Advance Journal of Food Science and Technology 9(2): 146-149, 2015
DOI: 10.19026/ajfst.9.1950
ISSN: 2042-4868; e-ISSN: 2042-4876

Submitted: February 8, 2015 Accepted: March 4, 2015 Published: August 05, 2015

Research Article

PLC Control System of Microwave Drying Apparatus on Honeysuckle

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Abstract: Control system of microwave drying apparatus on Honeysuckle is designed in order to control microwave drying apparatus automatically according to microwave drying process on Honeysuckle and the designed 20 kW circular microwave drying apparatus. PLC which type is CP1E-X20DR-A of Omron Corporation is adopted as controller and program flow chart is designed, the control of temperature, humidity and drying speed is realized according to Honeysuckle drying process requirements. Practice has proved that: the control system designed can control Honeysuckle drying process completely.

Keywords: Control system, honeysuckle, microwave drying, PLC

INTRODUCTION

Honeysuckle is a traditional Chinese medicine; modern medical research shows that the Honeysuckle medical value is very high: antipyretic, anti-inflammatory, antiviral and improving immunity (Chen and Du, 1997). Therefore, the market demand of Honeysuckle is increasing year by year, but the Honeysuckle drying process is relatively backward. Mostly, Coal is used as energy in drying Honeysuckle, coal as energy in drying Honeysuckle can bring pollution, the sensory effect of dried Honeysuckle is not good and the content of active ingredient of the dried Honeysuckle-Chlorgenic acid is low. Then there is microwave drying (Wang, 2004). Microwave is electromagnetic waves with strong penetration; microwave drying process is the water diffusion from inside to outside and speed up the drying process. Compared traditional drying method, microwave drying has short time, high efficiency, healthy and easy to control, reliable and feasible in technology. Currently, microwave drying technology has been applied in many areas of food drying (Figiel, 2009; Bondaruk *et al*., 2007; Sunjka *et al*., 2008; Maskan, 2001). Geng and Ge (2014a) proposed that microwave is adopted in drying Honeysuckle. Practice shows that, the dried Honeysuckle by using microwave is better than the traditional drying method in aspect of sensory effect and active ingredient. In this study, in order to make the drying process of honeysuckle realized automation control system of PLC as controller is designed based on microwave drying apparatus on Honeysuckle (Geng and Ge, 2014b), so that the dried Honeysuckle quality gets rid of the interference of human factors.

MATERIALS

Parts of microwave drying apparatus: Microwave drying apparatus mainly contains microwave generator, waveguide, drying box, cooling system, humidity discharging system, transmission system (Zhao *et al*., 2014), humidity measuring system, infrared measuring temperature system, control system and microwave suppressor (Zhang and Hong, 1999) and so on. Where, transmission system is a rotary worktable driven by stepper motor in drying box, the speed can be adjusted in order to adapt different drying process. The parts are shown in Fig. 1.

Principle of microwave drying apparatus: Structure diagram of microwave drying apparatus is shown in Fig. 2. Its working principle is: the microwave drying apparatus is power on, Honeysuckle loads on rotating worktable in drying box and is sent to drying area, microwave generator begins to work; in drying box, high frequency electromagnetic changes rapidly and polar water molecules in fresh Honeysuckle as dielectric, heat is generated in Honeysuckle inside, drying process on Honeysuckle is starting; in drying process, the signals of temperature and humidity measured on-line feed back to PLC; PLC control microwave generator working condition and stepper motor speed and then control the range of temperature and humidity that Honeysuckle drying process required; discharge the dried Honeysuckle after meeting drying process requirements from loading and discharging area, drying process is completed.

METHODS

Parts of control system: The microwave drying apparatus is employed to complete loading and

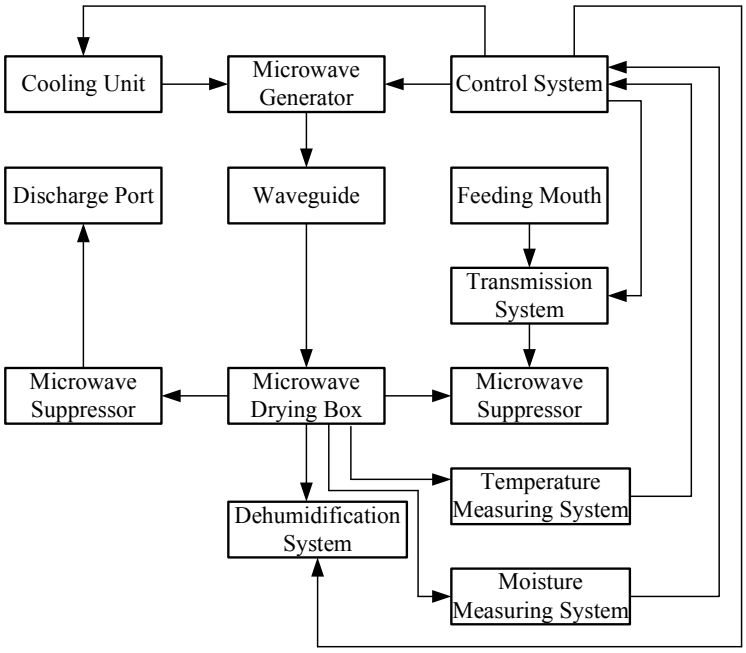

Fig. 1: Parts of microwave drying apparatus

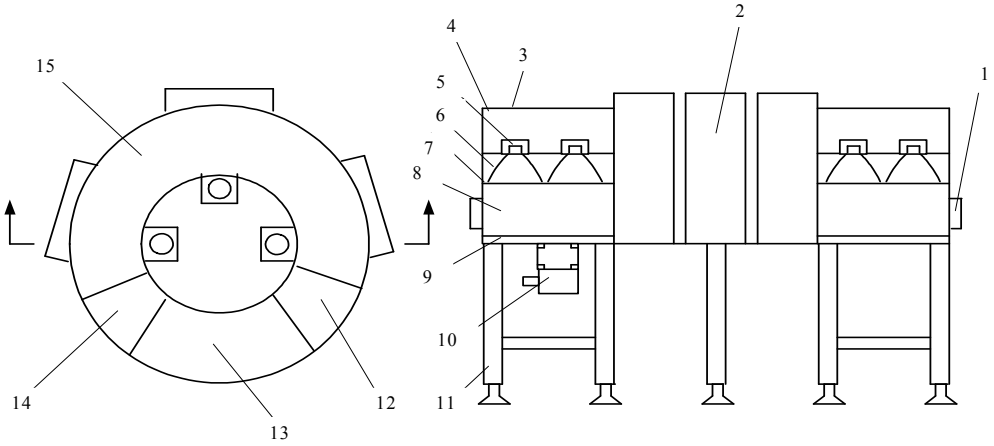

Fig. 2: Microwave drying apparatus structure; 1: inlet; 2: dehumidifying systems; 3: framework; 4: microwave generator mounting cavity; 5: microwave generator; 6: parabolic waveguide; 7: waveguide plate; 8: microwave drying cavity linear motor; 9: turntable guide rail; 10: inverter motor; 11: cover; 12: the right microwave leakage control mechanism; 13: material handling area; 14: the left microwave leakage control mechanism; 15: microwave drying zone

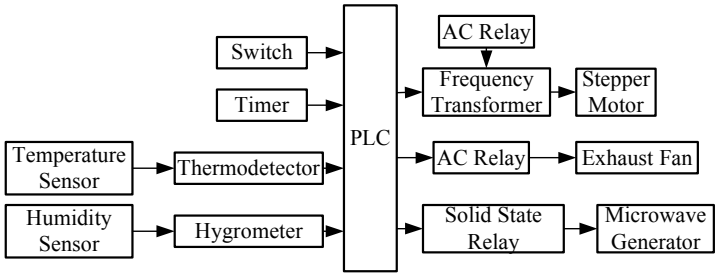

Fig. 3: The controlled principle of the microwave drying apparatus

discharge Honeysuckle, drying, rotary worktable, monitoring temperature and humidity. In order to ensure the quality of Honeysuckle to be dried, temperature and humidity of being dried must be

Table 1: I /O addresses assigned value

Type	Address	Function
Swith input	0.00	Time setting
Swith input	0.01	Start button
Swith input	0.02	Stop button
Swith input	0.03	Over-temperature signal
Swith input	0.04	Time out signal
Swith input	0.05	Door spacing
Swith input	0.06	Temperature setting range
Swith input	0.07	Temperature upper limit
Swith output	100.00	Timer suspend
Swith output	100.01	Frequency transform start stop
Swith output	100.02	Exhaust fan 2, 4
Swith output	100.03	Exhaust fan 1, 3, 5
Swith output	100.04	Microwavr generator 1-8
Swith output	102.05	Microwavr generator 9-18
Swith output	103.06	Microwavr generator 19-25

effectively controlled. Figure 3 is the controlled principle of the microwave drying apparatus.

Rotary worktable is driven by a stepper motor through gears; the speed can be adjusted by frequency Transformer. Honeysuckle to be dried has different drying characteristics in different drying stages; the drying temperature is different too. Infrared thermometer is employed to measure the drying temperature considering microwave drying characteristics; PLC is employed to control the drying temperature.

Lectotype of PLC: According to the control scheme of the microwave drying apparatus, the number input point is 8, the number output point is 7, CP1E-X20DR-A of Omron Corporation is chosen as controller.

Distributions of I/O: According to the number points of input, output and control requirements of PLC, the I/O distributions of the microwave drying apparatus is shown in Table 1.

RESULTS

Functions of control system:

Time setting: The time of three drying stages 1, 2, 3 can be set by timer after the control system power on, when the first and second stage are time out, switch signals are sent to PLC and recording their measuring temperatures; when the third stage is time out, switch signal is sent to PLC, the drying process is end.

Temperature setting: Control system after power on, temperature required in drying can be set according to temperature measured by infrared thermometer; when measured temperature is higher than the setting temperature, switch signal would be sent to PLC.

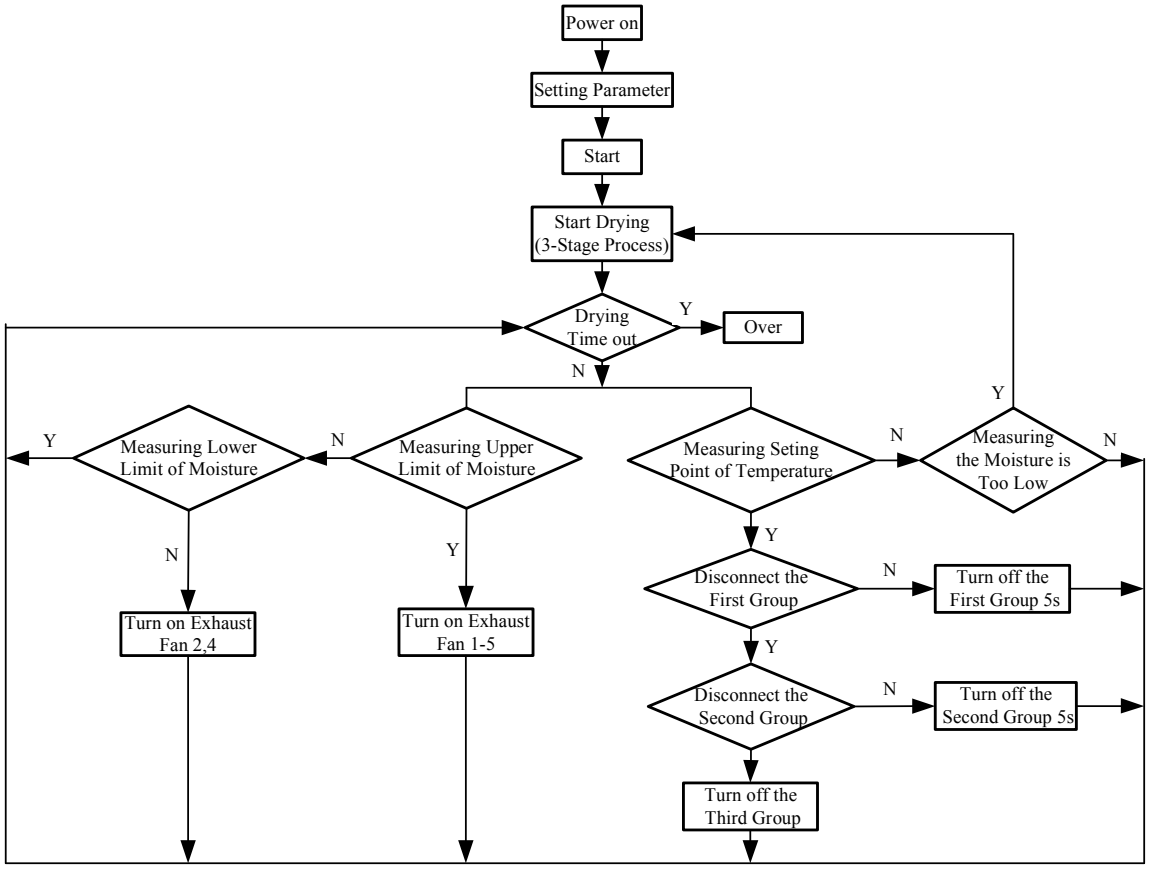

Fig. 4: Program flow chart

Rotary worktable is to work: PLC sends signals to frequency transformer, frequency transformer is power on, stepper motor is rotating and the rotary worktable starts to work.

The microwave generator start stop: In drying process, if the temperature is higher than setting temperature, switch signal is sent to PLC, PLC received signal, power off microwave magnetron circuits of 1 to 8; after 5s, if over temperature signal is not cancelled, power off microwave magnetron circuits of 9 to 18; after 5s, if over temperature signal is not cancelled too, power off magnetron microwave circuits of 19 to 25, until the temperature is lower than the lower limit that is set, all the magnetron circuits are power on, recycling.

Exhaust fan start stop: When microwave drying apparatus is beginning to work, humidity discharging by apparatus structure; when humidity reaches to setting limit, exhaust fans 2, 4 begin to work; when humidity reaches to upper limit, exhaust fans 1, 3, 5, also begin to work. If the humidity is between setting limit and upper limit, exhaust fans 1, 3, 5, stop working; if the humidity is lower than setting limit, exhaust fan 2, 4 stop working too.

Flow chart of control system: Drying time, drying temperature and drying humidity are set firstly after control system power on, then press start button, the apparatus begins to work; temperature is controlled by controlling the number of microwave generator start or stop, humidity is controlled by controlling the number of exhaust fan in drying process. The control process is shown in Fig. 4.

CONCLUSION

The circular microwave drying apparatus control system adopted PLC and infrared temperature control system, loading and discharging material, microwave drying, worktable rotating automatically and measuring and control of temperature effectively are realized, the program flow chart of PLC is given. Installation is convenient, repair is simple, occupying and investment are small; power combination is adopted, heating is uniform, sanitation, energy conservation and environment protection and suitable for agricultural products drying.

REFERENCES

Bondaruk, J., M. Markowski, W. Blaszczak *et al*., 2007. Effect of drying conditions on the quality of vacuum -microwave dried potato cubes [J]. J. Food Eng., 81(2): 306-312.

Chen, C.M. and G.X. Du, 1997. Honeysuckle herbs drying technology research [J]. J. Nanjing Forest Univ., 21(3): 48-50.

Figiel, A., 2009. Drying kinetics and quality of vacuum-microwave dehydrated garlic cloves and slices [J]. J. Food Eng., 94(9): 98-104.

Geng, Y.F. and X.F. Ge, 2014a. An experimental study on honeysuckle drying by microwave [J]. Adv. J. Food Sci. Technol., 6(2): 212-214.

Geng, Y.F. and X.F. Ge, 2014b. The annular microwave dryer design and study on Honeysuckle [J]. Adv. J. Food Sci. Technol., 6(3): 395-397.

Maskan, M., 2001. Kinetics of colour change of kiwifruits during hot air and microwave drying [J]. J. Food Eng., 48(2): 169-175.

Sunjka, P.S., V. Orsat and G.S.V. Raghavan, 2008. Microwave/vacuum drying of cranberries [J]. Am. J. Food Technol., 3(2): 100-108.

Wang, S.L., 2004. Application of the Microwave Heating Technology-dry and Sterilization [M]. Machinery Industry Press, Beijing.

Zhang, J.G. and L. Hong, 1999. Design and optimization of tunnel microwave heater leak-proof apparatus [J]. J. Tianjin Univ., Technol., 18(2): 83-85.

Zhao, H.Y., Z.J. Huo and C.X. Liu, 2014. Design of PLC control system of the 20 kW Circinal and Ring-shaped microwave drier [J]. J. Agr. Mech. Res., 7: 72-75.