Design of Error-proof System Centered on Cigarette Conveying System

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Abstract. In order to better meeting the market demand of "small batch, multi-varieties and multi-specifications", and solve the problem of error prevention in complex production process, this paper introduces an error-proof system centered on the cigarette conveying system. It improves the production synergy efficiency, closely combines production plan and actual execution, and at the same time, it prevents the mismatching and mixing of different tobacco brands. And coordinated control is carried out among MES system, cigarette conveying system, sealing machine and packing machine. Through the design of this system, Ningbo Cigarette Factory reduced the mixing accident to 0%, effectively guaranteed the healthy development of its brands.

Background

The high-speed conveying system is mainly composed of several high-altitude conveying crawlers connected with carton elevator, which is connected with high-speed packers, and air cushion type carton collator, which is connected with box packers, respectively. A method of improving the equipment to solve the idle rotation of motor is mentioned in [1]. A method of collecting fault information from PLC is mentioned [2-3] to improve the efficiency of system fault treatment. The flexible control mode of conveyor line is mentioned [4-5] to reduce the interconnection of key power transmission firmware. But the focus of these contents is mainly on the local transformation of the conveyor line, the use of PLC fault information in system fault treatment, and the improvement of flexible control. There is no systematic discussion on the error prevention and control of the conveyor line.

Main Points of Error-proof Function

The core idea of error-proof control is to take the cigarette brand as the core, the related equipment of upstream and downstream, which receiving production order from MES system, then real-time brand comparisons are made among cigarette making, packaging machine, feeding machine, Filter rod transmitter and switching station. When the comparison is abnormal, alarm information will be prompted by human-computer interaction interface in centralized control system. At the same time, the alarm information is uploaded to MES, of course it will be displayed clearly.

The brand change error prevention control includes four categories: cigarette making and packaging error prevention, tobacco feed error prevention, filter rod feed error prevention, and cigarette switch error prevention.

In cigarette manufacturing factories, cigarettes produced by packers are transported through carton elevator, conveyors and collator, eventually packed into boxes and stored in warehouses. During the whole process, the packaging machine and the sealing machine seem to be connected by the cigarette conveying system, but in fact, the three devices are running independently.

The packer produces cigarettes according to the production order which is issued by MES, and also the sealing machine. Several packers produce cigarettes of the same brand, which are sent to the corresponding sealing machine by manual setting of the cigarette conveying system. Whether the sealing machine is ready, whether the corresponding relationship of the cigarette conveying system is set up, whether the packaging machine can produce and deliver cigarettes should all be
confirmed by manual, and the whole production collaboration process is controlled by manual coordination.

Sealing machine, packaging machine and cigarette conveying system ensure that the three parties keep the same pace at the beginning of production or at the time of brand change production through manual observation and telephone communication, and the production coordination is poor, and once in case of human negligence, serious mismatching and mixing accidents may occur. For example, a sealing machine often corresponds to four packaging machines, when changing the brand, the packer production is completed in different sequence. If the brand-changing occurs on packaging machine which has completed before the other packaging machines which have not finished producing the previous brand, the production of the next brand will be started ahead of time due to the mistake of human coordination and confirmation, which will result in a mixed-brand accident.

The biggest problem is that if there is no full-automatic cooperative production control system, planning management of enterprise information layer is separated from production control system, and planning management system needs to be handled manually. Work order execution time is not synchronized with actual production time, which results in the disconnection between production management of upper planning level and lower execution level.

In order to better solve above problems, the Design of error-proof system centered on cigarette conveying system should cover the following four aspects:

1) Interconnection across different systems
2) Information interaction between upstream and downstream industrial control equipment in terms of production preparation, production brand changing and production ending based on the start and stop of work orders.
3) Consistency comparison of production brands
4) Establishment of human-computer interaction interface, prompt of collaborative information and lock-in function in case of brand mismatching and mixing accidents.

The full period of cigarette error-proof system can be shown as figure 1.

![Figure 1. Full Period of Cigarette Error-proof System.](image)

**Error-proof Management Objectives**

In order to better meeting the market demand of "small batch, multi-varieties and multi specifications", there are so many different brands in cigarette manufacturing workshop, and the number of brand changes is frequent. In order to improve the production synergy efficiency in
this situation, closely combine the plan and the actual production execution, and completely eliminate the occurrence of brand mismatching and mixing accidents at the same time, also ensure that the corresponding relationship between packing machine and sealing machine can remains fixed for a relatively long time, the production brands of upstream and downstream equipment are consistent, and the equipment managers are prevented from changing the wrong path and execution errors, it is necessary to coordinated control MES, cigarette conveying system, sealing machine and packing machine.

Through the realization of the whole supply chain management function of the conveyor line, the following four management objectives are achieved, which is shown as figure 2:

1. Full supply chain data integration links packaging and sealing logistics

Accurate collection, integration, analysis and sharing of production process information of packaging and sealing which are carried out by batches, and full integration on MES is realized by using conveyor line as a bridge. Product supply chain management can be established, finally achieve accurate control of production value chain.

2. Whole Process Production Control

In the whole supply chain management, the production value chain data is divided into small batches, and the minimum packaging unit data is taken as the basis to create a safe production environment, which is mainly embodied in the quality tracking management of cigarette packaging, conveying and sealing processes, so as to reduce the occurrence of quality problems and traceability of quality problems.

3. Data Application of Whole Supply Chain

Through the whole supply chain management mode, we can get through the data association of different business domains, introduce the technology of big data, establish the model of automatic judgment, dynamic simulation and value control, directly provide data support for business and decision-making problems, and enhance the value of enterprise data.

4. Overall Management Synergy

Based on the whole supply chain management platform and the production value chain data of small batch size, the collaborative management of production quality and efficiency is realized, the collaborative optimization of production quality and production efficiency is realized, and the effective linkage management is followed up through early warning on abnormal.

Figure 2. Whole supply chain management of conveying system.

Summary

Through the further improvement of this function, and the construction of correlation foundation, the data of packaging, conveying and sealing processes can be extracted effectively, the digital
simulation centered on conveying system can be realized, and the data twin-body can be constructed. Further we can realize the conveying consumption, conveying quality, conveying efficiency, executing results, and conveying status. The dynamic capabilities of material tracking and comparison are enhanced, as shown in figure 3, which can help to raise the lean innovation ability, and monitoring and early warning ability of manufacturing process.

Figure 3. Smart ecosystem centered on cigarette conveying system.

And in the smart ecosystem, to further maximize the use of data energy efficiency, through the construction of AI, AR and 3A interconnection, the demonstration of intelligent management and control of the conveying system will lead to maximum benefit, and better protect the healthy development of our brand.

Reference

[1] Wang Libin, He Quan. Application of cost management on cigarette carton transportation equipment [J], Technological Development of Enterprise, 2014, 33(16): 103-104.
[2] Xu Zhenzhen, Qi Zhendong, Fan Lifeng. Design of Fault Statistics System for Tobacco Conveyor Line Based on Profinet Protocol [J], Information System Engineering, 2016(6):33-35.
[3] Zhang Weifeng. Design of Fault Diagnosis and Remote Control Function for Tobacco Conveying System [J], Digital Technology and Application, 2014(12): 155-156.
[4] Zhang Weifeng. Design and Reform of Single-channel Independent Driving System for Tobacco Conveyor Line [J], Plant Maintenance Engineering, 2019(11): 81-82.
[5] Liu Zhenya, Zhang Nan, Tan Pengfei, etc. Design and Application of Power Flexible Control Device in Single Clutch Cigarette Conveyor Line [J], Plant Maintenance Engineering, 2014(4): 55-56.