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Control Systems of Rubber Dryer Machinery Components Using Programmable Logic Control (PLC)

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Abstract. Application of programmable logic control (PLC) is widely used on the control systems in the many field engineering such as automotive, aviation, food processing and other industries [1-2]. PLC is simply program to control many automatic activity, easy to use, flexible and others. PLC using the ladder program to solve and regulated the control system component. In previous research, PLC was used for control system of rotary dryer machine. In this paper PLC are used for control system of motion component in the rubber dryer machinery. Component of rubber dryer machine is motors, gearbox, sprocket, heater, drying chamber and bearing. Principle working of rubber dryer machinery is wet rubber moving into the drying chamber by sprocket. Sprocket is driven by motors that conducted by PLC to moving and set of wet rubber on the drying chamber. Drying system uses greenhouse effect by making hanger dryer design in the form of line path. In this paper focused on motion control system motors and sensors drying rubber using PLC. The results show that control system of rubber dryer machinery can work in accordance control input and the time required to dry the rubber.

1. Introduction

Application of control systems are commonly found in the engineering field such as automotive, manufacturing, food processing and other industries [1-2]. The control system is used to manage and arrange how to make the product by automatically processing. To control of motion component, control machine, control equipment, control of manufacturing process and quality product must using control system mechanism. Control of motion component can be seen at the conveyor, motors, servo, pump, gearbox, blower and sprocket. This control system has been used for manufacturing process, CNC machine, cutting process, assembly and joining by robot. In the food processing industry, the control system can be seen in the process of separation of the initial product, washing, transfer of food, packing process and quality control of product. In rubber industry control system are used for regulate of production processing like cleaning rubber processing.

Control system have open and close loop systems, which a system have some advantages and disadvantages. Open loop system is easily to use, simply program, easy to maintenance, cheaper and no need feedback information from output system. For close loop system the program is complex, high accuracy, more expensive and feedback from output is required. Control system can be create by using microcontroller, PLC and others programming [1-2]. The language program for control system used assembler language, C ++, ladder program and other programming languages. In this paper we

will focus for control system on the drying rubber processing. This control are used to get good quality of rubber dry, short time processing and smaller area for drying. Smart Relay Zelio PLC type and ladder languages programming is applied to control system mechanism by close loop system. Ladder language programs are used because simpler programming, easier to operate, flexible and can be changed faster without stopping running processes.

PLC system for rubber processing is applying by using greenhouse effect to drying a rubber. Greenhouse effect to drying rubber have some component such as drying chamber, wet rubber hanger, hanger tracking rail, sprocket and shaft, heater, blower, drive motor and sensor. Temperature sensor, motion wet/dry rubber sensor and heater sensor is applied in this system. All sensors activity and motion component of dryer machine is control by Smart Relay Zelio PLC using ladder programming language. In previous based on the processing of rubber especially crepe drying is done naturally by dried in the open space/area where as drying time required 12-14 days depend on the climate/weather. If the weather conditions is rain so drying time will be longer and rubber quality become decreases.

To solve a problem of rubber dry processing so in this paper we designed a rubber dryer machinery using PLC system. The drying process utilizes the greenhouse effect which heat from solar is enclosed in drying chamber made of glass.

The working process of control system of drying rubber is a wet rubber hung on a hanger installed outside drying chamber. Furthermore the PLC system will instruct the motor to move the hanger running on the track rail to enter wet rubber into the drying chamber. By setting time for enter of wet rubber into the drying chamber then starting of drying process using solar heat and heater. If solar heat condition is low due to cloudy/rainy/night so heater will be active to support heat into the drying chamber. The movement of rubber and heat into the drying chamber is arranged and control according to the condition of the rubber. If temperature inside of drying chamber is high then the blower be active to support the air to decrease of temperature.

2. Methods

Programmable Logic Control (PLC) [3-6] is a programmable for control system be able to communicate with the networking and easier to operation. In automation systems PLC playing important rule for control system, which can monitor the state of the system through signals input, and determine the action control of the output equipment. PLC have good ability to control system, simple tasks over and control more complex processes.

PLC consists of several models or types power supply, number of I/O terminals, and output circuit. Type of PLC power supply is AC and DC, the number of I/O depending on PLC brand. One PLC unit sometimes has 10 into 60 I/O terminals or up to 100 I/O. The I/O ratio is 3: 2 for PLC with 10 I/O terminals having 6 input and 4 output terminals. For output circuit in PLC there are 3 types: relay output, output of sinking transistor and output saucing transistor.

PLC has several advantages, namely:

1. Use wire for PLC control system is less.
2. Easy in modifying the control system without changing the wiring.
3. Does not require a control component such as timer for connecting equipment system output to the power source.
4. Operating speed of PLC system is very fast and high productivity.
5. PLC costs are cheaper.
6. PLC control system is more reliable.
7. PLC control program can be printed quickly.

PLC system in the rubber dryer machinery is control some component namely;

1. Temperature in the drying chamber.
2. Motion of drying machine components such as motor, sprocket, gearbox, chain, blower and heater.
3. Air exhaust and color of dry rubber.

Rubber dryer machinery consist of:

1. Drying chamber from acrylic.
2. Frame hanger and chain holder of wood, iron and steel.

3. Hanger rubber clamp from iron material.
4. Shaft of the gear holder of steel material.
5. Gear.
6. Hanger rubber clamping rail.
7. Temperature sensor.
8. Motion sensor.
9. Motor.
10. Chain.
11. PLC.

Stage manufacture and testing of control systems on rubber drying machines include:

1. Design and manufacture of control system using PLC for greenhouse effect drying machine (See Fig. 1).
2. Preparation of motion component of greenhouse effect drying machine.
3. Modeling of component control system with ladder programming language and PLC.
4. Testing of drying control system using PLC includes drying time, drying temperature, drying capacity, efficiency of rubber motion control system.

Dimension of rubber for experimental performance control system of rubber dryer machinery is thickness 10 mm, length 100 mm with width 50 mm and 150 mm with width 75 mm as shown in Fig. 2. The ladder programing language before using PLC has been tried in PC as shown in Fig. 3. Ladder program language consist on the motor, motion wet rubber sensor, temperature sensor, blower and heater. Setting time and number of hanger inside of dryer chamber is 3 second and 12 hanger with hang of wet rubber. After the wet rubber put in the hanger, the motor become active to moving chain insert of wet rubber.

3. Results

The result of manufacture and testing of control system of rubber drying machine by using PLC can be seen in Fig. 1. Figure 1 show that the dryer process and control system components have been installed on the rubber dryer machinery working in accordance with the input. The ladder program for this motion control system can be seen in Fig.2. After the system is functional well than it is connected to the rubber dryer machinery. The result show that the drier engine actuator component works according to the command input to the PLC.

The result of experimental of rubber drying with dimension of 100 x 50 mm and thickness of 10 mm can be seen in Table 1. Temperature setting on drying chamber is 32^0C-70^0C which the resources from the solar heat and heater. When the wet rubber is hung on the clamp hanger, the motion sensor give input signal to PLC to activate the motor to move the running chains on the guide rail. And PLC will activate the heater if the room temperature is higher than 70^0C or temperature is less than 32^0C. If the temperature more than 70^0C the blower will activate to dropout the hot air in the drying chamber.

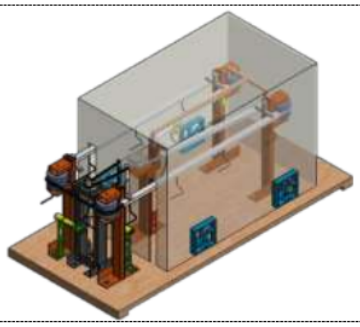

Figure 1. Control System Components Dryer Rubber Machinery

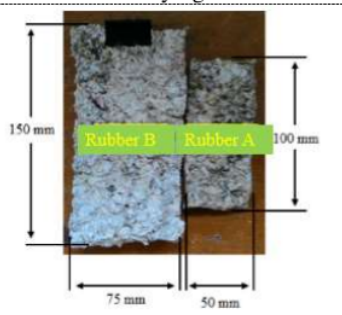

Figure 2. Dimension of Rubber

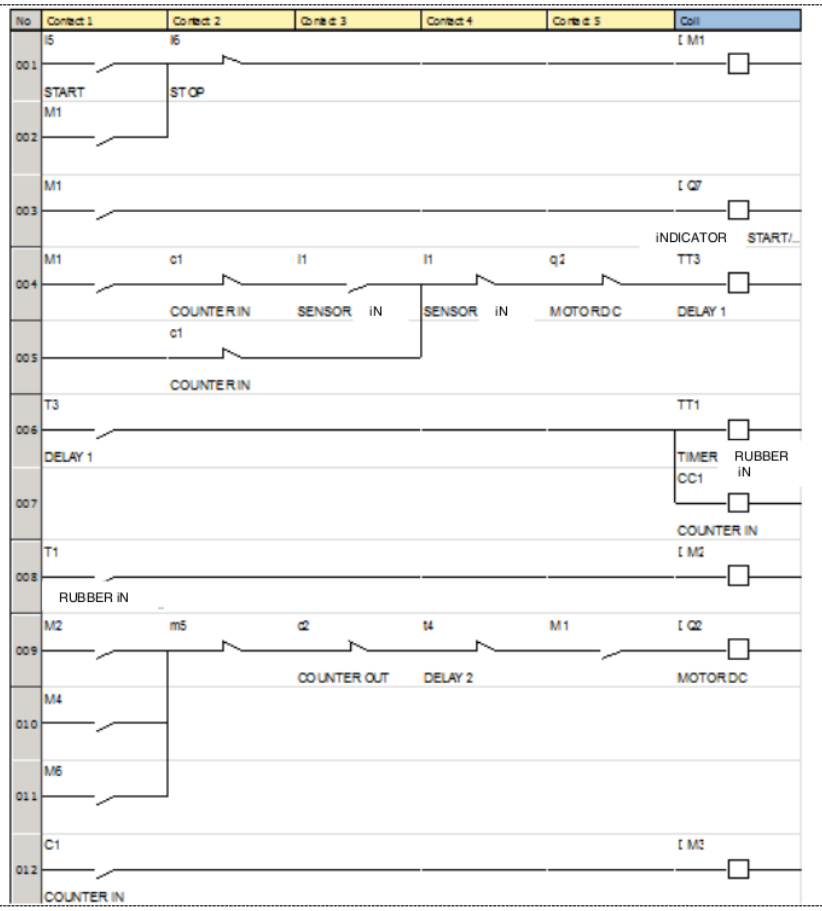

Figure 3. Ladder Program Control System Components Dryer Rubber Machinery

Table 1. Water Quality and Weight of Rubber before Drying Processing

Number Hanger of Rubber	Ave. Water Quality (%)	Weight (gram)
1	23,40	40
2	24,85	40
3	26,00	40
4	23,64	40
5	25,42	40
6	23,07	40
7	24,78	40
8	22,71	40
9	23,07	40
10	23,42	40
11	23,21	40
12	21,92	40

The amount of time required to dry the 12 piece of rubber with the dimensions of 100 x 50 mm from the initial temperature of 32 ^{0}C to the final temperature of 70.2^{0}C is 109 minutes. For wet rubber the moisture content 23-26% and weight 40 grams after drying processing become 30 grams and 0%. These data show that in rubber testing the weight is reduced 10 grams and in other words the motion control system on the rubber dryer machine can function well to dry the rubber. The amount moisture content of dry rubber from beginning until the end of drying process can be seen in Table 1 and 2 with the amount of dried rubber 12 pieces.

Table 2. Water Quality and Weight of Rubber after Drying Processing

Number Hanger of Rubber	Ave. Water Quality (%)	Weight (gram)
1	0	30
2	0	30
3	0	30
4	0	30
5	0	30
6	0	30
7	0	30
8	0	30
9	0	30
10	0	30
11	0	30
12	0	30

4. Conclusions

From the results of control system and performance of rubber drying machinery using PLC was concluded that:

1. The motion control system and the temperature of the rubber drying machine the greenhouse effect by using a PLC can work well to drying the rubber.
2. Time required for drying rubber is 109 minutes from initial temperature of 32^{0}C to 70.2^{0}C.
3. The moisture content and the final weight of dry rubber is 0% and 30 grams while the initial conditions of wet rubber is 23-26% for the moisture content and weight of 40 grams.

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