Advances in Engineering Research : Possibilities and Challenges
ISSN Print: 3079-5192
ISSN Online: 3079-5206
https://doi.org/10.63313/AERpc.9114

Fully Automatic PLC-Based Ice Pack Packaging Machine

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How to cite this paper: Wu, J. (2026). Fully Automatic PLC-Based Ice Pack Packaging Machine. Advances in Engineering Research : Possibilities and Challenges, 4(3), 29–32. ISSN Print: 3079-5192; ISSN Online: 3079-5206.
https://doi.org/10.63313/AERpc.9114
Published: 2026-07-27

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Abstract

Most ice pack packaging machines currently in production suffer from poor human-machine interaction, low production efficiency, and insufficient op-erational sensitivity, making them unable to meet the demands of the growing market. To address these issues, this paper proposes an ice pack packaging machine with a PLC as the core of the electrical control system. Buttons, encoders, and a touchscreen serve as input devices, while actuators include frequency converters, servo controllers, relays, and solenoid valves. Practical application demonstrates that this packaging machine significantly improves both production efficiency and safety, and effectively meets the production needs of the large-scale market.

Keywords

PLC; Fully Automatic; Electrical Control; Ice Pack Packaging Machine

1. Introduction

Prior to the 1980s, China's packaging machinery was primarily imported from leading manufacturing countries such as Germany and Japan [1]. With the rise of China's machinery industry and the broader structural adjustment of the equipment manufacturing sector, domestic packaging machinery companies have gradually broken the monopoly of international manufacturers, and the technological gap between China and developed countries has been steadily narrowing [2,3]. In recent years, domestic packaging machinery has undergone significant optimization, gaining a substantial market share [4]. From 2015 to 2019, the operating revenue of China's food and packaging machinery industry showed a consistent upward trend. In 2019, the operating revenue of 1,048 large-scale food and packaging machinery enterprises reached RMB 117.888 billion, representing a year-on-year increase of 2.63%, while the industry's profit margin reached 8.41%. The export performance of China's food and packaging machinery industry remains robust [5].As an essential component of packaging equipment, ice pack packaging machines are gaining

increasing attention due to the wide application of ice packs in cold chain logistics, medical transportation, and other fields. In large-scale production, users have observed that although the mechanical structures of existing ice pack packaging machines have been optimized, their electrical control systems still suffer from several common problems, including poor human-machine interaction, low production efficiency, and inadequate operational sensitivity [6,7].

To overcome these limitations, this paper proposes an electrical control system design for a fully automatic ice pack packaging machine based on PLC technology.

2. Overall design scheme

The overall structure of the fully automatic ice pack packaging machine based on PLC is shown in Figure 1. It consists of five main functional modules: bag clamping, bag opening, material feeding, heat sealing, and finished product output.

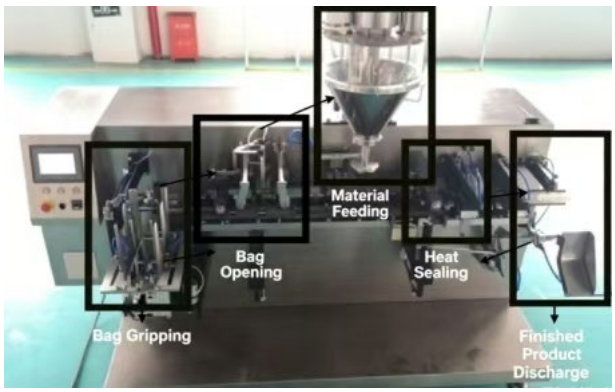


Figure 1. Overall design of the fully automatic ice pack packaging machine

The system architecture is illustrated in Figure 2. A PLC serves as the core of the electrical control system. It samples input signals from external buttons, sensors, and encoders, processes these signals internally, and outputs corresponding control signals to external actuators, including frequency converters, servo controllers, relays, and solenoid valves. The frequency converter controls the rotation speed of the main spindle motor, which drives the mechanical transmission system, thereby enabling the automated production process.

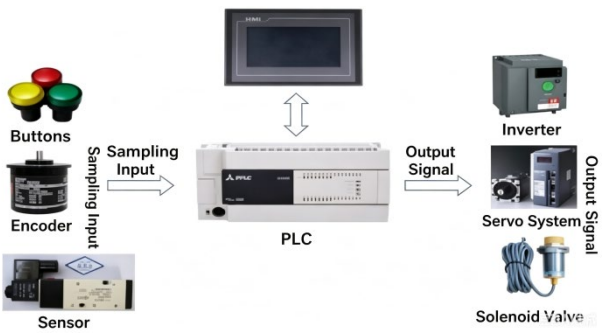


Figure 2. Equipment architecture diagram of the fully automatic ice pack packaging machine

3. Control scheme design

The control flow of the automatic ice pack machine is shown in Figure 3. After the equipment is powered on, it automatically checks whether the air pressure, three-phase power supply, servo motor, and frequency converter are functioning properly. If all parameters are normal, the equipment enters the product parameter setting mode. Otherwise, it enters a fault waiting state until the issue is resolved.

When the equipment is started, the robotic arm picks up the packaging bag and transfers it to the bag opening station, where compressed air is used to open the bag. A capacitive proximity switch then detects whether the bag has been successfully opened. If opening is confirmed, the system proceeds to the feeding stage. The feeding mechanism, driven by a servo motor, dispenses the material according to the preset parameters. After filling, the bag is sealed using a thermocouple-based heat-sealing unit. Finally, the finished ice pack is transferred onto a conveyor belt and delivered to the collection point, completing the entire packaging cycle.

Based on the flowchart shown in Figure 3, a PLC ladder logic program was designed and implemented, combined with the corresponding wiring diagram, to control the mechanical components effectively.

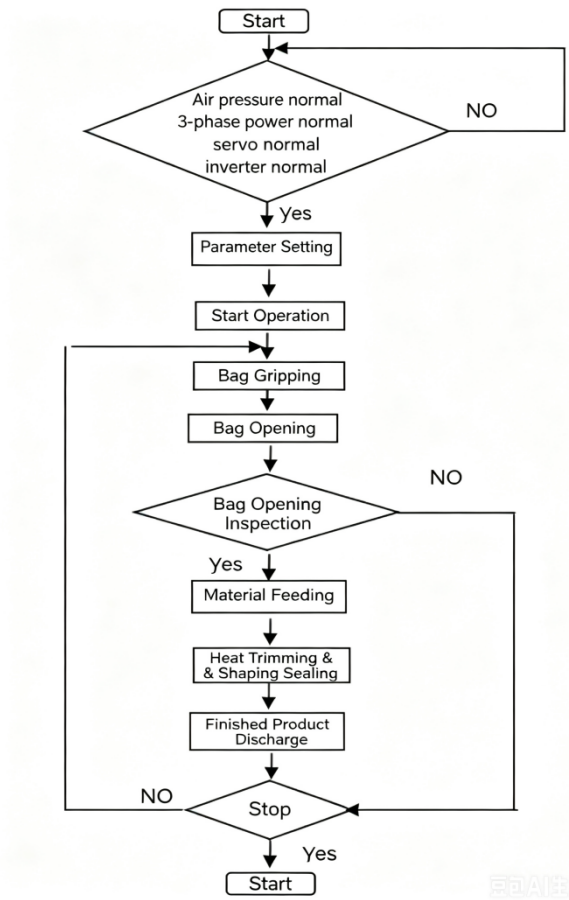


Figure 3. Automatic ice pack machine control program flow

4. Conclusion

Production practice has demonstrated that this equipment is capable of stably packaging ice packs of various sizes and offers the following advantages:

1) Efficient Human-Machine Interface: The use of a touchscreen allows operators to easily set, monitor, and debug various parameters and control processes. The system is equipped with a real-time status monitoring and alarm function, which can quickly shut down the machine and display the fault location on the screen in case of malfunction.

2) Adjustable Production Speed: Production speed can be effectively controlled by rotating the potentiometer, allowing the system to flexibly adapt to different production capacity requirements.

3) Energy and Material Efficiency: Each module can be individually started or stopped. In the event of a fault in any module, subsequent operations are automatically halted, reducing energy and material waste.

References

[1] One of the top ten industries in the machinery industry. Modern Manufacturing, 2020(15): 42.

[2] Han Zhanhua, Guo Fei. Application and prospect of automation in packaging machinery. Packaging and Food Machinery, 2011, 29(03): 49-52.

[3] The intelligent packaging industry has broad prospects. Modern Manufacturing, 2021(09): 42.

[4] Sun Chucai. Application and prospect of automation technology in packaging machinery. Southern Agricultural Machinery, 2020, 51(09): 127-128.

[5] Zhao Jinkang. Application and prospect of automation technology in packaging machinery. Science and Technology Innovation and Application, 2021(02): 158-160.

[6] Li Xiaogang. Research progress on automation technology of packaging machinery. Packaging and Food Machinery, 2021, 39(03): 52-57.

[7] Wang Shengbin. Optimization design of control system for automated food packaging machinery. Mechanical Design and Manufacturing, 2020(11).