Research and Design of Energy Management System in Cement Enterprise

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Abstract: In recent years, China has vigorously advocated energy conservation and emission reduction and the development of circular economy. The energy saving and emission reduction work of cement enterprises is an indispensable part of economic construction. This paper takes the production process of the production area of the cement enterprise and the energy used in the living area as the research object and develops data acquisition system and front-end web page display. First of all, this paper introduces hardware design, its software design and the web page realization, and gives the results of the page running display.

1. Introduction

The cement industry is an important raw material industry in China's national economy. However, there is serious pollution, high energy consumption [1] and serious waste of resources at the present stage. In view of this situation, the national "13th Five-Year" plan has put forward specific energy saving and emission reduction requirements for cement industry. And the country encourages cement enterprises to modernize, intelligentize and green development in order to improve the utilization of resources and energy and reduce the energy consumption of the unit cement products [2].

Establishing the energy management system of cement enterprises can carry on the information management and the statistical analysis to the data. It is beneficial to reduce energy consumption of unit cement products and raise economic efficiency.

2. System hardware design

The design of the cement enterprise energy management system is based on a cement plant in Shandong Province, which integrates the energy management of the production area and the living area. The hardware frame design of the energy management system is shown in Figure 1.

The data acquisition system server of the production area mainly completes the data collection of energy monitoring points such as electricity, coal and water. The collected data is analyzed, classified and calculated. Finally the collected data, all kinds of report information, alarm information and event records are stored in the database. The data collection system server of the living area mainly completes the information collection of the electricity and water monitoring

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points in the living area of the enterprise. The collected data, generated charge information and event records are stored in the database.

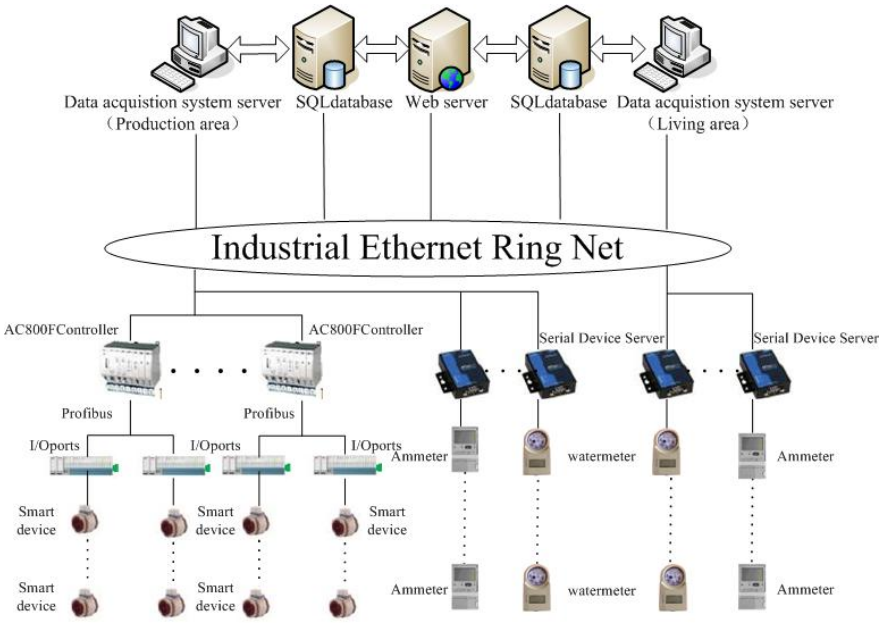

Figure 1. System hardware frame design.

The SQL database mainly completes the system configuration parameters and the storage function of real-time and historical data.It also provides data support for the data collection system and the Web server. The SQL database also stores all kinds of report information, alarm information and event records generated by the data acquisition system, so as to provide data support for Web server [3].

The Web server mainly completes the front page display, and realizes the information interaction between the web page and the SQL database.

The DCS system of this cement enterprise uses the Freelance distributed control system of ABB. The model of the controller is AC800F.The controller and the I/O module communicate with the Profibus bus. The controller connects the intelligent equipment through the I/O port, and realizes the production data collection [4]. Production data include pulverized coal consumption, equipment switch volume, clinker output and so on.

The function of serial device server in the system is to realize two-way transmission of data between RS-485 serial port and TCP/IP network interface [5]. Through RS-485 bus, ammeters or water meters are connected in parallel to serial port device server. Through virtual serial communication mode, a computer connects multiple serial port servers so as to exchange data.

3. System software design

The energy management system of the cement enterprise includes the production area and the living area. The production area includes the cement section, the clinker section, the aggregate section and the public part, such as the air compressor. The living area includes the 1# apartment building, the 2# apartment building and the flat room. There are 335 ammeters and 15 water meters under the serial port device server.DCS collection points more than 7000. In order to improve universality and maintainability, the comparison table and the formula table are designed for data acquisition and energy consumption calculation.

4. Comparison Table Design

The comparison tables include the ammeter comparison table, the water meter comparison table and the DCS comparison table. The ammeter comparison table is shown in Table 1.The system can realize the flexible reading of ammeters with different protocols through the ammeter comparison table. It can be well extensible. The ammeter comparison table can set the parameters read by the ammeter and whether the ammeter is enabled. The change of the software is not necessary. You only need to modify the ammeter comparison table to get the ammeter's communication protocol, related parameters, etc. Then the acquisition module will send, receive and parse the command frame and storage the data after the data is generated, which is beneficial to the maintenance. Since the living area ammeters are only used for living in the dormitory.It can be only collected by serial device server. The water meter comparison table is similar to the ammeter comparison table. There is no CT or PT field.

Table 1**.** Ammeter comparison table.

FieldName	Description
AmmeterNumber	Ammeter coding
AmmeterName	Name of ammeter
AmmeterSource	Ammeter data source
ElectricRoom	The electric room of the ammeter
CommunicationProtocol	Ammeter communication protocols
AmmeterAddress	Ammeter address
CommPort	Serial port number set by serial port device server
IpAddress	Serial device server IP
CT	Current transformer ratio
PT	Voltage transformer ratio
EnabledFlag	Ammeter enabled flag
Status	Collecting state of ammeter

The DCS comparison table is shown in Table 2. The cement enterprise has multiple DCS systems and the acquisition module can read data from OPC and store them in corresponding database tables. Generally, the production data is collected, such as equipment switching, cement output and so on,that is used for data processing analysis such as power consumption of web pages. Through the DCS comparison table, we can define, add, and delete DCS variables to be collected, which is good for maintenance.

Table 2. DCS comparison table.

FieldName	Description
OrganizationID	Organization of the ID, representing the production line of the DCS variable
Process	The DCS system of the DCS variable
VariableDescription	DCS variable description
IpAddress	IP of OPC Server
OPCName	The name of OPC Server
Item	DCS variable name
TableName	Table name of DCS variable data storage
FieldName	The field name of the storage table
IsCumulant	Whether it is a cumulant
CumulantName	Cumulant name

The formula table, as shown in Table 3, is used to calculate the coal consumption and electricity consumption of various production lines and processes. The level code of the formula is arranged from high to low. The formula hierarchy type represents the production line , process and master device included under the process in turn.The data acquisition module reads the table to calculate the coal consumption and electricity consumption. If the formula changes, you don't need to modify the software, you can modify the corresponding field, which is more flexible.

Table 3. Formula table.

FieldName	Description
KeyID	ID used to distinguish between production lines
LevelCode	The level code of the formula
LevelType	Formula hierarchy type
Name	Formula name
Formula	A molecular formula for electricity consumption and coal consumption
Denominator	The denominator of the power consumption formula
CoalDustConsumption	Denominator of coal consumption formula

5. Web Design and effect

Figure 2. System web page.

The webpage is mainly divided into six modules, as shown in Figure 2, which are real-time monitoring, production management, energy management, equipment management, public data and system settings. Real-time monitoring includes production monitoring, energy monitoring, alarm monitoring, and system monitoring. Since there are fewer water meters and ammeters in the living area, only real-time and historical data of each floor can be displayed to meet the demand.A small module in the energy management module is displayed,as shown in Figure 3. The real-time monitoring module realizes real-time monitoring of DCS data, ammeters and water meters in the production area,and alarms on on-site operation equipment, abnormal data collection of ammeters and water meters.It also monitors the situation of data acquisition system network and so on. The production management module has made the production plan of the cement enterprise and records production scheduling such as employee shifts. It also analyzes the cement output and other data information. The energy management module realizes the report display of information such as electricity, water volume, coal consumption, and power consumption. The equipment management

module realizes the inquiry and entry of the cement enterprise equipment account. The public data module implements the definition and configuration of public information such as shift schedules and formulas. The system settings can set the user role,user password modification and so on.

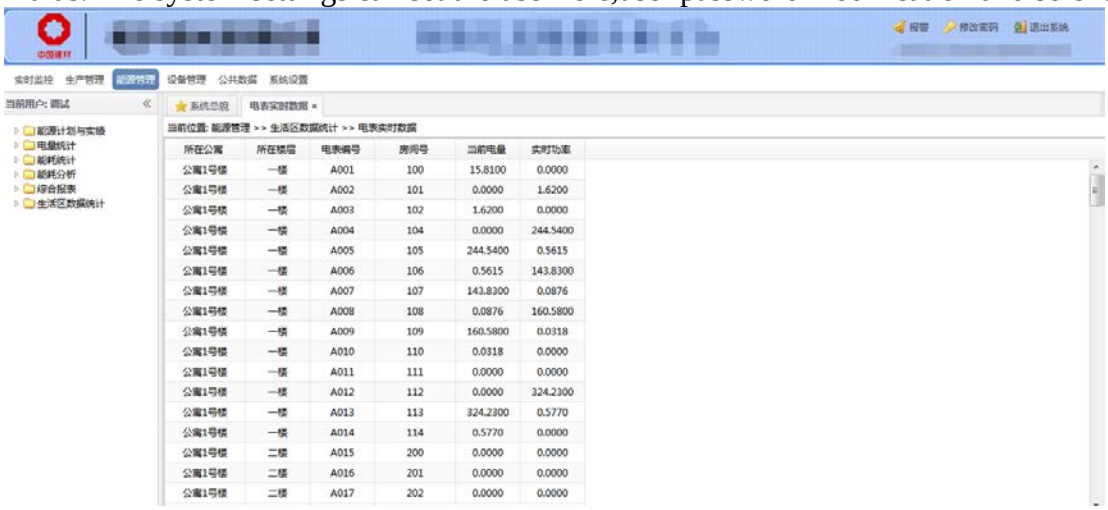

Figure 3. Living area web page

6. Conclusion

Based on the actual demand of a cement plant in Shandong Province, this paper proposes an energy management system with strong versatility and expandability, and has completed the expected function. At present, the system has been put into use. The system runs stably and the effect is obvious, which greatly improves the management efficiency of the enterprise and economic benefits.It has important practical significance.

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