HORIZONTAL VERTICAL DEEPWATER TREE

BACKGROUND OF THE INVENTION

The present invention is directed to a christmas tree for a subsea hydrocarbon production system. More particularly, the invention is directed to a tree which combines the ease of retrieval associated with vertical christmas trees with the ease of power feedthrough associated with horizontal christmas trees.

Vertical christmas trees ("VXT's") with fail safe closed ("FSC") barrier valves in the vertical bore are not compatible with hanging off elements in the top of the tree. Horizontal christmas trees ("HXT's") are not easy retrievable, as the tubing hanger is suspended in the tree.

SUMMARY OF THE INVENTION

According to an aspect of the present invention, there is provided a subsea hydrocarbon production system which includes: a tubing hanger which is positioned at an upper end of a well bore, the tubing hanger including a tubing hanger production bore; a tubing string which extends from the tubing hanger into the well bore and is fluidly connected to the tubing hanger production bore; a christmas tree which is positioned above the tubing hanger and which comprises: a production bore which is fluidly connected to the tubing hanger production bore; a production outlet which is connected to the production bore; a first barrier element which is positioned in the production outlet; and a first closure device which is positioned in the production bore above the production outlet; wherein access from above the christmas tree through the production bore does not require passage through a barrier element; a hydraulic submersible pump which is positioned in the tubing string, the pump including a fluid power conduit which is connected to a downhole equipment hanger that is secured to the production bore above the production outlet and below the first closure device; and a pump conduit having a first end which is connectable to a source of pressurized fluid and a second end which is connected to production bore below the first closure device and above the downhole equipment hanger; wherein with the first closure device closed, pressurized fluid is communicated through the pump conduit, the production bore and the fluid power conduit to activate the pump.

Disclosed herein is a subsea hydrocarbon production system which includes: a tubing hanger which is positioned at an upper end of a well bore, the tubing hanger including a tubing hanger production bore; a tubing string which extends from the tubing hanger into the well bore and is fluidly

connected to the tubing hanger production bore; a christmas tree which is positioned above the tubing hanger and which comprises: an axially extending tree production bore which is connected to the tubing hanger production bore; a laterally extending production outlet which is connected to the tree production bore; a first barrier element which is positioned in the production outlet; and a second barrier element which is positioned in the tree production bore below the production outlet; a downhole equipment device which is positioned in the tubing string and is connected to a suspension string which in turn is connected to a downhole equipment hanger; wherein the downhole equipment hanger is landed in one of the tubing hanger production bore or the tree production bore below the second barrier element.

In accordance with one embodiment of the present invention, a subsea hydrocarbon production system is provided which comprises a tubing hanger which is positioned at an upper end of a well bore, the tubing hanger including a tubing hanger production bore; a tubing string which extends from the tubing hanger into the well bore and is fluidly connected to the tubing hanger production bore; and a christmas tree which is positioned above the tubing hanger and which comprises a production bore which is fluidly connected to the tubing hanger production bore; a production outlet which is connected to the production bore; a first barrier element which is positioned in the production outlet; and a first closure device which is positioned in the production bore above the production outlet. In this manner access from above the christmas tree through the production bore does not require passage through a barrier element.

In accordance with one embodiment of the invention, the subsea hydrocarbon production system comprises a second closure device which is positioned in the production bore above the first closure device such that the first and second closure devices provide two pressure barriers between the well bore and the environment during the production mode of operation of the christmas tree. In this embodiment, the second closure device may comprise a tree cap or a wireline plug. In another embodiment of the invention, the subsea hydrocarbon production system comprises a third closure device which is positioned in the production bore below the production outlet.

CLAIMS

1. A subsea hydrocarbon production system which comprises:

a tubing hanger which is positioned at an upper end of a well bore, the tubing hanger including a tubing hanger production bore;

a tubing string which extends from the tubing hanger into the well bore and is fluidly connected to the tubing hanger production bore;

a christmas tree which is positioned above the tubing hanger and which comprises:

a production bore which is fluidly connected to the tubing hanger production bore;

a production outlet which is connected to the production bore;

a first barrier element which is positioned in the production outlet; and

a first closure device which is positioned in the production bore above the production outlet;

wherein access from above the christmas tree through the production bore does not require passage through a barrier element;

a hydraulic submersible pump which is positioned in the tubing string, the pump including a fluid power conduit which is connected to a downhole equipment hanger that is secured to the production bore above the production outlet and below the first closure device; and

a pump conduit having a first end which is connectable to a source of pressurized fluid and a second end which is connected to production bore below the first closure device and above the downhole equipment hanger;

wherein with the first closure device closed, pressurized fluid is communicated through the pump conduit, the production bore and the fluid power conduit to activate the pump.

2. The subsea hydrocarbon production system of claim 1, wherein fluid exhausted by the pump exits the production bore through the production outlet.

3. The subsea hydrocarbon production system of claim 1, further comprising a pump valve for controlling the flow of pressurized fluid through the pump conduit.