Application Research of Distributed Control Technology in Tobacco Primary Processing Control System

Shengnan Xu, Lin Wang *, Zhilin Tao, Tietuo Tao
Zhengzhou Tobacco Research Institute of Cntc, Zhengzhou, 450001, China
Corresponding Author: Lin Wang, wanglin_328@126.com

Abstract. Cigarette production includes cigarette product design and cigarette manufacturing processes. After the product designer completes the design of the cigarette product according to the requirements of the cigarette production, the process designer develops the cigarette manufacturing process, and the production personnel must manufacture according to the cigarette manufacturing process, in order to produce the high quality cigarette and obtain better economic benefits. The cigarette manufacturing process is based on the specified technical standards, existing machinery and equipment, processing methods and environmental conditions. It needs to organize processes scientifically, arrange time and space reasonably, and require a high degree of continuity and coordination. During the manufacturing process of cigarettes, the shape, size, composition and properties of tobacco leaves are constantly changing. Eventually become the expected product.

1. Introduction
In the process of globalization, the development of domestic tobacco enterprises is facing unprecedented opportunities and challenges. After China's entry into the WTO, the cigarette market is facing the pressure of opening up, and the market competition is more intense. In order to enhance competitiveness, the tobacco industry has carried out mergers and reorganizations and technological transformation activities aimed at improving industrial scale, product quality and brand influence.

The basic requirements for realizing this expected product are as follows: First, in the process of processing tobacco raw materials with a series of mechanical forces, such as pressure, cutting, impact, friction, etc., the damage of manufactured products (tobacco leaves, tobacco stems and cut tobacco, etc.) should be reduced as much as possible in order to reduce wastage. Secondly, it is necessary to make each cigarette fuller and consume less tobacco, that is, to require high filling value of tobacco, to achieve less consumption of raw materials, power and labor, and to produce more and better cigarette products. Thirdly, the quality of each cigarette needs to be stable and consistent. Therefore, besides the quality stability of various raw materials, the technological parameters such as the temperature, moisture content, the proportion of sugar spices and spices, and the proportion of expanded filaments in the tobacco formulation should also be controlled. In order to control these technological process, it is necessary to control a series of process parameters such as flow, pressure and temperature of materials (tobacco, flavors, fragrances, etc.), steam, water and other media.

Cigarette manufacturing process can be divided into three stages: tobacco primary processing, cigarette making and packaging. The tobacco primary process can be divided into five relatively independent process stages: stem pre treatment processing stage, stem segment, leaf segment, cut tobacco segment and blending flavoring stage. In the stem pre treatment processing section, there are some technological processes, such as washing stem and storing stem. In the stem segment, there are
pressing, cutting, warming and humidifying, feeding and flash expansion of the stem. In the leaf section, there are some technological processes, such as slicing, loosening and moisture regain, warming and humidification, feeding and storing blade. In the cut tobacco section, there are the process of cutting, expanding and drying. In the blending and flavoring section, there are the process of blending expanded cut tobacco, expanded cut Stem, expanded paper making cut tobacco and adding cigarettes flavors.

The purpose of warming and humidifying is to improve the moisture and temperature of leaves and stems, to meet the technological requirements of cut tobacco and to improve the absorptive capacity of leaves and stems to flavor. Tobacco drying is to control the final moisture content of finished tobacco. Blending is to make certain kinds of tobacco evenly mixed together according to the set proportion. Flavoring is mainly to supplement and improve the aroma of products. The purpose of storing cut stems and cut tobacco is to make the cut stems and cut tobacco with water, flavors and fragrances permeate uniformly in the storage cabinet. In these processes, real-time control of process parameters is needed.

2. Design Principles, Implementation Scheme and Hierarchical Structure of Control System for Tobacco Primary Processing Line

2.1 Design Principles of Control System for Tobacco Primary Processing Line

(1) The control system is stable, reliable and advanced, with perfect manual/automatic control function, adjusting function of process parameter setting, safety protection function, simple man-machine interface and easy operation and maintenance.

(2) Advanced control mode and new process equipment.

(3) The division of equipment control section is reasonable and clear, which meets the requirements of process production and information management.

(4) The combination of centralized control and decentralized control facilitates both management and field operation, installation, commissioning and maintenance.

(5) Easy to operate, clear and friendly interface, easy to maintain.

(6) Strict device selection ensures high reliability and safety of the control system.

(7) The data acquisition and management functions are perfect, which can meet the requirements of enterprises to implement more scientific, effective and standardized management of production process and the requirements of enterprises'information construction.

2.2 The control of tobacco primary processing line

As described in the introduction of tobacco primary process, the characteristics of tobacco primary process determine that there are many equipment and long layout for tobacco primary processing line, which can be produced in batches. The control of tobacco primary processing line is a hybrid control which combines batch logic control with batch most process control. In recent years, there are two control modes in the control system of tobacco primary processing, as follows:

(1) Sectional centralized PLC control

As shown in Fig. 1, in this way, the whole tobacco primary processing line is divided into several control sections according to the technological characteristics. Each section has a group of PLC control cabinets. All digital input and output signals and analog input/output signals in the control area are connected to the PLC control cabinet through cables, and are centrally controlled by PLC. The advantage of using hard connection between segments is that the distribution of control cabinet is centralized and the configuration is simple. Its disadvantage is that the number of cables is large and long, the interference of analog signal transmission is large, and the faults are difficult to find because of the large number and concentration of cables.
(2) Distributed Control

As shown in Fig. 2, in this control mode, the whole wire-making line is still divided into as many as 1000 control sections according to the process characteristics, but each section has a door PLC control cabinet and several field control cabinets or field I/O box digital input and output signals, analog input/output signals are connected to the field I/O box through the cable nearby. Motor controllers and frequency converters are also installed in the field. All field devices are connected to PLC through field bus. Interlocking and value transfer are carried out between segments through central control room network. Its advantages are: the number of cables is small and short, the wiring is simple, the analog signal is transmitted through the network without interference, the fault is easy to find and locate, and it can save manpower and material resources to monitor the whole line through the network.
2.3 Structural Hierarchy

The functions of the first and second layers are realized in the distributed control system of the tobacco primary processing line of some cigarette factory. For different layers, different environments and requirements require different types of 8-type networks. Because the reliability of monitoring C workstation is lower than that of PLC and server in order to improve the overall reliability of the system, the workstation and field PLC are divided into two different network layers. Each server has two network cards, which are connected with two layers of network, so that the failure of the upper network will not affect the operation of the whole field line and the recording of data. Therefore, from the network structure, the distributed control system of some cigarette factory's tobacco primary processing line can be divided into the following two network levels:

(1) Centralized Monitoring Layer

In the centralized monitoring layer of wire-making line, the main equipment is the monitoring computer and server, which are located in the central control room. The environmental conditions are guaranteed and used for monitoring purposes. The real-time requirement is not high. Therefore, the network structure uses the widely used fast ethernet, which connects two rack servers, three operator stations, one engineer station and one LED large screen real-time data display workstation with a star-shaped switch. The transmission rate is set to 100 Moits hard disk image redundancy of two servers. The state of each other is monitored in real time by configuration software between two servers. Once the master server fails, the redundant partner server takes over the control automatically. When the main control server returns to normal, the control is automatically restored, the redundant partner server automatically returns to the hot backup state, the data of the two servers are fully synchronized automatically, and the function of the operator's workstation can be replaced by each other. The centralized monitoring layer is set up as shown in Figure 3.
(2) Control Unit Layer

The control unit layer network mainly connects the field control devices, namely the field PLC cabinet and server. The network of this layer participates in the real-time control of the scene, which requires high real-time, certainty and reliability of communication. The network of this layer mainly includes industrial ethernet, Profibus FMS, ControlNet and so on.

Profibus is an international open fieldbus promoted by Siemens, which meets EN50170 European standard. Profbus FMS is used to solve the general communication tasks at the workshop level, provide a large number of communication services, and complete the cyclic and non-cyclic communication tasks with medium transmission speed. ControlNet is a workshop-level industrial communication network POI promoted by Rockwell Autonaion. It is customary to use these two networks in conjunction with the PLCs of their respective companies.

Industrial Ethernet refers to a network that is technically compatible with commercial ethernet, but in product design, it can meet the needs of industrial site in terms of material selection, product strength, applicability, real-time communication, certainty, reliability and intrinsic safety. It conforms to IEC 61158121. Because of the compatibility between industrial Ethernet and ordinary ethernet, Industrial Ethernet has been widely used in the control management layer of industrial enterprise automation system. In the control system of some tobacco primary processing line, the monitoring layer is ethernet. If the control unit layer chooses industrial ethernet, the integration and debugging of the system is very convenient. The real-time data in the field PLC can be easily read in the control room or office, and the PLC program can be modified and downloaded. So Industrial Ethernet is chosen in the control unit layer.

Industrial Ethernet mainly has star, ring and bus structure, transmission rate is 10Mb/s, 100Mb/s 1000Mb/s, transmission medium is screen twisted pair, optical fiber. According to the specification of industrial ethernet, the maximum transmission distance of twisted pair without medium dimension is 100 water 2. In the case of communication distance is not too far and interference is not too large, the star structure network using electric switch can be chosen; in the case of distance between control devices is too far, or interference, the backbone network using optical fiber ring network has greater advantages, which increases the reliability of data exchange compared with bus-type and yes-type networks. Therefore, in the control unit layer, six optical fiber switch modules OSM are used to form the optical fiber ring network. Five sets of S7 series PLC field controllers and two servers are connected. They are stem pre treatment processing PLC, stem PLC, leaf PLC, cut tobacco PLC, blending flavoring PLC and two IBM x345 servers. The PLC is connected with the optical switch module OSM through the CP343-1 series communication processor. The transmission rate is 100 Mbls.
The configuration of the control unit layer is shown in Figure 4.

3. Problems Existing in the Traditional System of Tobacco Primary Processing Technology

In traditional cigarette factory, centralized PLC control is adopted in some process sections of the original tobacco primary processing line, relay logic control is adopted in some parts, signal lamp is used to indicate the status of the equipment, manual control is used for temperature and humidity increase, and flavoring container mode is adopted in the flavoring and feeding system. That is to say, there is a set of feeding control system beside each spicing machine, which has no interlock with each other and is limited by the area of the factory building. It is difficult to communicate with each other and can not achieve the overall situation. Only according to the formulation standard issued by the technical department, the proportion of cut tobacco and cut stem produced in each batch is different, resulting in the total number of spices and materials added in each batch is not the same, either the surplus, or the amount of flavors and materials added in each section of the batch is not uniform, which seriously affects the internal quality of cigarettes. The traditional thread tobacco primary processing line has no production management, quality management and equipment management functions. In order to meet the technological requirements, ensure the stability of the internal quality of cigarettes and facilitate the integrated management, it is imperative to reform the primary processing line and control system.

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