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Research Article

Equipment Design of Camellia Fruit and Shell Separating by Micro-wave

[1]Jian Zhou, [2]Songlin Chen, [1]Xianjun Li, [1]Minglong Zhang and [3]Huaide Zen
[1]Centre South University of Forestry Science and Technology, Changsha, 410004, P.R. China
[2]Hunan Dizhi Middle School, Changsha, 410011, P.R. China
[3]Zhuzhou Central Hospital, Zhuzhou, 412007, P.R. China

Abstract: For obtaining excellent properties of separating Camellia fruit and shell, the micro-wave technology is used, the separating equipment is also designed. The set includes lifting raw material system, micro-wave controlling system, eliminating wet system, micro-wave affection body, dropping material system. The camellia fruits are transported into micro-wave system, then they are crashed with centrifugal throwing disc, by the affect of wind and centrifugal force, thus shells and seeds are separated obviously.

Keywords: Camellia oleifera fruit, centrifugal throwing, micro-wave, separating

INTRODUCTION

The design is improved according to the problems of camellia fruit and shell separation in nowadays. Firstly, in the principle of separating shell, the centrifugal bumping method is used to divide shell and fruit, thus the separated shell could suit for the different size seeds, it doesn't need the stage treatment before dividing, thus the separating efficiency could be improved; Secondly, riddle drum system is adopted in the selection period, this could separate camellia seed from impurity effetely and improve the purity of camellia seed (Zhou *et al*., 2012). The separating equipment suits for the dividing of camellia fruit shell and seeds, because the camellia oil is very healthy to people, it belongs to Chinese specialty, so the study is also very necessary.

MATERIALS AND METHODS

Tunnel type micro-wave equipment is adopted to bake camellia fruit, separating shell principle of centrifugal bumping is adopted, the separating shell set (centrifugal throwing disc, gear ring) are designed, wind selection set is designed, transporting system and frame are designed, key parts are calculated and analyzed.

Construction of camellia fruit baking, dividing shell, separating and work principle:

General construction design of micro-wave baking equipment, separating equipment: Tunnel kind micro-wave baking equipment is adopted to bake the camellia fruit, the construction is as Fig. 1.

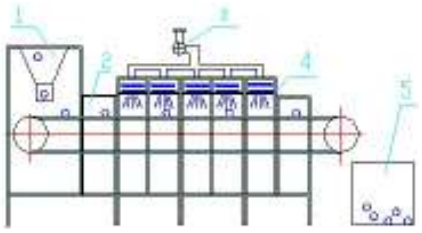

Fig. 1: The schematic diagram of micro-wave drying
1: System of lifting raw material; 2: micro-wave controlling system; 3: system of eliminating wet; 4: body of micro-wave affection; 5: system of dropping material

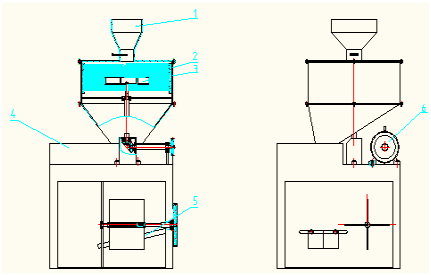

Fig. 2: General diagram of huller construction
1: Hopper; 2: gear circle frame; 3: centrifugal throwing disc; 4: frame (bed); 5: selecting mechanism; 6: electric motor

According to the principle of centrifugal kind huller, camellia fruit runs from aggregate bin, un-coating box, lower box export, size classification mechanism, to oulet hopper, the general construction is as Fig. 2.

Corresponding Author: Jian Zhou, Centre South University of Forestry Science and Technology, Changsha, 410004, P.R. China, Tel.:+0086-13975894394

Un-coating set is composed by centrifugal throwing disc and screw gear ring, it transports power by circular cone gear shifting and the selecting mechanism is adopted traditional wind selection equipment, the power is transported by belt pulley.

Working principle: While the equipment works, camellia fruits come into hopper, then they become thin layer falling into un-coating box through bottom material importing narrow mouth, the camellia fruits could be crashed by the biting of rapid spin throwing disc, they would departure by higher centrifugal velocity, strike and rub with the gear circle in the shell separating box, thus the shell would divide. The seeds and shells will fall through bottom box gate after shells are separated (Aristizabal *et al*., 2003). In the period of falling, they are affected by the wind of electric fan, because of different density and quality, inertial force is different, shells of lower density and quality would move far away with the higher density and quality seeds horizontally. Between the seeds, the full sized seeds would fall near the electric fan and the shrunken seeds and shells would fall far away the fan, they could be collected by two recovery tanks and the shells would fly away from the end of machine frame, thus the separating efficiency would be produced.

RESULTS AND DISCUSSION

Construction design of main parts of camellia fruit huller:

Parameter design of equipment separating shell and centrifugal throwing disc: The centrifugal throwing disc is the key part of separating set, blade kind throwing disc would be selected. In the period of shell separating, the effect of centrifugal disc is to crash the camellia fruit by the biting of higher rotating blades and fly off by higher centrifugal velocity, thus they would rub with the gear circle (Castro-Garcia *et al*., 2007). If the velocity is lower, the fruit would be difficult to crash by biting, the un-coating efficiency would decrease; If the velocity is higher, the crashing ratio of seeds would increase, so the rotating velocity should be determined by the shell characteristics of camellia fruit and real experiment. According to relative references, the rotating velocity is determined as 1000 r/m firstly. The throwing disc is shown as Fig. 3.

The diameter of rotating disc could be determined by the following formula (1):

$$D = 60\,V \Big/ \pi n \quad (m) \tag{1}$$

In the formula (1), V indicates tangent velocity of the edge of rotating disc, the camellia fruit's velocity should be greater than 11 m/sec, n indicates the rotating velocity of the rotating disc, if n = 1000 r/m, according to formula (1), then D>0.21 m, in the meantime D = 0.3 m.

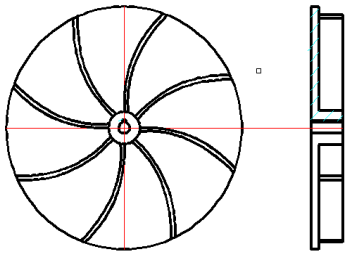

Fig. 3: General graph of centrifugal throwing disc

Parameter design of gear circle: Gear circle is the main part of dividing shell set, when the camellia fruits which have certain velocity crash with the circle gear, they would rub each other, thus the shell would separate from the seeds. For assuming the ratio of shell deviding, the inner circle of gear circle could be designed as the shape of inner screw, the outer circle's shape is cylinder, it inserts into the chassis, the construction is as Fig. 1, the outer diameter of gear circle is determined as 580 mm firstly, the inner diameter is 540 mm, the height is 200 mm.

Consumption power of separating shell: According to formula $P = \frac{Q}{t}$, the consumption power of separating shell could be calculated (Pezzi and Caprara, 2009).
The camellia fruits are done work by throwing disc:

$$Q = E_k + E_p \tag{2}$$

where,

E_K = Kinetic energy which throwing disc changes camellia fruits

E_p = Potential energy which throwing disc changes camellia fruits:

$$E_k = \frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2 \tag{3}$$

$$E_p = mgh \tag{4}$$

$$\therefore Q = \frac{m}{2}(v_1^2 + v_2^2 + 2gR) \tag{5}$$

$$P = \frac{Q}{t} = \frac{m}{2t}(v_1^2 + v_2^2 + 2gR) \tag{6}$$

If the demanded production is 500 kg/h, that is 0.139 kg/sec, according to Chinese standard, the de-hulled camellia ratio is 70%, the discounted camellia fruit production is 0.198 kg/sec, that is the camellia fruits' weight which enters into separating shell box. Assumed the camellia fruit velocity just entering into separating shell box is 0.5 m/sec, the direction is downward, the height of initial relative location is 100 mm while the fruits separating the throwing disc.

Table 1: Chief parameters of electromotor

		Motor velocity (r/min)		
Style of electric motor	Rated power (KW)	Sync	Full load	Motor weight (kg)
Y100L-6	1.5	1000	940	33

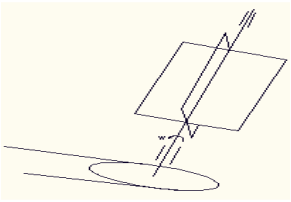

Fig. 4: Diagram of blade filtering system

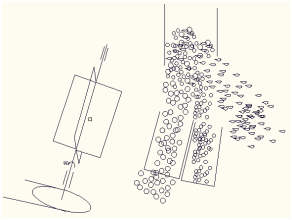

Fig. 5: Analysis of material filtering

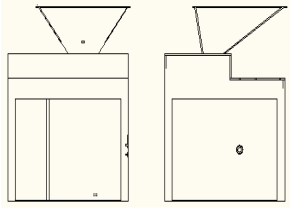

Fig. 6: Diagram of hopper frame

Selecting t = 1s, it is substituted in above equation:

$$P = \frac{0.198}{2}(0.5^2 + 11^2 + 2 \times 10 \times 0.1) = 12w$$

Adding the energy which throwing disc crashes with the camellia fruits and the friction energy, these could only be estimated, through other references of separating machinery, P couldn't exceed 1000 w, for calculating the demanded electric motor power, the total efficiency η should be determined firstly from electric motor to working machine. Assumed η_1, η_2 are the transmission efficiency of rolling bearing and bevel gear, so:

$$\eta = \eta_1 \cdot \eta_2 = 0.94$$

The consumption power of separating shell $P_d = \frac{P}{\delta}$, it couldn't exceed 1064 w, because the selected electric motor power ≤3 kw, it exceeds the calculated value, so the power of selected electric motor could satisfy the design demand.

The parameter design of separation system: According to the different density and quality of camellia shell and seed, the wind power separation system could be adopted, because there are many factors affected the system's characteristic, the main factors are blades geometry size, rolling speed, the distance between two falling material flots, the parameters should be designed each other bellow.

The geometry size design of blades: According to the width of tying on frame, the blade length is 400, the width is 300.

The rolling velocity: Because of the adjustability of falling material slot, the rolling velocity could be set at 300 r/min at first.

Blades moving analysis: The electric motor which was set on the frame could transmit movement to bigger belt pulley through belt transmission, thus the blade axis could be rotated, the rotating power of blades could be provided, the diagram is shown as Fig. 4.
The material movement is analyzed as Fig. 5.

Electric motor selection: According to the needed power of shell separating and filtering, the electric motor rated power P = 1.5 kw, the rotating velocity is 1000 r/min while separating shells, the rotating velocity of eccentric wheel is 300 r/min while filtering, so the style of electric motor is Y100L-6, shown as Table 1.

Hopper frame: Frame is used to contain and support different parts of the separating shell machine, the thickness of frame material is 1.5-2 mm and the triangle steel is used in the corner, because the general machine would produce heavy vibration (Zhou *et al*., 2014), so the demand of welding is higher relatively, of course screws are adopted in some joints, the construction is shown as Fig. 6.

CONCLUSION

- If the micro-wave is used to dry camellia fruits, it can separate the fruit shells and seeds very easily, the fruits could be cracked only by small force, the centrifugal throwing disc is used for the crash.
- The separating equipment mainly includes lifting raw material system, micro-wave controlling system, eliminating wet system, micro-wave affection body, dropping material system.

- Huller construction mainly concludes hopper, gear circle frame, centrifugal throwing disc, frame (bed), selecting mechanism, electric motor.
- Diameter of centrifugal throwing disc is 0.3 m, the electric motor rated power P = 1.5 kw, the rotating velocity is 1000 r/min while separating shells, the rotating velocity of eccentric wheel is 300 r/min while filtering, the style of electric motor is selected as Y100L-6.

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