CLAIMS

We claim:

1. A method for improving flowmeter reliability, wherein the flowmeter comprises at least one flow tube, at least one pickoff sensor attached to the flow tube, at least one driver attached to the flow tube, and meter electronics in communication with the at least one pickoff sensor and driver, comprising the steps of:

vibrating at least one flow tube in a drive mode vibration with the at least one driver;

receiving a sensor signal based on a vibrational response to the drive mode vibration from the at least one pickoff sensor;

calculating at least one flow variable;

measuring a pickoff sensor voltage;

determining whether the pickoff sensor voltage is below a predetermined voltage threshold; and

correcting the at least one flow variable during periods wherein the pickoff sensor voltage is below the predetermined voltage threshold.

2. The method of claim 1, wherein flow variables comprise at least one of: mass flow, volume flow, density, and water cut.

3. The method of claim 2, wherein the water cut is measured with a water cut analyzer in communication with the meter electronics.

4. The method of claim 1, wherein correcting the at least one flow variable comprises an averaging.

5. The method of claim 4, wherein the averaging comprises the steps of:

determining a point immediately prior to when the pickoff sensor voltage fell below the predetermined voltage threshold and determining a first at least one flow variable at this point;

determining a point wherein the pickoff sensor voltage returned above the predetermined voltage threshold and determining a second at least one flow variable at this point; and

calculating an average of the first and second at least one flow variables.

6. The method of claim 1, comprising the steps of:

correlating the pickoff sensor voltage with at least one of a mass flow rate under-read and a density under-read;

deriving an under-read correction factor based on the correlation; and

applying the under-read correction factor to the at least one flow variable.

7. The method of claim 1, comprising the steps of:

determining whether a fluid flow through the flowmeter is a multi-phase flow comprising predominantly a gas;

determining whether a fluid flow through the flowmeter is a multi-phase flow comprising predominantly a liquid;

applying a predominantly gas flow routine of the meter electronics if the fluid flow through the flowmeter is a multi-phase flow comprising predominantly a gas; and

applying a predominantly liquid flow routine of the meter electronics if the fluid flow through the flowmeter is a multi-phase flow comprising predominantly a liquid.

8. The method of claim 7, comprising the steps of:

measuring a mass flow rate and a bulk density with the flowmeter;

determining a gas density from a measured temperature, pressure, and gas composition;

empirically determining a liquid density; and

determining volumetric gas flow rate, volumetric liquid flow rate, and gas void fraction from the mass flow rate, the bulk density, the gas density, and the liquid density.

9. The method of claim 8, comprising the steps of:

determining a Lockhart-Martinelli parameter; and

determining a mass flow rate of a gas phase and a mass flow rate of a liquid phase.

10. The method of either claims 8 or 9, comprising the steps of:

determining whether the liquid comprises water;

measuring liquid density with a water cut analyzer;

determining the volumetric flow rate of an oil; and

determining the volumetric flow rate of the liquid.

11. Meter electronics (20) for a flowmeter (5) configured to improve measurement reliability, wherein the flowmeter (5) comprises:

at least one flow tube (130, 130');

at least one pickoff sensor (170L, 170R) attached to the at least on flow tube (130, 130'); and

at least one driver (180L, 180R) attached to the flow tube (130, 130');

wherein the meter electronics (20) are in communication with the at least one pickoff sensor (170L, 170R) and the at least one driver (180L, 180R), and configured to:

vibrate at least one flow tube (130, 130') in a drive mode vibration with the at least one driver (180L, 180R);

receive a sensor signal based on a vibrational response to the drive mode vibration from the at least one pickoff sensor (170L, 170R);

calculate at least one flow variable;

measure a pickoff sensor (170L, 170R) voltage;

determine whether the pickoff sensor voltage is below a predetermined voltage threshold (304); and

correct the at least one flow variable during periods wherein the pickoff sensor voltage is below the predetermined voltage threshold (304).

12. The meter electronics (20) of claim 11, wherein the flow variables comprise at least one of: mass flow, volume flow, density, and water cut.

13. The meter electronics (20) of claim 11, wherein the water cut is measured with a water cut analyzer in communication with the meter electronics (20).

14. The meter electronics (20) of claim 11, configured to average at least one flow variable.

15. The meter electronics (20) of claim 14, wherein the average comprises the calculated average of a first and a second flow variable, wherein:

the first flow variable is a pickoff sensor voltage value determined at a point immediately prior to when the pickoff sensor voltage falls below the predetermined voltage threshold (304); and

the second flow variable is a pickoff sensor voltage value determined at a point immediately after the pickoff sensor voltage returns above the predetermined voltage threshold (304).

16. The meter electronics (20) of claim 11, wherein the pickoff sensor voltage is correlated with at least one of a mass flow rate under-read and a density under-read, wherein the meter electronics (20) is configured to derive an under-read correction factor based on the correlation, and the under-read correction factor is applied to the at least one flow variable.

17. The meter electronics (20) of claim 11, configured to:

determine whether a fluid flow through the flowmeter (5) is a multi-phase flow comprising predominantly a gas; and

determine whether a fluid flow through the flowmeter (5) is a multi-phase flow comprising predominantly a liquid;

apply a predominantly gas flow routine (220) of the meter electronics (20) if the fluid flow through the flowmeter (5) is a multi-phase flow comprising predominantly a gas; and

apply a predominantly liquid flow routine (222) of the meter electronics (20) if the fluid flow through the flowmeter (5) is a multi-phase flow comprising predominantly a liquid.

18. The meter electronics (20) of claim 17, configured to:
measure a mass flow rate and a bulk density with the flowmeter (5);
determine a gas density from a measured temperature, pressure, and gas composition;
empirically determine a liquid density; and
determine a volumetric gas flow rate, a volumetric liquid flow rate, and a gas void fraction from the mass flow rate, the bulk density, the gas density, and the liquid density.

19. The meter electronics (20) of claim 18, configured to:
determine a Lockhart-Martinelli parameter; and
determine a mass flow rate of a gas phase and a mass flow rate of a liquid phase.

20. The meter electronics (20) of claims 18 or 19, configured to:
determine whether the liquid comprises water;
measure the liquid density with a water cut analyzer;
determine the volumetric flow rate of an oil; and
determine the volumetric flow rate of the liquid.