SUBSEA HORIZONTAL CHRISTMAS TREE

FIELD OF THE INVENTION

The present invention relates to a subsea horizontal Christmas tree comprising a plugging device comprising communication means for downhole communication.

BACKGROUND OF THE INVENTION

Oilfield production systems normally feature controls and monitoring devices in the well, at the Christmas tree and at the hydrocarbon receiving facility.

There is a need for communication between the downhole devices, such as sensors, actuators, etc, and the other parts of the oilfield production system. The communication between the downhole devices and access points outside the Christmas tree is today normally performed via cabling and piping in the annulus between the production tubing and the casing. At the Christmas tree, the production tubing is hung off and the tubing hanger contains electric, optical and hydraulic/chemical couplers between the tubing hanger and the Christmas tree. In the Christmas tree, communication is via cables, optical fibers and piping to new connectors at the access points external at the Christmas tree. From these access points in a subsea system, the communication to the overall control system typically to a Subsea Control Module (SCM) via traditional cables, optical fibers, hoses and piping. This downhole communication system is robust, does not interfere with the internal production bore and may contain many passages, but it may not be changed or repaired during the life of field without expensive and complex operations. These operations involve retrieval of the Christmas tree and / or the production tubing.

Plugging devices are used in oilfield production systems in the production tubing during the installation phase to provide temporary isolation and sealing, and during the production phase to provide more permanent isolation and sealing of the temporary well access.

Several plugging devices for oil- and gas wells are known. Such plugging devices are for example used in a horizontal Christmas tree, as illustrated in fig. 1. One such plugging device is known from Norwegian patent 322829.

WO9963202 describes a method and arrangement for monitoring reservoir parameters in subsea wells.

US 6478086 describes a method for plugging wells, where communication is provided between a sensor provided under a seal down in the well and a connection part. Over the seal the well is filled with a temperable, liquid sealant.

Embodiments of the invention seek to provide a subsea horizontal Christmas tree comprising a plugging device comprising communication means for downhole communication, which provides possibilities for permanent well access for monitoring and control in horizontal trees. Moreover, embodiments of the invention seek to provide the possibility for easy retrofit of new downhole sensors, actuators and tools.

SUMMARY OF THE INVENTION

In an aspect of the invention, there is provided a subsea horizontal Christmas tree, where the Christmas tree comprises a central bore and a horizontal outlet extending laterally from the central bore, and a tubing hanger locked into the central bore and connected to a production tubing extending into the well, the tubing hanger comprising a first passage axially aligned with the production tubing and a second passage extending laterally from the first passage and aligned with the outlet, where the first passage comprises means for releasable fastening of at least one plugging device for plugging the first passage above the second passage, characterized in that the plugging device comprises electrical or optical communication means for providing electrical or optical communication through the plug, where the electrical or optical communication means is connected to communication interfaces provided on the upper side and lower side of the plugging device respectively.

In an embodiment of the invention, the communication means comprises an electrical communication wire for transferring electrical energy or electrical signals through the device.

In an embodiment of the invention, the communication means comprises an optical fiber for transferring optical signals through the device.

In an embodiment of the invention, the communication means comprises communication means for transferring infrared communication signals, electromagnetic communication signals, infrared communication signals, piezo-electric communication signals or other types of communication signals.

In an embodiment of the invention, the communication means in provided through the plugging device by means of a communication feed-through comprising a pressure- and/temperature resisting material for protection of the communication means.

In an embodiment of the invention, the pressure- and/temperature resisting material comprises glass, ceramics etc.

In an embodiment of the invention, the device comprises communication connectors in the respective ends of the communication feed-through for connection to other communication equipment.

In an embodiment of the invention, the communication connectors comprise a wet mate electrical connection.

In an embodiment of the invention, the subsea horizontal Christmas tree comprises a power supply unit.

In an embodiment of the invention, the subsea horizontal Christmas tree comprises a signal amplifying unit.

DETAILED DESCRIPTION

In the following, an embodiment of the present invention will be described with reference to the enclosed drawings, where:

Fig. 1 illustrates a prior art Christmas tree with a plugging device in a horizontal Christmas tree;

Fig. 2 illustrates an embodiment of the system according to the invention in a Christmas three as shown in fig. 1;

Fig. 3 illustrates an embodiment of the upper device according to the invention of fig. 2;

Fig. 4 illustrates an embodiment of the lower device according to the invention of fig. 2; and

Fig. 5 is a simplified illustration of fig. 2.

It is now referred to fig. 2, where an embodiment of invention is illustrated. Fig. 2 illustrates a horizontal Christmas tree of the same type as the prior art Christmas three shown in fig. 1.

A first, upper device 1a and a second, lower device lb are forming a double safety barrier in the horizontal Christmas tree.

As illustrated in fig. 2, a subsea control module (SCM) is connected to the upper end of the first device la by means of a first connector 50. The first connector 50 is guided through a feedthrough of a debris cap on the top of the Christmas tree. The subsea control module SCM can be connected to a remote control station, for example a floating vessel, by means of umbilicals. In systems without SCMs (e.g. Direct Hydraulic systems), the communication may be directly to the vessel. The communication may also go via other communication hubs subsea, e.g. a Subsea Router Module.

The horizontal Christmas tree comprises a central bore and a horizontal outlet extending laterally from the central bore. A tubing hanger is locked into the central bore and connected to a production tubing extending into the well. The tubing hanger comprises a first passage axially aligned with the production tubing and a

second passage extending laterally from the first passage and aligned with the outlet. The first passage comprises means for releasable fastening of at least one plugging device 1a, 1b for plugging the first passage above the second passage.

The plugging device comprises communication means for providing communication through the plug, where the communication means is connected to communication interfaces provided on the upper side and lower side of the plugging device respectively.

The first and second plugging devices 1a, 1b each have a communication feedthrough comprising communication means, which will be explained in detail further below, for providing communication between their respective upper ends and lower ends. Hence, the communication means in provided through the plugging device by means of the communication feed-through.

Moreover, the lower end of the first device 1a is connected to the upper end of the second device 1b by means of a second connector 52. In the lower end of the second device 1b, a first wireless communication device 54 is provided.

Far down in the well it is provided a downhole device 56, for example a sensor or tool, comprising a second wireless communication device 58. The second wireless communication device 58 is provided for wireless communication with the first wireless communication device 54.

First device 1a

The first device 1a will now be described in detail with reference to fig. 3. The device 1a comprises a plugging device or plug 2 for plugging of a well, as for example known from Norwegian patent No. 322829, which is hereby incorporated by reference. The elements of the plugging device 2 will consequently not be described in detail here. It should be noted that the present invention is not limited to the above type of plugging device 2, several other types of plugging devices can be adapted for use with the present invention.

The first device 1a further comprises a communication feed-through 30 comprising communication means through the plugging device 2, for providing communication from a first, upper end 3 of the plugging device 2 to a second, lower end 4 of the plugging device 2.

The first device 1a further comprises communication connectors 40 in the respective ends of the communication feed-through 30. The communication connectors 40 comprise means for connecting the communication means of the communication feed-through 30 to other types of communication equipment.

The communication connector 40 of the upper end 3 of the first device 1a is a connector adapted for connection to the end of the first connector 50.

The communication connector 40 of the lower end 4 of the first device 1a is a connector adapted for connection to the upper end of the second connector 50. Since the second device 1b will be inserted into the Christmas three before the first device 1a, the second connector 50 could be a rigid element protruding downwardly from the lower end 4 of the first device 1a.

Second device 1b

The second device 1b will now be described in detail with reference to fig. 4. Like the first device 1b described above, the second device 1b comprises a plugging device or plug 2 for plugging of a well.

Also the second device 1b comprises a communication feed-through 30 comprising communication means through the plugging device 2, for providing communication from a first, upper end 3 of the plugging device 2 to a second, lower end 4 of the plugging device 2.

Moreover, the second device 1b further comprises communication connectors 40 in the respective ends of the communication means of the communication feed-through 30. The communication connectors 40 comprise means for connecting the communication means of the communication feed-through 30 to other types of communication equipment.

The communication connector 40 of the upper end 3 of the second device 1b is a connector adapted for connection to the end of the second connector 52. The connection between this communication connector 40 and the second connector 52 could for example be a type of prior art wet mate connector.

The communication connector 40 of the lower end 4 of the second device 1b is a connector adapted for connection to the wireless communication device 54.

In the description above, each of the first and second devices 1a and 1b have communication connectors 40 in both their respective ends. In this way, the devices 1a, 1b can be made in a batch production, and the needed communication connectors and other equipment can be connected to them according to the requirements for the different applications. Alternatively, the first device 1a is made with the second connector 52 being fixed to its lower end 4, and the second device 1b is made with the first wireless device 54 being fixed to its lower end 4.

In the description above, the communication means of the communication feed-through 30 comprises one or several electrical wires, for example enveloped in a temperature- and pressure resisting material. The electric wires comprise for

example power cables for transferring electric energy (AC current or DC current) from the SCM through the first and second devices 1a, 1b to the first wireless communication device 54 and signal cables for transferring electric communication signals to and from the SCM through the first and second devices 1a, 1b to the first wireless communication device 54. Consequently, signals could be transferred between the SCM and the downhole device 56 via wireless connection and the communication feedthrough of the first and second devices 1a and 1b.

The temperature- and pressure resisting material can for example comprise glass, ceramics or other types of materials to protect the electric wires from the high temperatures or pressures that may occur in downhole wells. The devices 1a, 1b should function as a pressure barrier in the way usual plugging devices 2 does.

Alternatively, the communication means of the communication feed-through 30 comprises optic fibres for transferring optical communication signals. It would also be possible to provide the first and second devices 1a, 1b with a power supply unit, for supplying power to the wireless communication device, for signal amplifiers, etc.

In yet another embodiment, the second connector 52 can be omitted. Here, the communication connector 40 of the lower end of the first device 1a and the communication connector of the upper end of the second device 1b can comprise a lens device for transferring an optical communication signal as light signals between the first and second devices 1a and 1b.

There are several other alternative embodiments of the present invention. For example, it would be possible to use communication methods based on inductive fields, electromagnetic pulse/vibration, piezo-electric pulse/vibration, infrared light etc.

It should be noted that the present invention is not limited to the type of plugging device described and shown in the drawings, it would be possible to use the present invention with several other types of plugs.

In the example above, the lower end of the second device 1b, a first wireless communication device 54 is provided. However, several types of equipment can be provided here, for example an instrument for monitoring pressure, temperature, erosion, or other type of parameters that are considered relevant for the subsea production process.

Moreover, the communication means of the communication feed-through can comprise an electrical communication wire for transferring electrical energy only. In this case, the lower end of the second device 1b can be connected to equipment

that needs electrical power supply, such as power pumps or other power consumers located in the well.

In an alternative embodiment, the communication feed-through comprises communication means for transferring chemical or hydraulic fluid through the device 1a, 1b.

Moreover, the invention could comprise signal amplifiers, power supplying units in the form of batteries etc.

CLAIMS

1. Subsea horizontal Christmas tree, where the Christmas tree comprises a central bore and a horizontal outlet extending laterally from the central bore, and a tubing hanger locked into the central bore and connected to a production tubing extending into the well, the tubing hanger comprising a first passage axially aligned with the production tubing and a second passage extending laterally from the first passage and aligned with the outlet, where the first passage comprises means for releasable fastening of at least one plugging device for plugging the first passage above the second passage, characterized in that the plugging device comprises electrical or optical communication means for providing electrical or optical communication through the plug, where the electrical or optical communication means is connected to communication interfaces provided on the upper side and lower side of the plugging device respectively.

2. Subsea horizontal Christmas tree according to claim 1, wherein the communication means comprises an electrical communication wire for transferring electrical energy or electrical signals through the device.

3. Subsea horizontal Christmas tree according to claim 1, wherein the communication means comprises an optical fiber for transferring optical signals through the device.

4. Subsea horizontal Christmas tree according to claim 1, wherein the communication means comprises communication means for transferring infrared communication signals, electromagnetic communication signals, infrared communication signals, piezo-electric communication signals or other types or communication signals.

5. Subsea horizontal Christmas tree according to claim 1, wherein the communication means in provided through the plugging device by means of a communication feed-through comprising a pressure- and/temperature resisting material for protection of the communication means.

6. Subsea horizontal Christmas tree according to claim 5, where the pressure- and/temperature resisting material comprises glass, ceramics etc.

7. Subsea horizontal Christmas tree according to claim 1, where the device comprises communication connectors in the respective ends of the communication feed-through for connection to other communication equipment.

8. Subsea horizontal Christmas tree according to claim 7, where the communication connectors comprise a wet mate electrical connection.

9. Subsea horizontal Christmas tree according to claim 1, wherein it comprises a power supply unit.

10. Subsea horizontal Christmas tree according to claim 1, wherein it comprises a signal amplifying unit.

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