

CLAIMS

1. A downhole control arrangement (60) for installation in hydrocarbon well and for controlling the operation of a downhole valve arrangement (10) comprising an electrically controlled control valve, wherein the control arrangement comprises a control system (70) and an electric power supply source configured for supplying electric power to the control system.
2. The downhole control arrangement according to claim 1, wherein the electric power supply source comprises a downhole induction coil arrangement (80).
3. The downhole control arrangement according to claim 2, wherein the induction coil arrangement (80) is configured for transmitting signals from a topside controller(90) to the control system (70) and vice versa.
4. The downhole control arrangement according to claim 3, wherein the control system (70) comprises a control unit (100) and an actuator (110), wherein the induction coil arrangement is configured for transmitting signals (40, 42; 41, 43) from the topside controller (90) to the control unit and vice versa, wherein the control unit is configured to send signals (45) to the actuator, and the actuator is configured to move (47) a control valve of the valve arrangement (10) between an open position and a closed position based on said signals.
5. The downhole control arrangement according to claim 4, wherein the actuator (110) is configured to send signals (51) to the control unit (110) with information about the open/closed status of the control valve.
6. The downhole control arrangement according to any one of claims 4-5, wherein the control system (70) comprises a sensor (130) configured to determine the open/closed status of the control valve and to send information (52) about the status to the control unit (100).
7. The downhole control arrangement according to any one of claims 2-6, wherein the induction coil arrangement (80) is configured for supplying electric power from the topside controller (90) to the actuator (110).

8. The downhole control arrangement according to any one of claims 4-7, wherein it comprises an electric power storage device (120) connected to the induction coil arrangement (80), and the electric power storage device is connected to supply electric power to actuator (110).

9. The downhole control arrangement according to claim 8, wherein the electric power storage device (120) is a chargeable device that is chargeable by means of transmitting electric power from the induction coil arrangement (80).

10. The downhole control arrangement according to any one of claims 2-9, wherein the induction coil arrangement (80) comprises a first induction coil (81) electrically connectable to a topside controller (90), located externally of the well, and a second induction coil (82) connected to the control system (70).

11. A downhole valve arrangement for controlling the flow of an injection fluid into a production tubing of a hydrocarbon well, comprising:

- a valve housing (11) having an interior space (12) and with at least one flow inlet (13) for infeed of injection fluid, and at least one flow outlet (14) for delivering injection fluid to the well tubing,
- an electrically controlled control valve (15) located in the housing, and the control valve being configured to open or close a fluid communication path between the inlet and the outlet,
- a downhole control arrangement (60) in accordance with any one of claims 1-10, which controls the operation of the downhole valve arrangement including the opening and closing of the control valve (15).

12. A side pocket mandrel (1) for installation in a production tubing (3) for use in a hydrocarbon well, wherein the side pocket mandrel comprises an interior pocket space (6) and a valve arrangement (10) located in the pocket space for controlling the flow of an injection fluid from an external injection fluid source into the production tubing, characterised in that the side pocket mandrel comprises

an induction coil arrangement (80) connected to a topside controller (90) and connected to the valve arrangement (10) for transmission of signals from the topside controller to the valve arrangement or vice versa and/or for transfer of electric power from topside controller to the valve arrangement.

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13. The side pocket mandrel according to claim 12, wherein the induction coil arrangement (80) comprises a first induction coil (81) located at least partly along an interior wall part (33) of the pocket space and a second induction coil (82) located along an exterior part of the valve arrangement, and the second induction coil is located inside the first induction coil in a concentric manner.

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14. The side pocket mandrel according to any one of claims 12-13, wherein it comprises a recess (23) provided in an external wall part (21) of the first side wall (20), and the recess reaches down into the first compartment (32), and the recess is configured to receive the first induction coil (81) of the induction coil arrangement for insertion into the first compartment.

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15. The side pocket mandrel according to claim 16, wherein it comprises a lid (25) configured to cover the recess (23).

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16. The side pocket mandrel according to any one of claims 12-15, wherein it comprises - a first seal member (28) located between an internal wall (29) of the pocket space and the valve arrangement (10) at a first location and a second seal member (30) located between the internal wall (29) of the pocket space and the valve arrangement (10) at a second location, whereby a first compartment (32) is obtained in the pocket space between the first seal member and the second seal member.

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17. The side pocket mandrel according to claim 16, wherein the induction coil arrangement (80) is located in a first compartment (32).

18. The side pocket mandrel according to any one of claims 16-17, wherein it comprises - an inlet port (22) for injection fluid provided in a first side wall (20) of the side pocket mandrel, which first side wall is located between the first seal member (28) and the second seal member

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(30), wherein the inlet port is connectable to the external injection fluid source, and wherein the valve arrangement comprises a flow inlet (13) located in the first compartment (32),
- an outlet port (26) for injection fluid provided in a second side wall (24) of the side pocket mandrel, which second side wall is located in a second compartment (34) of the pocket space,
5 which second compartment is separated from the first compartment by one of the seal members, which outlet port (26) connects the second compartment (34) with the well tubing (3), and wherein the valve arrangement comprises a flow outlet (14) located in the second compartment (34).

10 19. The side pocket mandrel according to any one of claims 12-18, wherein the valve arrangement (10) is a valve arrangement as defined in claim 11, wherein the induction coil arrangement (80) is connected to the valve arrangement via the control system (70).

20. A side pocket mandrel (1) for installation in a production tubing (3) of a hydrocarbon well,
15 wherein the side pocket mandrel comprises an interior pocket space (6) and a valve arrangement (10) as defined in claim 11, located in the pocket space for controlling the flow of an injection fluid from an external injection fluid source into the production tubing.

21. A method for operating a downhole valve arrangement (10), installed in a side pocket
20 mandrel (1) forming part of a production tubing (3) of a hydrocarbon well, the valve arrangement comprising an electrically controlled control valve for controlling the flow of an injection fluid from an external injection fluid source into the production tubing, and wherein the valve arrangement is connected to a downhole control arrangement (60) comprising an induction coil arrangement (80) comprising two induction coils, comprising steps of
25 - sending (40) a signal from a topside controller (90), via cabling provided in the annulus, to a first induction coil (81) functioning as a transmitter coil, (200)
- transfer of signal by induction to the second induction coil (82) functioning as a receiver coil, (210)
- transmission of signal (42) via cabling to a control unit (100), (220)
30 - sending a signal (45) from the control unit to an actuator (110) to open the control valve, or alternatively to close the valve. (230)

22. The method of claim 21, comprising sending a valve status signal (51) from the actuator (110) to the control unit (100) confirming that the control valve is open alternatively closed, or using a sensor (130) to check (53) if the control valve is open or closed and send (52) a valve status signal to the control unit,

further comprising

- sending (43) the valve status signal from the control unit(100) to the second induction coil (82) now functioning as a transmitter coil, (250)
- transfer of valve status signal by induction to the first induction coil (81) now functioning as a receiver coil, (260)
- transmission of the valve status signal via cabling (41) to topside controller (90). (270)

23. A method for supplying electric power to a downhole valve arrangement (10), installed in a side pocket mandrel (1) forming part of a production tubing (3) of a hydrocarbon well, the valve arrangement comprising an electrically controlled control valve for controlling the flow of an injection fluid from an external injection fluid source into the production tubing, and wherein the valve arrangement is connected to a downhole control arrangement (60) comprising an induction coil arrangement (80) comprising two induction coils, comprising steps of

- transmitting electric power 40 from a topside controller (90) connected to an electric power source, via cabling provided in the annulus, to a first induction coil (81) functioning as a transmitter coil, (300)
- transfer of electric power by induction to the second induction coil (82) functioning as a receiver coil, (310)
- transmission of electric power (42) via cabling to a control unit (100) that controls an actuator (110) to open the control valve, or alternatively to close the valve. (320)

24. The method according to claim 23, comprising using the electric power to charge a power storage device (210) that supplies electric power to the actuator. (330)