

Research Article

The Annular Microwave Dryer Design and Study on Honeysuckle

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Abstract: In order to dry fresh honeysuckle, microwave drying process were studied on fresh honeysuckle; and microwave drying apparatus on fresh honeysuckle is designed according to the drying process. The designed microwave dryer contains microwave generator, microwave dryer, dehumidifying systems, control system, transmission systems, microwave leakage inhibited mechanism and other components. The drying experiment is carried by the designed dryer, from the setting-to-work test, the design was success.

Keywords: Microwave control system, microwave dryer, microwave drying, microwave power generator

INTRODUCTION

Honeysuckle is a traditional Chinese herbal medicine commonly used in China (Li, 1991); modern medical research shows that other than detoxification it also has antibacterial, antiviral, antipyretic, anti-inflammatory, hepatoprotective, hemostatic, antioxidant, immune regulation and so on. More and more pharmacological effects of honeysuckle were found, the market demand for honeysuckle is also a substantial increase. However, honeysuckle are saved after dried, honeysuckle drying process has become a hot research. Chen and Du (1997) studied hot air circulation drying process of honeysuckle and found that the drying effect using a higher temperature and high drying speed is better than a lower temperature and a long time drying, photogenic acid content is relatively low using hot air circulation drying and the medicinal value is small. Microwave drying effect is much better than the other drying methods by comparing the experimental result (Geng and Ge, 2013; Geng *et al.*, 2013). Microwave drying apparatus used in drying honeysuckle process is not reported because of the high cost of microwave apparatus. Microwave drying apparatus is designed based on microwave drying experimental results; and find the microwave drying conditions and the best process route on honeysuckle in this study.

METHODOLOGY

The whole structure and principle of microwave dryer:

The whole structure of microwave dryer: The whole structure of the apparatus is designed to be annulus according microwave drying process and basic

principles of microwave drying honeysuckle and has structure compact, footprint small, material handling convenience and ease of continuous production. The microwave drying apparatus is assembled mainly by microwave generator, microwave dryer, dehumidifying systems, control system, transmission systems, microwave leakage inhibited mechanism and other components, shown in Fig. 1.

The components design:

The microwave generator: The microwave generator consists of a magnetron (2M210-M1 Panasonic), high-voltage transformer (700E-1 (AL)), high-voltage diodes (HVH-12) high-voltage capacitor (CH85 1.0 $\mu\text{F}\pm 3\%$ 2100VAC 50/60 HZ -10/85 internal discharge resistor, fuse (8A250V SICHERUNG FUSE). The microwave generator function is to generate microwave, honeysuckle is in high temperature under the microwave affecting and then play the effect of drying.

The energy transport mechanism: The energy transport mechanism is to ensure the transmission of microwave energy. According to the distribution characteristics of microwave energy (Chen *et al.*, 1993), the apparatus is designed similar car headlights (Fig. 2); the role of the headlamp reflector is that gathered radiation from a point in a limited taper angle and produce a high luminous intensity. The design can make the microwave distribute uniformly and the drying effect is better.

The design of microwave drying chamber: Since microwave energy are more concentrated in the drying chamber, materials heating is rapid, especially for sheet materials heating and drying, therefore waveguide type drying chamber is selected. Designed ring-shaped

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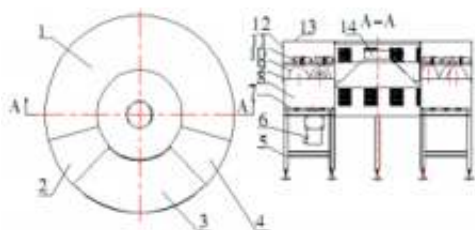


Fig. 1: The whole structure figure of annulus microwave dryer

1: Microwave drying zone; 2: The left microwave leakage control mechanism; 3: Material handing area; 4: The right microwave leakage control mechanism; 5: The microwave dryer framework; 6: Inverter motor; 7: Transmission systems; 8: Microwave dryer; 9: Waveguide mounting plate; 10: Parabolic waveguide assembly; 11: Microwave generator; 12: Microwave generator installation; 13: Cover; 14: Dehumidifying systems

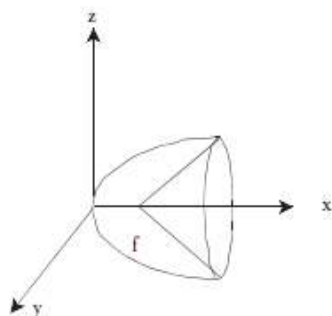


Fig. 2: Shape of the energy transport mechanism

tunnel microwave dryer made from galvanized tin, the upper wall opened a coupling port for inputting microwave; both sides of the upper wall has two rows of apertures for discharging moisture; in the middle sidewall provided with an observation window for observing the internal running (Wang, 2004). The microwave dryer size is designed according to size and volume of honeysuckle and how to make the electric field evenly distributed and drying efficiency. The drying efficiency determines the maximum size, the size and volume of honeysuckle and the uniformity of the electric field determine the minimum size under normal circumstances.

Material transmission system: Honeysuckle transmission trays are set in the bottom of the microwave drying chamber, rubber roller is supported in the bottom of tray and located by the inner circular orbit guide wheel, the tray is driven by motor and frequency control of motor speed is used according to the thickness of honeysuckle and microwave power.

Dehumidifying system: Air humidity inside the drying chamber is an important factor affecting drying efficiency. Vapor from honeysuckle is discharged

continuously in drying process, if not discharged promptly the vapor from the chamber, it will reduce the drying efficiency and the discharged humidity is to be set thus can improve drying efficiency. Holes are opened the inner wall with 10 rows, 3 mm diameter and center distance of 8 mm. ventilation is installed outside the drying chamber and prevent condensation of water back, both preventing microwave leakage and ensuring the vapor discharged smoothly.

The microwave leakage control mechanism: The microwave leakage control mechanism is disposed at both ends of the microwave dryer, the microwave leakage control mechanism installed in order to avoid harm to the human. The home heating microwave oven and industrial microwave drying apparatus leakage is stipulated as follows: at 50 mm distance from the apparatus, the microwave power cannot exceed 500 mW/mm² (2450 MHz) (Wang, 2004). The microwave leakage control mechanism of microwave drying apparatus is used hybrid-type mechanism (Zhang and Hong, 1999); suppressor is composed by comb-type attenuator and added absorbed material in the end.

The principle of microwave dryer: Fresh honeysuckle contains a lot of water; the water molecules rub strongly in a very short time at sufficiently high frequency under the microwave effect, make the molecular motion increase, the temperature rise and while water in fresh honeysuckle evaporated in form of vapor. Surface temperature is slightly lower than temperature of the inner layer due to evaporative cooling, at the same time the heat is generated in honeysuckle and the vapor is formed continuously, so that pressure gradient is formed. Water in honeysuckle is discharged under impacting of pressure gradient, which is microwave drying principle (Hatibaruah *et al.*, 2013).

MICROWAVE DRYER PERFORMANCE ANALYSIS

The same mass with same quality is taken; drying fresh honeysuckle using different drying methods (natural drying, coal drying and microwave drying), then determined of photogenic acid content (Huang *et al.*, 1996). The results are shown in Table 1.

Table 1 shows that content of photogenic acid is the highest in microwave drying, the content of photogenic acid is higher in coal drying, and the content of photogenic acid is minimum.

Table 1: Content of photogenic acid in different drying methods

Drying method	Sample No.	Content of photogenic acid (peak area/peak height)
Natural drying	1	6536318/383243
Coal drying	2	8913332/518366
Microwave drying	3	9671787/567369

CONCLUSION

The annular microwave dryer can be used for drying fresh honeysuckle and can realize continuous production, improved production efficiency and clean. A parabolic waveguide is used in microwave dryer, microwave distribution is more uniform in microwave dryer.

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