Design of the control system for the delivery of the wallboard to kiln

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Abstract. With the development of the assembly building and the increasing demand of the wall plate, it is important to realize the efficient and automatic production of the wallboard. The main task of the end of the wallboard automation production line is to deliver the wallboard to the kiln. At present, the wallboard production line is mostly realized by the track folding car, the process is complicated and the cost is high. Based on this, the paper designs the PLC-based kiln system and the Meina wheel-based handling system respectively, which can be effectively combined through the ranging sensor device etc., so as to ensure the accuracy and reliability of the wallboard to kiln. The control system for the delivery of the wallboard to kiln introduced in this paper can effectively reduce the construction of the plant area under the premise of ensuring the accuracy work.

1. Introduction to wall panel production line

The construction of the building gradually develops to the assembly type. The wall panel consumption market has a bright future[1]. The production process of wallboard is composed of many steps. It is meaningful to realize the splicing of each part, reduce the time waste between the steps and realize the efficient and automatic production of wallboard. The automatic production process of wallboard is roughly as shown in Figure 1.

The wallboard is produced on the template by extrusion molding machine. The template is provided by the template placement system. Template placement system uses the Cartesian coordinate palletizing machine to carry out the template code[2]. The material is provided by mixing station. The wall blank is sent to the cutting system by conveyor belt for cutting, the cutting remainder is recycled and reused by the recycling unit, the cutting wall blank is palletized by blank palletizing system, and then sent to the maintenance kiln system for maintenance. After the maintenance of the wall board is taken out, the wall board and the template are separated by palletizer, and the template is washed and sent back to the on-line sheet of the template. The wall panels are packaged and stored to complete a cycle of production.
In the whole working process of the production line, the right-angle stacker and mixing station have been used in many industrial occasions for a long time[3]. At present, they are very mature. In the design process of the maintenance kiln system, it is difficult to directly apply some conveying platforms in other industrial fields. Therefore, many wallboard production lines use folding carts to carry out wallboard. The transport is actually shown in Figure 2.

Taking X direction as the transverse direction and Y direction as the longitudinal direction, the folding trolley can be divided into two parts: the transverse trolley and the longitudinal trolley, which are folded together to form a folding trolley[4]. The transverse trolley is responsible for carrying the longitudinal trolley to move in the X direction, while the longitudinal trolley is responsible for carrying the wallboard to move in the Y direction. That is to say, the transverse trolley carries out the selection of different tunnels for the maintenance kiln, and the longitudinal trolley carries out the transportation of the wallboard. The combination of the two can transport the wallboard to different tunnels for the maintenance kiln.

Using folding trolley to transport wallboard can ensure the accuracy and reliability of the transport, but this way requires track design to ensure the smooth movement of the trolley, also requires a large number of proximity switches and other sensor devices for positioning, which on the one hand increases the difficulty of plant construction, on the other hand, makes the control system more complex.

2. Maintenance kiln system design

2.1. Overall structure design of curing kiln

The overall structure design of curing kiln is shown in Figure 3.
Maintenance kiln system is composed of several kiln paths, both sides of the kiln paths are equipped with wallboard stacking racks, carrying trolleys to the stacking racks, each kiln path has a kiln door, but also equipped with a movable longitudinal baffle, and the side of the moving path of the carriage fixed baffle.

2.2. Control system design of curing kiln
The control system of single Kiln Road is shown in Figure 4.

In the initial state, the kiln door closes and the longitudinal baffle rises. After the system starts, as shown in Figure 3, the first kiln door opens and the corresponding longitudinal baffle falls. The photoelectric detection switch is mounted on the wall of the kiln passage which is a short distance from the inside of the kiln door. It is used to detect whether the wall panels have been stacked to the position of the kiln door, that is, whether the kiln passage is full or not. The proximity switch is triggered when the delivery cart reaches the kiln door. In order to determine whether it is an optoelectronic detection switch triggered by a wall panel, the trigger is timed when the switch is triggered. If it lasts 10 seconds, the trigger is proved to be a wall panel trigger rather than a moving cart. After determining the proximity switch triggered by the wall panel, the kiln door closes, the adjacent kiln door opens, the longitudinal baffle corresponding to the adjacent kiln door falls down, and then the wall panel of the adjacent Kiln Road is stacked.

3. Transport system design

3.1. Selection of handling platform
McNam wheel platform uses different speed combinations of wheels to achieve omnidirectional motion without independent steering drive mechanism, stable and reliable system support, simple control process. McNam wheel has two forms: A and B wheels, which are mirror images of each other. When A wheel moves forward, its speed can be decomposed into two directions of solid line, namely X+ and Y+ direction[5]. When A wheel moves backward, its speed can be decomposed into two directions of dotted line, namely X- and Y- direction. At the two speed, the B wheel receding speed is decomposed into two speeds in X- and Y+ directions.
Figure 5. Decomposition of motion velocity of the canal.

The combinations selected in this paper are shown in Figure 6. AB wheels are used in front and BA wheels are used in rear. When all four wheels are turned forward, the speed of A1 and B1 toward the inside is offset, the speed of B2 and A2 toward the outside is offset, and the car closes in the forward direction, so the car moves forward[6-7].

Figure 6. Schematic diagram of velocity analysis of wheat wheel.

3.2. Prototype design

3.2.1. Structural design of test prototype

The whole structure of the prototype is shown in Figure 7. The prototype includes a moving chassis based on wheels to move the platform; a control center based on STM32 to control the whole machine; a reciprocating electric pusher to pick up and drop the wallboard; a weighing module based on A/D conversion to calculate the weight of the wallboard; and a red-based weighing module; the distance module of the external line completes the distance detection.

(a). chassis (b). controller (c). electric push rod (d). weighing module (e). distance detection module

Figure 7. Whole structure design of test prototype.
3.2.2. Design of control system for test prototype
The overall composition of the control system of the test prototype is shown in Figure 8. Combining with Figure 8, the weighing module is located at the center of the loading platform, and directly contacts with the wall panel to weigh to determine the number of wall panels. There are four distance detection modules, which are located around the loading platform for car positioning. The push rod is connected with the loading platform. The STM32 uses L298N. The module drives the platform to lift, the wheels move by STM32 through BTN module to drive the motor, the encoder is used to constitute a speed closed-loop control, through PID speed adjustment, so that the whole machine operates at a set speed.

![Figure 8. Overall structure of control system.](image)

3.2.3. Upper computer aided software design
The interaction between the prototype and the host computer software can be realized by Bluetooth, serial port, WiFi and so on. The host computer software is written based on serial communication. The software interface is shown in Figure 9.

![Figure 9. Upper computer software interface.](image)

4. Two system coordination
The separate design of the kiln maintenance system and the haulage system has been completed above. The combined use of the two systems is shown in Figure 10.

![Figure 10. Two system matching diagram.](image)

After the system starts up, the kiln door of No. 1 Kiln Road opens, the baffle 1 falls down, the
parameters of the car are set by the upper computer software, the stacker works after setting. Placing the wallboard on the car, and the weighing device on the car carries out weight detection. After the weight reaches the preset value, the car begins to transport the wallboard. At this point, infrared ranging device 1 for distance detection, detection value is the distance from the car to the kiln door, according to the preset value can determine whether the car reached position B, after arriving at position B, the car moved to position C, at this time infrared ranging device 4 for distance detection, detection value is the distance from the car to the baffle 1, compared with the preset value can be. Determine whether the car moves to position C, and then the car moves toward position D. Infrared ranging device 1 detects the distance. According to the preset value, the car can reach position D. After reaching position D, the push rod shrinks to complete the wall panel lowering. Similarly, the infrared ranging device 2 and the infrared ranging device 3 make the car return to the initial point according to the D-C-B-A motion.

5. Summary
The wall panel kiln entry system designed in this paper is simple in structure, simple in control process, accurate and reliable. It is of great significance to improve the quality of automatic production line of wall panel.

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