

Vacuum Pump Lubricating Oil Monitoring Method

The present application claims priority to the Chinese patent application entitled "vacuum pump lubricating oil monitoring method" with the application number 202310450082.9 filed before the China National Intellectual Property Administration on April 24, 2023, the entire contents of which are incorporated herein by reference.

Technical Field

The present application relates to the technical field of vacuum pumps, and in particular to a vacuum pump lubricating oil monitoring method.

Background Art

A vacuum pump refers to an apparatus or equipment that uses mechanical, physical, chemical, or physicochemical methods to extract gas from a container to achieve a vacuum. That is, a vacuum pump is a device that improves, generates, and maintains a vacuum in a certain closed space by various methods. In a pump chamber, a rotor rotates to generate volume changes, thereby discharging gas out of the pump. During the suction process, the volume of the suction chamber increases, the vacuum degree decreases, and the gas in the container is drawn into the pump chamber; and during the exhaust process, the volume decreases, the pressure increases, and the sucked gas is finally discharged out of the pump.

A pump body of a vacuum pump is typically provided with movable connecting structures such as bearings. In order to ensure that these movable connecting structures can operate normally in the vacuum pump (e.g., rotating, sliding, etc.), lubrication is generally provided by using the lubricating oil stored inside an end cover of the pump body of the vacuum pump.

In order to monitor the state and quantity of the lubricating oil, in the prior art, a sight window is typically provided on the end cover of the vacuum pump, and monitoring of the lubricating oil in the vacuum pump is performed manually. The existing monitoring method is inconvenient and consumes manpower, and oil level data cannot be acquired in real-time. The oil quality condition of the lubricating oil cannot be detected in real time. Manual monitoring has delays, failing to timely and accurately determine the state of the lubricating oil in the vacuum pump.

Summary of the Invention

The main objective of the embodiments of the present application is to provide a vacuum pump lubricating oil monitoring method, intending to improve the technical problem of inaccurate

manual monitoring of the lubricating oil state in the prior art.

The technical solution of the present application is as follows.

In a first aspect, an embodiment of the present application provides a vacuum pump lubricating oil monitoring method for monitoring lubricating oil stored in a pump body of a vacuum pump, applied to a controller in a monitoring system for monitoring lubricating oil in a vacuum pump, the monitoring system comprising:

an oil quality sensor disposed in the pump body, a probing end of the oil quality sensor being in contact with the lubricating oil stored in the pump body, the oil quality sensor configured to monitor a lubricating oil dielectric constant in the vacuum pump and output a first signal carrying lubricating oil dielectric constant information;

an ultrasonic level sensor provided on an outer wall of the vacuum pump, the ultrasonic sensor configured to monitor a lubricating oil level in the vacuum pump and output a second signal carrying lubricating oil level height information;

a controller connected to the oil quality sensor and further connected to the ultrasonic level sensor; and

a display device connected to the controller, and used for receiving a display driving signal sent by the controller to display corresponding information;

wherein the vacuum pump lubricating oil monitoring method comprises:

receiving the first signal, and sending a first display driving signal to the display device according to the lubricating oil dielectric constant information carried by the first signal, and driving the display device to display the corresponding lubricating oil dielectric constant; and

receiving the second signal, and sending a second display driving signal to the display device according to the lubricating oil level height information carried by the second signal, and driving the display device to display the corresponding lubricating oil level height.

Further, the vacuum pump lubricating oil monitoring method further comprises an alarm device connected to the controller, the vacuum pump lubricating oil monitoring method further comprising:

processing the lubricating oil dielectric constant information carried in the first signal, and judging whether to send a first alarm signal to the alarm device based on a processing result;

processing the lubricating oil level height information carried in the second signal, and judging whether to send a second alarm signal to the alarm device based on a processing result; and

configuring the alarm device to receive the first alarm signal and/or the second alarm signal sent by the controller and to generate an alarm.

Further, processing the lubricating oil dielectric constant information carried in the first signal and judging whether to send an alarm signal to the alarm device based on a processing result

comprises:

acquiring the lubricating oil dielectric constant monitored by the oil quality sensor based on the lubricating oil dielectric constant information carried in the first signal;

comparing the lubricating oil dielectric constant monitored by the oil quality sensor with a preset standard dielectric constant range, and obtaining a judgment result;

when it is determined that the lubricating oil dielectric constant monitored by the oil quality sensor is within the standard dielectric constant range, not sending the first alarm signal to the alarm device; and

when it is determined that the lubricating oil dielectric constant monitored by the oil quality sensor is not within the standard dielectric constant range, sending the first alarm signal to the alarm device.

Further, comparing the lubricating oil dielectric constant monitored by the oil quality sensor with a preset standard dielectric constant and obtaining a judgment result comprises:

comparing the lubricating oil dielectric constant monitored by the oil quality sensor with the standard dielectric constant;

if the lubricating oil dielectric constant monitored by the oil quality sensor is greater than the standard dielectric constant, judging that the lubricating oil dielectric constant monitored by the oil quality sensor is not within the standard dielectric constant range; and

if the lubricating oil dielectric constant monitored by the oil quality sensor is smaller than the standard dielectric constant, judging that the lubricating oil dielectric constant monitored by the oil quality sensor is within the standard dielectric constant range.

Further, processing the lubricating oil level height information carried in the second signal, and judging whether to send a second alarm signal to the alarm device based on a processing result comprises:

acquiring the lubricating oil level height monitored by the ultrasonic level sensor according to the lubricating oil level height information carried in the second signal;

comparing the lubricating oil level height monitored by the ultrasonic level sensor with a preset standard liquid level height range, and obtaining a judgment result;

when it is determined that the lubricating oil level height monitored by the ultrasonic level sensor is within the standard liquid level height range, not sending a second alarm signal to the alarm device; and

when it is determined that the lubricating oil level height monitored by the ultrasonic level sensor is not within the standard liquid level height range, sending a second alarm signal to the alarm device.

Further, the standard liquid level height range is a threshold range formed by a first liquid level

height and a second liquid level height, the first liquid level height being smaller than the second liquid level height, and comparing the lubricating oil level height monitored by the ultrasonic level sensor with a preset standard liquid level height range, and obtaining a judgment result comprises: comparing the lubricating oil level height monitored by the ultrasonic level sensor with the first liquid level height;

if the lubricating oil level height monitored by the ultrasonic level sensor is lower than the first liquid level height, judging that the lubricating oil level height monitored by the ultrasonic level sensor is not within the standard liquid level height range;

if the lubricating oil level height monitored by the ultrasonic level sensor is higher than the first liquid level height, comparing the lubricating oil level height monitored by the ultrasonic level sensor with the second liquid level height;

if the lubricating oil level height monitored by the ultrasonic level sensor is higher than the second liquid level height, judging that the lubricating oil level height monitored by the ultrasonic level sensor is not within the standard liquid level height range; and

if the lubricating oil level height monitored by the ultrasonic level sensor is higher than the first liquid level height and lower than the second liquid level height, judging that the lubricating oil level height monitored by the ultrasonic level sensor is within the standard liquid level height range.

Further, the oil quality sensor is further configured to monitor the lubricating oil water content in the vacuum pump, and output the first signal carrying water content information of the lubricating oil in the vacuum pump, the vacuum pump lubricating oil monitoring method comprising:

sending a third display driving signal to the display device according to the lubricating oil water content carried by the first signal, and driving the display device to display the corresponding lubricating oil water content based on a received third display driving signal; and

processing the lubricating oil water content information carried in the first signal, and judging whether to send a first alarm signal to the alarm device based on the processing result.

Further, processing the lubricating oil water content information carried in the first signal and judging whether to send a first alarm signal to the alarm device based on the processing result includes:

acquiring the lubricating oil water content monitored by the oil quality sensor according to the lubricating oil water content information carried in the first signal;

comparing the lubricating oil water content monitored by the oil quality sensor with a preset standard water content range, and obtaining a judgment result;

when it is determined that the lubricating oil water content monitored by the oil quality sensor is within the standard water content range, not sending the first alarm signal to the alarm device; and

when it is determined that the lubricating oil water content monitored by the oil quality sensor is not within the standard water content range, sending the first alarm signal to the alarm device.

Further, the vacuum pump lubricating oil monitoring method further comprises:

when the first alarm signal is sent to the alarm device, a first abnormal display signal being simultaneously sent to the display device to drive the display device to display an abnormal lubricating oil state; and

when the second alarm signal is sent to the alarm device, a second abnormal display signal being simultaneously sent to the display device to drive the display device to display an abnormal lubricating oil level.

Further, the vacuum pump lubricating oil monitoring method further comprises:

controlling the oil quality sensor to monitor the lubricating oil in the vacuum pump at a first preset time interval and acquiring the first signal; and

controlling the ultrasonic level sensor to detect the lubricating oil level in the vacuum pump at a second preset time interval and acquiring the second signal.

Beneficial Effects

The beneficial effects of the present application are as follows: by providing the oil quality sensor to monitor in real time the lubricating oil dielectric constant in the pump body of the vacuum pump, and displaying in real time the lubricating oil dielectric constant in the vacuum pump through the controller and the display device, the contamination level of the lubricating oil can be reflected by the lubricating oil dielectric constant, and therefore, the real-time monitoring and display of the lubricating oil dielectric constant enables real-time monitoring of the contamination level of the lubricating oil in the vacuum pump. Meanwhile, by providing the ultrasonic level sensor, the lubricating oil level in the pump body of the vacuum pump can be monitored in real time, and the lubricating oil level in the vacuum pump is displayed in real time through the controller and the display device. Compared with the prior art of manual monitoring by providing a sight window on the vacuum pump, the vacuum pump lubricating oil monitoring method provided by the present invention can monitor and visually display the contamination level and liquid level of the lubricating oil in the vacuum pump in real time and accurately, thereby improving the accuracy of judging the operating state of the vacuum pump.

Brief Description of the Drawings

The technical solutions and other advantageous effects of the present application will become apparent from the following detailed description of specific embodiments of the present application, taken in conjunction with the accompanying drawings.

Fig. 1 is a block diagram of a monitoring system according to an embodiment of the present

invention;

Fig. 2 is a schematic diagram illustrating steps for judging whether to issue an alarm based on a first signal processing structure according to an embodiment of the present invention; and

Fig. 3 is a schematic diagram illustrating steps for judging whether to issue an alarm based on a second signal processing structure according to an embodiment of the present invention.

Detailed Description of the Invention

The specific structural and functional details disclosed herein are merely representative and are intended to describe exemplary embodiments of the present application. However, the present application may be embodied in many alternative forms and should not be construed as limited to the embodiments set forth herein.

In describing the present application, it needs to be understood that the orientations or positional relationships indicated by the terms "center", "transverse", "up", "down", "left", "right", "vertical", "horizontal", "top", "bottom", "inner", "outer" and the like are based on the orientations or positional relationships shown in the drawings for purposes of describing the present application and simplifying the description only, and are not intended to indicate or imply that the referenced device or element must have a particular orientation or be constructed and operated in a particular orientation. It is therefore not to be understood as limiting the present application. Furthermore, the terms "first" and "second" are used for descriptive purposes only and are not to be construed as indicating or implying relative importance or implicitly indicating the number of technical features indicated. Therefore, features defining "first" and "second" may explicitly or implicitly include one or more such features. In the description of the present application, unless otherwise specified, "a plurality" means two or more. In addition, the terms "comprises" and any variations thereof are intended to cover a non-exclusive inclusion.

In describing the present application, it needs to be understood that the terms "install", "link", "connect", as they appear, are to be construed broadly, for example, either supporting connection or detachable connection or integrated connection, unless expressly specified and limited otherwise; it can be a mechanical connection, or an electrical connection; the connection may be connected directly or indirectly through intervening media, and the connection may be internal connection between two elements. For those of ordinary skill in the art, the specific meanings of the above terms in the present application can be understood according to specific circumstances.

The terminology used herein is solely for the purpose of describing particular embodiments and is not intended to limit the exemplary embodiments. Unless the context clearly indicates otherwise, the singular forms "a" and "one" as used herein are intended to include the plural forms as well. It should further understood that the terms "comprises" and/or "comprising, " when used herein,

specify the presence of stated features, integers, steps, operations, units, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, units, components, and/or combinations thereof.

The present application will now be further described with reference to the accompanying drawings and embodiments.

As shown in Fig. 1, an embodiment of the present invention provides a vacuum pump lubricating oil monitoring method for monitoring lubricating oil stored in a pump body of a vacuum pump, applicable to a controller in a monitoring system for monitoring lubricating oil in a vacuum pump, wherein the monitoring system includes an oil quality sensor, an ultrasonic level sensor, a controller, and a display device.

The oil quality sensor is arranged in the pump body, the probing end of the oil quality sensor is in contact with the lubricating oil stored in the pump body, and the oil quality sensor is used for monitoring the lubricating oil dielectric constant in the vacuum pump and outputting a first signal with information about the lubricating oil dielectric constant.

The ultrasonic level sensor is provided on an outer wall of the vacuum pump, and the ultrasonic sensor is used for monitoring the lubricating oil level in the vacuum pump and outputting a second signal with information about the lubricating oil level height.

The controller is connected to the oil quality sensor for receiving or acquiring the first signal, and the controller is also connected to the ultrasonic level sensor for receiving or acquiring the second signal.

The display device is connected to the controller, and is used for receiving a display driving signal sent by the controller to display corresponding information.

The vacuum pump lubricating oil monitoring method includes:

receiving the first signal, and sending a first display driving signal to the display device according to the lubricating oil dielectric constant information carried by the first signal, and driving the display device to display the corresponding lubricating oil dielectric constant;

receiving the second signal, and sending a second display driving signal to the display device according to the lubricating oil level height information carried by the second signal, and driving the display device to display the corresponding lubricating oil level height.

That is, the controller is configured to send the first display driving signal to the display device according to the lubricating oil dielectric constant information carried by the first signal, and the display device displays the corresponding lubricating oil dielectric constant according to the received first display driving signal. The controller is used for sending the second display driving signal to the display device according to the lubricating oil level height information carried in the second signal, and the display device displays the corresponding lubricating oil level height

according to the received second display driving signal.

The first signal may carry not only lubricating oil dielectric constant information but also other lubricating oil state information, such as temperature, water content, etc.

It needs to be noted that the oil quality sensor is installed in the pump body of the vacuum pump, and the probing end is located at least at the lower limit liquid level of the lubricating oil of the vacuum pump, so as to ensure that the lubricating oil dielectric constant of the vacuum pump can be monitored when the lubricating oil is in the normal state.

Meanwhile, the ultrasonic level sensor is disposed directly above or below the lubricating oil level so that accurate liquid level information can be acquired.

The display device may be a device such as a display screen connected to the controller, and the controller may be a microcontroller or a computer connected to the ultrasonic level sensor and the oil quality sensor.

It needs to be added that the lower limit liquid level of the lubricating oil is the minimum liquid level of lubricating oil required to ensure proper operation of the vacuum pump.

Therefore, it can be understood that by providing the oil quality sensor to monitor in real time the lubricating oil dielectric constant in the pump body of the vacuum pump, and displaying in real time the lubricating oil dielectric constant in the vacuum pump through the controller and the display device, the contamination level of the lubricating oil can be reflected by the lubricating oil dielectric constant, and therefore, the real-time monitoring and display of the lubricating oil dielectric constant enables real-time monitoring of the contamination level of the lubricating oil in the vacuum pump. Meanwhile, by providing the ultrasonic level sensor, the lubricating oil level in the pump body of the vacuum pump can be monitored in real time, and the lubricating oil level in the vacuum pump is displayed in real time through the controller and the display device. Compared with the prior art of manual monitoring by providing a sight window on the vacuum pump, the vacuum pump lubricating oil monitoring method provided by the present invention can monitor and visually display the contamination level and liquid level of the lubricating oil in the vacuum pump in real time and accurately, thereby improving the accuracy of judging the operating state of the vacuum pump.

At the same time, by real-time monitoring of the lubricating oil in the vacuum pump, planned replacement of the lubricating oil and shutdown inspection can be carried out, thereby avoiding unexpected situations during operation.

In some embodiments, the monitoring system further includes an alarm device connected to the controller, and the vacuum pump lubricating oil monitoring method further comprises:

processing the lubricating oil dielectric constant information carried in the first signal, and judging whether to send a first alarm signal to an alarm device based on the processing result;

processing the lubricating oil level height information carried in the second signal, and judging whether to send a second alarm signal to the alarm device based on the processing result; and configuring the alarm device to receive the first alarm signal and/or the second alarm signal sent by the controller and to generate an alarm.

It needs to be noted that the judgment result obtained after processing the first signal may be either an alarm or no alarm; when the processing result indicates an alarm, the controller sends the first alarm signal to the alarm device to trigger an alarm; and when the processing result indicates no alarm, the controller sends no signal to the alarm device.

Similarly, the judgment result obtained from processing the second signal may be either alarm or no alarm; when the processing result is alarm, the controller sends the second alarm signal to the alarm device to trigger an alarm; and when the processing result is no alarm, the controller sends no signal to the alarm device.

It needs to be noted that the alarm device may be any one of a whistling alarm and a light alarm, and may be an alarm device perceivable by at least one of visual and auditory means.

As shown in Fig. 2, in some embodiments, processing the lubricating oil dielectric constant information carried in the first signal, and judging whether to send an alarm signal to the alarm device based on the processing result, includes:

acquiring the lubricating oil dielectric constant monitored by the oil quality sensor based on the lubricating oil dielectric constant information carried in the first signal;

comparing the lubricating oil dielectric constant monitored by the oil quality sensor with a preset standard dielectric constant range, and obtaining a judgment result;

when it is determined that the lubricating oil dielectric constant monitored by the oil quality sensor is within the standard dielectric constant range, not sending a first alarm signal to the alarm device; and

when it is determined that the lubricating oil dielectric constant monitored by the oil quality sensor is not within the standard dielectric constant range, sending the first alarm signal to the alarm device.

In some embodiments, comparing the lubricating oil dielectric constant monitored by the oil quality sensor with a preset standard dielectric constant, and obtaining a judgment result, comprises:

comparing the lubricating oil dielectric constant monitored by the oil quality sensor with the standard dielectric constant;

if the lubricating oil dielectric constant monitored by the oil quality sensor is greater than the standard dielectric constant, judging that the lubricating oil dielectric constant monitored by the oil quality sensor is not within the standard dielectric constant range; and

if the lubricating oil dielectric constant monitored by the oil quality sensor is smaller than the standard dielectric constant, judging that the lubricating oil dielectric constant monitored by the oil quality sensor is within the standard dielectric constant range.

Specifically, the standard dielectric constant is set to 4.0; generally qualified lubricating oil has a dielectric constant of 2.0; after mixing in water or iron powder, the relative lubricating oil dielectric constant increases; and therefore, when the detected dielectric constant is greater than 4.0, it can be considered that the contamination level of the lubricating oil exceeds the limit and the lubricating oil needs to be replaced.

As shown in Fig. 3, in some embodiments, processing the lubricating oil level height information carried in the second signal, and judging whether to send a second alarm signal to the alarm device based on the processing result, comprises:

acquiring the lubricating oil level height monitored by the ultrasonic level sensor according to the lubricating oil level height information carried in the second signal;

comparing the lubricating oil level height monitored by the ultrasonic level sensor with a preset standard liquid level height range, and obtaining a judgment result;

when it is determined that the lubricating oil level height monitored by the ultrasonic level sensor is within the standard liquid level height range, not sending a second alarm signal to the alarm device; and

when it is determined that the lubricating oil level height monitored by the ultrasonic level sensor is not within the standard liquid level height range, sending a second alarm signal to the alarm device.

In some embodiments, the standard liquid level height range is a threshold range formed by a first liquid level height and a second liquid level height, wherein the first liquid level height is smaller than the second liquid level height.

Comparing the lubricating oil level height monitored by the ultrasonic level sensor with a preset standard liquid level height range, and obtaining a judgment result, comprising:

comparing the lubricating oil level height monitored by the ultrasonic level sensor with the first liquid level height;

if the lubricating oil level height monitored by the ultrasonic level sensor is lower than the first liquid level height, judging that the lubricating oil level height monitored by the ultrasonic level sensor is not within the standard liquid level height range;

if the lubricating oil level height monitored by the ultrasonic level sensor is higher than the first liquid level height, comparing the lubricating oil level height monitored by the ultrasonic level sensor with the second liquid level height;

if the lubricating oil level height monitored by the ultrasonic level sensor is higher than the second

liquid level height, judging that the lubricating oil level height monitored by the ultrasonic level sensor is not within the standard liquid level height range; and

if the lubricating oil level height monitored by the ultrasonic level sensor is higher than the first liquid level height and lower than the second liquid level height, judging that the lubricating oil level height monitored by the ultrasonic level sensor is within the standard liquid level height range.

Specifically, the first liquid level height is the highest level of lubricating oil allowed during normal operation of the vacuum pump, and the second liquid level height is the lowest level of lubricating oil allowed during normal operation of the vacuum pump; and therefore, in order to ensure normal operation of the vacuum pump, it is necessary to monitor the lubricating oil level in the vacuum pump in real time to ensure that it is between the first liquid level height and second liquid level height.

In some embodiments, the oil quality sensor is further configured to monitor the lubricating oil water content in the vacuum pump, and output a first signal carrying information about the lubricating oil water content in the vacuum pump. The vacuum pump lubricating oil monitoring method in the above embodiments further comprises:

sending a third display driving signal to the display device according to the lubricating oil water content carried by the first signal, and driving the display device to display the corresponding lubricating oil water content based on the received third display driving signal; and

processing the lubricating oil water content information carried in the first signal, and judging whether to send a first alarm signal to the alarm device based on the processing result.

In some embodiments, processing the lubricating oil water content carried in the first signal, and judging whether to send a first alarm signal to the alarm device based on the processing result, comprises:

acquiring the lubricating oil water content monitored by the oil quality sensor according to the lubricating oil water content information carried in the first signal;

comparing the lubricating oil water content monitored by the oil quality sensor with a preset standard water content range, and obtaining a judgment result;

when it is determined that the lubricating oil water content monitored by the oil quality sensor is within the standard water content range, not sending a first alarm signal to the alarm device; and

when it is determined that the lubricating oil water content monitored by the oil quality sensor is not within the standard water content range, sending a first alarm signal to the alarm device.

In some embodiments, comparing the lubricating oil water content monitored by the oil quality sensor with a preset standard water content range, and obtaining a judgment result comprises steps as follows:

comparing the lubricating oil water content monitored by the oil quality sensor with a first water content;

if the lubricating oil water content monitored by the oil quality sensor is smaller than the first water content, judging that the lubricating oil water content monitored by the oil quality sensor is within the standard water content range; and

if the lubricating oil water content monitored by the oil quality sensor is greater than the first water content, judging that the lubricating oil water content monitored by the oil quality sensor is not within the standard water content range.

Specifically, the first water content is generally set to 4%. When the oil quality sensor detects that the lubricating oil water content in the vacuum pump is greater than 4%, the controller sends a first alarm signal to the alarm device to indicate abnormal lubricating oil.

In some embodiments, the vacuum pump lubricating oil monitoring method in the above embodiment further comprises steps as follows:

when a first alarm signal is sent to the alarm device, a first abnormal display signal is simultaneously sent to the display device to drive the display device to display an abnormal lubricating oil state; and

when a second alarm signal is sent to the alarm device, a second abnormal display signal is simultaneously sent to the display device to drive the display device to display an abnormal lubricating oil level.

It could be understood that when the controller judges an abnormal lubricating oil state or an abnormal lubricating oil level, it simultaneously informs the display device the abnormality information for display so that an observer or the control center can promptly detect the vacuum pump abnormality and perform troubleshooting.

The display device may display the abnormal display signal by using a different color from that used for normal liquid level display or normal lubricating oil state display, or by using a flashing frequency different from that used for normal liquid level display or normal lubricating oil state display.

For example, the scenario that when the display device shows liquid level information in a normal state, it displays green digits; and when the display device shows liquid level information in an abnormal state, it displays red digits.

For example, the scenario that when the display device shows liquid level information in a normal state, it displays green digits without flashing; and when the display device shows liquid level information in an abnormal state, it displays red digits that blink every two seconds.

In some embodiments, the vacuum pump lubricating oil monitoring method in the above embodiment further comprises:

controlling the oil quality sensor to monitor the lubricating oil in the vacuum pump at a first preset time interval and acquiring a first signal; and

controlling an ultrasonic level sensor to detect the lubricating oil level in the vacuum pump at a second preset time interval and acquiring a second signal.

It could be appreciated that monitoring the lubricating oil state of the vacuum pump at a preset time, as compared to continuous real-time monitoring over a long period, can reduce power consumption while still enabling accurate monitoring of the lubricating oil state in the vacuum pump.

In some embodiments, the oil quality sensor is further configured to monitor the dynamic viscosity, density, electrical resistance, and temperature of the lubricating oil in the vacuum pump, and to output a first signal containing information on the dynamic viscosity, density, electrical resistance, and temperature of the lubricating oil. The vacuum pump lubricating oil monitoring method further comprises:

sending a fourth display driving signal to the display device according to the lubricating oil parameter information carried in the first signal, and driving the display device to display the corresponding dynamic viscosity of the lubricating oil, density of the lubricating oil, electrical resistance of the lubricating oil, and temperature of the lubricating oil based on the received fourth display driving signal.

It could be appreciated that by monitoring the dielectric constant, water content, dynamic viscosity, density, electrical resistance, and temperature of the lubricating oil using the oil quality sensor, and displaying the information via the display device, the lubricating oil state in the vacuum pump can be visually and accurately reflected, thereby enabling planned maintenance of the vacuum pump.

The above descriptions are merely optional embodiments of the present invention, and are not intended to limit the patent scope of the present invention. Any equivalent structural transformation made under the application concept of the present invention using the content of the description and drawings of the present invention, or directly/indirectly applied in other related technical fields, is included in the scope of patent protection of the present invention.

Claims

1. A vacuum pump lubricating oil monitoring method for monitoring lubricating oil stored in a pump body of a vacuum pump, applied to a controller in a monitoring system for monitoring lubricating oil in a vacuum pump, the monitoring system comprising:

an oil quality sensor disposed in the pump body, a probing end of the oil quality sensor being in contact with the lubricating oil stored in the pump body, the oil quality sensor configured to monitor a lubricating oil dielectric constant in the vacuum pump and output a first signal carrying lubricating oil dielectric constant information;

an ultrasonic level sensor provided on an outer wall of the vacuum pump, the ultrasonic sensor configured to monitor a lubricating oil level in the vacuum pump and output a second signal carrying lubricating oil level height information;

a controller connected to the oil quality sensor and further connected to the ultrasonic level sensor; and

a display device connected to the controller and configured to display corresponding information in response to a display driving signal sent by the controller; wherein

the vacuum pump lubricating oil monitoring method comprises:

receiving the first signal, and sending a first display driving signal to the display device according to the lubricating oil dielectric constant information carried by the first signal, and driving the display device to display the corresponding lubricating oil dielectric constant; and

receiving the second signal, and sending a second display driving signal to the display device according to the lubricating oil level height information carried by the second signal, and driving the display device to display the corresponding lubricating oil level height.

2. The vacuum pump lubricating oil monitoring method according to claim 1, wherein the monitoring system further comprises an alarm device connected to the controller, the vacuum pump lubricating oil monitoring method further comprising:

processing the lubricating oil dielectric constant information carried in the first signal, and judging whether to send a first alarm signal to the alarm device based on a processing result;

processing the lubricating oil level height information carried in the second signal, and judging whether to send a second alarm signal to the alarm device based on a processing result; and

configuring the alarm device to receive the first alarm signal and/or the second alarm signal sent by the controller and to generate an alarm.

3. The vacuum pump lubricating oil monitoring method according to claim 2, wherein processing the lubricating oil dielectric constant information carried in the first signal and judging whether to send an alarm signal to the alarm device based on a processing result comprises:

acquiring the lubricating oil dielectric constant monitored by the oil quality sensor according to

the lubricating oil dielectric constant information carried in the first signal;
comparing the lubricating oil dielectric constant monitored by the oil quality sensor with a preset standard dielectric constant range, and obtaining a judgment result;
when it is determined that the lubricating oil dielectric constant monitored by the oil quality sensor is within the standard dielectric constant range, not sending the first alarm signal to the alarm device; and
when it is determined that the lubricating oil dielectric constant monitored by the oil quality sensor is not within the standard dielectric constant range, sending the first alarm signal to the alarm device.

4. The vacuum pump lubricating oil monitoring method according to claim 3, wherein comparing the lubricating oil dielectric constant monitored by the oil quality sensor with a preset standard dielectric constant and obtaining a judgment result comprises:

comparing the lubricating oil dielectric constant monitored by the oil quality sensor with the standard dielectric constant;

if the lubricating oil dielectric constant monitored by the oil quality sensor is greater than the standard dielectric constant, judging that the lubricating oil dielectric constant monitored by the oil quality sensor is not within the standard dielectric constant range; and

if the lubricating oil dielectric constant monitored by the oil quality sensor is smaller than the standard dielectric constant, judging that the lubricating oil dielectric constant monitored by the oil quality sensor is within the standard dielectric constant range.

5. The vacuum pump lubricating oil monitoring method according to claim 1, wherein processing the lubricating oil level height information carried in the second signal, and judging whether to send a second alarm signal to the alarm device based on a processing result comprises:

acquiring the lubricating oil level height monitored by the ultrasonic level sensor according to the lubricating oil level height information carried in the second signal;

comparing the lubricating oil level height monitored by the ultrasonic level sensor with a preset standard liquid level height range, and obtaining a judgment result;

when it is determined that the lubricating oil level height monitored by the ultrasonic level sensor is within the standard liquid level height range, not sending a second alarm signal to the alarm device; and

when it is determined that the lubricating oil level height monitored by the ultrasonic level sensor is not within the standard liquid level height range, sending a second alarm signal to the alarm device.

6. The vacuum pump lubricating oil monitoring method according to claim 5, wherein the standard liquid level height range is a threshold range formed by a first liquid level height and a

second liquid level height, the first liquid level height being smaller than the second liquid level height, and comparing the lubricating oil level height monitored by the ultrasonic level sensor with a preset standard liquid level height range, and obtaining a judgment result comprises:

comparing the lubricating oil level height monitored by the ultrasonic level sensor with the first liquid level height;

if the lubricating oil level height monitored by the ultrasonic level sensor is lower than the first liquid level height, judging that the lubricating oil level height monitored by the ultrasonic level sensor is not within the standard liquid level height range;

if the lubricating oil level height monitored by the ultrasonic level sensor is higher than the first liquid level height, comparing the lubricating oil level height monitored by the ultrasonic level sensor with the second liquid level height;

if the lubricating oil level height monitored by the ultrasonic level sensor is higher than the second liquid level height, judging that the lubricating oil level height monitored by the ultrasonic level sensor is not within the standard liquid level height range; and

if the lubricating oil level height monitored by the ultrasonic level sensor is higher than the first liquid level height and lower than the second liquid level height, judging that the lubricating oil level height monitored by the ultrasonic level sensor is within the standard liquid level height range.

7. The vacuum pump lubricating oil monitoring method according to claim 2, wherein the oil quality sensor is further configured to monitor a lubricating oil water content in the vacuum pump, and output the first signal carrying water content information of the lubricating oil in the vacuum pump, the vacuum pump lubricating oil monitoring method further comprising:

sending a third display driving signal to the display device according to the lubricating oil water content carried by the first signal, and driving the display device to display the corresponding lubricating oil water content according to a received third display driving signal; and

processing the lubricating oil water content information carried in the first signal, and judging whether to send a first alarm signal to the alarm device based on the processing result.

8. The vacuum pump lubricating oil according to claim 7, wherein processing the lubricating oil water content information carried in the first signal, and judging whether to send a first alarm signal to the alarm device based on the processing result comprises:

acquiring the lubricating oil water content monitored by the oil quality sensor according to the lubricating oil water content information carried in the first signal;

comparing the lubricating oil water content monitored by the oil quality sensor with a preset standard water content range, and obtaining a judgment result;

when it is determined that the lubricating oil water content monitored by the oil quality sensor is

within the standard water content range, not sending the first alarm signal to the alarm device; and when it is determined that the lubricating oil water content monitored by the oil quality sensor is not within the standard water content range, sending the first alarm signal to the alarm device.

9. The vacuum pump lubricating oil monitoring method according to any one of claims 2 to 8, wherein the vacuum pump lubricating oil monitoring method further comprises:

when the first alarm signal is sent to the alarm device, a first abnormal display signal being simultaneously sent to the display device to drive the display device to display an abnormal lubricating oil state; and

when the second alarm signal is sent to the alarm device, a second abnormal display signal being simultaneously sent to the display device to drive the display device to display an abnormal lubricating oil level.

10. The vacuum pump lubricating oil monitoring method according to claim 9, wherein the vacuum pump lubricating oil monitoring method further comprises:

controlling the oil quality sensor to monitor the lubricating oil in the vacuum pump at a first preset time interval and acquiring the first signal; and

controlling the ultrasonic level sensor to detect the lubricating oil level in the vacuum pump at a second preset time interval and acquiring the second signal.