

MONITORING THE PHASE COMPOSITION OF PRODUCTION FLUID FROM A HYDROCARBON EXTRACTION WELL

Field of the Invention

The present invention relates to monitoring the phase composition of production fluid from a hydrocarbon extraction well.

Background of the Invention

Knowledge of the phase composition of individual fluid production wells within a well complex comprising a production gathering network, enables production optimization strategies to accelerate the production rate of fields. In many instances, these strategies cannot be adopted because of the high cost of having a multiphase flow meter for each well. Previous attempts to overcome this problem are by virtual multiphase flow metering, involving complex optimisation algorithms that are difficult to implement and are sensitive to instrumentation errors. This invention allows the benefits of production optimisation to be gained, without the cost and complexity of having a flow meter for each well, and the method provides a better estimate, as its based on direct measurements.

Summary of the Invention

According to the present invention from one aspect, there is provided a method of monitoring the phase composition resulting from different phases in production fluid from at least one of the wells of a plurality of hydrocarbon production wells, the method comprising:

modulating the flow of said fluid from said at least one of the wells;

passing the flow of production fluid from all of said wells through a multiphase flow meter common to the wells; and

processing data from said multiphase flow meter by means responsive to the modulation of the flow from said at least one of the wells to produce information relating to the phase composition of production fluid from said at least one of the wells.

According to the present invention from another aspect, there is provided a well system comprising a plurality of hydrocarbon production wells, the system including means for monitoring the phase composition resulting from different phases in production fluid from at least one of the wells, the monitoring means comprising:

means for modulating the flow of said fluid from said at least one of the wells;

a multiphase flow meter common to the wells and means for passing the flow of production fluid from all of said wells through said flow meter; and

means for processing data from said multiphase flow meter comprising means responsive to the modulation of the flow from said at least one of the wells to produce information relating to the phase composition of production fluid from said at least one of the wells.

Typically, the flows of production fluid from all of said wells are modulated (for example in turn), said processing being carried out on data from the multiphase flow meter to produce information relating to the phase composition of production fluid from each of said wells.

The flow of production fluid from the at least one of the wells could be modulated by modulating a respective choke through which the production fluid flows from the well.

The flow of production fluid from the at least one of the wells could be modulated by frequency modulation.

Production fluid from all of said wells could be passed to said flow meter via a manifold common to the wells.

Typically, said different phases comprise oil, gas and water.

Typically, said processing comprises filtering signals from said data from the multiphase flow meter.

The wells could be subsea wells, said processing being carried out topside.

The embodiment to be described involves the determination of the phase composition (%oil, %gas, %water) of individual production wells feeding a common manifold, using data from a single downstream multiphase flow meter (MPFM), by modulating, at a frequency of f Hz, the production flow from one well and by digitally filtering the data from the MPFM, at the frequency f , thus extracting the phase composition of that well from the total flow. The process is repeated for each well in turn to reveal the phase composition for all wells feeding the manifold.

Brief Description of the Drawings

Fig. 1 is a schematic block diagram of part of a well complex in which an embodiment of the invention may be carried out;

Fig. 2 shows typical waveforms resulting from different phases when performing the invention; and

Fig. 3 is a block diagram in respect of the processing of data from an MPFM of Fig. 1.

Description of an Embodiment of the Invention.

Fig. 1 shows the production flow from a well complex comprising a plurality of subsea hydrocarbon wells 1, 2, ---n, each connected to a common manifold 3. The output of each well passes through a respective one of chokes 41, 42 ---4n to manifold 3 via respective ones of output lines 51, 52 ---5n. Each choke is controlled by a respective one of well subsea control modules (SCMs) 61, 62 ---6n. The combined production flow on a line 7 out of the manifold 3 passes through a single multiphase flow meter (MPFM) 8 common to the wells, before exiting the well complex on an output line 9. The data output on a communication line 10 from the multiphase flowmeter 8 is fed to a topside master control station (MCS) at the surface via the normal communication system of the subsea well complex, where it is processed to provide the phase composition of each of wells 1, 2 ---n.

The mode of operation of the embodiment of the invention is as follows. Starting at the first well 1, its production choke 41 is modulated around its nominal set position by a, typically, sinusoidal modulating signal from the subsea electronics module (SEM) of the SCM 61 to provide a relatively small amplitude flow component at frequency f superimposed on the nominal flow for a time period t . During time t , the downstream MPFM 8 measures the

phase composition of the combined flow from all of the wells feeding the manifold 3, including the flow from well 1 and its component modulated at frequency f . During time t , subsea data from the MPFM 8 is transmitted via the normal communication line 10 to the topside MCS, where it is stored. Data relating to production choke 41 of well 1 is also stored and time synchronised with the flow phase data. From the stored data, a time history of the combined production fluid phases can be obtained.

Fig. 2 is a graph that illustrates the typical resultant modulation at frequency f of each of the phases (% oil, % gas, % water) at the output line 51 of the choke 41.

Fig. 3 illustrates the processing of this data stored in a store 11 at the MCS. By using an appropriately designed digital filter 12 and applying this to the time series, the components of the phases modulated at frequency f can be isolated from the combined flow. This provides flow phase data that is specific to well 1 only. The relative phase composition of well 1 (%oil, %gas, %water) can then be determined by a calculator 13 and absolute composition can then be obtained by a calculator 14 by correlating the relative composition against a measure of total flow from well 1, derived from synchronised choke data (position, pressure drop and temperature).

After this process has been completed for well 1, the modulation of well 1 flow will stop and the process repeated for well 2 through to well n such that the phase composition for each well can be determined. The process will then repeat on a cyclic basis.

In practice, the modulation of the chokes 41---4 n and thereby the production flows from them is scheduled by the topside MCS.

As an alternative to modulation of the flows from the wells 1--- n in a cyclic manner, they could be modulated simultaneously if the modulation frequencies are suitably separated, with demodulation of data from the MPFM8 occurring in the topside MCS.

Advantages of using the Invention

Multiphase measurements for each well with dramatically reduced number of multi-phase flowmeters.

Enablement of production optimisation services.

No additional sensors or complex virtual flow metering algorithms are needed.

CLAIMS

1. A method of monitoring the phase composition resulting from different phases in production fluid from at least one of the wells of a plurality of hydrocarbon production wells, the method comprising:

modulating the flow of said fluid from said at least one of the wells;

passing the flow of production fluid from all of said wells through a multiphase flow meter common to the wells; and

processing data from said multiphase flow meter by means responsive to the modulation of the flow from said at least one of the wells to produce information relating to the phase composition of production fluid from said at least one of the wells wherein:

the flow of production fluid from the at least one of the wells is modulated by modulating a respective one of a plurality of chokes through which the production fluid flows from the well by modulating the choke around its nominal set position by a modulating signal from a subsea electronics module of a respective one of a plurality of subsea control modules to provide a relatively small amplitude flow component at a frequency superimposed on the nominal flow for a time period.

2. A method according to claim 1, wherein the flow of production fluid from all of said wells is modulated, said processing being carried out on data from the multiphase flow meter to produce information relating to the phase composition of production fluid for each of said wells.

3. A method according to claim 2, wherein the flows of production fluid from said wells are modulated in turn, so that information relating to the phase composition of production fluid is produced for each of said wells in turn.

4. A method according to any one of the preceding claims, wherein the flow of production fluid from all of said wells is passed to said meter via a manifold common to the wells.

5. A method according to any one of the preceding claims, wherein said different phases comprise oil, gas and water.

6. A method according to any one of the preceding claims, wherein said processing comprises filtering signals from said data from the multiphase flow meter.

7. A method according to any one of the preceding claims, wherein the wells are subsea wells, said processing being carried out topside.

8. A well system comprising a plurality of hydrocarbon production wells, the system including means for monitoring the phase composition resulting from different phases in production fluid from at least one of the wells, the monitoring means comprising:

means for modulating the flow of said fluid from said at least one of the wells;

a multiphase flow meter common to the wells and means for passing the flow of production fluid from all of said wells through said flow meter; and

means for processing data from said multiphase flow meter comprising means responsive to the modulation of the flow from said at least one of the wells to produce information relating to the phase composition of production fluid from said at least one of the wells wherein:

the modulating means is adapted for modulating the flow of production fluid from the at least one of the wells by modulating a respective one of a plurality of chokes through which the production fluid flows from the well by modulating the choke around its nominal set position by a modulating signal from a subsea electronics module of a respective one of a plurality of subsea control modules to provide a relatively small amplitude flow component at a frequency superimposed on the nominal flow for a time period.

9. A system according to claim 8, adapted for modulating the flow of production fluid from all of said wells, said processing means processing data from the multiphase flow meter to produce information relating to the phase composition of production fluid from each of said wells in use of the monitoring means.

10. A system according to claim 9, wherein the modulating means is adapted for modulating the flows of production fluid from said wells in turn, the processing means being adapted for producing information relating to the phase composition of production fluid from each of said wells in turn.

11. A system according any one of claims 8 to 10, wherein the modulating means is

adapted for modulating the flow of production fluid from the at least one of the wells by modulating a respective choke through which the production fluid flows from the well.

12. A system according to any one of claims 8 to 11, wherein said passing means comprises a manifold common to the wells.

13. A system according to any one of claims 8 to 12, wherein said processing means comprises filtering means.

14. A system according to any one of claims 8 to 13, wherein the wells are subsea wells, said processing being means being located topside.