# Design of Temperature Test System for Explosion-Proof Lamps under the Most Unfavorable Conditions

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**Abstract.** According to the technical requirements in the national standard GB/T 3836.1-2021 "Explosive atmospheres - Part 1: General requirements for equipment", the temperature test system under the most unfavorable conditions for explosion-proof lamps is designed, and the maximum operating power detection and trigger technology for temperature test of explosion-proof induction lamps is proposed.

**Keywords:** Explosion-proof Lamps; Temperature; Test; React.

## 1. Introduction

Explosion-proof lamps and lanterns refer to flameproof roadway lamps, flameproof bracket lamps, flameproof lighting signal lamps, flameproof emergency lamps and other lighting lamps used in explosive places, which are widely used in coal mines, chemical industry, petroleum and other flammable and explosive places The flameproof shell structure not only prevents the external explosive gas from being ignited by the electric spark inside the explosion-proof lamps, but also prevents the external environment from exploding and damaging the explosion-proof lamps, thus ensuring the safe operation of the explosion-proof lamps in explosive places However, the flameproof enclosure structure causes that the internal heat cannot be distributed in a timely manner, and there is no natural lighting in the underground. The explosion-proof lamps are in a 24-hour operation state, especially in explosive places where the operating environment temperature is high, up to 40 ℃ in the underground working face of the coal mine, resulting in the temperature of the explosion-proof lamps is much higher than the ground lighting equipment.

The national standard GB/T 3836.1-2021 "Explosive Environment Part 1: General Requirements for Equipment" clearly stipulates that the surface temperature of explosion-proof lamps should not exceed 150℃ under the most unfavorable condition At present, the highest surface temperature test of explosion-proof lamps uses infrared point thermometer to test the temperature data, and the test point selection is inaccurate (explosion-proof lamps have complex structure and large maximum surface area, and the point thermometer can only select the test point according to experience).




**Fig 1.** Physical Drawing of Explosion proof Lamps

## 2. Design of Temperature Test System

The temperature test system under the most unfavorable conditions of explosion-proof lamps consists of PIC single chip microcomputer system, thermocouple unit A, thermocouple unit B, multi-channel power supply device, thermal imager, pressure sensor, humidity sensor, voltage transformer, current transformer, display screen, communication unit, industrial computer and man-machine interaction panel. During the test of thermal imager, the imaging test end is aligned with the surface of explosion-proof electrical apparatus. The mobile module runs on the front of the glass cover of the explosion-proof lamp. Thermocouple unit A and thermocouple unit B are used to test the temperature of explosion-proof lamps and inspection environment. The test points of explosion-proof lamps include two test points: shell and glass cover. Two thermocouples of thermocouple unit A are pasted on the surface of shell and glass cover with thermal insulation tape. The two thermocouples of thermocouple unit B for inspection and environmental testing are placed at two sides of the explosion-proof lamp 1 m away from the same horizontal plane. Voltage transformer and current transformer are high-precision passive transformers, which are used to test the voltage and current of explosion-proof lamps. Pressure sensor and humidity sensor are used to test the temperature and humidity of the inspection environment. The display screen is used to display the working state of the system, environmental temperature, environmental humidity, environmental pressure, shell temperature and glass cover temperature data.

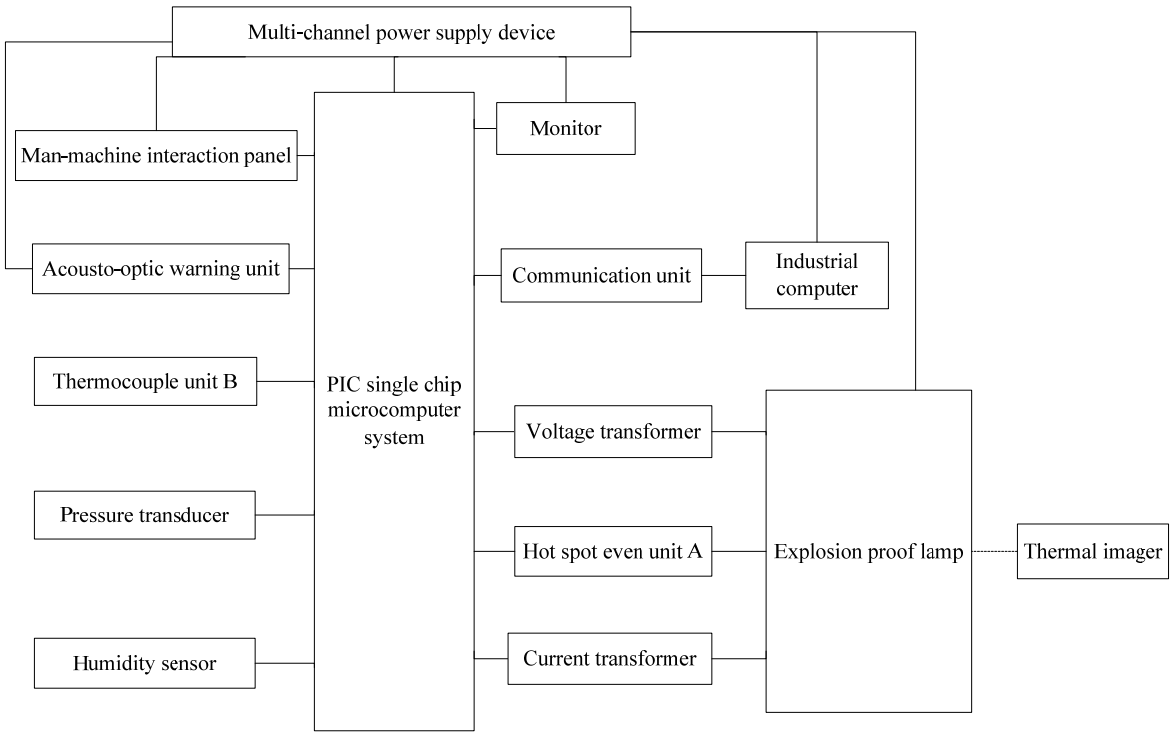



**Fig 2.** Structure diagram of temperature test system under the most unfavorable conditions of explosion-proof lamps

The human-computer interaction panel is used to realize the start, test and stop of the power supply control and inspection system, including the power start and stop buttons of the multi-channel power supply device, the power output control button of the PIC single-chip microcomputer system, the power output control button of the explosion-proof lamps, the power output control button of the display screen, the power output control button of the industrial computer, the start, test and stop buttons of the inspection system, and the emergency stop button.

Description of the working process of the temperature test system under the most unfavorable conditions for explosion-proof lamps:

(1) Start the multi-channel power supply, PIC single-chip microcomputer system power supply, display screen power supply and industrial computer power supply through the man-machine interaction panel, and select an appropriate power supply line to start the power output of the explosion-proof lamps according to the voltage level of the explosion-proof lamps.

(2) PIC MCU system collects and processes the data of current transformer, voltage transformer, pressure sensor and humidity sensor, stops the temperature test of explosion-proof lamps under the most unfavorable conditions when the data exceeds the set value, and gives a prompt on the display screen; When the data is within the set value range, the temperature test of explosion-proof lamps will continue to run under the most unfavorable conditions;

(3) PIC microcontroller system records the temperature test time under the most unfavorable conditions of explosion-proof lamps, and prompts on the display screen when the test time reaches half an hour;

(4) The tester uses a thermal imager to find the highest temperature point on the explosion-proof lamp housing and glass cover, and then uses thermal insulation tape to fix the thermocouple at the highest temperature point on the explosion-proof lamp housing and glass cover;

(5) PIC single-chip microcomputer system continues to collect temperature data, and makes judgment at the same time. When the change value of two measurement results is less than 2K at the interval of 1 hour, it is considered that the temperature test of explosion-proof lamps is finished under the most unfavorable conditions.

PIC single chip microcomputer system collects the temperature data under the most unfavorable conditions of the ambient temperature and explosion-proof lamps in real time, processes the ambient temperature to obtain the average temperature within a quarter of the time after the temperature test, and then converts the temperature data under the most unfavorable conditions (+40 ℃) of explosion-proof lamps. The conversion method is as follows:

$$T_w = T_c - \frac{T_1 + T_2 + \cdots + T_n}{n} + 40 \tag{1}$$

Where, $T_w$ is the temperature under the most unfavorable conditions of explosion-proof lamps, and the unit is degrees Celsius (℃); $T_c$ is the measured temperature of explosion-proof lamps, and the unit is degrees Celsius (℃); $T_1$, $T_2$, $T_n$ are the 1st, 2nd, and N temperature data of the environment in a quarter of time after the most unfavorable condition temperature test of explosion-proof lamps, and the unit is degrees Celsius (℃); N is the number of ambient temperatures collected within a quarter of the time after the most unfavorable temperature test of explosion-proof lamps, dimensionless.

PIC single chip microcomputer system calls the data required by the most unfavorable condition temperature test standard of explosion-proof lamps and compares it with the temperature under the most unfavorable condition of explosion-proof lamps to judge whether the temperature test under the most unfavorable condition of explosion-proof lamps is qualified. If the data required by the temperature test standard under the most unfavorable conditions of explosion-proof lamps is greater than the temperature under the most unfavorable conditions of explosion-proof lamps, the temperature test under the most unfavorable conditions of explosion-proof lamps is qualified; If the data required by the most unfavorable condition temperature test standard of explosion-proof lamps is equal to or less than the temperature under the most unfavorable condition of explosion-proof lamps, the temperature test under the most unfavorable condition of explosion-proof lamps is unqualified.

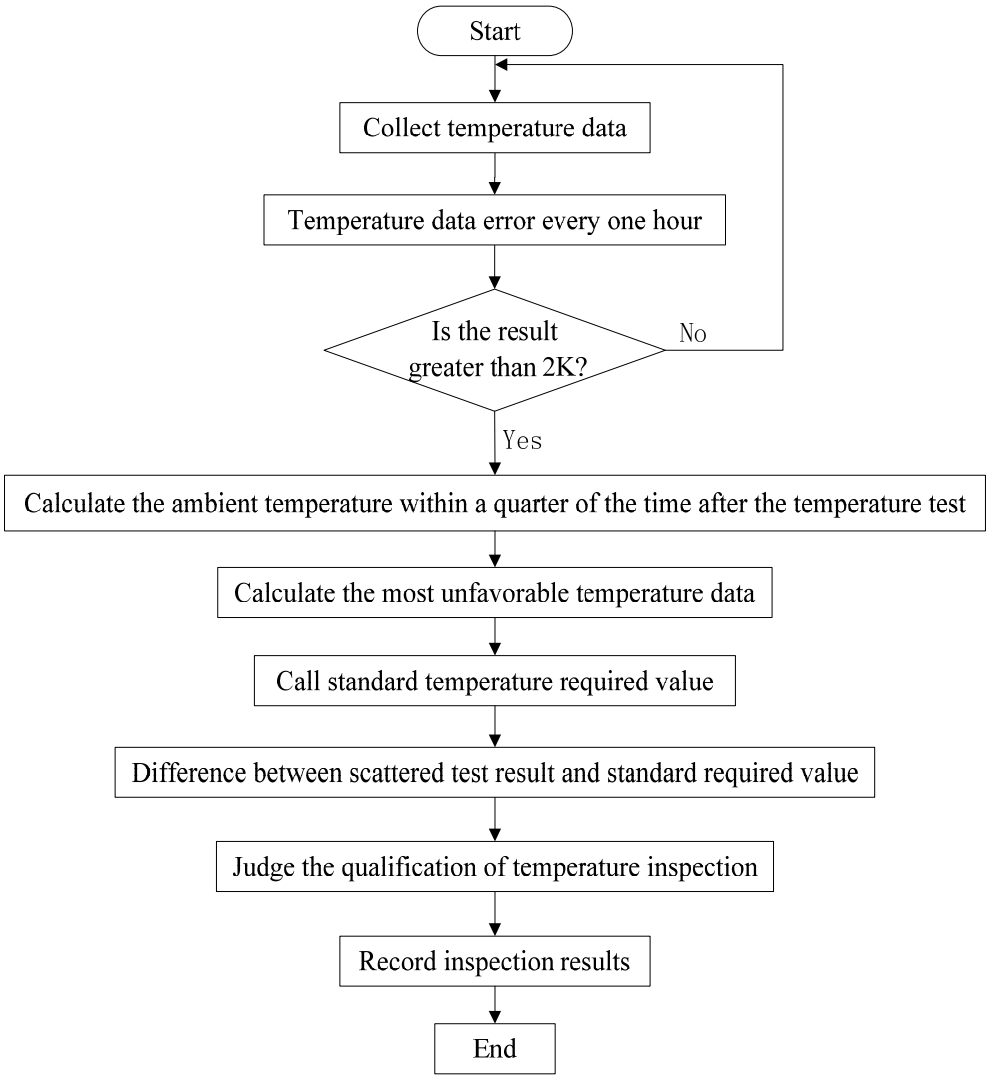



**Fig 3.** Temperature Test Process of Explosion proof Lamps under the Most Unfavorable Conditions

## 3. Temperature Test

Connect the explosion-proof lamps with the temperature test system to test the temperature data under the most unfavorable conditions. The thermal imager is used to find the highest surface temperature point, and the thermal imaging figure is shown in Figure 4. The temperature test result of explosion-proof lamps under the most unfavorable conditions is 58.9℃.

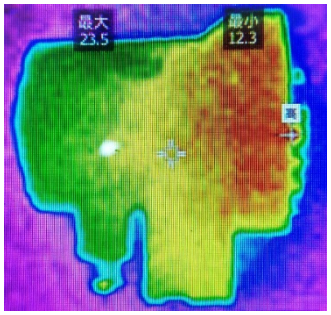



**Fig 4.** Thermal imaging map of Explosion proof Lamps

## 4. Conclusion

Temperature is the main performance index to evaluate explosion-proof lamps. Based on PIC microcontroller, the temperature test system of explosion-proof lamps under the most unfavorable conditions is designed, and the temperature test of explosion-proof lamps under the most unfavorable conditions is realized. The application of temperature test system under the most unfavorable conditions of explosion-proof lamps improves the inspection efficiency of explosion-proof lamps and promotes the sustainable and healthy development of the inspection industry.

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