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DAIRY PLANT EQUIPMENT BASED ON A MODERN FREEZING DEVICE

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Анотація

У даному дослідженні розглядаються принципи роботи та будова обладнання молокозаводу на базі сучасного морозильного пристрою. Основна увага приділяється системі управління та її компонентам, включаючи реле тиску, виконавчі механізми та реле, для забезпечення належного контролю температури та захисту морозильного блоку. Результати підкреслюють важливість добре розробленої схеми контролю та регулярних технічних перевірок для ефективної роботи та захисту параметрів.

Ключові слова: обладнання молочного цеху, сучасний морозильний апарат, система керування, виконавчі механізми, реле.

Abstract

This study examines the principles of operation and structure of dairy plant equipment based on a modern freezing device. The focus is on the control system and its components, including pressure relays, executive mechanisms, and relays, to ensure proper temperature control and protection of the freezer unit. The results highlight the importance of a well-designed control scheme and regular technical inspections for effective operation and parameter protection.

Keywords: dairy plant equipment, modern freezing device, control system, executive mechanisms, relays.

Introduction

At food processing plants, milk is cooled in special containers, whose temperature is maintained at 40C. The temperature is maintained by coils that are laid in the middle of the milk tanks. In this way, we can observe the principle of a "pipe within a pipe". A constant supply of cold water to the coils is provided by refrigeration units, which are compressor refrigeration units in which water is cooled by freon. Controlling and maintaining temperature is very important, as cooling milk below freezing leads to the loss of some of milk fat. Therefore, the automatic control system for the milk cooling process is given special attention. In addition, the automatic control of the freezing unit should be focused on maintaining the pressure, providing the necessary alarms, monitoring the limit parameters cooling parameters and the operating time of the whole system.

Results of the study

The main components of the signaling and control system for the parameters of the freezer unit include: pressure relays, pressure differential relay, compressor control relay, oil drain control relay, and refrigerant supply control relay. The control system for the operation of the freezer unit can be divided into three components: control panel, executive mechanisms, and relays.

The executive mechanisms control the process of oil injection into the hydraulic system and the operation of the pump, as well as special solenoid valves with electromagnetic actuators used for oil drainage and refrigerant supply. The unit is powered by a voltage of 380 V and has a capacity of up to 18.5 kW. Control of the relays and signaling can be carried out at both 380 V and 27 V DC.

It is recommended to supply the executive mechanisms of the refrigeration unit (electric drives) from a separate distribution device for convenience. The following executive devices should be installed on the front panel of the control panel: power supply automatic circuit breaker, compressor start and stop buttons, release buttons, indicator lamps, toggles for manual and automatic compressor control with corresponding indication of selected modes, power supply presence indicator, and time counter.

The control system should ensure the correct operation of the refrigeration unit, mainly by maintaining the desired cooling temperature. Depending on the pressure of the refrigerant in the system, relay SP3

controls the process of turning the compressor on or off to maintain the desired boiling temperature. Pressure differential relay SP4 controls the operation of solenoid valve Y1 to maintain the specified pressure difference.

The automatic control system is designed to control the freezing process of the products in the unit, maintain the suction pressure, and provide alarm signals for blocking and protection when the control parameters reach their limit values.

Compressor protection based on pressure is carried out by pressure relay SP1, which is set to turn off the compressor if the pressure exceeds 1.6 MPa, with indicator lamp HL4 lighting up. Relay SP2 is set to stop the compressor when the pressure difference in the compressor lubrication system falls below 0.05 MPa. Protection in this case should be delayed, indicated by the lighting of lamp HL5.

The control scheme of the freezer unit is shown in Figure 1.

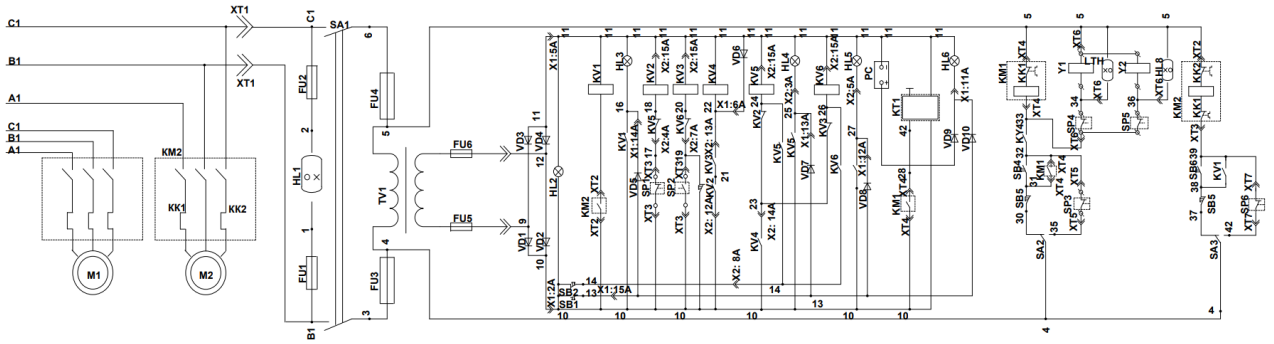

Figure 1 – Control scheme of the freezer unit

The shutdown of the refrigeration unit occurs when all the aforementioned protections are activated. After addressing the cause of the protection activation, the system is unlocked, and only then can the compressor be started using the SB2 button.

The proper operation of the control and signaling system, as well as the protection of the freezer unit, is ensured through regular technical inspections and insulation resistance testing using a megohmmeter. Insulation resistance testing in the 380 V circuit is performed after switching off the SA1 switch and disconnecting the automatic circuit breakers, with the fuse links (FU3-FU4) removed.

To test the insulation resistance in the DC circuits, the XT2...XT4, XT8 connectors on the control panel need to be disconnected and the fuse links (FU5-FU6) removed. In this case, the resistance measurement is conducted between contact 1 of the XT2...XT4, XT8 terminals and terminal 11 on diode VD4, as well as between the contact and the chassis. The insulation resistance in the 380 V and 27 V circuits should be 1 MΩ, while for motor windings, it should be 5 MΩ.

The sequence for switching on the control panel to start the freezer unit is as follows: before switching on, perform an external inspection of the panel and then power on the 380 V supply. Then, sequentially switch on the QF1-QF2 and SA1 switches. To set the operating mode of the time relay KT1, wait for 3-5 seconds. The panel is ready for operation. Simultaneously, check the functionality of the indicator lamps (by pressing the SB1 button). If necessary, to unlock the control scheme, press the SB2 button.

When toggling the SA2 and SA3 switches, the compressor starts in automatic mode. Automatic shutdown can occur in case of emergency conditions or in the event of a complete power outage. To restart the compressor, determine the cause of the shutdown, address it, and then start it using the SB2 button. Manual control of the compressor is performed using the SB4-SB6 buttons when the SA2 and SA3 switches are turned on.

Conclusions

The operation principle and control scheme of the most common freezer unit have been discussed, and its effectiveness is unquestionable. However, there are freezer units designed as cabinets that have limited use due to their low productivity.

The utilization of modern freezer chambers in the food industry for milk processing has proven to be effective, and the modern control system based on various types of relays ensures not only proper operation but also necessary protection of all parameters of the freezer unit.

REFERENCES

1. Хмельнюк, М. Г. Холодильні установки спеціального призначення [Текст] : підручник / Хмельнюк Михайло Георгійович, Подмазко Олександр Степанович ; Одес. нац. акад. харч. технологій. - Херсон : Вид. Грінь Д.С., 2013. - 488 с. : табл., рис. - Бібліогр.: с. 483. – ISBN 978-966-2660-87-6
2. Захаров, Ю.В., 1994. Судовые установки кондиционирования воздуха и холодильные машины. Рипол Классик.
3. Чумак, И. Г., and Д. Г. Никульшина. Холодильные установки. Рипол Классик, 1991.
4. Barboni, Toussaint, Magali Cannac, and Nathalie Chiaramonti. "Effect of cold storage and ozone treatment on physicochemical parameters, soluble sugars and organic acids in Actinidia deliciosa." Food chemistry 121.4 (2010): 946-951.

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