Application of WinCC in lithium battery separator production line

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Abstract: Given the complexity of the production process and the high demand for data traceability in lithium battery separator production, this paper designs and implements a highly adaptable and fully functional SCADA system based on the Siemens WinCC platform. The system achieves comprehensive real-time data collection and centralized monitoring of the lithium battery separator production line, possesses efficient fault alarm and diagnosis functions, and establishes a comprehensive historical data management system. The deployment of this system effectively enhances the transparency, controllability, and traceability of each production process step, providing reliable data support for process optimization and quality control, and significantly improving the stability and intelligence level of lithium battery separator production.

Key words: WinCC; lithium battery separator production line; SCADA; monitoring system; data query; archive

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With the vigorous development of the new energy industry, the demand for high-performance lithium batteries has increased dramatically. As a key component of lithium-ion batteries, the stability, consistency, and high-precision control of the production process of lithium battery separators directly determine the safety and performance of the batteries. Lithium battery separators are thin films with a microporous structure, which have high technical barriers and extremely demanding requirements for production environment and process parameters. Traditional manual recording and decentralized control methods are difficult to meet the requirements of modern industrial production for high precision, high efficiency, and high reliability. Therefore, it is crucial to build a supervisory computer monitoring system that integrates monitoring, control, management, and analysis.

Siemens WinCC is an advanced SCADA (Supervisory Control and Data Acquisition) software, renowned for its robust data management capabilities, extensive communication drivers, flexible visualization functions, and reliable security. It is widely used in the field of industrial automation and is particularly suitable for processes like lithium battery separator production. Practical applications have shown that this system boasts a user-friendly interface, stable and reliable operation, significantly enhancing production efficiency, and providing an effective solution for the intelligent production of lithium battery separators.

1 Composition and requirements of the production line

The lithium battery separator production line consists of various process sections, including the feeding system, extrusion, casting, biaxial stretching, extraction, transverse stretching, traction, and winding. Based on the characteristics of the production line, the SCADA system fulfills the following core requirements:

(1) Establish a full-process visual monitoring system. This system can dynamically present the operating status, key process parameters, and trend curves of equipment in various

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process sections of the production line in real time. It also supports remote operation and precise adjustment of equipment operating modes and process parameter settings by relevant process personnel, thus providing comprehensive real-time monitoring and refined control for the production process, and facilitating efficient and stable operation of the production line.

(2) Centralized alarm management. In response to various production anomalies such as equipment malfunctions, sudden emergency stops, and process parameter overruns, the system can trigger real-time alarms and automatically record events. Based on the actual needs of lithium battery separator production, alarm types are finely categorized, and differentiated color codes are assigned to different types of alarms. This helps on-site operators quickly identify the level and type of alarm, enabling them to take precise and efficient measures to ensure the stable operation of the production line.

(3) Data query. Implement archiving management for process parameters and alarm information. By collecting, storing, and backing up various key process parameters and alarm events throughout the entire production process, an efficient and convenient historical data query channel is established for process personnel. Process personnel can quickly retrieve relevant historical data through the SCADA system, thereby achieving precise traceability of the production process and ensuring the monitorability of the production process and the verifiability of product quality.

(4) Develop a one-click report generation function. This function can accurately capture real-time data of various key process parameters during production based on the actual needs of the on-site production process, and quickly generate standardized reports through a one-click operation, providing precise and reliable data support for the optimization and adjustment of production processes, quality control, and other related tasks.

2 Overall composition and scheme design of SCADA system

2.1 System architecture composition

The SCADA system for the lithium battery separator production line adopts a three-tier structure of "device layer - control layer - monitoring layer". The device layer mainly includes on-site sensors, transmission devices, pneumatic devices, intelligent instruments, etc. The control layer employs industrial PLCs to perform logic control and PID regulation, and exchanges data with the device layer. The monitoring layer deploys WinCC V7.5 SP2, communicates with multiple PLCs through industrial Ethernet, and achieves data integration and visual display. The system framework adopts a C/S (client/server) structure, which can fully leverage the data processing and storage advantages of the server, as well as the convenient interactive operation of the client, providing solid architectural support for efficient monitoring and precise control of the lithium battery separator production process. The network topology diagram is shown in Figure 1.

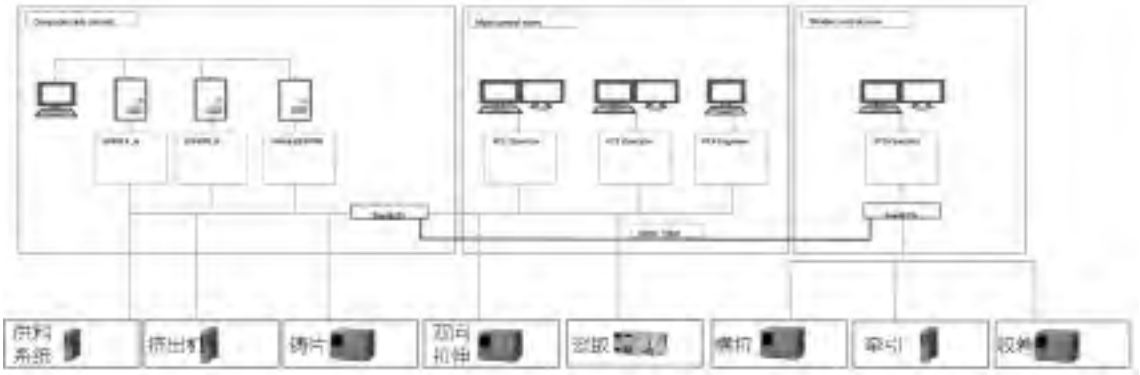

Figure 1 SCADA system network topology diagram

2.2 Software configuration

2.2.1 Project management

The WinCC Project Manager, as a key component of the WinCC system, provides users with comprehensive and convenient project management functions. In terms of project management, users can easily create and open projects, whether it's building a brand new project or continuing the development of an existing one, both can be handled efficiently. At the same

time, the management and archiving functions for project data ensure the integrity and traceability of project data, facilitating users to quickly find and use relevant data in subsequent work.

In terms of editing functionality, the project manager can open an editor, enabling users to meticulously edit and adjust projects to meet diverse design requirements. In terms of project operation control, it supports the activation or deactivation of projects, allowing users to flexibly control the project's operational status based on actual situations. Furthermore, it provides a wealth of settings options, allowing users to precisely configure various parameters according to the specific requirements and usage scenarios of the project.

As shown in Figure 2, the configuration scheme for redundant servers and clients is presented. This configuration aims to enhance the reliability and stability of the system, ensuring swift switching in case of server or client failures, and safeguarding the continuity of SCADA system functions.

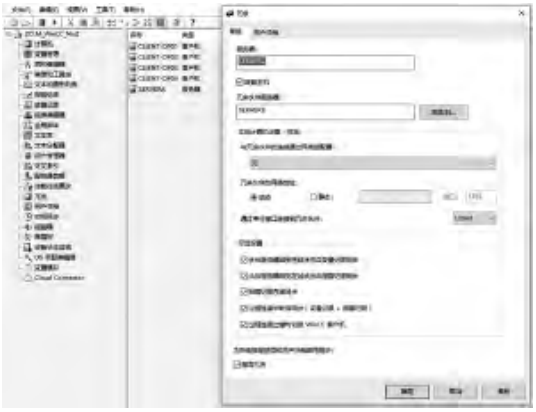

Figure 2 Redundancy settings of wincc project manager

2.2.2 Variable management

In variable management, the system possesses the capability to define both internal variables and process variables. Internal variables exist independently within the system, without any direct connection to any process, and their functions are typically confined to non-process interaction scenarios such as logical operations and data storage within the system. On the other hand, process variables are the core elements that facilitate efficient communication between the WinCC system and the control layer. Serving as a bridge for data transmission, they ensure the accurate and timely transfer of control instructions and feedback information between the WinCC system and the control layer.

In the variable manager, when users create process variables, these variables are automatically allocated and stored in specific communication drivers according to the rules set by the system. The communication driver is a key component responsible for handling communication protocol conversion and data transmission. It can communicate with multiple PLCs through different protocols, such as Siemens' S7 protocol or Modbus protocol, to achieve communication with the control-level PLC. The system can accurately identify and process data from the PLC, while accurately sending control instructions to the PLC. The configuration of its channel units and the connection method with the PLC are set according to actual communication requirements and system architecture. The specific details are shown in (Figure 3).

Figure 3 Variable management

2.2.3 Graphic design

In the interface design, based on functional requirements, the interface is primarily divided into three modules: process flow interface, alarm interface, and trend interface. Among them, the process flow interface serves as the core display area, encompassing the initial interface, overall process interface, detailed interfaces for each process segment, and pop-up windows. The pop-up window interface, as an important interface for system interaction, is used to display in detail the operating status, parameter information, and operation interface of specific process segments, facilitating users to quickly obtain key data and perform real-time monitoring and adjustment. Based on the different characteristics of each control object, customized and highly adaptable pop-up interfaces can be developed to enhance the system's precise control capability and operational convenience. Figure 5 shows the pop-up interface for temperature PID control. To optimize

the operational experience of on-site process personnel, a navigation bar design has been specially added on the right side of the interface to enable quick navigation and operation, as shown in Figure 4. The alarm interface centrally displays all alarm information to ensure timely response to abnormal situations; the trend interface, as shown in Figure 6, provides powerful support for process monitoring and analysis with real-time data curve query function.

Figure 4 Starting screen

Figure 5 Pop-up window

2.2.4 Data archiving and report generation

In the production process of lithium battery separators, WinCC's archiving management function plays a crucial role.

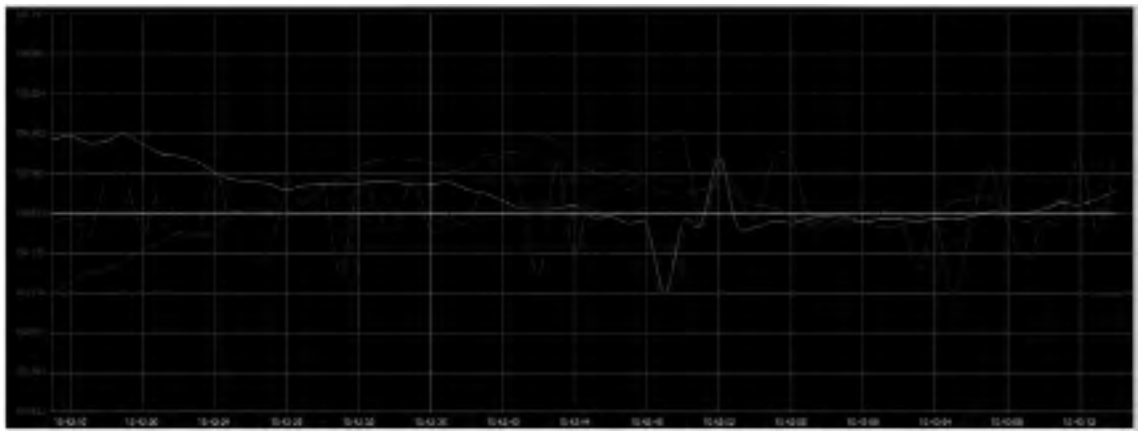

Figure 6 Trend display

It can comprehensively and accurately archive various process values and alarm messages generated during the production process. For key process data, such as temperature, pressure, flow rate, and various alarm messages, the system will store them in the server for a long time, forming a complete data record. These data records not only help process personnel understand the historical status of process operation but also provide important basis for subsequent process optimization and fault analysis. By operating a computer, relevant personnel can quickly call these archived data to achieve data traceability and analysis. At the same time, through WinCC's VBS scripting function (as shown in Figure 7), customized functions can be developed. Based on the specific needs of process personnel, this function can be used to generate customized reports for key data of interest, including real-time data display, deviation display from set values, and prompts for deviation exceeding limits, thus providing a more intuitive understanding of process operation status and strong support for production decision-making.

Figure 7 VBS script function of WinCC

3 Conclusion

Proven through practical application, the SCADA system has demonstrated significant advantages in the field of lithium battery separator production lines. By centralizing the control and management of the production line, this system enables production personnel to monitor and control the operational status and parameters of the entire line more conveniently and efficiently, thereby enhancing overall management level and production efficiency. The data traceability feature provides process personnel with detailed and accurate historical data, allowing them to conduct in-depth analysis of various parameters and states during the production process, providing a scientific basis for process optimization. The reporting function allows for the convenient generation of user-required reports with a single click, not only saving a significant amount of time and effort that would otherwise be required for manual data collection and organization but also avoiding errors caused by human factors, providing reliable data support for production decision-making. The application of this system has effectively addressed many pain points associated with traditional control methods, such as scattered production information, management difficulties, and inconvenient data traceability.