(12) STANDARD PATENT APPLICATION (11) Application No. **AU 2023270259 A1**
(19) AUSTRALIAN PATENT OFFICE

(54) Title
TEMPERATURE TESTING SYSTEM AND METHOD FOR EXPLOSION-PROOF LAMP UNDER MOST UNFAVORABLE CONDITIONS

(51) International Patent Classification(s)
G01K 13/00 (2021.01)

(21) Application No: **2023270259** (22) Date of Filing: **2023.08.23**

(30) Priority Data

(31) Number	(32) Date	(33) Country
202211013459.6	**2022.08.23**	**CN**

(43) Publication Date: **2024.03.14**
(43) Publication Journal Date: **2024.03.14**

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ABSTRACT OF THE DISCLOSURE

The present invention provides a temperature testing system and method for an explosion-proof lamp under most unfavorable conditions, and relates to the technical field of temperature testing of an explosion-proof lamp. The system comprises a PIC microcontroller, two thermocouple units, a multi-channel power supply device, a thermal imager, a pressure sensor, a humidity sensor, a voltage transformer, a current transformer, a display screen, a mobile module, a communication unit, an industrial computer, a human-computer interaction panel, and a sound and light warning unit, wherein the PIC microcontroller controls the movement of the mobile module through the human-computer interaction panel to enable the explosion-proof induction lamp to be in the full power operation state, thereby ensuring that the temperature testing process of the explosion-proof induction lamp is always under the most unfavorable conditions; and when current data, voltage data, pressure data and humidity data are within the set value range, the PIC microcontroller receives environment temperature and temperate data of the explosion-proof lamp under most unfavorable conditions, acquired by the two thermocouple units, processes the environment temperature to obtain the temperature data of the explosion-proof lamp under the most unfavorable conditions, and further judges whether temperature testing is qualified.

TEMPERATURE TESTING SYSTEM AND METHOD FOR EXPLOSION-PROOF LAMP UNDER MOST UNFAVORABLE CONDITIONS

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to the technical field of temperature testing of an explosion-proof lamp, in particular to a temperature testing system and method for an explosion-proof lamp under most unfavorable conditions.

2. The Prior Arts

[0002] An explosion-proof lamp refers to illumination lamps such as explosion insulation tunnel lights, explosion insulation bracket lights, explosion insulation illumination signal lights, and explosion insulation emergency lights used in explosive places, which are widely used in flammable and explosive places such as coal mines, chemical engineering, and places using petroleum. An explosion insulation housing structure not only prevents the internal electric spark of the explosion-proof lamp from igniting external explosive gas, but also avoids damage to the explosion-proof lamp by external environmental explosion, thereby ensuring safe operation of the explosion-proof lamp in explosive places. However, the explosion insulation housing structure enables internal heat not to release timely, and besides, there is no natural illumination underground, so that the explosion-proof lamp is in a 24-hour operating state; and especially in explosive places, the operating environment temperature is high, and in coal mine underground working faces, the maximum temperature can reach 40 °C, resulting in the temperature of the explosion-proof lamp being much higher than that of ground illumination equipment.

[0003] The national standard GB/T 3836.1-2021 "Explosive Atmospheres -Part 1: General Requirements for Equipment" clearly stipulates that the surface temperature of the explosion-proof lamp shall not exceed 150 °C under the most unfavorable conditions. At present, during the highest surface temperature testing of the explosion-proof lamp, infrared point thermometers are used to test temperature data, and selection of testing points is not accurate (the explosion-proof lamp has complex structure and large maximum surface area, and by using the point thermometers, the testing points can only be selected based on experience). At the same time, testing data needs to be manually recorded, and whether the testing is completed needs to be manually judged, resulting in a large workload in the testing process, low accuracy of testing data, and poor reliability of testing results, thereby bringing accident hazards to the safe operation of the explosion-proof lamp in the explosive places. In addition, for energy-saving explosion-proof induction lights, manual triggering of the light emitting side of the lamp is required to ensure that the temperature testing process is under the most unfavorable conditions. Completing temperature testing needs several hours (usually more than 4 hours), thereby increasing the workload of testing personnel, reducing testing efficiency, and hindering the intelligent development of the inspecting and testing industry.

SUMMARY OF THE INVENTION

[0004] The technical problem to be solved by the present invention is to provide a temperature testing system and method for an explosion-proof lamp under most unfavorable conditions, in response to the shortcomings of the existing technology mentioned above, to achieve temperature testing for the explosion-proof lamp under the most unfavorable conditions.

[0005] In order to solve the technical problem,

[0006] the temperature testing system for the explosion-proof lamp under most unfavorable conditions is characterized by comprising a PIC microcontroller, a thermocouple unit A, a thermocouple unit B, a multi-channel power supply device, a thermal imager, a pressure sensor, a humidity sensor, a voltage transformer, a current transformer, a display screen, a mobile module, a communication unit, an industrial computer, a human-computer interaction panel, and a sound and light warning unit, wherein testing ends of the thermocouple unit A and the thermocouple unit B are respectively placed on the surface of the explosion-proof lamp and in testing environment; temperature data output ends of the thermocouple unit A and the thermocouple unit B are electrically connected with a temperature data input end of the PIC microcontroller; an input end of the multi-channel power supply device is connected with electric supply, and an output end is electrically connected with power input terminals of the PIC microcontroller, the display screen, the industrial computer, the sound and light warning unit, and the explosion-proof lamp; testing ends of the pressure sensor and the humidity sensor are both placed in the testing environment; a pressure signal output end of the pressure sensor and a humidity signal output end of the humidity sensor are electrically connected with a pressure signal input end and a humidity signal input end of the PIC microcontroller respectively; a testing end of the voltage transformer is electrically connected with the power input terminal of the explosion-proof lamp, and a voltage signal output end is electrically connected with a voltage signal input end of the PIC microcontroller; a testing end of the current transformer is connected in series with a power supply line of the explosion-proof lamp, and a current signal output end is electrically connected with a current signal input end of the PIC microcontroller; a signal input end of the display screen is electrically connected with a signal output end of the PIC microcontroller; the industrial computer is electrically connected with the PIC microcontroller through the communication unit so as to store data received by the PIC microcontroller; a control signal output end of the human-computer interaction panel is connected with the multi-channel power supply device and the PIC microcontroller; a signal input end of the sound and light warning unit is electrically connected with a warning signal output end of the PIC microcontroller; and an imaging testing end of the thermal imager faces opposite to the surface of an explosion-proof electrical appliance during testing; and the mobile module operates on the front of a glass cover of the explosion-proof lamp.

[0007] Preferably, the thermocouple unit A and the thermocouple unit B each comprise two thermocouples which are used to test the temperature of the surface of the explosion-proof lamp and the temperature of the testing environment; the two thermocouples of the thermocouple unit A are pasted on the surfaces of two testing points of a housing and the glass cover of the explosion-proof lamp; and the two thermocouples of the thermocouple unit B are placed on two sides of the explosion-proof lamp at a distance of 1 meter from a same horizontal plane to test the temperature of the testing environment.

[0008] Preferably, the voltage transformer and the current transformer are both passive transformers which are used to test the voltage and the current of the explosion-proof lamp;

[0009] preferably, the pressure sensor and the humidity sensor are respectively used to test the pressure and the humidity of the testing environment;

[0010] preferably, the display screen is used to display the working status of the system, the temperature of the testing environment, the humidity of the testing environment, the pressure of the testing environment, and temperature data of the housing and the glass cover of the explosion-proof lamp; and

[0011] preferably, the human-computer interaction panel is used for starting, testing, and stopping a power control and testing system, and comprises a power starting and stopping button of the multi-channel power supply device, a power starting control button of the PIC microcontroller, a power starting control button of the explosion-proof lamp, a power starting control button of the display screen, a power starting control button of the industrial computer, a starting, testing and stopping button of the testing system, and an emergency stop button.

[0012] On the other hand, the present invention also provides a temperature testing method for an explosion-proof lamp under most unfavorable conditions, comprising the following steps:

[0013] Step 1: the power supply of the multi-channel power supply device, the power supply of the PIC microcontroller, the power supply of the display screen, and the power supply of the industrial computer are started through the human-computer interaction panel, the power supply line is selected according to the voltage level of the explosion-proof lamp, and the power supply of the explosion-proof lamp is started;

[0014] Step 2: the PIC microcontroller controls the movement of the mobile module through the human-computer interaction panel to enable the explosion-proof induction lamp to be in the full power operation state, thereby ensuring that the temperature testing process of the explosion-proof induction lamp is always under the most unfavorable conditions;

[0015] Step 3: the PIC microcontroller receives electrical signals acquired by the current transformer, the voltage transformer, the pressure sensor, and the humidity sensor, converts the electrical signals into corresponding current data, voltage data, pressure data, and humidity data, stops temperature testing under the most unfavorable conditions of the explosion-proof lamp when any data exceeds the set value, and prompts system fault on the display screen, the sound and light warning unit performs sound and light warnings, when the current data, voltage data, pressure data and humidity data are all within the set value range, Step 4 is performed, and running the temperature testing on the explosion-proof lamp under the most unfavorable conditions is continued;

[0016] Step 4: the PIC microcontroller receives the temperature data acquired by the thermocouple unit A and the thermocouple unit B, and records the temperature testing time of the explosion-proof lamp under the most unfavorable conditions, and when the testing time reaches the set value, prompting is performed on the display screen;

[0017] Step 5: the thermal imager is used to search for the highest temperature point on the housing and the glass cover of the explosion-proof lamp, and fixes the thermocouple unit A at the highest temperature point of the housing and the glass cover of the explosion-proof lamp;

[0018] Step 6: the PIC microcontroller continues to receive *n* temperature data t_1, t_2, ..., t_n, acquired by the thermocouple unit A, and calculates the difference value of the temperature data within the period after 1 hour of temperature data acquisition, so as to judge whether the temperature testing of the explosion-proof lamp has ended under the most unfavorable conditions, wherein the calculation method is as follows:

$$\Delta t = t_{m+60} - t_m \tag{1}$$

[0019] wherein t_m is the temperature data acquired by the thermocouple unit A for the m_{th} time, and m is a positive integer between 1 and n-60; t_{m+60} is the temperature data acquired by the thermocouple unit A for the $(m+60)_{th}$ time; Δt is difference value of the temperature data which is acquired by the thermocouple unit A for the $(m+60)_{th}$ time and the m_{th} time;

[0020] the PIC microcontroller compares Δt with 1, if Δt is greater than or equal to 1, the PIC microcontroller controls the thermocouple unit A and the thermocouple unit B to continue to acquire the environment temperature and the temperature data of the explosion-proof lamp under the most unfavorable conditions, and Step 7 is performed; if Δt is less than 1, the temperature testing on the explosion-proof lamp under the most unfavorable conditions ends; t_n is actual temperature of the explosion-proof lamp under the most unfavorable conditions;

[0021] Step 7: the PIC microcontroller receives the environment temperature and the temperature data of the explosion-proof lamp under the most unfavorable conditions, acquired by the thermocouple unit A and the thermocouple unit B in real time, processes the environment temperature to obtain the average temperature within a quarter of the time after the temperature testing, and converts the temperature to obtain the temperature data of the explosion-proof lamp under the most unfavorable conditions, as shown in the following formula:

$$T_w = t_n - \frac{T_1 + T_2 + \cdots + T_g}{g} + 40 \qquad (2)$$

[0022] wherein T_w is the temperature of the explosion-proof lamp under the most unfavorable conditions; T_1 is the first temperature of the environment within a quarter of the time after the temperature testing of the explosion-proof lamp under the most unfavorable conditions; T_2 is the second temperature of the environment within a quarter of the time after the temperature testing of the explosion-proof lamp under the most unfavorable conditions; T_g is the last temperature of the environment within a quarter of the time after the temperature testing of the explosion-proof lamp under the most unfavorable conditions; g is the number of environment temperature acquired within a quarter of the time after the temperature testing of the explosion-proof lamp under the most unfavorable conditions;

[0023] Step 8: the PIC microcontroller compares the temperature of the explosion-proof lamp under the most unfavorable conditions with data of the explosion-proof lamp under the most unfavorable conditions, required by a temperature testing standard, and judges whether the temperature testing of the explosion-proof lamp under the most unfavorable conditions is qualified; if the data of the explosion-proof lamp under the most unfavorable conditions, required by the temperature testing standard, is greater than the temperature of the explosion-proof lamp under the most unfavorable conditions, the temperature testing of the explosion-proof lamp under the most unfavorable conditions is qualified; and if the data of the explosion-proof lamp under the most unfavorable conditions, required by the temperature testing standard, is less than or equal to the temperature of the explosion-proof lamp under the most unfavorable conditions, the temperature testing of the explosion-proof lamp under the most unfavorable conditions is not qualified.

[0024] The PIC microcontroller controls the movement of the mobile module through the human-computer interaction panel to enable an explosion-proof induction lamp to be in the full power operation state through the following specific method:

[0025] the explosion-proof induction lamp is triggered in a wireless driving manner, when the explosion-proof induction lamp is in the low-power operation state, the PIC microcontroller controls the mobile module to move along a straight line L in the direction of a tangent of a circle formed by using the explosion-proof induction lamp as a center O, two explosion-proof induction light inducing points being symmetrical with the center O are found, and the mobile module moves back and forth within the range of two endpoints at a certain distance from the two explosion-proof induction light inducing points.

[0026] In order to guarantee that the temperature testing process of the explosion-proof induction lamp is under the most unfavorable conditions, the PIC microcontroller acquires voltage and current signals from the full power operation and temperature testing process, calculates the maximum power and operating power of the explosion-proof induction lamp, and then judges whether the explosion-proof induction lamp operates under the most unfavorable conditions, wherein the specific method is as follows:

[0027] Step S1: the PIC microcontroller receives the voltage and current signals of the explosion-proof induction lamp in the full power operation state acquired by the current transformer and the voltage transformer, and calculates the full power of the explosion-proof induction lamp, wherein the calculation method is as follows:

$$P_{\max} = U_{\max} \times I_{\max} \tag{3}$$

[0028] wherein $P_{\max}$ is the full power of the explosion-proof induction lamp; $U_{\max}$ is voltage of the explosion-proof induction lamp in the full power operation state; $I_{\max}$ is current of the explosion-proof induction lamp in the full power operation state;

[0029] Step S2: the PIC microcontroller receives voltage data and current data of the explosion-proof induction lamp under the most unfavorable conditions during the temperature testing process, acquired by the current transformer and the voltage transformer, and further obtains the operating power of the explosion-proof induction lamp, wherein the calculation method is as follows:

$$P = U \times I \tag{4}$$

[0030] wherein P is the operating power of the explosion-proof induction lamp; U is operating voltage of the explosion-proof induction lamp; I is operating current of the explosion-proof induction lamp;

[0031] Step S3, a difference value between the full power P_{max} of the explosion-proof induction lamp and the operating power P of the explosion-proof induction lamp is obtained, as shown in the following formula:

$$\Delta P = P_{max} - P \tag{5}$$

[0032] wherein ΔP is a difference value between the full power P_{max} of the explosion-proof induction lamp and the operating power P of the explosion-proof induction lamp;

[0033] if ΔP is less than or equal to zero, it is determined that the explosion-proof induction lamp does not operate in the full power condition, and the temperature testing of the explosion-proof induction lamp under the most unfavorable conditions ends; and if ΔP is greater than zero, it is determined that the explosion-proof induction lamp operates in the full power condition, Step S4 is executed, and the temperature testing of the explosion-proof induction lamp under the most unfavorable conditions is continued.

[0034] The beneficial effect of adopting the above technical solution lies in that the temperature testing system and method for the explosion-proof lamp under the most unfavorable conditions solve the technical problems of high temperature testing workload and low testing accuracy of the explosion-proof lamp under the most unfavorable conditions, improve the temperature testing ability and testing level under the most unfavorable conditions, improve testing efficiency, and save power resources, thereby providing testing and verification technical support for the selection of the explosion insulation housing and components in the research and development process of new explosion-proof lamp products, ensuring the quality of explosion-proof lamp products, and promoting continuous and healthy development of the fields of detection and testing and explosion-proof lamps.

BRIEF DESCRIPTION OF DRAWINGS

[0035] Fig. 1 shows a structural block diagram of a temperature testing system for an explosion-proof lamp under most unfavorable conditions provided by the embodiment of the present invention;

[0036] Fig.2 shows a flowchart of a temperature testing method for the explosion-proof lamp under most unfavorable conditions provided by the embodiment of the present invention;

[0037] Fig.3 shows a schematic diagram of a movement trajectory of a mobile module provided by the embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0038] The following will provide a further detailed description of the specific embodiments of the present invention in conjunction with the accompanying drawings and embodiments. The following embodiments are used to illustrate the present invention, but are not intended to limit its scope.

[0039] In the embodiments, the temperature testing system for an explosion-proof lamp under most unfavorable conditions, as shown in Fig. 1, comprises a PIC microcontroller, a thermocouple unit A, a thermocouple unit B, a multi-channel power supply device, a thermal imager, a pressure sensor, a humidity sensor, a voltage transformer, a current transformer, a display screen, a mobile module, a communication unit, an industrial computer, a human-computer interaction panel, and a sound and light warning unit, wherein testing ends of the thermocouple unit A and the thermocouple unit B are respectively placed on the surface of the explosion-proof lamp and in testing environment; temperature data output ends of the thermocouple unit A and the thermocouple unit B are electrically connected with a temperature data input end of the PIC microcontroller; an input end of the multi-channel power supply device is connected with electric supply through a three-pin plug, and an output end is electrically connected with power input terminals of the PIC microcontroller, the display screen, the industrial computer, the sound and light warning unit, and the explosion-proof lamp so as to supply power for electrical equipment; the pressure sensor and the humidity sensor are respectively used for testing the pressure and the humidity of the testing environment; testing ends of the pressure sensor and the humidity sensor are both placed in the testing environment; a pressure signal output end of the pressure sensor and a humidity signal output end of the humidity sensor are electrically connected with a pressure signal input end and a humidity signal input end of the PIC microcontroller respectively; a testing end of the voltage transformer is electrically connected with the power input terminal of the explosion-proof lamp, and a voltage signal output end is electrically connected with a voltage signal input end of the PIC microcontroller; a testing end of the current transformer is connected in series with a power supply line of the explosion-proof lamp, and a current signal output end is electrically connected with a current signal input end of the PIC microcontroller; the voltage transformer and the current transformer are both high-accuracy passive transformers which are used to test the voltage and the current of the explosion-proof lamp; a signal input end of the display screen is electrically connected with a signal output end of the PIC microcontroller so as to display the working status (normal operation, fault and stop) of the system, the temperature of the testing environment, the humidity of the testing environment, the pressure of the testing environment, and temperature data of the housing and the glass cover of the explosion-proof lamp;

[0040] the industrial computer is electrically connected with the PIC microcontroller through the communication unit so as to store data received by the PIC microcontroller; a control signal output end of the human-computer interaction panel is connected with the multi-channel power supply device and the PIC microcontroller; a signal input end of the sound and light warning unit is electrically connected with a warning signal output end of the PIC microcontroller; an imaging testing end of the thermal imager faces opposite to the surface of an explosion-proof electrical appliance during testing; and the mobile module operates on the front of the glass cover of the explosion-proof lamp under the control of the PIC microcontroller, so as to enable the explosion-proof induction lamp to be in full power operation state.

[0041] The human-computer interaction panel is used for starting, testing, and stopping a power control and testing system, and comprises a power starting and stopping button of the multi-channel power supply device, a power starting control button of the PIC microcontroller, a power starting control button of the explosion-proof lamp, a power starting control button of the display screen, a power starting control button of the industrial computer, a starting, testing and stopping button of the testing system, and an emergency stop button.

[0042] In the embodiments, the thermocouple unit A and the thermocouple unit B each comprise two thermocouples which are used to test the temperature of the surface of the explosion-proof lamp and the temperature of the testing environment; the two thermocouples of the thermocouple unit A are pasted on the surfaces of two testing points of the housing and the glass cover of the explosion-proof lamp with insulating tapes; and the two thermocouples of the thermocouple unit B are placed on two sides of the explosion-proof lamp at a distance of 1 meter from a same horizontal plane to test the temperature of the testing environment.

[0043] In the embodiments, the temperature testing method for an explosion-proof lamp under most unfavorable conditions, as shown in Fig.2, comprises the following steps:

[0044] Step 1: the power supply of the multi-channel power supply device, the power supply of the PIC microcontroller, the power supply of the display screen, and the power supply of the industrial computer are started through the human-computer interaction panel, the appropriate power supply line is selected according to the voltage level of the explosion-proof lamp, the power supply of the explosion-proof lamp is started;

[0045] Step 2: the PIC microcontroller controls the movement of the mobile module through the human-computer interaction panel to enable the explosion-proof induction lamp to be in the full power operation state, thereby ensuring that the temperature testing process of the explosion-proof induction lamp is always under the most unfavorable conditions;

[0046] Step 3: the PIC microcontroller receives electrical signals acquired by the current transformer, the voltage transformer, the pressure sensor, and the humidity sensor, converts the electrical signals into corresponding current data, voltage data, pressure data, and humidity data, stops temperature testing under the most unfavorable conditions of the explosion-proof lamp when any data exceeds the set value, and prompts system fault on the display screen, the sound and light warning unit performs sound and light warnings, when the current data, voltage data, pressure data and humidity data are all within the set value range, Step 4 is performed, and running the temperature testing on the explosion-proof lamp under the most unfavorable conditions is continued;

[0047] Step 4: the PIC microcontroller receives the temperature data acquired by the thermocouple unit A and the thermocouple unit B (acquisition is performed once per minute), and records the temperature testing time of the explosion-proof lamp under the most unfavorable conditions, and when the testing time reaches the set value, prompting is performed on the display screen;

[0048] Step 5: the thermal imager is used by testers to search for the highest temperature point on the housing and the glass cover of the explosion-proof lamp, and the thermocouple unit A is fixed at the highest temperature point of the housing and the glass cover of the explosion-proof lamp with the insulating tapes;

[0049] Step 6: the PIC microcontroller continues to receive *n* temperature data t_1, t_2, ... t_n, acquired by the thermocouple unit A, t_n is actual temperature of the explosion-proof lamp under the most unfavorable conditions, and the difference value of the temperature data within the period after 1 hour of temperature data acquisition is calculated, so as to judge whether the temperature testing of the explosion-proof lamp has ended under the most unfavorable conditions, wherein the calculation method is as follows:

$$\Delta t = t_{m+60} - t_m \qquad (1)$$

[0050] wherein t_m is the temperature data acquired by the thermocouple unit A for the m_{th} time, and m is a positive integer between 1 and n-60, with the unit of Celsius degree (°C); t_{m+60} is the temperature data acquired by the thermocouple unit A for the $(m+60)_{th}$ time, with the unit of Celsius degree (°C); Δt is a difference value of the temperature data which is acquired between the $(m+60)_{th}$ time and the m_{th} time by the thermocouple unit A, with the unit of Celsius degree (°C);

[0051] the PIC microcontroller compares Δt with 1, if Δt is greater than or equal to 1, the PIC microcontroller controls the thermocouple unit A and the thermocouple unit B to continue to acquire the environment temperature and the temperature data of the explosion-proof lamp under the most unfavorable conditions, and Step 7 is performed; and if Δt is less than 1, the temperature testing on the explosion-proof lamp under the most unfavorable conditions ends.

[0052] Step 7: the PIC microcontroller receives the environment temperature and the temperature data of the explosion-proof lamp under the most unfavorable conditions, acquired by the thermocouple unit A and the thermocouple unit B in real time, processes the environment temperature to obtain the average temperature (the temperature data within a quarter of the time after the temperature testing is T_1, T_2, ..., T_g) within a quarter of the time after the temperature testing, and converts the temperature to obtain the temperature data of the explosion-proof lamp under the most unfavorable conditions (+ 40 °C), as shown in the following formula:

$$T_w = t_n - \frac{T_1 + T_2 + \cdots + T_g}{g} + 40 \tag{2}$$

[0053] wherein T_w is the temperature of the explosion-proof lamp under the most unfavorable conditions, with the unit of Celsius degree (°C); T_1 is the first temperature of the environment within a quarter of the time after the temperature testing of the explosion-proof lamp under the most unfavorable conditions, with the unit of Celsius degree (°C); T_2 is the second temperature of the environment within a quarter of the time after the temperature testing of the explosion-proof lamp under the most unfavorable conditions, with the unit of Celsius degree (°C); T_g is the last temperature of the environment within a quarter of the time after the temperature testing of the explosion-proof lamp under the most unfavorable conditions, with the unit of Celsius degree (°C); g is the number of environment temperature acquired within a quarter of the time after the temperature testing of the explosion-proof lamp under the most unfavorable conditions, without dimension;

[0054] Step 8: the PIC microcontroller compares the temperature of the explosion-proof lamp under the most unfavorable conditions with data of the explosion-proof lamp under the most unfavorable conditions, required by a temperature testing standard, and judges whether the temperature testing of the explosion-proof lamp under the most unfavorable conditions is qualified; if the data of the explosion-proof lamp under the most unfavorable conditions, required by the temperature testing standard, is greater than the temperature of the explosion-proof lamp under the most unfavorable conditions, the temperature testing of the explosion-proof lamp under the most unfavorable conditions is qualified; and if the data of the explosion-proof lamp under the most unfavorable conditions, required by the temperature testing standard, is less than or equal to the temperature of the explosion-proof lamp under the most unfavorable conditions, the temperature testing of the explosion-proof lamp under the most unfavorable conditions is not qualified.

[0055] The explosion-proof induction lamp belongs to an energy-saving special explosion-proof lamp. The explosion-proof induction lamp operates in two power consumption ranges. Before induction, the explosion-proof induction lamp operates in low-power and energy-saving mode, and after induction, the explosion-proof induction lamp operates in full power mode. Under the most unfavorable conditions, temperature testing should be performed during the maximum power stage. Therefore, it is necessary to trigger the induction function of the explosion-proof induction lamp in real time, and calculate the power of the explosion-proof induction lamp based on voltage and current, thereby ensuring that the explosion-proof induction lamp operates under the most unfavorable conditions.

[0056] In the embodiment, the PIC microcontroller controls the movement of the mobile module through the human-computer interaction panel to enable the explosion-proof induction lamp to be in the full power operation state through the following specific method:

[0057] the explosion-proof induction lamp is triggered in a wireless driving manner, and the PIC microcontroller controls the mobile module to move through the human-computer interaction panel to guarantee the explosion-proof induction lamp to be in the full power operation state; when the explosion-proof induction lamp is in the low-power operation state, the PIC microcontroller controls the mobile module to move along a straight line L in the direction of a tangent of a circle formed by using the explosion-proof induction lamp as a center O (if the mobile module is extremely near the explosion-proof induction lamp, the temperature testing results are affected, if the mobile module is extremely far away from the explosion-proof induction lamp, it is not guaranteed that the explosion-proof induction lamp is always in full power operation state, so that after comprehensively considering the effect on the temperature testing results of the explosion-proof induction lamp and guaranteeing that the explosion-proof induction lamp is always in the full power operation state, the vertical distance of L to the explosion-proof induction lamp is 2 m), two explosion-proof induction light inducing points symmetrical with the center O are found, and the mobile module moves back and forth within the range of two endpoints at a certain distance from the two explosion-proof induction light inducing points.

[0058] In the embodiments, a determination method for two explosion-proof induction light inducing points and the two endpoints, as shown in Fig. 3, specially comprises:

[0059] the mobile module moves on the straight line L, and when the mobile module reaches a point A on the straight line L, the explosion-proof induction light switches from the low power consumption state to the full power operation state, and the point A is the explosion-proof induction light inducing point; and in the same method, an explosion-proof induction light inducing point D on the other side of the straight line L corresponding to the point A is found(opposite to the direction of the same line as the point A and the center of the circle). The operating trajectory points B and C of the mobile module are marked on the straight line L, wherein BO=0.6AO and CO=0.6DO, then B and C are the two endpoints of the operating trajectory of the mobile module, and the mobile module moves back and forth between B and C.

[0060] In the embodiments, in order to guarantee that the temperature testing process of the explosion-proof induction lamp is under the most unfavorable conditions, the PIC microcontroller acquires voltage and current signals from the full power operation and temperature testing process, calculates the maximum power and operating power of the explosion-proof induction lamp, and then judges whether the explosion-proof induction lamp operates under the most unfavorable conditions, wherein the specific method is as follows:

[0061] Step S1: the PIC microcontroller receives the voltage and current signals of the explosion-proof induction lamp in the full power operation state acquired by the current transformer and the voltage transformer, and calculates the full power of the explosion-proof induction lamp, wherein the calculation method is as follows:

$$P_{\max}=U_{\max}\times I_{\max} \tag{3}$$

[0062] wherein $P_{\max}$ is the full power of the explosion-proof induction lamp, with the unit of Watt (w); $U_{\max}$ is voltage during the full power operation of the explosion-proof induction lamp, with the unit of volt (V); and $I_{\max}$ is current during the full power operation of the explosion-proof induction lamp, with the unit of ampere (A). In the embodiments, the voltage and the current of the explosion-proof induction lamp in the full power operation state are obtained by taking the average of multiple measurements of the voltage and the current. Generally, the voltage data and current data of the explosion-proof induction lamp during full power operation are measured 5 times.

[0063] Step S2: the PIC microcontroller receives voltage data and current data of the explosion-proof induction lamp under the most unfavorable conditions during the temperature testing process, acquired by the current transformer and the voltage transformer, and further obtains the operating power of the explosion-proof induction lamp, wherein the calculation method is as follows:

$$P=U\times I \tag{4}$$

[0064] wherein P is the operating power of the explosion-proof induction lamp, with the unit of Watt (w); U is operating voltage of the explosion-proof induction lamp, with the unit of volt (V); I is operating current of the explosion-proof induction lamp, with the unit of ampere (A);

[0065] Step S3, a difference value between the full power $P_{\max}$ of the explosion-proof induction lamp and the operating power P of the explosion-proof induction lamp is obtained, as shown in the following formula:

$$\Delta P = P_{\max} - P \tag{5}$$

[0066] wherein ΔP is a difference value between the full power $P_{\max}$ of the explosion-proof induction lamp and the operating power P of the explosion-proof induction lamp, with the unit of Watt (w);

[0067] if ΔP is less than or equal to zero, it is determined that the explosion-proof induction lamp does not operate in the full power condition, and the temperature testing of the explosion-proof induction lamp under the most unfavorable conditions ends; and if ΔP is greater than zero, it is determined that the explosion-proof induction lamp operates in the full power condition, Step S4 is executed, and the temperature testing of the explosion-proof induction lamp under the most unfavorable conditions is continued.

[0068] Finally, it should be noted that the embodiments are only used to illustrate the technical solution of the present invention, but not to limit it; although the present invention has been described in detail with reference to the aforementioned embodiments, ordinary skilled in the art should understand that they can still modify the technical solution recorded in the aforementioned embodiments, or equivalently replace some or all of the technical features; and these modifications or replacements do not make the essence of the corresponding technical solution deviate from the scope limited by the claims of the present invention.

WHAT IS CLAIMED IS:

1 A temperature testing system for an explosion-proof lamp under most unfavorable conditions, characterized by comprising a PIC microcontroller, a thermocouple unit A, a thermocouple unit B, a multi-channel power supply device, a thermal imager, a pressure sensor, a humidity sensor, a voltage transformer, a current transformer, a display screen, a mobile module, a communication unit, an industrial computer, a human-computer interaction panel, and a sound and light warning unit, wherein testing ends of the thermocouple unit A and the thermocouple unit B are respectively placed on the surface of the explosion-proof lamp and in testing environment; temperature data output ends of the thermocouple unit A and the thermocouple unit B are electrically connected with a temperature data input end of the PIC microcontroller; an input end of the multi-channel power supply device is connected with electric supply, and an output end is electrically connected with power input terminals of the PIC microcontroller, the display screen, the industrial computer, the sound and light warning unit, and the explosion-proof lamp; testing ends of the pressure sensor and the humidity sensor are both placed in the testing environment; a pressure signal output end of the pressure sensor and a humidity signal output end of the humidity sensor are electrically connected with a pressure signal input end and a humidity signal input end of the PIC microcontroller respectively; a testing end of the voltage transformer is electrically connected with the power input terminal of the explosion-proof lamp, and a voltage signal output end is electrically connected

with a voltage signal input end of the PIC microcontroller; a testing end of the current transformer is connected in series with a power supply line of the explosion-proof lamp, and a current signal output end is electrically connected with a current signal input end of the PIC microcontroller; a signal input end of the display screen is electrically connected with a signal output end of the PIC microcontroller; the industrial computer is electrically connected with the PIC microcontroller through the communication unit so as to store data received by the PIC microcontroller; a control signal output end of the human-computer interaction panel is connected with the multi-channel power supply device and the PIC microcontroller; a signal input end of the sound and light warning unit is electrically connected with a warning signal output end of the PIC microcontroller; an imaging testing end of the thermal imager faces opposite to the surface of an explosion-proof electrical appliance during testing; and the mobile module operates on the front of a glass cover of the explosion-proof lamp.

2 The temperature testing system for an explosion-proof lamp under most unfavorable conditions according to claim 1, characterized in that the thermocouple unit A and the thermocouple unit B each comprise two thermocouples which are used to test the temperature of the surface of the explosion-proof lamp and the temperature of the testing environment; the two thermocouples of the thermocouple unit A are pasted on the surfaces of two testing points of a housing and the glass cover of the explosion-proof lamp; and the two thermocouples of the thermocouple unit B are placed on two sides of the

explosion-proof lamp at a distance of 1 meter from a same horizontal plane to test the temperature of the environment.

3 The temperature testing system for an explosion-proof lamp under most unfavorable conditions according to claim 1, characterized in that the voltage transformer and the current transformer are both passive transformers which are used to test the voltage and the current of the explosion-proof lamp.

4 The temperature testing system for an explosion-proof lamp under most unfavorable conditions according to claim 1, characterized in that the pressure sensor and the humidity sensor are respectively used to test the pressure and the humidity of the environment.

5 The temperature testing system for an explosion-proof lamp under most unfavorable conditions according to claim 1, characterized in that the display screen is used to display the working status of the system, the temperature of the testing environment, the humidity of the testing environment, the pressure of the testing environment, and temperature data of the housing and the glass cover of the explosion-proof lamp.

6 The temperature testing system for an explosion-proof lamp under most unfavorable conditions according to claim 1, characterized in that the human-computer interaction panel is used for starting, testing, and stopping a power control and testing system, and comprises a power starting and stopping button of the multi-channel power supply device, a power starting control button of the PIC microcontroller, a power starting control button of the explosion-proof lamp, a

power starting control button of the display screen, a power starting control button of the industrial computer, a starting, testing and stopping button of the testing system, and an emergency stop button.

7 A temperature testing method for an explosion-proof lamp under most unfavorable conditions, based on the temperature testing system according to claim 1, comprising the following steps:

Step 1: the power supply of the multi-channel power supply device, the power supply of the PIC microcontroller, the power supply of the display screen, and the power supply of the industrial computer are started through the human-computer interaction panel, the power supply line is selected according to the voltage level of the explosion-proof lamp, and the power supply of the explosion-proof lamp is started;

Step 2: the PIC microcontroller controls the movement of the mobile module through the human-computer interaction panel to enable the explosion-proof induction lamp to be in the full power operation state, thereby ensuring that the temperature testing process of the explosion-proof induction lamp is always under the most unfavorable conditions;

Step 3: the PIC microcontroller receives electrical signals acquired by the current transformer, the voltage transformer, the pressure sensor, and the humidity sensor, converts the electrical signals into corresponding current data, voltage data, pressure data, and humidity data, stops temperature testing under the most unfavorable conditions of the explosion-proof lamp when any data exceeds the set value, and prompts system fault on the display screen, the sound and light warning unit performs sound and light warnings, when the current data, voltage data, pressure data and humidity data are all within the set value range, Step 4 is performed, and running the temperature testing on the explosion-proof lamp under the most unfavorable conditions is continued;

Step 4: the PIC microcontroller receives the temperature data acquired by the thermocouple unit A and the thermocouple unit B, and records the temperature testing time of the explosion-proof lamp under the most unfavorable conditions, and when the testing time reaches the set value, prompting is performed on the display screen;

Step 5: the thermal imager is used to search for the highest temperature point on the housing and the glass cover of the explosion-proof lamp, and fixes the thermocouple unit A at the highest temperature point of the housing and the glass cover of the explosion-proof lamp;

Step 6: the PIC microcontroller continues to receive n temperature data t_1, t_2, ..., t_n, acquired by the thermocouple unit A, and calculates the difference value of the temperature data within the period after 1 hour of temperature data acquisition, so as to judge whether the temperature testing of the explosion-proof lamp has ended under the most unfavorable conditions, wherein the calculation method is as follows:

$$\Delta t = t_{m+60} - t_m \tag{1}$$

wherein t_m is the temperature data acquired by the thermocouple unit A for the m_{th} time, and m is a positive integer between 1 and n-60; t_{m+60} is the temperature data acquired by the thermocouple unit A for the $(m+60)_{th}$ time; Δt is difference value of the temperature data which is acquired by the thermocouple unit A for the $(m+60)_{th}$ time and the m_{th} time;

the PIC microcontroller compares Δt with 1, if Δt is greater than or equal to 1, the PIC microcontroller controls the thermocouple unit A and the thermocouple unit B to continue to acquire environment temperature and the temperature data of the explosion-proof lamp under the most unfavorable conditions, and Step 7 is performed; if Δt is less than 1, the temperature testing on the explosion-proof lamp under the most unfavorable conditions ends; t_n is actual temperature of the explosion-proof lamp under the most unfavorable conditions;

Step 7: the PIC microcontroller receives the environment temperature and the temperature data of the explosion-proof lamp under the most unfavorable conditions, acquired by the thermocouple unit A and the thermocouple unit B in real time, processes the environment temperature to obtain the average temperature within a quarter of the time after the temperature testing, and converts the temperature to obtain the temperature data of the explosion-proof lamp under the most unfavorable conditions, as shown in the following formula:

$$T_w = t_n - \frac{T_1 + T_2 + \cdots + T_g}{g} + 40 \tag{2}$$

wherein T_w is the temperature of the explosion-proof lamp under the most unfavorable conditions; T_1 is the first temperature of the environment within a quarter of the time after the temperature testing of the explosion-proof lamp under the most unfavorable conditions; T_2 is the second temperature of the environment within a quarter of the time after the temperature testing of the explosion-proof lamp under the most unfavorable conditions; T_g is the last temperature of the environment within a quarter of the time after the temperature testing of the explosion-proof lamp under the most unfavorable conditions; g is the number of environment temperature acquired within a quarter of the time after the temperature testing of the explosion-proof lamp under the most unfavorable conditions;

Step 8: the PIC microcontroller compares the temperature of the explosion-proof lamp under the most unfavorable conditions with data of the explosion-proof lamp under the most unfavorable conditions, required by a temperature testing standard, and judges whether the temperature testing of the explosion-proof lamp under the most unfavorable conditions is qualified; if the data of the explosion-proof lamp under the most unfavorable conditions, required by the temperature testing standard, is greater than the temperature of the explosion-proof lamp under the most unfavorable conditions, the temperature testing of the explosion-proof lamp under the most unfavorable conditions is qualified; and if the data of the explosion-proof lamp under the most unfavorable conditions, required by the temperature testing standard, is less than or equal to the temperature of the explosion-proof lamp under the most unfavorable conditions, the temperature testing of the explosion-proof lamp under the most unfavorable conditions is not qualified.

8 The temperature testing method for an explosion-proof lamp under most unfavorable conditions according to claim 7, characterized in that the PIC microcontroller controls the movement of the mobile module through the human-computer interaction panel to enable an explosion-proof induction lamp to be in the full power operation state through the following specific method:

the explosion-proof induction lamp is triggered in a wireless driving manner, when the explosion-proof induction lamp is in the low-power operation state, the PIC microcontroller controls the mobile module to move along a straight line L in the direction of a tangent of a circle formed by using the explosion-proof induction lamp as a center O, two explosion-proof induction light inducing points being symmetrical with the center O are found, and the mobile module moves back and forth within the range of two endpoints at a certain distance from the two explosion-proof induction light inducing points.

9 The temperature testing method for an explosion-proof lamp under most unfavorable conditions according to claim 7, characterized in that the specific method for ensuring that the temperature testing process of the explosion-proof induction lamp is always under the most unfavorable conditions in step 2 is as follows: the PIC microcontroller acquires voltage and current signals from the full power operation and temperature testing process, calculates the maximum power and operating power of the explosion-proof induction lamp, and then judges whether the explosion-proof induction lamp operates under the most unfavorable conditions, wherein the specific judgment method is as follows:

Step S1: the PIC microcontroller receives the voltage and current signals of the explosion-proof induction lamp in the full power operation state acquired by the current transformer and the voltage transformer, and calculates the full power of the explosion-proof induction lamp, as shown in the following formula:

$$P_{\max}=U_{\max}\times I_{\max} \tag{3}$$

wherein $P_{\max}$ is the full power of the explosion-proof induction lamp; $U_{\max}$ is voltage of the explosion-proof induction lamp in the full power operation state; $I_{\max}$ is current of the explosion-proof induction lamp in the full power operation state;

Step S2: the PIC microcontroller receives voltage data and current data of the explosion-proof induction lamp under the most unfavorable conditions during the temperature testing process, acquired by the current transformer and the voltage transformer, and further obtains the operating power of the explosion-proof induction lamp, wherein the calculation method is as follows:

$$P=U\times I \tag{4}$$

wherein P is the operating power of the explosion-proof induction lamp; U is operating voltage of the explosion-proof induction lamp; I is operating current of the explosion-proof induction lamp;

Step S3, a difference value between the full power $P_{\max}$ of the explosion-proof induction lamp and the operating power P of the explosion-proof induction lamp is obtained, as shown in the following formula:

$$\Delta P=P_{\max}-P \tag{5}$$

wherein ΔP is a difference value between the full power $P_{\max}$ of the explosion-proof induction lamp and the operating power P of the explosion-proof induction lamp;

if ΔP is less than or equal to zero, it is determined that the explosion-proof induction lamp does not operate in the full power condition, and the temperature testing of the explosion-proof induction lamp under the most unfavorable conditions ends; and if ΔP is greater than zero, it is determined that the explosion-proof induction lamp operates in the full power condition, Step S4 is executed, and the temperature testing of the explosion-proof induction lamp under the most unfavorable conditions is continued.

DRAWINGS OF DESCRIPTION

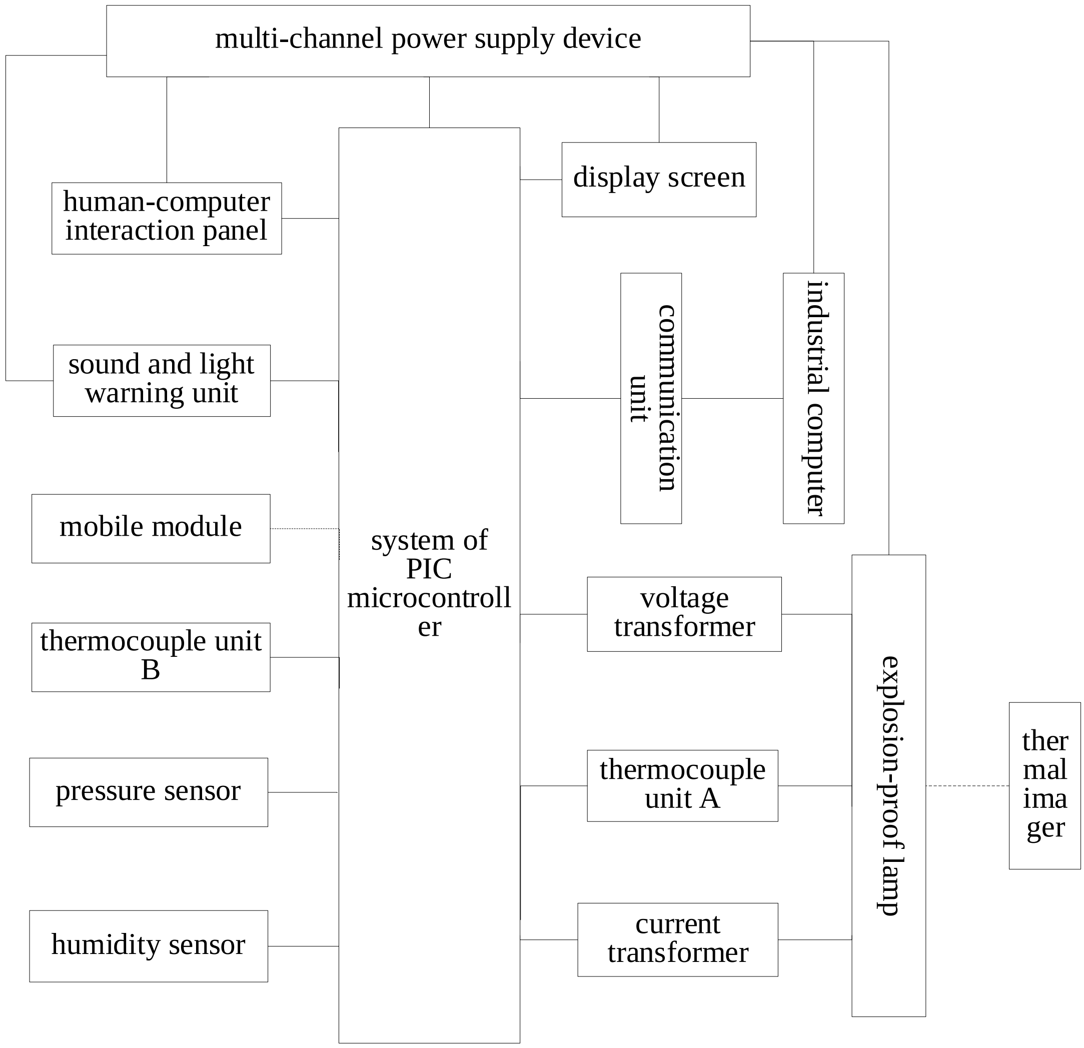

Fig.1

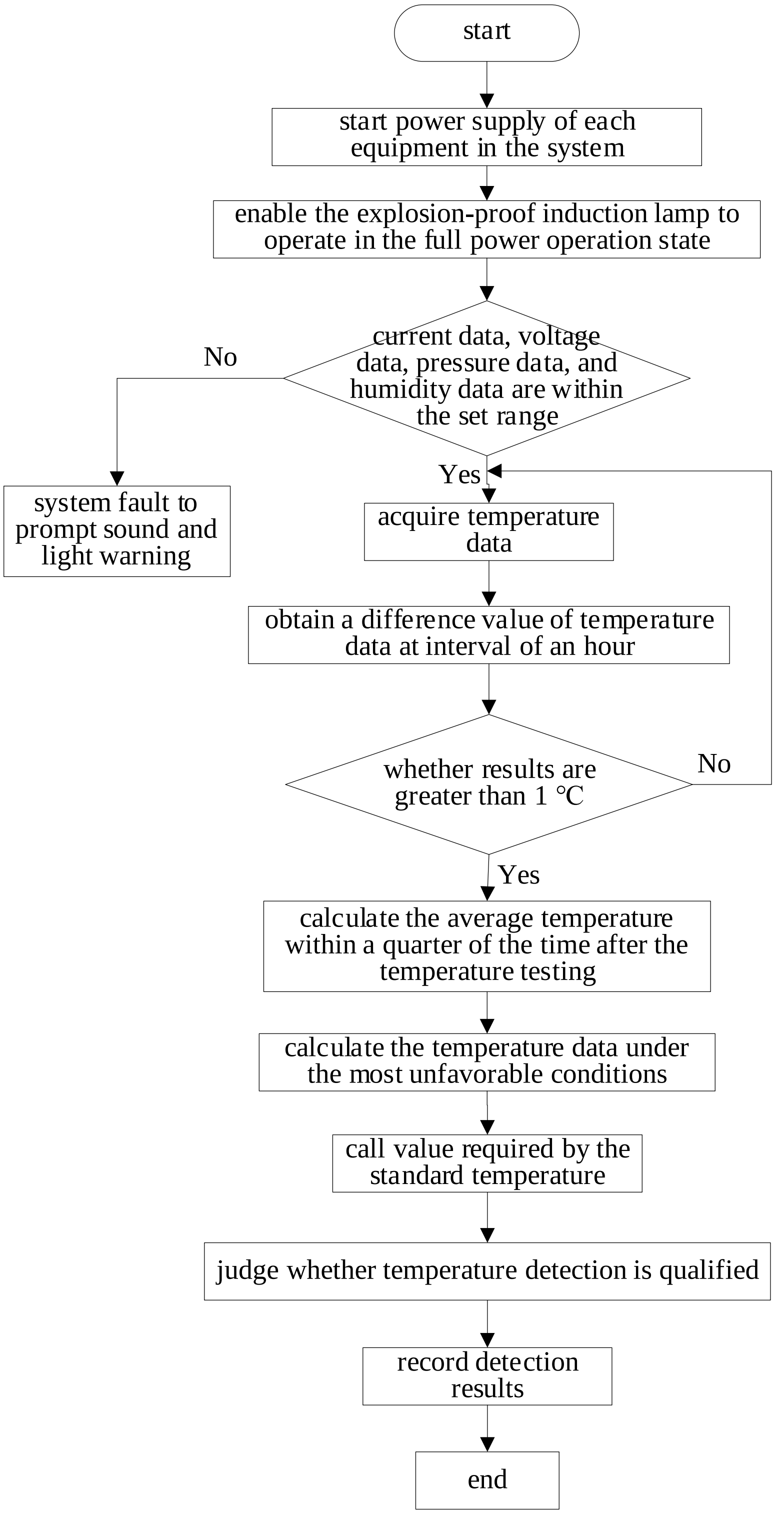
start
start power supply of each equipment in the system
enable the explosion-proof induction lamp to operate in the full power operation state
current data, voltage data, pressure data, and humidity data are within the set range
No
system fault to prompt sound and light warning
Yes
acquire temperature data
obtain a difference value of temperature data at interval of an hour
whether results are greater than 1 ℃
No
Yes
calculate the average temperature within a quarter of the time after the temperature testing
calculate the temperature data under the most unfavorable conditions
call value required by the standard temperature
judge whether temperature detection is qualified
record detection results
end

Fig.2

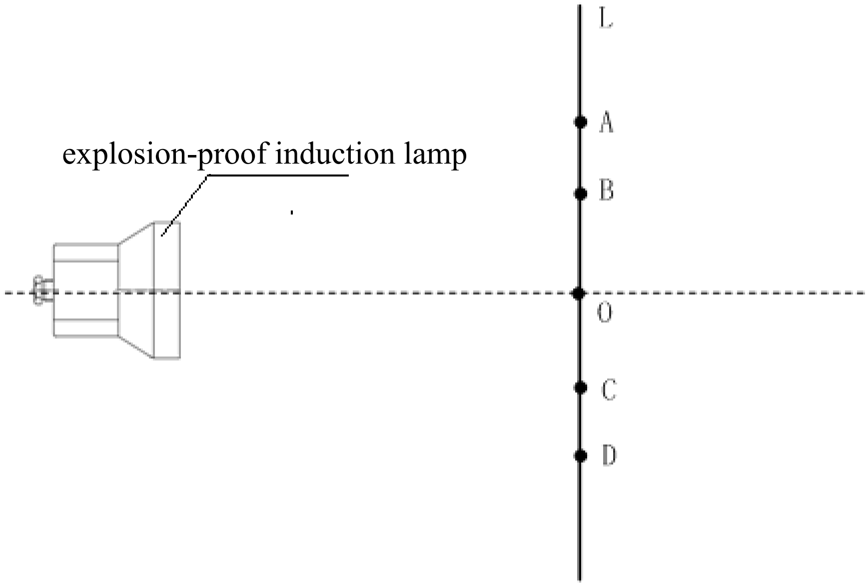

Fig.3