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Research Article

Application of Control System Based on S7-300 in the Producting of Pu'er Tea

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Abstract: Aim to the workshop temperature and humidity fluctuation is bigger influence the stability of the pu-erh tea ripe tea fermentation quality and the production efficiency of the enterprise. Control system is developed based on S7-300, it can automatically adjust the workshop environment temperature and humidity. According to the conditions for pu 'er ripe tea production, the S7-300 PLC control system overall scheme is put forward. The system is divided into data acquisition and workshop control two parts. Data acquisition part can automatically collect workshop environment temperature and humidity, tea reactor temperature; Control part can automatically adjust according to the need of production workshop temperature and humidity and ventilation oxygen. The small artificial fermentation environment is created and it can improve the uniform of the pu-erh tea ripe tea fermentation efficiency, shorten the fermentation period. Finally by analyzing the collected data, the results of the analysis verify the control system is feasible. This study provides the technical support for the late pu'er ripe tea production quality control and automation.

Keywords: Control systems, S7-300, tea, temperature and humidity

INTRODUCTION

The yunnan big-leaf tea which is also called C. sinensis var. assamica is taken as materials to develop Pu-erh ripe tea. Then fermentation process is applied (Chen *et al*., 2006). pu-erh tea is a typical tea of Yunnan, according to the unique processing technology and method of storage puer tea, it has the characteristic of health care effect (Wu, 2012). Based on the special health care efficacy of pu-erh tea, the tea consumption group is growing stronger and stronger in recent years. But the puer tea production enterprise production conditions and technological equipment is not optimistic (Bao *et al*., 2008). According to Zhao *et al*. (2012) and others research, pu 'er tea processing of clean production, low degree of standardization and scientization are under a low degree. And pu 'er tea processing technology and equipment lags behind that of developed countries generally 10 to 20 years, pu 'er tea processing can't meet the requirement of people. To improve the efficiency and safety and health, puer tea fermentation equipment is developed by Huang Yunzhan (Yunnan Agricultural University, 2010), but it is still in the experimental stage.

In pu 'er ripe tea production process, the application of modern technology level is low, the w pile fermentation is an important part in pu 'er ripe tea production, during this section, the manufacturers are the tea stored directly on the ground to pile fermentation, the pile fermentation progress and quality is highly affected by the environment and climate change. "pile fermentation" is the essence of a variety of microorganisms involved in solid-state Fermentation, Solid State Fermentation, SSF) process, the chemical change caused by heat effect and microorganism is happened in this process. Good sensory quality and the unique health care efficacy with the characteristics of gan, fragrant and mellow is produced (Gong *et al*., 2005). During the fermentation process, Oxygen is the essential condition of solid-state fermentation of the tea, tea polyphenols in fermentation, aldehydes, ketones, lipids, vitamin C and other substances can be automatically oxidation, but the oxidation of tea polyphenols needs a large number of oxygen and enough oxygen to make solid state fermentation of oxidation can be smoothly.

According to the essential conditions of puer tea fermentation, this control system can automatically detect the workshop environment temperature and humidity, tea of temperature and humidity. It can also control the temperature and humidity of workshop, workshop ventilation rate and other important parameters, which can create the right conditions for puer tea fermentation production. So this study designs a set of S7-300 as the core intelligent control system, it can obtain the environment parameters and tea temperature occasionally. Simultaneously, according the demand of the manufacturer, it can coordinate the environment temperature and humidity, ventilation, these can also create the best artificial small bad border, increase the production efficiency of puer tea fermentation and fermentation stability.

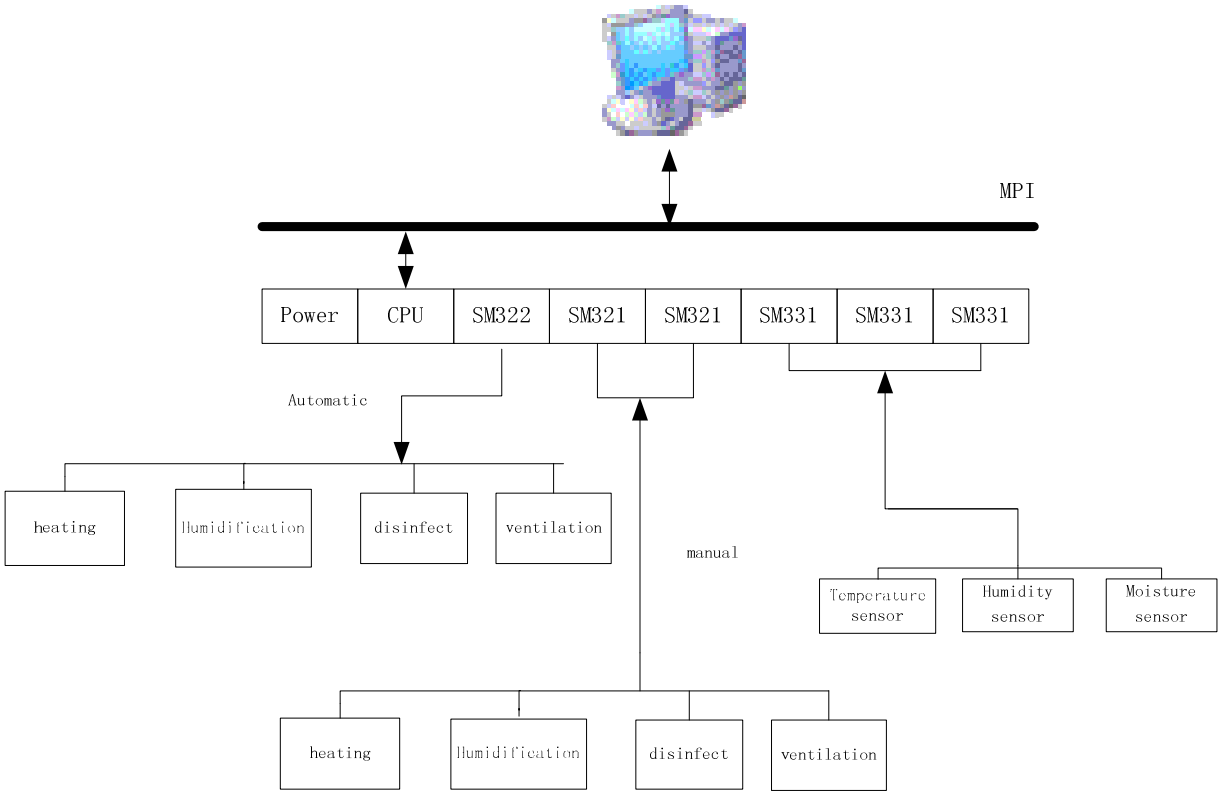

Fig. 1: Block diagram of control system

THE GENERAL DESIGN OF CONTROL SYSTEM

According to the Pu'er Tea production requirements, the control system is divided into data acquisition and control part two. The core of the control system is the central processing unit module of CPU 315-2DP, which has PROFIBUS DP master/slave interface, can be used for large-scale I/O configuration, can be used to build distributed I/O structure and has the advantages of large scale, program storage capacity and data structure, has the high processing ability of the binary and floating point numbers. Acquisition section with 3 analog acquisition module SM331 to collect temperature and humidity sensors and other sensor data and through the CPU into the PC machine to storage; control part is divided into two types of manual and automatic, automatic control mode composed of 16 digital output module SM322 and some control equipment, manual control mode by switch and 16 digital input module SM321. Figure 1 is the overall structure of control system diagram.

DESIGN OF DATA ACQUISITION

To Siemens S7-300 series programmable controller CPU315-2DP as acquisition system CPU, with the addition of 3 analog input module to collect all sensor data. The temperature sensor, temperature and humidity sensors and pH sensor used in this system. Acquisition system block diagram shown in Fig. 2.

Control system adopts Sensirion digital temperature and humidity sensor SHT11 (Sensor as shown in Fig. 3) to detect environmental temperature and humidity data in workshop fermentation. In Pu'er Tea tea fermentation production process, the workshop of temperature and humidity are very high, the average temperature around 30° Celsius, average moisture content in 88% above, in this special environment of high temperature and high humidity, the temperature and humidity sensor damage is very serious, in view of this situation, we designed the structure can swap sensor probe. In the Pu'er Tea production process, turning three to four times, will produce the massive dust heap when turning, the dust is mainly Pu'er Tea fluff, very small and the high wet environment, easy to adhesion in the sensor humidity probe point, the influence of humidity detection. In order to prevent the dust adhesion on the sensor and can't influence the sensor data collection, this study designed a removable shell as the sensor and in the above uniform made holes.

A batch of Pu'er Tea fermentation production of tea consumption was 10 tons, piled high 70-120 cm, the surface because the contact area with the air is relatively

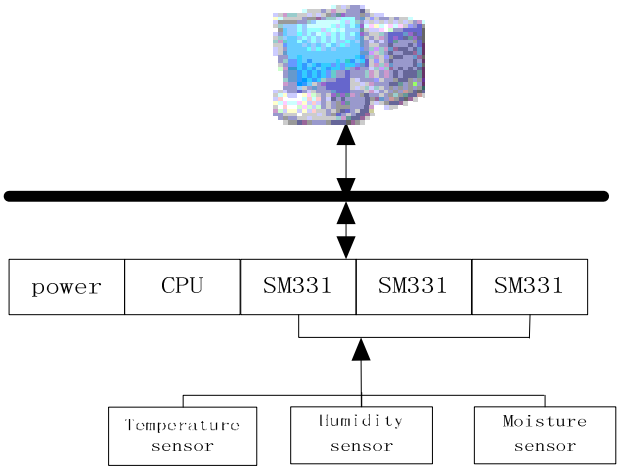

Fig. 2: Control system block diagram

Fig. 3: Sensor material of tea reactor

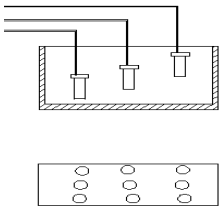

Fig. 4: The placement of sensor in tea reactor

large, the heat and moisture loss serious, effects of tea fermentation is not ideal; the bottom because the water precipitation, tea reactor pressure, water is relatively large, gas permeability is poor, fermentation the effect is not ideal. In addition, tea reactor internal temperature should not exceed 65° Celsius, if more than this temperature, there will be tea carbonization, tea is damaged. According to the actual production situation of tea, need to surface, middle, bottom fermented tea pile detection, three layer temperature, surface temperature and humidity of tea, tea middle pH. Because the acidic and corrosive showing Pu'er Tea during fermentation of tea, sensor surface temperature and humidity data the system design and arrangement is shown in Fig. 3 and 4.

DESIGN OF CONTROL PART

Control part of the control system has 2 control modes: manual control and automatic control. When Pu'er Tea is need of turning operations or workers need into the workshop to view Pu'er Tea production state, can choose to use the manual control mode; the rest of the time with automatic control mode. I/O point distribution of manual control mode is shown in Table 1.

This control system has 4 control loops, which are the heating control circuit, humidification, ventilation control loop control loop, ultraviolet sterilization control loop. Structure diagram of control section as shown in Fig. 5.

There are six sets of heating equipment in the heating control circuit, each heating equipment power is 3 kilowatts.

Table 1: The input part of the I\O allocation table

Function	Input point	function	Input point
The total stop	I0.1	Stop heating	I1.1
Emergency stop	I0.2	Tea pile humidification	I1.2
Manual and automatic	I0.3	Stop	I1.3
Local remote	I0.4	Tea pile of air	I1.4
Clock set	I0.5	Stop blowing	I1.5
Records cleared	I0.6	Ultraviolet radiation sterilization	I1.6
Once per minute	I0.7	Stop killing	I1.7
Clock correction mode	I4.0	1 Thermal relay	I5.0
Clock correction is closed	I4.1	2 Thermal relay	I5.1
Recording reset mode	I4.2	3 Thermal relay	I5.2
Clear off the record	I4.3	4 Thermal relay	I5.3
Periodic selection mode	I4.4	5 Spare	I5.4
Select a period close	I4.5	6 Thermal relay	I5.5
Data collection started	I4.6	7 Thermal relay	I5.6
Data acquisition stop	I4.7	8 Thermal relay	I5.7

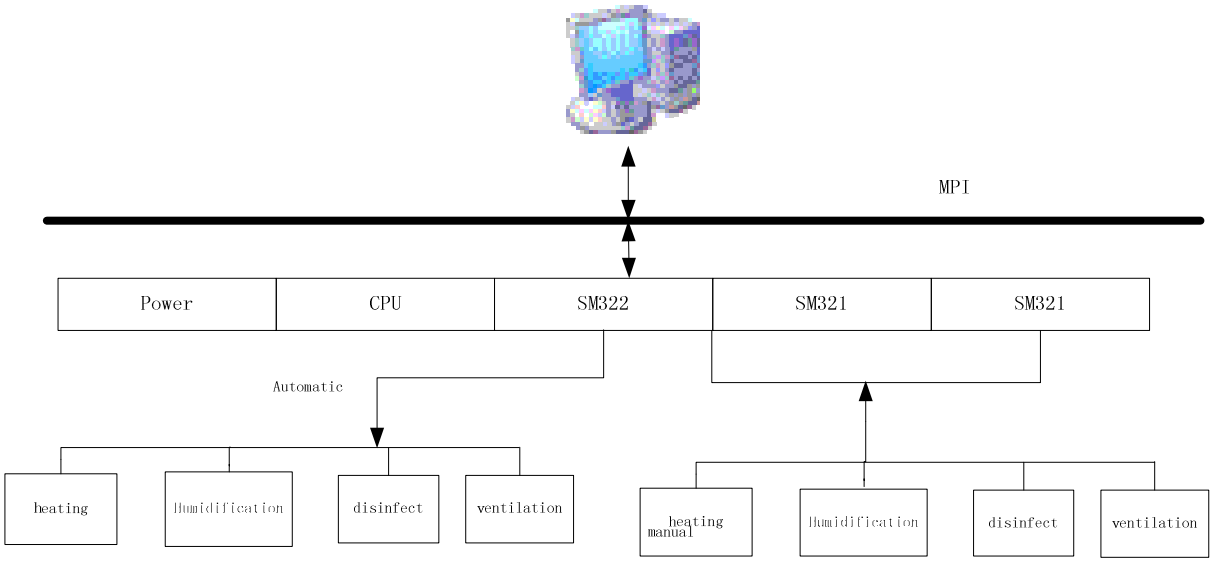

Fig. 5: Structure diagram of control part

The ultrasonic humidifier as humidification equipment workshop, the ultrasonic transducer in the ultra high frequency electromagnetic oscillation source function, can be directly with the liquid atomization piezoelectric ceramic contact into tiny particles of 10-30 μM. Generated by the cavitation effect of shock wave on vibration frequency oscillator repeatedly, surface tension of the liquid surface waves of finite amplitude. This kind of tension wave head off, make water atomization, have a large number of negative ions at the same time, turned into spray and air with certain pressure, fusion, achieve greater space humidification purposes; and high humidifying efficiency, minimal energy consumption, to meet the requirements of production.

According to actual production of workshop, designed the position of humidification nozzle, according to the height of the nozzle and the workshop area, the axial direction set two humidification nozzle, each nozzle to ground tilt 45°.

RESULTS AND DISCUSSION

Merits of Agent-oriented modeling: Agent is an advanced computing, if we compare with the traditional numerical analysis method. It not only provides modeling methods, but also gives solution of the problem. In particular, agent-oriented system may deal with complex interactions between environment and the robot. Now more and more people think that the intelligence of robot is increased in these interactions.

CONCLUSION

Puer tea fermentation workshop environment temperature and humidity by controlling the control system, stable in the range suitable for Pu'er Tea production, the control system for the tea fermentation to create artificial environment right. Through the analysis of experimental data, can prove that the application of this control system, effectively prolong the best surface tea, extended the optimal reactor temperature holding time, thereby shortening the fermentation period, improve the production efficiency of manufacturers, it proves that the design and the application of this system to achieve the expected goal.

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