Claims

1. A method of operating an acoustic sand detector deployed at a flowline within a flow system, the detector having an acoustic sensor and functioning to produce electrical output signals in dependence on acoustic signals detected by the acoustic sensor, the acoustic signals being at least partially produced by the impact of sand particles within the flow on an object, comprising the steps of:

a) estimating the location of particle impacts on the flowline; and

b) weighting the output signals according to the distance between the estimated location and the detector location.

2. A method according to claim 1, wherein step a) includes determining a value for the flow velocity.

3. A method according to claim 2, wherein the determination comprises estimating the velocity of the flow.

4. A method according to claim 2, wherein the determination comprises measuring the velocity of the flow.

5. A method of calibrating an acoustic sand detector, comprising the method according to any of claims 1 to 4, and further comprising the steps of:

c) measuring the amount of sand collected at a location downstream of the detector within a certain time period;

d) calculating the amount of the collected sand which has been carried along the flowline based on both the amount of sand collected in step c) and the weighted output signals over a period of time corresponding to the time period of step c); and

e) calibrating the detector by integrating the weighted output signals over the period of time.

6. A method according to claim 5, comprising the step of estimating the time taken for sand to travel from the vicinity of the detector to the downstream location, and using this estimated time to select the period of time used in step d).

7. A method according to either of claims 5 and 6, wherein the flow system comprises a plurality of flowlines, each having an acoustic detector deployed thereat.

8. A method according to claim 7, wherein step d) comprises equating the amount of sand collected in step c) with the total amount of sand carried by each flowline over the period of time.

9. A method according to claim 8, wherein step d) further comprises calculating the relative amounts of sand carried along each flowline using the relative average acoustic signal output from each detector over the period of time.

10. A method of determining a life expectancy of a flowline, comprising the steps of:

i) calibrating an acoustic sand detector deployed at the flowline using the method of any of claims 5 to 9;

ii) measuring the amount of sand passing through the flowline over a period of time using the acoustic sand detector;

iii) determining the level of erosion at an area of the flowline;

iv) correlating the level of erosion with the measured sand amount to determine a relationship therebetween; and

v) applying the relationship to the output of the acoustic sand detector.

11. A method according to claim 10, wherein step iii) comprises measuring the thickness of a flowline wall.

12. A method according to either of claims 10 and 11, wherein the location of the area of flowline for which the level of erosion is determined is selected using computational fluid dynamic modelling.

13. A method according to any preceding claim, wherein the flow system comprises an underwater hydrocarbon well.

CLAIMS

What is claimed is:

1. A method of operating an acoustic sand detector deployed at a flowline within a flow system, the detector comprising an acoustic sensor and functioning to produce electrical output signals in dependence on acoustic signals detected by the acoustic sensor, the acoustic signals being at least partially produced by the impact of sand particles within the flow on an object, the method comprising:

estimating the location of particle impacts on the flowline; and

weighting the output signals according to the distance between the estimated location and the detector location.

2. The method according to claim 1, wherein estimating the location of particle impacts on the flowline comprises determining a value for the flow velocity.

3. The method according to claim 2, wherein determining a value for the flow velocity comprises estimating the velocity of the flow.

4. The method according to claim 2, wherein determining a value for the flow velocity comprises measuring the velocity of the flow.

5. The method according to claim 1, wherein the flow system comprises an underwater hydrocarbon well.

6. A method of calibrating an acoustic sand detector deployed at a flowline within a flow system, the detector comprising an acoustic sensor and functioning to produce electrical output signals in dependence on acoustic signals detected by the acoustic sensor, the acoustic signals being at least partially produced by the impact of sand particles within the flow on an object, the method comprising:

estimating the location of particle impacts on the flowline;

weighting the output signals according to the distance between the estimated location and the detector location;

measuring the amount of sand collected at a location downstream of the detector within a certain time period;

calculating the amount of the collected sand which has been carried along the flowline based on both the amount of sand collected at a the location downstream of the detector within the time period and the weighted output signals over the time period; and

calibrating the detector by integrating the weighted output signals over the period of time.

7. The method according to claim 6, further comprising estimating the time taken for sand to travel from the vicinity of the detector to the downstream location, and using this estimated time to select the period of time used in calculating the amount of the collected sand which has been carried along the flowline.

8. The method according to claim 6, wherein the flow system comprises a plurality of flowlines each comprising an acoustic detector deployed thereat.

9. The method according to claim 8, wherein calculating the amount of the collected sand which has been carried along the flowline comprises equating the amount of sand collected at the location downstream of the detector within the time period with the total amount of sand carried by each flowline over the period of time.

10. The method according to claim 9, wherein calculating the amount of the collected sand which has been carried along the flowline further comprises calculating the relative amounts of sand carried along each flowline using the relative average acoustic signal output from each detector over the period of time.

11. A method of determining a life expectancy of a flowline, the method comprising:

calibrating an acoustic sand detector deployed at the flowline within a flow system, the detector comprising an acoustic sensor and functioning to produce electrical output signals in dependence on acoustic signals detected by the acoustic sensor, the acoustic signals being at least partially produced by the impact of sand particles within the flow on an object, wherein calibrating the acoustic sand detector comprises:

estimating the location of particle impacts on the flowline;

weighting the output signals according to the distance between the estimated location and the detector location;

measuring the amount of sand collected at a location downstream of the detector within a certain time period;

calculating the amount of the collected sand which has been carried along the flowline based on both the amount of sand collected at a location downstream of the detector within the time period and the weighted output signals over the time period; and

calibrating the detector by integrating the weighted output signals over the period of time;

measuring the amount of sand passing through the flowline over the period of time using the acoustic sand detector;

determining the level of erosion at an area of the flowline;

correlating the level of erosion with the measured sand amount to determine a relationship therebetween; and

applying the relationship to the output of the acoustic sand detector.

12. The method according to claim 11, wherein determining the level of erosion at an area of the flowline comprises measuring the thickness of a flowline wall.

13. The method according to claim 11, wherein the location of the area of flowline for which the level of erosion is determined is selected using computational fluid dynamic modeling.