

MONITORING HYDROCARBON FLUID FLOW

Field of the Invention

The present invention relates to monitoring hydrocarbon fluid flow, more particularly at a tree of a subsea hydrocarbon extraction facility.

5 **Background of the Invention**

Hydrocarbon fluid flowing from an offshore reservoir or well is multiphase in nature in that it contains oil, gas and water and can also contain particulates such as sand. Multiphase meters are used to measure the content of gas, oil and water in the fluid and other sensors are incorporated to measure the particulates. The sensor equipment is normally mounted on
10 the Christmas tree installed on the seabed and is usually placed on the Christmas tree after the design has been established and therefore the sensor location is often dictated by practical issues rather than the optimum position for measurements. Current practice is to install a multiphase meter on the Christmas tree with a sensor package positioned at a convenient position. The sensor package usually contains a bundle of sensors and so the
15 individual sensors may not all be ideally positioned to accurately measure their particular parameter. Some fluid flow measurement techniques require the flow to be conditioned (for example, laminar or turbulent) to be at their most accurate. There is a need for a more accurate method of measurement.

One of the most critical aspects of fluid flow is the effect that it has on equipment and fluid
20 pipes due to:

- hydrate formation
- wax deposition
- slugging
- corrosion

25 These have a serious effect on efficient fluid flow, equipment lifetime and through-life maintenance requirements, but can be minimised by taking appropriate remedial action such as the use of chemical injection to clean the surfaces of the fluid pipes. There is a need for accurately identifying, locating and measuring these effects. However, the availability of sufficiently reliable and accurate sensors has limited the capability to provide the required
30 information and also because the positioning of the sensor package on the Christmas tree is decided after the Christmas tree design has been established and so the positioning is not optimised.

Summary of the Invention

According to the present invention from one aspect, there is provided a method of providing a tree for a subsea hydrocarbon extraction facility with means for monitoring a plurality of different properties relating to hydrocarbon fluid flow through a pipeline at the tree, the method comprising providing a plurality of sensing means, each for monitoring at least one of said properties, and locating each of the sensing means at or near a position which is optimum for monitoring the at least one of the properties having regard to the configuration of the pipeline.

According to the present invention from another aspect, there is provided a tree for a subsea hydrocarbon extraction facility, the tree being provided with means for monitoring a plurality of different properties relating to hydrocarbon fluid flow through a pipeline at the tree, said monitoring means comprising a plurality of sensing means, each for monitoring at least one of said properties, and each of the sensing means being located at or near a position which is optimum for monitoring the at least one of the properties having regard to the configuration of the pipeline.

One of said sensing means could comprise means for monitoring vibration and/or strain and be located at or near a valve.

Additionally or alternatively, one of said sensing means could comprise means for monitoring vibration and/or strain and be located at or near a known weak point of the pipeline.

One of said sensing means could comprise means for monitoring bulk density and be located at or near a point of turbulence in the pipeline.

One of said sensing means could comprise means for monitoring particulates in said flow and be located at or near a bend in the pipeline.

One of said sensing means could be located at or near a region of steady state flow in the pipeline.

One of said sensing means could comprise means for monitoring erosion of the pipeline and be located at or near a position of most serious erosion of the pipeline.

One of said sensing means could comprise means for monitoring a pressure drop and be located at or near a restriction or known change in the geometry of the pipeline.

One of said sensing means could comprise means for monitoring temperature and be located at or near a region isolated from an interfering temperature.

Brief Description of the Drawing

Fig. 1 is a simplified schematic illustration of a subsea Christmas tree according to an embodiment of the invention.

Description of an Embodiment of the Invention.

- 5 A subsea Christmas tree of a subsea hydrocarbon extraction facility, in its basic form houses a number of valves for controlling the flow of fluid from a well (such as the main flow control and directional flow valves) together with a subsea control module which enables the valves to be controlled by means of electric or hydraulic actuators. There is also a sensor pack which provides essential data on the state of health of the subsea system and for the
10 provision of data for optimising the fluid flow from the well.

The physical configuration of the Christmas tree mechanical structure and of the equipment installed results in the flow pipeline which carries the hydrocarbon fluid having several sharp bends, and use can be made of these to provide the necessary optimised positions for some sensor measurements.

- 15 Fig. 1 is a simplified schematic illustration showing the main hydrocarbon flow pipeline components and appropriate positions for installing some typical sensors in a tree according to an embodiment of the invention.

In Fig. 1, a subsea Christmas tree 1 at a wellhead 2 has a tree cap 3 and a flow pipeline 4 fed from production tubing 5. The flow pipeline 4 exits the tree 1 to a flow line in the
20 direction of arrow A and has first, second and third severe or sharp bends 6, 7 and 8. Between the tubing 5 and bend 6, the pipeline 4 has a flow control valve 9 and between bend 8 and the flow line the pipe has a directional control valve 10, there being between bend 8 and valve 10 a branch section 11 of pipeline 4, having a directional control valve 12.

- The embodiment of the invention utilises the knowledge of the flow regimes in the
25 hydrocarbon flow pipeline and valve configurations on the tree to place suitable discrete sensors in the most appropriate positions to get a more accurate overall monitoring of properties relating to hydrocarbon fluid flow. The arrangement of sensors utilises the physical configuration of the tree, having regard to the configuration of the pipeline 4, to enable measurements of such properties to be made by using discrete sensors each placed
30 at or near an optimum position in the fluid flow for its measurement in a most meaningful manner.

Typical measurements for which optimum positions (shown in Fig. 1) can be identified on the Christmas tree are:

- vibration and/or strain measurement – by locating a sensor 13 at or near valve 9, which could cause vibration, or at a known weak point;
- 5 - bulk density measurement - by locating a sensor 14 at or near a point of high turbulence such as after valve 9 or other disruption;
- particulate detection, such as sand detection – by locating an acoustic sensor 15 at or near severe bend 7 in pipeline 4 to detect particle impact, this being non-intrusive and fitted to the outside of the pipeline 4;
- 10 - ultrasound, electrical impedance spectroscopy, microwave measurements or similar - by locating a sensor 16 between bends 7 and 8 where there is a conditioned steady state flow;
- erosion measurement – by locating a sensor 17 at or near bend 8 where there is most serious erosion, to make a direct measurement;
- pressure drop – by locating a sensor 18 which measures pressure drop through a
15 restriction or known change in geometry, such as the pressure drop across valve 10; and
- temperature measurement – by placing a sensor 19 before valve 12 at or near a most isolated point from any interfering temperature.

Advantages of using the Invention

Technical:

- 20 - It offers a significantly more detailed and accurate method of measuring produced fluid properties compared to conventional methods

Commercial:

- It would offer increased functionality for an Christmas tree compared to the conventional approach of integrating instruments attached to a tree as stand-alone
25 instrument packages.

CLAIMS:

1. A method of providing a tree for a subsea hydrocarbon extraction facility with means for monitoring a plurality of different properties relating to hydrocarbon fluid flow through a pipeline at the tree, the method comprising providing a plurality of sensing means, each for monitoring at least one of said properties, and locating each of the sensing means at or near a position which is optimum for monitoring the at least one of the properties having regard to the configuration of the pipeline.
2. A method according to claim 1, wherein one of said sensing means comprises means for monitoring vibration and/or strain, the method comprising locating it at or near a valve.
3. A method according to claim 1 or 2, wherein one of said sensing means comprises means for monitoring vibration and/or strain, the method comprising locating it at or near a known weak point of the pipeline.
4. A method according to any preceding claim, wherein one of said sensing means comprises means for monitoring bulk density, the method comprising locating it at or near a point of turbulence in the pipeline.
5. A method according to any preceding claim, wherein one of said sensing means comprises means for monitoring particulates in said flow, the method comprising locating it at or near a bend in the pipeline.
6. A method according to any preceding claim, comprising locating one of said sensing means at or near a region of steady state flow in the pipeline.
7. A method according to any preceding claim, wherein one of said sensing means comprises means for monitoring erosion of the pipeline, the method comprising locating it at or near a position of most serious erosion of the pipeline.
8. A method according to any preceding claim, wherein one of said sensing means comprises means for monitoring a pressure drop, the method comprising locating it at or near a restriction or known change in the geometry of the pipeline.
9. A method according to any preceding claim, wherein one of said sensing means comprises means for monitoring temperature, the method comprising locating it at or near a region isolated from an interfering temperature.

10. A tree for a subsea hydrocarbon extraction facility, the tree being provided with means for monitoring a plurality of different properties relating to hydrocarbon fluid flow through a pipeline at the tree, said monitoring means comprising a plurality of sensing means, each for monitoring at least one of said properties, and each of the sensing means
5 being located at or near a position which is optimum for monitoring the at least one of the properties having regard to the configuration of the pipeline.
11. A tree according to claim 10, wherein one of said sensing means comprises means for monitoring vibration and/or strain and is located at or near a valve.
12. A tree according to claim 10 or 11, wherein one of said sensing means comprises
10 means for monitoring vibration and/or strain and is located at or near a known weak point of the pipeline.
13. A tree according to any of claims 10 to 12, wherein one of said sensing means comprises means for monitoring bulk density and is located at or near a point of turbulence in the pipeline.
- 15 14. A tree according to any of claims 10 to 13, wherein one of said sensing means comprises means for monitoring particulates in said flow and is located at or near a bend in the pipeline.
15. A tree according to any of claims 10 to 14, wherein one of said sensing means is located at or near a region of steady state flow in the pipeline.
- 20 16. A tree according to any of claims 10 to 15, wherein one of said sensing means comprises means for monitoring erosion of the pipeline and is located at or near a position of most serious erosion of the pipeline.
17. A tree according to any of claims 10 to 16, wherein one of said sensing means comprises means for monitoring a pressure drop and is located at or near a restriction or
25 known change in the geometry of the pipeline.
18. A tree according to any of claims 10 to 17, wherein one of said sensing means comprises means for monitoring temperature and is located at or near a region isolated from an interfering temperature.