Description

The present invention relates to a process for measuring the water content of a wet stream which is predominantly non-aqueous.

The present invention also relates to an apparatus for measuring the water content of a wet stream which is predominantly non-aqueous.

A device for measurement of basic sediment and water (BS&W) in a predominantly non-aqueous stream (e.g. pipeline crude oil) is disclosed in U.S. Patent No. 4,184,952. This device is an improvement on capacitance type instruments of the art which are dependent upon the extent to which the intrinsic dielectric constant of the subject fluid varies with time. The gravity and physical composition of crude oil are two factors which determine its intrinsic dielectric constant. If one or both of these properties should vary, instruments measure the accompanying change in the dielectric constant as percent BS&W. This yields an inaccurate measurement of BS&W because instruments must be initially set to read zero BS&W at the intrinsic dielectric constant of the fluid. The capacitance type instruments of the prior art have no means for automatically correcting the zero BS&W setting to compensate for periodic variations in the oil properties mentioned. By comparison, the device of U.S. Patent No. 4,184,952 provides for automatic compensation of BS&W measurements by producing a clean, dry sample of the line fluid for measurement of its intrinsic dielectric constant. In this way, the true BS&W content of the fluid is measured by finding the difference between the dielectric constants of the wet and dry streams.

Even though the improvement over the prior art represented by the invention of U.S. Patent No. 4,184,952 is substantial, it now has been discovered that other improvements can be made which even further improve the efficiency and accuracy of this invention. Thus, temperature variations within the apparatus of the invention can cause some loss of accuracy of readings. For example, the indications from the wet and dry cells of the apparatus are compared to determine BS&W content. This comparison presumes that all other properties of the oils are identical, including temperature. The error introduced by temperature difference is about 0.02% BS&W per degree Fahrenheit. While this error might be neglected if the temperature difference were only one or two degrees, it is desirable to reduce error introduced by a larger temperature difference, for example up to 10°C (18°F) temperature differences between the wet and dry cells as have been noted with the apparatus of U.S. Patent No. 4,184,952.

In addition, changing temperatures within the apparatus of U.S. Patent No. 4,184,952 tend to cause wax to plate the inner surfaces of the various parts thereof. This will usually occur when the stream leaving the pipeline is cool enough to contain traces of solidified wax. Passage through the pump of the apparatus, centrifugal filter and associating tubing tends to raise the temperature of the oil and melt some of the crystals. The melted wax will then re-solidify on any surfaces that are cooler than the oil. This occurs, for example in a heat exchanger, to be described hereinafter, wherein the warm, dry oil leaving the centrifuge is cooled by the incoming wet stream from the pipeline. In this case, the wax is detrimental in two ways:

(1) it tends to impede flow and (2) it reduces the heat exchange capacity of the affected surfaces. It also has been observed that a certain amount of residue tends to collect in the dry oil capacitance measurement cell. The cell comprises two coaxial tubes electrically insulated from each other within the annular space between the tubes, which constitutes an electrical capacitor whose value depends upon the material in the annular space. The residue buildup usually tends to cause an error in the direction of wetness. Thus, the dry cell indicates less dry than it should compared to the wet cell, where flow is more rapid and the residue does not tend to accumulate.

Accordingly, the present invention is directed to overcoming the above problems.

Therefore, it is an object of the present invention to alleviate or overcome difficulties arising from temperature variations within a BS&W measurement system.

The method of the present invention is characterized by the steps of removing a sample of the wet stream, extracting a dry stream sample from the wet stream sample, heat exchanging the dry stream sample with the wet stream sample to reduce any temperature difference therebetween, and measuring the dielectric constants of the wet stream sample and the dry stream sample to facilitate determining the water content of the wet stream.

The apparatus of the present invention is characterized by means for removing a sample of the wet stream, means for extracting a dry stream sample from the wet stream sample, a heat exchanger for reducing any temperature difference between the dry sample and the wet stream sample, and means for measuring the dielectric constants of the wet stream sample and the dry stream sample.

In an advantageous embodiment of the invention the wet stream is pipeline crude oil containing water and sediment and having a varying dielectric constant, and the wet stream sample is admitted to an outer chamber containing an inner chamber having a wall formed of a filter, the inner chamber is rotated while pressuring the wet stream sample from the outer chamber into the inner chamber, and sediment is filtered from the wet stream sample passing into the inner chamber and centrifugal force in the inner chamber forces water in the wet stream sample back into the outer chamber, so that clean, dry sample is withdrawn from the inner chamber.

In addition, the present invention provides a process for de-waxing the inner surfaces of apparatus receiving waxy oil via pump at tem-

peratures whereat waxy components of the oil deposit on contacting surfaces therewithin, by increasing the temperature of the waxy oil by recycling the oil through the pump until the oil is at a temperature sufficient to dissolve the waxy deposits. The waxy oil may contain water and the apparatus is an instrument for measuring the amount of water in the waxy oil.

The invention will now be described by way of example in more detail with reference to the accompanying drawing in which the figure provides a schematic diagram of oil flow within a BS&W measurement system of the present invention.

With reference to the figure a pipeline 10 containing crude oil or another predominantly non-aqueous fluid is represented. The flow direction has been represented by the arrow "A". A wet stream sample is withdrawn from the pipeline 10 by means of an isokinetic probe 11 or other means known to the art. The sample is passed via a line 12 through a valve 3 and into a pump 13, preferably of the variable rate type. From there a stream 14 passes through a heat exchanger 15 and then into a wet cell 16 which is preferably a capacitor having coaxial tubes which measure the capacitance of the fluid between the tubes in the wet state. From there, a stream 17 passes into a centrifuge 18, substantially as described in U.S. Patent No. 4,184,952. A clean, dry stream 19 is withdrawn from the centrifuge 18 and passed through the heat exchanger 15 and into a dry cell 20. From the dry cell 20 a stream 21 is merged with a stream 22 which passes through a valve 2 to form a stream 23 which is returned along with a stream 24, which passes through a valve 1 back to the pipeline 10 via a stream 25.

In order to raise the temperature of the system and dissolve any deposited wax therein, the heating method of this invention requires closing the valve 3 and opening a valve 4 whereby the stream 25 then passes via a line 26 back through the pump 13. Thus, the process utilizes the energy of the circulation pump to create heat via the friction in the system. This valving operation causes the stream to circle back on itself while addition of new oil is stopped. The result is a quick increase in temperature of 28°C (50°F) or more in a few minutes which melts wax deposits. This dewaxing cycle may be necessary, more or less, once each day, or once each 8-hour shift during winter months. A timer and solenoid valve (not shown) may be designed into the system to accomplish the dewaxing cycle automatically.

The heat exchanger 15 is employed to accomplish temperature equalization within the system to offset any discrepancies between capacitance readings between the wet cell 16 and the dry cell 20. It is not unusual to have a difference of temperature of as much as 10°C (18°F) without the existence of the heat exchanger 15. Accordingly, the warm stream 19 leaving the centrifuge 18 and proceeding to the dry cell 20 first gives up heat to the incoming stream 14. Since the volumetric ratio of the streams is for example about 30 and ranges from 5 to 500 or more, the temperature of the incoming stream is hardly affected as the dry stream temperature is dropped to within a degree or so of the wet stream temperature. A manual bypass around the heat exchanger (not shown) permits determination of a temperature error factor. Bypassing the heat exchanger raises the dry stream temperature, whereupon the ratio change of BS&W variation to temperature change can be determined.

Claims

1. A process for measuring the water content of a wet stream which is predominantly non-aqueous, characterized by the steps of removing a sample of the wet stream, extracting a dry stream sample from the wet stream sample, heat exchanging the dry stream sample with the wet stream sample to reduce any temperature difference therebetween, and measuring the dielectric constants of the wet stream sample and the dry stream sample to facilitate determining the water content of the wet stream.

2. The process as claimed in claim 1 characterized in that the volumetric ratio of the wet stream sample to dry stream sample ranges from about 5 to about 100 or more.

3. The process as claimed in claim 1 or 2 characterized in that the wet stream is pipeline crude oil containing water and sediment and having a varying dielectric constant, the wet stream sample is admitted to an outer chamber containing an inner chamber having a wall formed of a filter, the inner chamber is rotated while pressuring the wet stream sample from the outer chamber into the inner chamber, sediment is filtered from the wet stream sample passing into the inner chamber and centrifugal force in the inner chamber forces water in the wet stream sample back into the outer chamber, and clean dry sample is withdrawn from the inner chamber.

4. The process as claimed in claim 1 for dewaxing the inner surfaces of apparatus receiving waxy oil via a pump at temperatures whereat waxy components of the oil deposit on contacting surfaces, characterized by the step of increasing the temperature of the waxy oil by recycling the oil through the pump until the oil is at a temperature sufficient to dissolve the waxy deposits.

5. An apparatus for measuring the water content of a wet stream which is predominantly non-aqueous, characterized by means for removing a sample of the wet stream, means for extracting a dry stream sample from the wet stream sample, a heat exchanger for reducing any temperature difference between the dry sample and the wet stream sample, and means for measuring the dielectric constants of the wet stream sample and the dry stream sample.

6. The apparatus as claimed in claim 4, characterized in that the wet stream is crude oil containing BS&W and that the extracting means is part of an instrument for measuring the BS&W.

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4. The process as claimed in claim 1 for dewaxing the inner surfaces of apparatus receiving waxy oil via a pump at temperatures whereat waxy components of the oil deposit on contacting surfaces, characterized by the step of increasing the temperature of the waxy oil by recycling the oil through the pump until the oil is at a temperature sufficient to dissolve the waxy deposits.

5. An apparatus for measuring the water content of a wet stream which is predominantly non-aqueous, characterized by means for removing a sample of the wet stream, means for extracting a dry stream sample from the wet stream sample, a heat exchanger for reducing any temperature difference between the dry sample and the wet stream sample, and means for measuring the dielectric constants of the wet stream sample and the dry stream sample.

6. The apparatus as claimed in claim 4, characterized in that the wet stream is crude oil containing BS&W and that the extracting means is part of an instrument for measuring the BS&W.

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Patentansprüche

1. Verfahren zum Messen des Wassergehalts einer feuchten Strömung, die hauptsächlich nicht aus Wasser besteht, dadurch gekennzeichnet, daß eine Probe aus der feuchten Strömung entnommen wird, eine trockene Probe aus der feuchten Probe extrahiert wird, ein Wärmetausch zwischen der trockenen Probe und der feuchten Probe durchgeführt wird, um mögliche Temperaturunterschiede auszugleichen, und daß die Dielektrizitätskonstanten der feuchten und der trockenen Probe gemessen werden, um den Wassergehalt der feuchten Probe zu bestimmen.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß das Volumenverhältnis der feuchten Probe der Strömung zur trockenen Probe der Strömung im Bereich von etwa 5 bis etwa 100 oder höher liegt.

3. Verfahren nach einem der Ansprüche 1 oder 2, dadurch gekennzeichnet, daß es sich bei der feuchten Strömung um Rohöl in einer Pipeline handelt, welches Wasser und Sedimentstoffe enthält und eine veränderliche Dielektrizitätskonstante aufweist, wobei die Probe der feuchten Strömung in eine äußere Kammer geführt wird, die eine innere Kammer mit einer aus einem Filter gebildeten Wand enthält, wobei die innere Kammer gedreht wird während die Probe der feuchten Strömung aus der äußeren Kammer in die innere Kammer gepreßt wird, Sedimentstoffe aus der in die innere Kammer dringenden Probe der feuchten Strömung ausgefiltert werden, Zentrifugalkräfte in der inneren Kammer Wasser in der Probe zurück in die äußere Kammer drücken und wobei aus der inneren Kammer eine saubere, trockene Probe entnommen wird.

4. Verfahren nach Anspruch 1 zum Entwachsen der inneren Oberfläche einer Vorrichtung, die über eine Pumpe wachsartiges Öl bei Temperaturen aufnimmt, bei denen die Wachs-Komponenten des Öls sich auf den Flächen niederschlagen, mit denen das Öl in Berührung kommt, dadurch gekennzeichnet, daß die Temperatur des wachsartigen Öls dadurch erhöht wird, daß das Öl solange durch die Pumpe rezirkuliert wird, bis das Öl eine Temperatur aufweist, die ausreicht, um alle wachsartigen Niederschläge aufzulösen.

5. Vorrichtung zum Messen des Wasergehalts einer feuchten, im wesentlichen aber nichtwässrigen Strömung, gekennzeichnet durch eine Einrichtung zum Entfernen einer Probe aus der feuchten Strömung, eine Einrichtung zum Extrahieren einer trockenen Probe der Strömung aus der feuchten Probe der Strömung, einen Wärmetauscher zum Vermindern einer möglichen Temperaturdifferenz zwischen der trockenen Probe und der feuchten Probe der Strömung, und Einrichtungen zum Messen der Dielektrizitätskonstante der feuchten Probe und der trockenen Probe der Strömung.

6. Vorrichtung nach Anspruch 5, dadurch gekennzeichnet, daß es sich bei der feuchten Strömung um Rohöl handelt, welches BS&W enthält und daß die Einrichtung zum Extrahieren als Teil eines Gerätes vorgesehen ist, mit dem BS&W gemessen wird.

Revendications

1. Procédé pour mesurer la teneur en eau d'un courant humide qui est principalement non aqueux, caractérisé par les étapes qui consistent à prélever un échantillon du courant humide, extraire un échantillon de courant sec de l'échantillon de courant humide, échanger la chaleur de l'échantillon de courant sec avec l'échantillon de courant humide poure réduire toute différence de température entre les deux, et mesurer les constantes diélectriques de l'échantillon de courant humide et de l'échantillon de courant sec pour faciliter la détermination de la teneur en eau du courant humide.

2. Procédé selon la revendication 1, caractérisé en ce que le rapport volumétrique de l'échantillon de courant humide à l'échantillon de courant sec s'échelonne d'environ 5 à environ 100 ou plus.

3. Procédé selon la revendication 1 ou 2, caractérisé en ce que le courant humide est une huile brute d'oléoduc contenant de l'eau et des sédiments et ayant une constante diélectrique variable, l'échantillon de courant humide est introduit dans une enceinte extérieure contenant une enceinte intérieure ayant une paroi formée par un filtre, l'enciente intérieure est mise en rotation tandis que l'échantillon de courant humide est introduit sous pression depuis l'enceinte extérieure vers l'enceinte intérieure, les sédiments sont séparés de l'échantillon de courant humide par filtration, en passant dans l'enceinte intérieure, et la force centrifuge dans l'enceinte intérieure force l'eau contenue dans l'échantillon de courant humide à retourner dans l'enceinte extérieure, et un échantillon sec et propre est retiré de l'enceinte intérieure.

4. Procédé selon la revendication 1 pour déparaffiner les surfaces internes d'un appareil recevant une huile paraffineuse par l'intermédiaire d'une pompe à des température où les constituants paraffineux de l'huile se déposent au contact des surfaces, caractérisé par l'étape qui consiste à augmenter la température de l'huile paraffineuse en recyclant l'huile à travers la pompe jusquà ce que l'huile soit à une température suffisante pour dissoudre les dépôts paraffineux.

5. Appareil pour mesurer la teneur en eau d'un courant humide qui est principalement non aqueux, caractérisé par un dispositif pour prélever un échantillon d'un courant humide, un dispositif pour extraire un échantillon de courant sec de l'échantillon humide, un échangeur de chaleur pour réduire toute différence de température entre l'échantillon de courant sec et l'échantillon de courant humide, et un dispositif pour mesurer les constantes diélectriques de l'échantillon de courant humide et de l'échantillon de courant sec.

6. Appareil selon la revendication 5, caractérisé en ce que le courant humide est une huile brute contenant des sédiments basiques et de l'eau et en ce que le dispositif d'extraction fait partie d'un instrument de mesure de la teneur en sédiments basiques et en eau.

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