Design of Deicing Device for Air Vent of Cold Storage

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Abstract. Due to the cold storage vents are the intersection of outdoor warm flow and indoor cold flow, there is often ice accumulation. In this paper, we design one deicing device for air vent of cold storage which can automatically detect the icing condition of the vent and heat and deice the steel tube. The device includes contact sensor, power module, I/O acquisition module, control module, heating copper tube and leakage protection switch. When the contact sensor is completely covered with ice, the contact sensor sends out an alarm signal. The signal is transmitted to the I/O acquisition module and to the control module to drive the heating copper tube to automatically heat and deice. This design can be widely used in unmanaged cold storage vents and indoor and outdoor temperature environment of the warehouse with a large difference.

Keywords: cold storage, automatic deicing, design.

1. Introduction
As an important part of cold chain, cold storage has been paid more and more attention in recent years and developed rapidly[1]. Cold storage generally built in the suburbs and is adjacent to the producing area, which result in great inconvenience on the management [2]. In the cold storage design, the air in the cold storage should be properly circulated so that the air temperature is uniform throughout the storage, especially for storing fresh agricultural products and traditional Chinese medicine cold storage. Traditional cold storage vents often freeze when ventilation is needed, so manual de-icing is needed to open the vents for ventilation. Therefore, it is necessary to provide an automatic deicing device for cold storage vents to ensure the smooth flow of cold storage vents.

2. Literature review
Because of the big temperature difference between the cold storage and outside the cold storage, the air at the air exchange is easy to reach the dew point (the temperature which air cools to saturation with water vapor is called "dew-point"). The temperature in the cold storage is usually below zero and the water droplets adsorbed in the air exchange are easy to form ice, so it is easy to leads to the refrigeration failure of the exhaust blocked refrigerator.
Several common deicing methods include chemical liquid deicing, gas heat deicing, mechanical deicing and electric deicing. For example, chemical liquid can be used to increase the concentration of Cl-ion and add antifreeze. However, foreign studies have shown that artificially increasing the concentration of Cl-ions in the natural environment which will lead to acid rain and thus pollute the environment. For example, it was found that chlorine ions were redistributed between gas and aerosol phases in the Moscow atmosphere, and hydrogen chloride participated in the acidification of precipitation [3,4]. Mechanical deicing techniques such as impact-breaking, which USES vibrating wheels to crush the ice and break it up to remove ice. Besides, the machine can be pulled by motor vehicles and the ice layer can be washed and shaved by the roller, so as to break the ice and remove ice. Furthermore there are shoveling ice, "multi-section whip" whip deicing and other mechanical deicing methods [5]. Air heat is used to prevent ice by means of airflow heating and mechanical deicing. For example, the ice is heated by jet so that the ice reaches the melting point, and a gap is formed between the ice attached surface and the ice, and then a deicer is used to separate the ice from the surface [6]. But it will use too much energy and requires a large deicer. If the electric heating anti-ice increases the load on the electrical device, the use of the electrical device will generate a large amount of heat [7]. Therefore, this paper adopts the method of electrothermal anti-ice, and detects whether the ice is removed through the sensor.

3. Principle design of deicing device
The device is composed of six modules: leakage protection switch, power module, contact sensor, I/O signals acquisition module, control module and heating steel tube. The contact sensor is installed on the shutter, and when the sensor is covered with ice, the alarm switch will be sent out, than through the I/O acquisition module, the alarm switch quantity is collected and fed into the control module. The control module drives the heating copper tube to heat the shutter, which achieves automatic deicing. Because the heating steel tube is needed for deicing, leakage protection switches are added to the circuit to ensure the safety of electricity use. Schematic diagram of deicing device (refer with: Fig. 1).

![Figure 1. Schematic diagram of deicing device.](image-url)

4. Deicing device structure and circuit working principle
The structure diagram of the deicing device (refer with: Fig. 2). The contact sensor (position 1) is installed on the shutter blade of the vent, and the heating copper pipe is installed on the connecting shaft of the vent (position 5). Position 2 is the power module, position 3 is the I/O acquisition module, and position 4 is the control module.
Figure 2. Structure drawing of deicing device.

When the shutter freezes, the surface of the contact sensor freezes, and then the contact sensor sends out an alarm signal. The signal output end of the contact sensor is connected to the signal input end of the I/O acquisition module I/O. The acquisition module receives the alarm signal and transmits it to the control module. The signal output end of the I/O acquisition module is connected to the signal input end of the control module. The signal output end of the control module is connected to the heating copper tube. After receiving the alarm signal from the I/O acquisition module, the control module drives the heating copper tube to heat, so that the shutter of the vent can be de-iced automatically. The power module supplies power to the modules that need it, because heating copper pipes heats the shutters, creating a flow of water when the ice melts. In order to avoid the short circuit of heating copper pipe caused by water flow and safety hazard, as a preferred choice, the leakage protection switch is installed before the power supply module. When the back-end equipment short circuit leakage, leakage protection switch will automatically disconnect, to avoid greater security risks. The circuit diagram of the deicing device (refer with: Fig. 3).

Figure 3. Circuit diagram of deicing device.
5. Summary
In this paper, a simple automatic deicing is set to ensure the air vent of cold storage ice-free, so as to ensure the quality of fresh products and traditional Chinese medicine. This design has simple structure, low cost and strong economic applicability. If the tuyere deicer can be integrated with the central control system, it cannot only deicer automatically but also heat up the external convective air to achieve the cold storage temperature balance.

Acknowledgements
This work was supported by the Opening Fund of Key Lab of Process Analysis and Control of Sichuan Universities of China (2018002), and by the Social Science Youth Project of Yunnan agricultureal of China (2015SK03).

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