motor and pump barrier fluid circuits comprises a respective pressure control unit, and the on/off valves in each barrier fluid circuit are individually controllable from the associated pressure control unit in response to differential pressures received in the pressure control unit from a corresponding differential pressure transmitter monitoring the differential pressure between the pumped medium and the respective one of the motor barrier fluid circuit or the
15 pump barrier fluid circuit.

The embodiment provides valve position indication and operator control of each valve. The valves are operated based on differential pressure between barrier fluid and process medium. This can either be with reference to suction side or discharge
20 side of pump – whichever side of the pump and motor to which the barrier fluid is connected. Valves are operated from the control system based on readings by differential pressure transmitters. The differential pressure set point can either be a single value, e.g. 10 bar, or it can be a range, such as 5 to 15 bar, e.g. The latter is achieved by closing the supply valve(s) when differential pressure has reached 15
25 bar, and opening supply valve(s) when pressure differential has again reached 5 bar.

The pressure regulation system of the present invention enables the operator full control of valves and valve position, and the pressure set-point can be varied by the operator at the push of a button.

30 Leakage through seals in the motor and pump module can vary and may be low or high. Low in the sense that an on/off valve in the supply circuit is required to open only rarely, such as once or twice a day, or high in the sense that a supply valve of low capacity in combination with a flow restriction of fixed orifice diameter will be in
35 open position most of the time.

Also, pumps can experience transient conditions where the differential pressure between the pump's reference side and the barrier fluid pressure varies independent of the leakage rate.

- 5 Accumulators can be incorporated in the circuits to prevent the valves from operating frequently, and can provide added time between valve operations. However, the pressure regulation system can be designed to operate sufficiently without accumulators.
- 10 To this purpose, at least one of the barrier fluid supply and barrier fluid relief sections preferably comprises a set of pressure controlled on/off valves, including at least a first and a second valve, which are arranged in parallel to feed hydraulic fluid through the barrier fluid circuit, and which are each responsive to the differential pressure, and further wherein said at least two pressure controlled
- 15 on/off valves are individually responsive to separate ranges of differential pressure between the barrier fluid circuit and the pumped medium.

More precisely, in a set of first and second pressure controlled on/off supply valves the first motor barrier fluid supply valve may be set to open for hydraulic fluid flow in result of a differential pressure at or below 10 bar, and the second motor barrier

20 fluid supply valve be set to open for hydraulic fluid flow in result of a differential pressure at or below 9.5 bar.

Correspondingly, in a set of first and second pressure controlled on/off supply

25 valves the first pump barrier fluid supply valve may be set to open for hydraulic fluid flow in result of a differential pressure at or below 5 bar, and the second pump barrier fluid supply valve be set to open for hydraulic fluid flow in result of a differential pressure at or below 4.5 bar.

30 Likewise in a set of first and second pressure controlled on/off relief valves, the first motor barrier fluid relief valve may be set to open for hydraulic fluid flow in result of a differential pressure above 10.5 bar, and the second motor barrier fluid relief valve be set to open for hydraulic fluid flow in result of a differential pressure at or above 11 bar.

35 Also in a set of first and second pressure controlled on/off relief valves, the first pump barrier fluid relief valve may be set to open for hydraulic fluid flow in result of a differential pressure above 5.5 bar, and the second pump barrier fluid relief valve

be set to open for hydraulic fluid flow in result of a differential pressure at or above 6 bar.

In preferred embodiments, the first valve in a parallel set of first and second on/off valves is sized for lower flow rates ranging down to about 0.3 l/min, and the second valve is sized for higher flow rates ranging up to about 100 l/min.

Specifically, the restriction orifice arranged downstream of the first valve may be sized for lower flow rates ranging down to about 0.3 l/min, and the restriction orifice downstream the second valve may be sized for higher flow rates ranging up to about 100 l/min.

A differential pressure transmitter may alternatively be arranged to monitor the pressure difference between the motor barrier fluid circuit and the pump barrier fluid circuit, and to transmit its readings to the pressure control unit of the motor barrier fluid circuit. In such alternative embodiment, the motor barrier fluid circuit is controlled by pressure controlled on/off valves that are individually controllable in response to monitored difference in pressure between the motor barrier fluid and the pump barrier fluid. The pressure differential set points of the motor barrier fluid valves are then typically equal to the pressure differential set points of the pump barrier fluid valves.

Without being limited to any specific type or model of motor or pump, the motor and pump barrier fluids pressure regulating system of the present invention is advantageously applied in a subsea motor and pump module comprising an electric pump motor disposed in a motor housing, a pump disposed in a pump housing having a pump inlet at a suction side and a pump outlet at a discharge side of the pump, and a pump-rotor assembly arranged there between and journaled in bearings in the pump housing, the pump-rotor assembly drive-connected to the motor and configured to displace a fluid medium from the pump inlet for discharge via the pump outlet.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In the following, preferred embodiments of the invention will be described in more detail with reference made to the accompanying diagrammatic drawings, Figs. 1 and 2. In the drawings, a subsea motor and pump module comprises a motor/pump assembly 1 to which motor barrier fluid and pump barrier fluid are supplied from an external hydraulic fluid supply.

Since the invention is not limited to any specific type or model of motor/pump assembly, but indeed can be applied to various motor/pump configurations involved in the transport of a process fluid from subsea hydrocarbon production, and which are familiar to the skilled person, the internals of the motor/pump assembly 1 need not be discussed in detail. In general, the motor/pump assembly comprises a motor M that is encased in a pressurized water tight enclosure or motor housing 2, as well as a pump rotor assembly P encased in a pump housing 3. The motor driving the pump is typically an electric motor, although other drive units such as hydraulic motors or turbines may alternatively be employed.

The pump rotor is configured for displacement of a pumped medium which enters the pump via a pump inlet 4 to be discharged via a pump outlet 5, as illustrated by an arrow F. The pump rotor is drive-connected to the motor, and the pump interior is hydraulically separated from the pressurized (typically liquid-filled) motor housing by means of a seal and bearing arrangement 6 which seals against the outside of a rotary shaft (indicated at 7) by which the pump rotor is drive-connected to the motor. The pump rotor is journaled in seal and bearing arrangements 6 and 8 in the pump housing 3. Internally of the pump, pump barrier fluid is typically circulated as indicated through the dash dotted lines connecting the seal/bearing arrangements 6 and 8, for lubrication of internal structures in the pump, such as bearings, seals, timing gears if appropriate, etc.

Motor barrier fluid and pump barrier fluid is supplied to the subsea motor and pump module from an external supply of hydraulic fluid via feed line 9. The motor barrier fluid is supplied to the motor housing via an on/off valve 10 connected in series with a flow restriction 11 of fixed orifice diameter. The on/off valve 10 is pressure controlled and operated in response to the difference in pressure between the motor barrier fluid circuit and the pumped medium. The pressures in the pumped medium are continuously monitored and detected and returned to a pressure control unit 12 that operates the on/off valve 10 between open and closed states. The pressures are monitored and detected by means of a pressure differential transmitter 13 inserted between the motor barrier fluid circuit and the pumped medium on the suction side or on the discharge side of the pump. The choice of side is determined by flow direction through the pump and location of motor/pump seals, as illustrated in Fig. 2.

Likewise, pump barrier fluid is supplied to the pump housing via an on/off valve 14 connected in series with a flow restriction 15 of fixed orifice diameter. The on/off

valve 14 is pressure controlled and operated in response to the difference in pressure between the pump barrier fluid circuit and the pumped medium. The pressures in the pumped medium are continuously monitored and detected and returned to a pressure control unit 16 that operates the on/off valve 14 between open and closed states. The pressures are monitored and detected by means of a pressure differential transmitter 17 inserted between the pump barrier fluid circuit and the pumped medium on the suction side or on the discharge side of the pump.

The control logic in pressure control units 12 and 16 is set to provide valve operation in immediate response to any change in pressure of the pumped medium, and maintains a predetermined pressure difference between them by refilling the barrier fluid circuits via the pressure controlled on/off valves 10 and 14. The illustrated embodiment provides immediate response to pressure variations in the pumped medium on the suction side of the pump, keeping the circuit pressures in balance with the pressure of the pumped medium, this way effectively avoiding intrusion of process fluids, sea water and particulate matter into the barrier fluid circuits.

In alternative embodiment, as previously stated, the pressure differential transmitters 13 and 17 may instead be connected to the discharge side of the pump in dependence on, e.g., flow direction through pump and the location of motor/pump seal arrangements.

Sufficient supply of fluid to the barrier fluid circuits can be accomplished by a corresponding setting of the control logic. In alternative to a more frequent valve operation in case of sudden peaks in fluid leakage or pressure variation, additional barrier fluid can be instantly supplied through a parallel arrangement of pressure controlled on/off valves. To this purpose, a second pressure controlled on/off valve 18 connected in series with a flow restriction 19 of fixed orifice diameter is arranged in parallel with on/off valve 10 and flow restriction 11 included in the motor barrier fluid circuit. Correspondingly, a second pressure controlled on/off valve 20 connected in series with a flow restriction 21 of fixed orifice diameter is arranged in parallel with on/off valve 14 and flow restriction 15 included in the pump barrier fluid circuit.

Both first and second on/off valves arranged in parallel are individually operated by the pressure control units 12 and 16, respectively. Flow capacity through the valves in open state is determined by the orifice diameter. As previously explained in the

Summary of Invention part of the disclosure, the first and second on/off valves in parallel arrangement are in a preferred embodiment designed for different flow capacities and pressure ranges. Naturally, the invention is not strictly limited to the pressures/pressure ranges and flow rates stated above, and those values are merely
5 to be seen as preferred examples.

Transient conditions in operation of the subsea motor and pump module may also require the barrier fluid pressures to be reduced in order to maintain a steady differential pressure. In that case, a similar valve and orifice arrangement can be
10 installed to open for relief of barrier fluids to the pumped medium on the suction side or on the discharge side of the pump.

To this purpose, the motor barrier fluid circuit comprises a barrier fluid relief section 22, 23 in addition to the barrier fluid supply section 10, 11 as described
15 above. At least a first pressure controlled on/off valve 22 is connected in series with a flow restriction 23 of fixed orifice diameter, and operated by the pressure control unit 12 for feeding barrier fluid into the pumped medium in response to the readings of pressure differential transmitter 13, which returns the pressure difference between the motor barrier fluid and the pumped medium to the pressure
20 control unit 12. A second pressure controlled on/off valve 24 connected in series with a flow restriction 25 of fixed orifice diameter can be arranged in parallel with the first on/off valve 22 in the motor barrier fluid relief section for increased flow capacity.

Correspondingly, the pump barrier fluid circuit comprises a barrier fluid relief section 26, 27 in addition to the barrier fluid supply section 14, 15 as described
25 above. At least a first pressure controlled on/off valve 26 is connected in series with a flow restriction 27 of fixed orifice diameter, and operated by the pressure control unit 16 for feeding barrier fluid into the pumped medium in response to the readings of pressure differential transmitter 17, which returns the pressure difference between the pump barrier fluid and the pumped medium to the pressure
30 control unit 16. A second pressure controlled on/off valve 28 connected in series with a flow restriction 29 of fixed orifice diameter can be arranged in parallel with the first on/off valve 26 in the pump barrier fluid relief section for increased flow
35 capacity.

Likewise in correspondence with the barrier fluid supply sections, valves in parallel arrangement in the barrier fluid relief sections may be designed for different flow capacities and pressure ranges.

5 Alternatively, a third pressure differential transmitter 30 may optionally be inserted between the motor and pump barrier fluid circuits, to read the pressures therein and to return its readings to the motor barrier pressure control unit 12. In this embodiment, the pressure differential set points of the motor barrier fluid valves 10, 22, 18, and 24 are typically equal to the pressure differential set points of the pump
10 barrier fluid valves 14, 20, 26 and 28.

Basically, the components which are incorporated in the barrier fluids pressure regulation system are familiar to the skilled person and need no further presentation. On/off valves suitable for the purpose are for example solenoid
15 operated directional control valves (DCVs) which are normally used in subsea hydraulic systems. The DCVs are electrically activated and can either be of a mono-stable or bi-stable type, and of 2-port or 3-port configuration. The return/relief connection of the DCV can be coupled to the suction side of the pump if the suction side pressure is the reference for the differential pressure set points in the barrier
20 fluid system. Alternatively, the return/relief connection can be coupled to the discharge side of the pump if the discharge side pressure is the reference for the differential pressure set points. Another valve alternative includes hydraulically activated valves which are controlled by bi-stable DCVs. The on/off valves can be arranged in an oil-filled chamber in the subsea control unit 12, 16, or be situated in
25 a separate oil-filled chamber which is mountable on the motor/pump assembly. Another valve alternative comprises hydraulically operated $\frac{1}{2}$ inch gate or needle valves or similar, which are controlled by bi-stable DCVs located inside the subsea control module (SCM). The same system control set-up can still be employed.

30 As for the necessary instrumentation and control system, single pressure sensors or differential pressure sensors can be employed and connected to a subsea electronics module (SEM) that is situated in the SCM. The signals can be processed either subsea in the SEM, or topside. If processing is situated topside, the topside communication with the SEM can be effected via optical modem. Local
35 communication, i.e. sensor signal communication, can be performed through conventional copper based electric leaders.

The invention is of course not in any way restricted to the embodiments described above. On the contrary, many possibilities to modifications thereof will be apparent to a person with ordinary skill in the art without departing from the basic idea of the invention such as defined in the appended claims.

CLAIMS

1. A motor and pump barrier fluids pressure regulation system for a subsea motor and pump module, the system comprising:

- a motor barrier fluid circuit hydraulically separating the motor from the pump, comprising a barrier fluid supply section (10, 11) supplying barrier fluid to the motor from a hydraulic fluid supply, as well as a barrier fluid relief section (22, 23) discharging barrier fluid from the motor to the pumped medium;

- a pump barrier fluid circuit, hydraulically separating the internal structure of the pump from the pumped medium, and comprising a barrier fluid supply section (14, 15) supplying barrier fluid to the pump from a hydraulic fluid supply, as well as a barrier fluid relief section (26, 27) discharging barrier fluid from the pump to the pumped medium, wherein the fluid flow and pressure in each of the motor barrier fluid and the pump barrier fluid circuits are controlled by pressure controlled on/off valves (10, 22; 14, 26) arranged in each circuit, said on/off valves being individually controllable in response to detected difference in pressure between the pumped medium, on a suction side or on a discharge side of the pump, and the fluid in the motor and pump barrier fluid circuits.

2. The regulation system of claim 1, wherein each on/off valve (10, 22; 14, 26) is arranged in series with a flow restriction (11, 23; 15, 27) of fixed orifice diameter.

3. The regulation system of claim 1 or claim 2, wherein each of the motor and pump barrier fluid circuits comprises a respective pressure control unit (12; 16), and the on/off valves in each barrier fluid circuit are individually controllable from the associated pressure control unit in response to differential pressures received in the pressure control unit from a corresponding differential pressure transmitter (13; 17) monitoring the differential pressure between the pumped medium and the respective one of the motor barrier fluid circuit or the pump barrier fluid circuit.

4. The regulation system of claim 3, wherein at least one of the barrier fluid supply and barrier fluid relief sections comprises a set of pressure controlled on/off valves, including at least a first (10, 22; 14, 26) and a second (18, 24; 20, 28) valve, which are arranged in parallel to feed hydraulic fluid through the barrier fluid circuit, and which are each responsive to the differential pressure, and further wherein said at least two pressure controlled on/off valves (10, 18; 14, 20; 22, 24; 26, 28) are individually responsive to separate ranges of differential pressure between the barrier fluid circuit and the pumped medium.

5. The regulation system of claim 4, wherein in a set of first and second pressure controlled on/off supply valves the first motor barrier fluid supply valve (10) is set to open for hydraulic fluid flow in result of a differential pressure at or below 10 bar, and the second motor barrier fluid supply valve (18) is set to open for hydraulic fluid flow in result of a differential pressure at or below 9.5 bar.
6. The regulation system of claim 4 or 5, wherein in a set of first and second pressure controlled on/off supply valves the first pump barrier fluid supply valve (14) is set to open for hydraulic fluid flow in result of a differential pressure at or below 5 bar, and the second pump barrier fluid supply valve (20) is set to open for hydraulic fluid flow in result of a differential pressure at or below 4.5 bar.
7. The regulation system of any of claims 4-6, wherein in a set of first and second pressure controlled on/off relief valves the first motor barrier fluid relief valve (22) is set to open for hydraulic fluid flow in result of a differential pressure above 10.5 bar, and the second motor barrier fluid relief valve (24) is set to open for hydraulic fluid flow in result of a differential pressure at or above 11 bar.
8. The regulation system of any of claims 4-7, wherein in a set of first and second pressure controlled on/off relief valves the first pump barrier fluid relief valve (26) is set to open for hydraulic fluid flow in result of a differential pressure above 5.5 bar, and the second pump barrier fluid relief valve (28) is set to open for hydraulic fluid flow in result of a differential pressure at or above 6 bar.
9. The regulation system of any of claims 5-8, wherein in a set of first and second pressure controlled on/off valves the first valve (10, 14, 22, 26) is sized for lower flow rates ranging down to about 0.3 l/min, and the second valve (18, 20, 24, 28) is sized for higher flow rates ranging up to about 100 l/min.
10. The regulation system of claim 9, wherein the restriction orifice (11, 15, 23, 27) downstream the first valve is sized for lower flow rates ranging down to about 0.3 l/min, and the restriction orifice (19, 21, 25, 29) downstream the second valve is sized for higher flow rates ranging up to about 100 l/min.
11. The regulation system of any previous claim, wherein a differential pressure transmitter (30) is arranged to monitor the pressure difference between the motor barrier fluid circuit and the pump barrier fluid circuit, and to transmit its readings to a pressure control unit (12) of the motor barrier fluid circuit.

12. The regulation system of claim 11, wherein the motor barrier fluid circuit is controlled by pressure controlled on/off valves (10, 22, 18, 24) being individually controllable in response to monitored difference in pressure between the motor barrier fluid and the pump barrier fluid.

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13. The regulation system of claim 12, wherein the pressure differential set points of the motor barrier fluid valves (10, 22, 18, 24) are equal to the pressure differential set points of the pump barrier fluid valves (14, 20, 26, 28).