Research and development of compacting process control system for bowl food

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Abstract: In order to solve the contradiction between the extrusion of solid and liquid food materials and the standardization of the volume of food materials in the bowl after compaction in the process of producing bowl food. Configuration touch screen and programmable logic controller are used as the control core of the system. Position parameters are obtained by photoelectric sensor. PLC drives the servo motor to make the linear module sliding block move, and drives the stepper motor to make the pressure plate rotate. Configuration of the touch screen to achieve the man-machine interface scheme. The force in the bowl is changed by adjusting the mechanical shape of the pressure plate. The controlled parameters of the execution program stored in PLC were obtained by orthogonal experiment. To realize the numerical control function of position, speed and force Angle in the process of food compression with digital precision. In addition, the mechanical structure of the spring cover plate is added to solve the problem of overflow of soup food materials from the bowl and its ring during the volume compression of solid and liquid food materials in the bowl.

1.Introduction

There are two main types of bowl snacks. One is a bowl of solid food products. The other is a bowl filled solid-liquid mixed food products, of which the plum vegetable braised pork product is a typical one. China's food processing enterprises are still using manual processing bowl solid liquid food products tamping station operation. During the tamping process, the practical power of manual tamping is large, which leads to the overflow of soup and food in the mixing gap between bowl and ring during the tamping process. Therefore, after tamping, the overflow of soup in the bowl and the change in the volume of food in the bowl caused a contradiction[1].

In this paper, digital precise control method is used to solve the problem of tamping solid and liquid co-existing ingredients in bowl. The PLC detects the signal according to each sensor and drives the servo motor and stepper motor to work by integrating the executive program stored in the logic controller. Servo motor and stepper motor control disc speed, Angle, speed, position of the movement. The additional mechanical structure of the spring cover plate to solve the tamping process of the bowl and bowl ring with the gap overflow of the phenomenon of double security. Achieved the goal of 100% pass rate of tamping technology in the production of braised pork with plum vegetables in bowl and greatly improved the production efficiency[2].

2.Tamping process control system design

2.1 overview of ramming technology of braised pork with plum vegetables in bowl
As shown in figure 1, the ramming process flow chart of production bowl filling plum vegetable and braised pork is presented. The first step is to place the pork in a bowl and add the soup. The second step is to put a ring on the bowl with the meat and soup, so that the ring and the inside edge of the bowl form a match. The third step is as shown in figure 2 put the quantitative plum vegetables and beans into the bowl with the bowl ring. Use the height of the ring to make the contents of the bowl larger, so that the contents of the bowl larger than the volume of the bowl. The fourth step is the tamping process. After tamping, the soup in the bowl is flush with the edge of the bowl. The fifth step remove the bowl ring for encapsulation.

2.2 design of the lower computer of the control system
The control core of this system adopts omron programmable logic controller as the core control component, as shown in figure 4. The control requires a logic controller with two pairs of high speed pulses and a directional outlet. Reserve 20%-30% of the number of I/O ports according to the number of input/output signals.

The driver of the servo system is the panasonic A6 series MBDLN25SE, and the servo motor is the same panasonic MSMF042L1V2M motor. RISYM company's 42-step motor set is adopted for the stepping-motor, among which 42BYGH34 plug-in motor is adopted for the motor, torque is 0.28N /M, and the drive control board is TB6600, with A maximum output current 4.0A and A maximum subdivision of 16. Omron photoelectric sensor is selected as the signal acquisition of limit switch and position detection. The light screen sensor with a beam interval of 10mm is selected as the safety protection switch of this control system. Mechanical part of the design of spring cover plate and pressure plate. 2mm stainless steel plate is selected for processing in the spring cover plate. Then select the pressure spring with a spring elasticity of 150N. A pair of bearing with supporting spring is selected and combined to form a spring platen device, as shown in figure 3[3-4].

2.3 upper computer design of control system
Upper computer programming is a necessary program for human - machine interaction. The upper computer written in this control system is shown in figure 6. Upper computer programming starts from the program register code and relay code corresponding to each other, so as to ensure the upper computer input constant after accurate drive lower computer PLC to issue instructions. The programmable logic controller USES GX Works software for programming design[5-6].

Figure 1. tamping process flow chart
Figure 2. tamping bowl tamping pork with plum vegetables

Figure 3. Hardware diagram of control system
Figure 4. Physical diagram of control cabinet
3. Optimization of ramming food process control system parameters:

3.1 Optimization of pressure Angle of pressure plate
Carefully observe the tamping process of experienced employees. During the process of pressing the platen in hand, the platen is pressed at a certain Angle instead of vertically. Artificial ramming craft experienced staff after tamping found solid liquid ingredients in a bowl of tamping surface formed on the micro convex surface, but the surface peak flush with the edge height of the bowl or higher for the edge of 1 ~ 2 mm, so can make tamping bowl edge space increases, the ingredients in the process of puddling broth by extrusion is not easy to squeeze liquid in the platen press after an action, tamping process operations staff will replace another measurement of tamping to tamp flap. From this observation, the principle of local compression is obtained. Therefore, the finger-shaped pressure plate is designed to fan downward at 60° and bend at 15°, as shown in figure 6, to simulate the artificially tamped local high pressure area[7].

3.2 Optimization of orthogonal experimental parameters
The purpose of the experiment was to optimize the design parameters of the tamping experiment by determining the influence of the factors from splashing the juice to the edge of the bowl on the rate of tamping. The evaluation method is divided into three grades: excellent 9 points, good 6 points and bad 3 points. The juice output is divided into five grades: no 10 points, very few 9 points, less 8 points, more 7 points and very many 6 points. The higher the score, the better. Test factors: A umbrellar curvature (level: 0mm, 5mm, 10mm); B descending pulse (level: 10000, 15000, 20000); C descending frequency (level: 10000, 11000, 120000); D ascending frequency (level: 9000, 11000, 130000); E (level: 30°, 60°, 90°); F high pressure zone bending (horizontal: 5mm, 10mm, 15mm); G rising pulse (level: 1000, 2000, 3000). After the orthogonal design analysis results, we can draw the following conclusions: the optimal process conditions A2, B2, C2, D2, E2, F1, G1[8].

4 conclusion
The system can effectively solve the contradiction between the overflow of soup in the bowl and the change of the volume of food in the bowl after tamping. After tamping to achieve the shape requirements under the premise of 98% do not spill the juice rate. The control system is also equipped with a spring cover plate to press the coordination between the bowl ring and the bowl, so that the control system will not overflow 100% of the soup, forming a double guarantee for the soup and the shape of the bowl. Compared with the tamping process data of artificial bowl food, the control system is shown in figure 7. The production time and qualified rate are significantly improved, reducing the labor force by half and increasing the net profit of the enterprise by 15%.

|              | Several test bowl | Shape acceptance rate | Soup pass rate | Percent of pass |
|--------------|-------------------|-----------------------|---------------|----------------|
| Manual tamping process | 100               | 90%                   | 10%           | 10%            |
| Random control system  | 100               | 98%                   | 60%           | 60%            |
| Digital control system  | 100               | 100%                  | 100%          | 100%           |

Figure 7. Analysis of test results
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