Research and Application of AGV Technology in Tobacco Industry Logistics System

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Abstract. With the development of modern logistics technology, AGV has been widely used in logistics system of tobacco industry as automatic logistics equipment. In this paper, we introduce the research and application of AGV technology in tobacco industry logistics system illustrated by the case of Hangzhou Cigarette Factory in the "11th Five-Year" technical innovation, and provides a reference for the similar system construction.

Introduction

AGV (Automatic Guided Vehicle) is a kind of advanced automatic logistic equipment, which has the characteristics of high automation, good safety and flexible line. It has been widely used in the foreign automated logistics system. However, China began its commercial applications in 1990s [1]. At present, AGV is mainly used in optical manufacturing, tobacco, automotive, banking, printing and other industries.

The tobacco manufacturing industry has the features of large material flow, many transport links, automatic production process, high degree of flexibility and strict information management requirements. AGV meets the above requirements greatly [2]. Hangzhou Cigarette Factory began to introduce the AGV of Swisslog in late 1990s and transformed to AGV of KSEC in the "11th Five-Year" technical innovation. Meanwhile, the management and control system of AGV changes from NT700 to NT8000. Hence, Hangzhou Cigarette Factory has accumulated an amount of practical experience in use and maintenance of AGV during the period.

We introduce the research and application of AGV technology in tobacco industry logistics system illustrated by the example of Hangzhou Cigarette Factory in the "11th Five-Year" technical innovation, and provides a reference for the system construction in tobacco industry.

AGV Operational Principle

When the system is working, NT8000 assigns the tasks to the well-state AGV, which is closest to the mission work point (determined by the time the vehicle travels on the planned path) through the wireless LAN automatically. AGV travels to the work site in the pre-determined path according to the task command. AGV confirms its current position and direction by the laser scanner in the top, which can collect reflector laser beam to achieve accurate guidance by continuous trigonometric geometry.

AGV communicates with management control computer through wireless LAN. Meanwhile, AGV reports its state and task completion to the scheduling system at any time, and displayed on the graphics control system.

NT8000 will manage the operation of the AGV automatically. AGV can avoid traffic-jam if the huddle is congested due to the concentration of the vehicle in some sections, where NT8000 can handle it to smooth the running of AGV automatically.

When the AGV battery power is low, it will request charging issued by the management control system charging instructions, and then AGV automatically travel to the charging station for charging. The beginning and ending signal of charging, collected by the signal acquisition system, which reported to the management control system for control and regulation.
AGV System Structure

The structure of AGV system introduced by Hangzhou Cigarette Factory is shown in Figure 1. It is mainly composed of management dispatching computer, NT8000 (AGV management control and monitoring computer), laser guiding vehicle, wireless AP, digital I/O, charging station and network communication equipment[3]. AGV system operates under NT8000, and receives instructions through the Ethernet and wireless AP.

AGV Business Process Design

Since the "11th Five-Year" technical innovation, Hangzhou Cigarette Factory comprises more than 60 sets of equipment and 256 working sites covering 10 types. Besides, Hangzhou Cigarette Factory introduces 16 BJ311-type AGV of KSEC, 8 charging stations.
The material storage is in the form of a three-dimensional warehouse. Material is assorted into pallets, scanned code with relative information, transported to the shelf by the conveyor and stacker. Workers click touch screen for the required material. After receiving the request of the material triggered by the machine, the system will automatically generate the task according to the storage condition, and assign it to the specific stacker. The stacker will send material into the delivery conveyor, then the conveyor will transport material pallet to the AGV docking station by the task instructions ordered by the library scheduling system. NT8000 assigns the task to well-state AGV, which is closest to the material pallet station by warehouse management systems (WMS). Afterwards, pallet is transported to the needed site by AGV, and the task completion information is sent to the WMS.

When the material on the working stage is almost exhausted, workers can directly click touch screen to call the empty pallet recovery. First, the AGV will reclaim the empty pallet, and then the stacker will start the material out of stock and AGV will transport it to the corresponding position. The specific business process shown in Figure 3.

**Figure 3. Material out of stock and empty pallet recycling flow chart.**

**Ultrahigh Speed Cigarette Packing Equipment**

Hangzhou Cigarette Factory introduced 5 sets of PROTOR-M8 after "11th Five-Year" technical innovation. The introductions of 5 PROTOR-M8 are leading level of ultrahigh speed cigarette packing equipment in the world (production capacity of 20000 ton / min).

PROTOR-M8 cigarettes’ material supply has been fully automated. Cigarette paper, tipping paper is automatic feeding, and the region is a closed system achieved by the BD device. Cigarette paper,
tipping paper material pallet tasks, empty pallet recovery, the remaining material recycling are all achieved automatically by the BD system.

The WMS and BD, the WMS and AGV, are connected through Ethernet. AGV and BD do not directly communicate. They exchange information through WMS. In order to ensure the safety of the AGV and BD, safety interlock information interface protocol is designed specifically. The safety interlock information is the required linkage information between the AGV and the BD when the AGV enters the BD safety door. And it is connected through TCP/IP, unified by the WMS, as shown in Figure 4.

AGV information exchange in loading: <1>AGV travels to the BD security front position; <2> AGV send "AGV loading application"; <3>the security door system open the security door after determining the robot position and the status of cargo loading status ; <4> When the security door opens, the BD system sends the message "Allow AGV to enter the BD"; <5> AGV enters the platform to carry out the loading work; <6> AGV comes out and sends the "Loading Complete" message after the job is finished; <7> The door closes automatically.

AGV information exchange in unloading: <1>AGV travels to the BD security front position; <2> AGV send "AGV unloading application"; <3>the security door system open the security door after determining the robot position and the status of cargo loading status ; <4> When the security door opens, the BD system sends the message "Allow AGV to enter the unloading"; <5> AGV enters the platform to discharge the cargo; <6> AGV sends out the "unloading complete" message after the job is finished; <7> The door closes automatically.

**Figure 4. Ultrahigh speed cigarette machine automatic call communication structure.**

The Model of Production Waste Automatic Recovery System

After the "11th Five-Year" technical innovation of Hangzhou Cigarette Factory, the original artificial waste recycling form cannot meet the requirements of new workshop. A new model of waste automatic recovery is urgently-needed.
AGV system running one year later, AGV control system and stand-alone equipment run stable and fully meet the production needs. According to the design requirement of the pre-technical ability, with the maximum compound efficiency of 15%, 16 sets of AGV are equipped, and the utilization rate of the equipment is 77.93%. Considering the premise of AGV capacity surplus, technicians designed and developed automatic recovery of production waste based on AGV mode.

The new production waste recycling mode, AGV equipment as the carrier, AGV took a special metal scrap recycling barrels, according to the plan to develop a fixed line (production line), timing, fixed-point to the charter stage recycling waste. WMS’s time server triggers request task recycling production waste to the AGV management and control system (NT8000), finally NT8000 dispatching task to the free AGV.

After the waste recycling task is generated, AGV receives the task to the garbage transfer station to the waste recycling bucket, and then presses the task instruction to the target station to designate the place to move, staying 1 minute in designated place. Workers can pack waste bag into the AGV waste recycling bin. According to the workshop production and waste capacity, the current average of about 90 minutes for AGV touring the work place. Accounting into the shift-shift time, dining and other special time, the waste recycling time was further adjusted to optimize and maximum recovery rate. The new waste mode has been well received to improve the level of plant management at the scene.

![Image](image.png)

Figure 5. The model of production waste automatic recovery.

**AGV Maintenance**

According to the daily operation of AGV equipment, workshop equipment management and AGV use and maintenance requirements, the workshop has developed AGV maintenance plan. At present, the workshop uses the daily maintenance and regular maintenance.

The workshop is arranged two days a week to maintain 4 AGV respectively, including safety protection device inspection, hydraulic system checks, drive system checks, laser navigator and obstacle detection device inspection, drive system checks, charging boots and Brush cleaning, body shell cleaning and fork lift encoder error accumulated.

Every year, equipment factory staffs arrange AGV maintain. The main contents include hydraulic oil replacement, pump filter cleaning, reducer gear oil replacement, drive and steering motor carbon brush inspection and replacement, battery pack distilled water supplement, battery activation and so on.

In order to improve the efficiency of AGV maintenance, workshop designed AGV maintenance platform, as shown in Figure 6. The maintenance platform comprises a frame, two lifting cylinders, a cross bar, a hydraulic power unit, an electric control cabinet and a button switch. The frame comprises two side frames and a rear frame, the two side frames are respectively fixed on the rear vehicle, and two side frames are parallel to each other. Two hoisting cylinders are respectively arranged on two
side frames. The top of the two lifting cylinders are connected by a cross bar, and the middle part of the cross bar is provided with a hoisting cylinder for hoisting AGV. And the middle frame of the side frame is further provided with a supporting rod, a hydraulic power unit, a control cabinet and a push button switch fixed on the rear frame. The side frame and the rear frame connection corner also have a caster at the bottom of each side frame which is provided with a directional wheel. The development of AGV maintenance platform, benefits to both AGV maintenance and solving the AGV running on the way to smooth the flow of material transport, improving material transport efficiency.

![Figure 6. AGV maintenance platform.](image)

**Conclusion**

For Chinese Tobacco, although after years of development and efforts, industry has initially realized the factory automation. But in accordance with the requirements of intelligent factories, there are still many weak links and need to break through the bottleneck. Through AGV and other automated logistics technology applications in China's tobacco industry, it provides a practical way to build digital, information technology, intelligent cigarette factory.

For the tobacco industry, the road leading to the intelligent factory will be a difficult process. But the transformation from manufacturing to intellectual is the only way.

**References**

