



Study on the Application of CIPS in the Pulp and Papermaking Engineering

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Abstract

For the modern pulp and papermaking industry with high technical requirement, huge energy consumption and large pollution output in, the computer integrated process system (CIPS) of the flow industry which could effectively integrate corporate management concept, information technology and automatic control technology is necessary. Based on the analysis of the characteristics of various workshop sections of the pulp and papermaking industry and its demands of CIPS, we put forward the CIPS three-layer system structure (ERP, MES and PCS) which could be applied in the pulp and papermaking industry, and a new CIPS optimized application project based on SIMATIC PCS7 for the papermaking corporation.

Keywords: Pulp and papermaking, Computer integrated process system (CIPS), Process control system, SIMATIC PCS7

1. Introduction

In 1973, American Dr. Joseph Harrington put forward a sort of enterprise production organization theory, CIM (Computer Integrated Manufacturing). CIMS (Computer Integrated Manufacturing System) is the system based on CIM theory, i.e. it is the large-scale complex system which comprehensively utilizes modern management technology, manufacturing technology, information technology, automatization technology and system engineering technology to integrate and optimize correlative personnel, technology and management in the whole production process of the enterprise and the information flow and material flow organically through computer hardware and software. In 1986, European Community also developed the concept of CIMS to CIPS in time, and formed the concept of CIPS in the flow industry, and advocated implementing CIPS plan in the successive production processes such as petrification and energy sources.

In this article, we mainly analyzed the characteristics of the pulp and papermaking industry and its demands for CIPS, put forward the CIPS three-layer system structure which could be applied in the pulp and papermaking industry, and a new CIPS optimized application project based on SIMATIC PCS7 for the papermaking corporation.

2. Characteristics of the pulp and papermaking industry and the demands of CIPS

The pulp and papermaking industry is an important industry which is closely linked to the development of national economy, and it related to many industries such as the forest industry, agriculture, mechanical manufacturing, chemical industry, electric automatization, traffic transportation and environmental protection. The whole pulp and papermaking process flow can be described as that the wheat straw, cotton stalks, bulrush and other papermaking materials are prepared through the dry and wet process, and are digested in the digestion section mixing with digestion liquors (black liquor and white liquor) under high temperature, and produce coarse pulps through the digestion reaction, and through washing and filtering, the black liquors, residues and coarse fibers could be removed from the coarse pulps which could be turned into accepted pulps, and the accepted pulps are sent to the whitening section and turned into paper pulps through CEH three-section continual whitening, and the pulps from the washing, filtering and whitening workshop mix with other pulps according to certain proportion, and mix with fillings, gluing materials, coloring matters and other accretions, the mixed pulps could be formed, and the mixed pulps are put into the pulp pool, and diluted as the paper pulp with regulated concentration by clear water and white water, and mixed with fillings such as alums, and filtered through the intermediate stuff box, desander, steady flow box and stock discharge box, and the finished rolls could be

formed through procedures such as pressing, drying, gluing, press polishing, taking up and distorting (Wang, 2003).

Thus it can be seen that the pulp and papermaking industry is the industry with intensive technologies, large resource consumption and many pollution outputs. To adapt the drastic market competition and realize the modernization of the pulp and papermaking industry, when we enhance its economic benefits, we should try to reduce pollution and energy consumption and protect the environment in the production process, so we need effectively integrating modern management technology, manufacturing technology, automatization technology and information technology, i.e. under the guidance of flow industry CIPS, realizing CIPS in the pulp and papermaking industry aiming at the production characteristics of the pulp and papermaking corporation (Li, 2003, P.35-37).

3. CIPS three-layer system structure of the papermaking corporation

The CIPS of the papermaking corporation is divided by three layers, i.e. ERP (Enterprise Resource Planning), MES (Manufacturing Execution System) and PCS (Process Control System) (Zhao, 1999, P.137-139 & Hu, 2005, P.35-38) (seen in Figure 1).

The layer of ERP is the technology of the total resource optimization which emphasizes the planning character of the corporation, pays attention to the production plan, dispatching, cost and logistics, and takes the financial analysis and decision-making as the core. ERP could effectively realize the material stock, repertory management, code management, order arrangement, production management, quality management, sales management, transportation management, client complaint management, cost accounting and financial analysis of the papermaking industry, and support the special management of the distribution in the papermaking industry. The keystone of ERP of the papermaking corporation is the logistic management, and the raw materials, finished product quality and quality traceability should fulfill very high management requirements, and the system should follow from the finished goods to semi finished articles and to material suppliers, so the ERP system must effectively help the corporation to follow the quality responsibility, and offer strong quality management and following function, and allow the corporation to follow the quality from the finished goods to raw materials. In a word, for the papermaking corporation, to judge whether one ERP system is effective, we should judge whether it produce significant effects for reducing cost, enhancing quality and increasing benefits through the information-based reconstruction.

The layer of MES is the technology about the production process optimization control, production execution optimization operation and optimization management which emphasizes the execution of plan, pays attention to the equipment management and takes the production comprehensive index as the objective. Concretely speaking, the layer of MES mainly takes the realization of the three-optimization of the production comprehensive index, i.e. optimized operation, optimized control and optimized management, as the objective, and it possesses the backbone function which could link the preceding and the following, and it could realize many functions such as production dispatching, material following, resource distribution and management in the production, quality management, flow simulation, system data acquirement in the production process, model computation and process optimization, and it is also the basic data processing platform. Many papermaking corporations have their bottom production control system, and many of them implement the ERP system, but the communication is still lacked between the management layer and the control layer, and MES could just fill the blank to realize the integration of management and control. MES is a set of system which could transmit and produce correlative information in time and optimize a series of production activities from receiving order to completing finished-product. MES takes the software as the base, takes the real-time database and historical database in the network environment as the supports, adopts the client/server system structure and the objective-oriented design method to realize the information management of the whole lifecycle of product and achieve the function of information hub between the upper planning layer and the lower control layer.

The layer of PCS is the technology which emphasizes the equipment monitoring (if the field-bus technology is adopted, the information of equipment fault diagnosis will be more abundant), takes the quality and quantity of the product (such as the finished rolls) and the technical requirement fulfillment as the objective, and takes the comprehensive management control of equipment as the core. The layer of PCS could automatically control the technical process of the production with high efficiency, high precision and high level to ensure the quality, cost and delivery term of the products and make the products possess strong competitive power in the market. It is mainly used to control the pulp and papermaking production process including process test, soft measurement, meter control, electric control and execution institution.

By the comprehensive automatic system structure composed by three associative systems such as PCS, MES and ERP, the papermaking corporation could realize the comprehensive integration of three systems under the drives of control technology, computer technology and optimization technology, really complete the comprehensive application of information, and realize the integration of management and control.

4. A new CIPS application in the papermaking corporation based on PCS7

To fully integrate ERP, MES and PCS, Siemens pushed its new standard automatic control system, i.e. SIMATC PCS7,

and SIMATIC PCS7 is the comprehensive automatic solution based on process control. Traditional process automatization includes the electric control system PLC and the instrument control system DCS, and through several years' development and technical advancement, Siemens developed the concept of whole integrated TIA which integrated PLC and DOS, combined advanced electric manufacturing technology, figure and image processing technology, field-bus technology, computer technology and advanced automatization control theory, and it was the advanced process control system oriented to all process control applications. The application of SIMATIC PCS7 in the papermaking corporation could realize the whole integrated automatization, and the core of the system integration includes integrated allocation and program configuration, integrated data management and integrated communication. It could offer complete automatic solution for the papermaking industry, and reduce stop time, spare parts and interfaces of the paper machine to the largest extent, and offer intelligent service for the factory.

Except for controlling the production line, the SIMATIC PCS7 in the papermaking corporation could monitor and control the running of the assistant factories. In the system, operators could control and monitor all processes and obtain the important information of the whole corporation in time by the consistent user interface. The standard software modules about MES, process control layer and quality management could ensure the coherence of the data flow between the process and the production layout. From planning and running production to reducing costs, this system could offer powerful supports and guarantees for the production corporations, strengthening the system performance largely and ensure achieving the requirements of the environmental protection. Figure 2 is the CIPS application system structure of the papermaking corporation.

In ERP, the system use special enterprise resource programming ERP software to comprehensively manage the supply, sale, repertory, finance, personnel and equipments, and make comprehensive plan and management decisions, and the major control objective of ERP is the capital flow of the corporation.

According to the middle and long planning requirements from the market and the corporation, MES comprehensively harmonizes and balances the production systems of the whole corporation, allocates the resources, deals with the accidents to obtain largest comprehensive benefits. The exertion layer mainly considers the logistic balance, abilities (reaction ability, repertory ability and transportation ability) balance and environmental protection requirement, and the major control objective of this layer is the logistics of the corporation.

PCS mainly includes the optimized control of technology, fault diagnosis and system monitoring. We adopt SIMATIC PCS7 as the concrete implement tool to realize the whole integrated automatization control. The integrated allocations includes S7-400 series, distributed I/O, ET200M and Profibus, and the integrated program configuration includes that the PCS7 of STEP7+WinCC in the host computers of OS and ES.

The hardware and software systems are the base to compose the automatic control system. Thousands of I/O signals are processed by the several servers in the dispersedly designed automatic system, and the concrete implementation approaches can be described as follows.

(1) ES. In the engineer station (ES), according to the pulp and papermaking technical flow and the process control requirements of various loops, engineer uses PCS7 to compile CFC/SFC programs and make the WinCC human-computer interface. CFC is used in the configuration controlled by the continual process, and PCS7 offers a great lot of standard process industrial function modules such as PID control, valve control and motor control. SFC is used in sequence control, especially for the configurations of the control system which are exerted in turn.

(2) OS. Operator station (OS) connects with the server by the high speed industrial Ethernet, and operator monitors and control the operation by the WinCC of the host computer. WinCC is the multi-functional operation system based on Windows NT, and it can quickly and highly effectively respond the process events and alarm, and ensure the reliability of data effectively. The human-computer interface software of WinCC is the base to control and monitor the operation for various operation stations. It could make PC turn into the monitoring system with high efficiencies. This integrated data management system could optimize the control loop and solve problems in the debugging process.

(3) AS. Process control station (AS) controls the locale equipments such as transducer and control valve by the Profibus interface, and implements the net connection by the optical fiber or cable according to their corresponding distance. Data are transmitted by the 100Mbps Ethernet which is very fit for the papermaking corporation needing huge data exchanges, and these high speed data could largely enhance the performance of the network.

The corporation process analysis system could acquire data by the industrial standard interface OPC. When WinCC server is failed, OPC communication mode will be switched automatically to avoid data loss. The ISDN connection with the automatization system could implement remote diagnosis and remote configuration to ensure the reliable production of the corporation.

5. Conclusions

At present, many problems such as numerous corporate quantity, small scale, deficient raw materials, large resource and

energy consumption, lower production efficiency and serious pollution still exist in Chinese pulp and papermaking industry, and the key reason is that the technologies (including the industrial technology and the equipment automatization technology) are lagged. To enhance the competitive power of Chinese pulp and papermaking industry in the world, when we introduce, digest and absorb foreign advanced papermaking technology, we should adopt the high and new technologies with measured strokes, and adjust and optimize the structure to implement clean production, save natural resources and enhance the production efficiency and economic benefit. Therefore, based on the theories about foreign and domestic CIPS, it is very meaningful to exert Chinese advantages in the domain of CIMS and implement CIPS in major corporations in Chinese pulp and papermaking industry.

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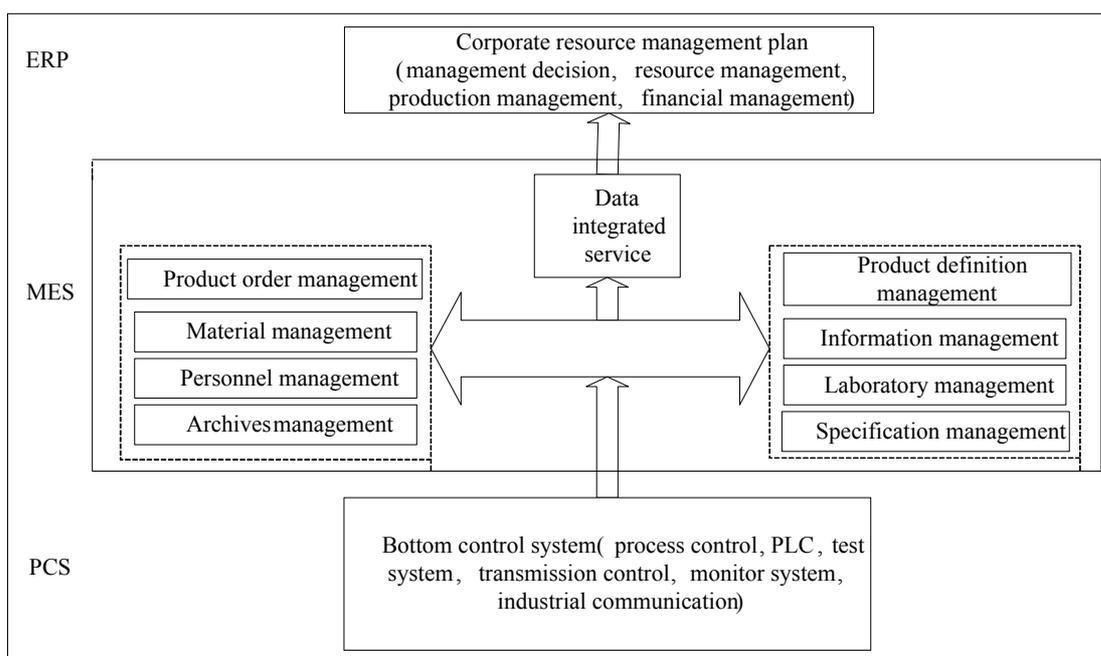


Figure 1. CIPS Three-layer Structure System of Papermaking Corporation

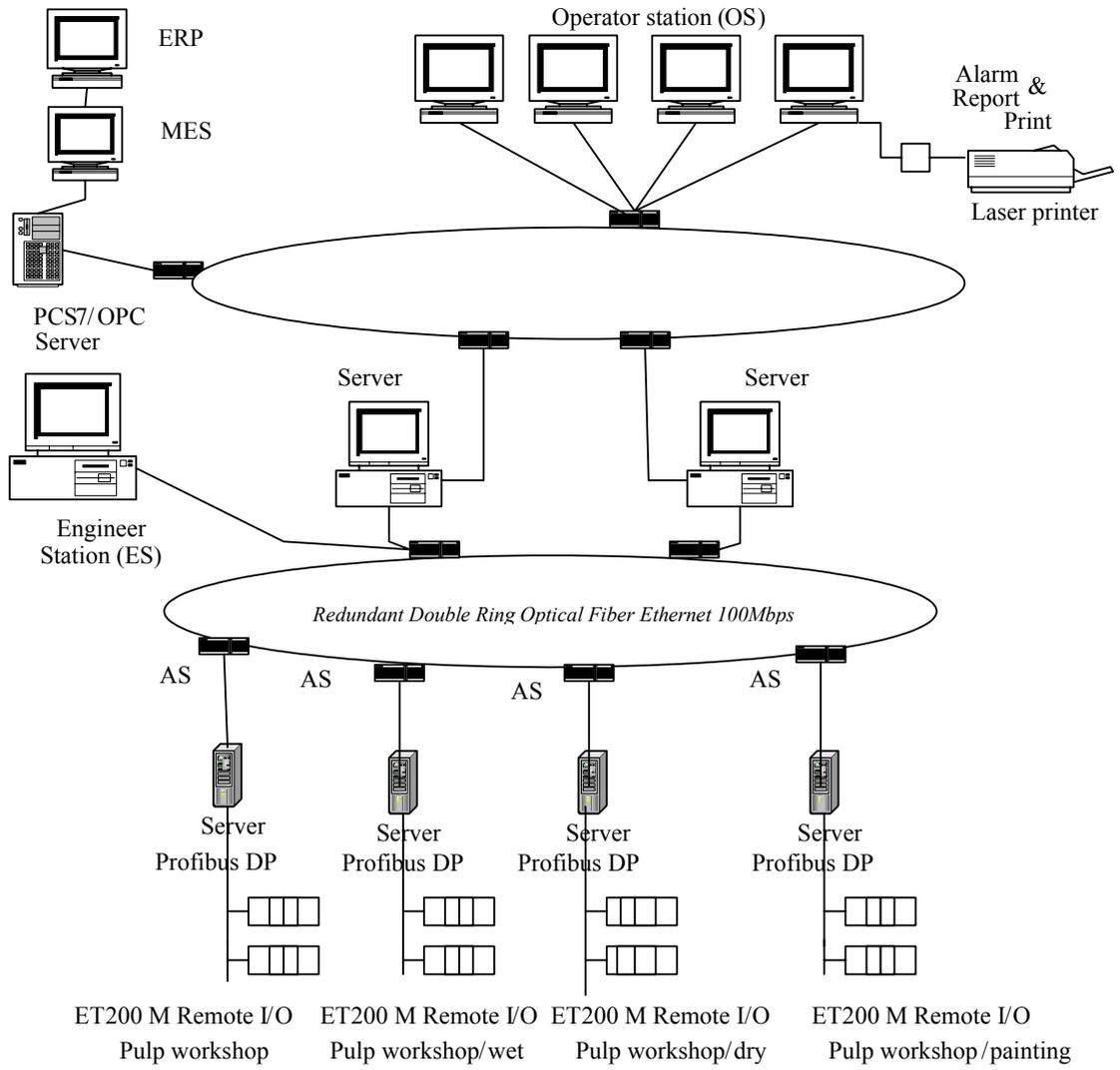


Figure 2. CIPS Application Project of Papermaking Corporation