

# A New Type of Tea Baking Machine Based on Pro/E Design

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**Abstract.** In this paper, the production process of wulong tea was discussed, mainly the effect of baking on the quality of tea. The suitable baking temperature of different tea was introduced. Based on Pro/E, a new type of baking machine suitable for wulong tea baking was designed. The working principle, mechanical structure and constant temperature timing intelligent control system of baking machine were expounded. Finally, the characteristics and innovation of new baking machine were discussed. The mechanical structure of this baking machine is more simple and reasonable, and can use the heat of the inlet and outlet, more energy saving and environmental protection. The temperature control part adopts fuzzy PID control, which can improve the accuracy and response speed of temperature control and reduce the dependence of baking operation on skilled experience.

## 1. Introduction

In the whole process of wulong tea, baking is a very important process after fixing, twisting. The quality of tea baking has a great impact on the quality of tea. Before tea baking, the water content in the tea is relatively large, Chen flavor and Oxidation of polyphenols increased. Through baking, inclusions in the tea for thermal physicochemical reaction under the heat can enhance the quality of tea, such as Aromatic substances spread from the inside out to strengthen the tea. At the same time, the reduction of moisture content can slow down the tea aging rate, easy to store. Baking can tighten the strip, evaporate moisture, develop aroma, and promote the transformation of ingredients in tea. In short, baking has played an important role in promoting the quality of wulong tea. In the finishing process of wulong tea, baking can enhance the fragrance and ripeness, changing the quality of tea to meet the needs of different taste. Tea drying is generally carried out by using hot air as a medium, and the formation of excellent quality of tea is closely related to the drying temperature. According to the type of wulong tea, variety, season, shape and different needs of consumer tastes, the operator should take different baking time and baking temperature.

In the tea baking, baking temperature is usually changed to meet the quality requirements of tea by fixing the baking time and the amount of put in order to facilitate the operation. In general, the baking temperature of high-grade tea is 80-100 °C, the baking temperature of mid-range tea is 100-110 °C, the baking temperature of low-grade tea is 110-120 °C, the baking temperature of Tea sticks etc is preferably 110-130 °C.

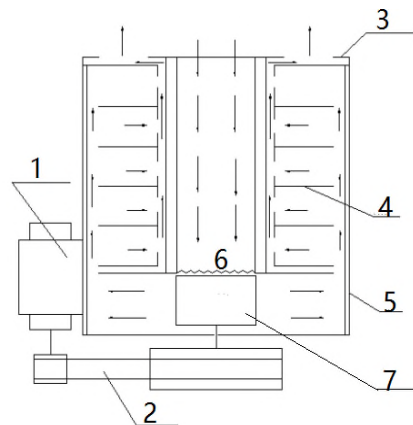
## 2. The design principle of baking machine

The baking machine is the electric type, using circulating hot air to bake. Every layer has access to the outlet, making the box more uniform temperature, dehydration better. Baking machine is mainly



composed of mechanical parts and intelligent temperature control part. Mechanical parts are mainly composed of the fan, heater, box, motor, belt drive and other components. The Intelligent control part is mainly composed of industrial computer, micro-controller, heater and sensor detection department. The main structure of the baking machine schematic diagram is shown in figure 1.

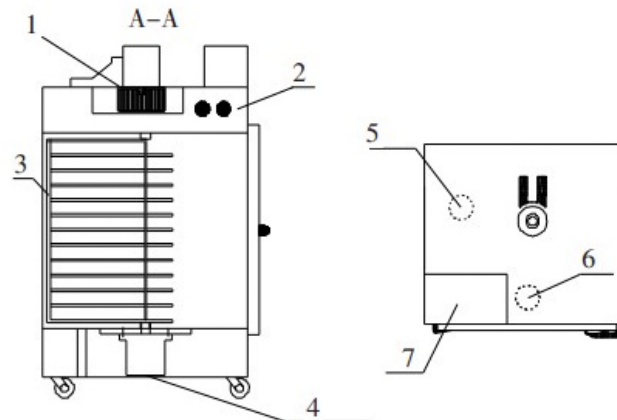
The main structure of the baking machine is circular box, the fan and heating electric wire are placed in the lower part of the baking box, and the electric motor is arranged at the bottom. The electric motor drives the fan through the belt drive, sucks the air flow from the middle air inlet, enters the hot air through the electric furnace wire, enters the inner oven through the tuyere, So that the layers of tea evenly heated, evaporated hot and humid wind from the exhaust port, so continue to cycle. Tea is left on the sieve frame the in middle of the baking box. In the process of tea baking, setting up air purification mechanism in the circulating air duct so that the volatile green and other miscellaneous substances in time to be filtered out in the baking and will not eventually remain in the tea inside when the wind from the air purification mechanism through the tea. It can be a good way to improve the aroma and quality of tea. Also insulation cotton is placed in the baking box inside and outside the wall in order to reduce heat loss and improve thermal efficiency.



1. Motor, 2. Belt drive, 3. Cover, 4. Sieve frame, 5. Box, 6. Electric wire, 7. Fan

**Figure 1.** Schematic diagram.

The main structure of the existing rotary baking machine on the market structure is shown in figure 2. The main structure of the baking machine is a rectangular box. The fan and the heating electric wire are placed in the upper part of the baking box and the bottom is equipped with a low speed rotating electric motor. Baking boxes are inside the air inlet and exhaust. The upper part of the baking box is placed with an electric control box for temperature control. The tea leaves on the sieves inside the baking box. In the process of tea baking, the control flow generated by the fan becomes into hot air after through the electric furnace wire, and enters the oven through the outlet. The motor in the bottom of box drives sieve frame in low-speed rotation, making the layers of tea evenly heated, evaporated hot and humid wind from the exhaust mouth to discharge, so continue to cycle.



1. Fan, 2. Electric wire, 3. Sieve frame, 4. Rotating motor,  
5. Exhaust hole, 6. Intake hole, 7. Electric control box

**Figure 2.** Schematic diagram of the structure of an electric baking machine.

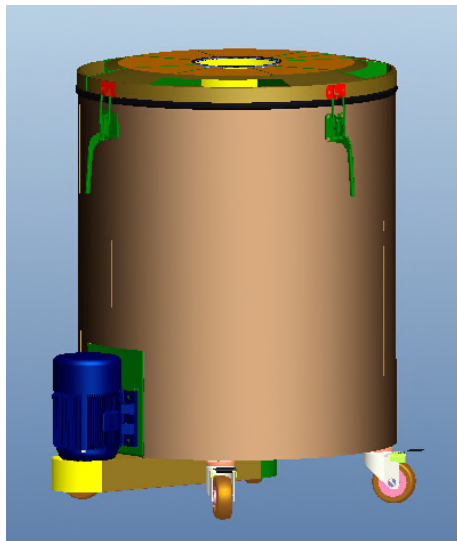
The above two kinds of structures are compared with each other, the structure of the new type of tea baking machine has the following characteristics and innovation:

(1) The main structure of the baking machine is cylindrical, making the heat more uniform. At the same time baking machine can compensate the air volume and heat. And the rotating motor at the bottom is not required so that the cost can be reduced.

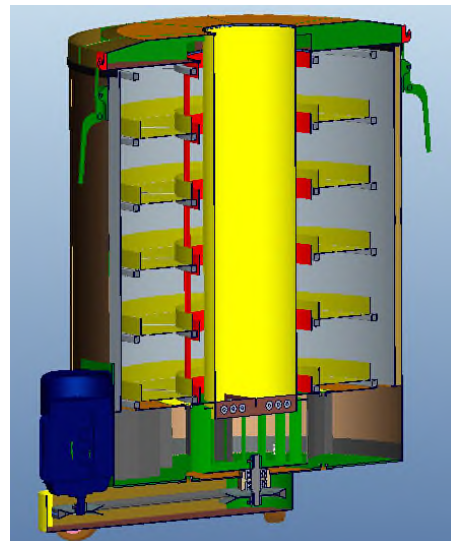
(2) The motor is placed externally and does not require a high temperature resistant motor. At the same time the centrifugal fan speed can be easily adjusted by changing the pulley combination.

(3) The outlet and the inlet have a large heat transfer contact area. The air inlet can be effectively recycled to the heat of the outlet to achieve energy efficiency.

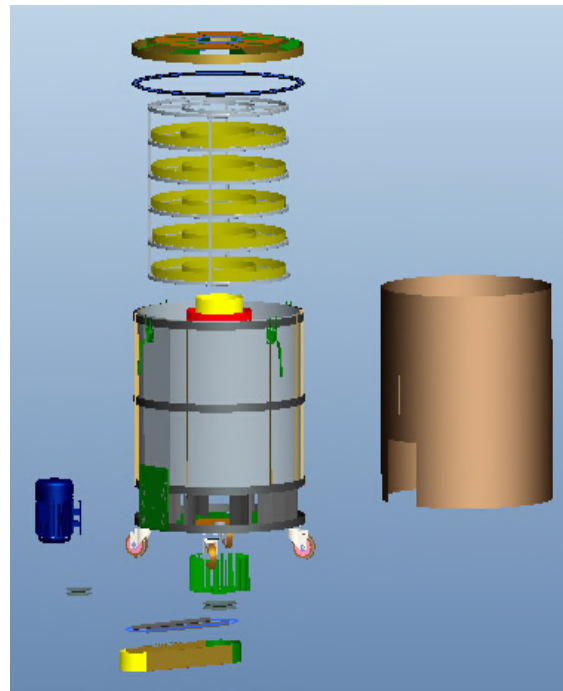
(4) The structure of baking machine is more compact, better to achieve miniaturization, easy to apply to drying tea.



**Figure 3.** External structure of the baking machine.



**Figure 4.** Internal structure of the baking machine.



**Figure 5.** Structure of the baking machine.

### 3. The mechanical structure design of the baking machine

Pro/Engineer is a parametric design, based on the characteristics of the entity model of the design software. Engineering designers can generate models by using feature-based features with intelligent features, and models can be easily changed. At the same time, Pro/Engineer is built on the unified grassroots on the database. As long as the entire design process changes anywhere, can be reflected in the entire design process related to the link. Pro/E using modular design, designers can achieve sketching, parts design, assembly design, sheet metal design, processing and so on. Designers can choose to use as needed.

With the Pro/E three-dimensional design software platform, the author has designed the working principle, created the parts, assembled the components into components, and then assembled components into the whole machine, and finally completed the whole baking machine design and improvement process.

The external structure of the baking machine is shown in figure 3, and the internal structure is shown in figure 4, and the decomposed structure is shown in figure 5.

### 4. The control system design of baking machine

This machine has designed the temperature control system based on fuzzy PID control and the humidity control system. For the temperature control, the system takes for PC as the host computer (VB platform for the design interface software), single-chip for the next machine. PC mainly completes the complex data processing and the control of the next bit machine, single-chip mainly finish data acquisition and the control of the heating device. In the next bit machine module, the temperature and humidity of baking box is collected real-time by using temperature and humidity sensors, and temperature and humidity data is sent by serial communication to the VB software interface. In VB software interface we can achieve fuzzy controller real-time correction PID controller parameters by temperature difference and rate of temperature difference through using VB and Matlab mixed programming. And we can obtain the control amount by PID algorithm, and send the control commands and control amount through the serial communication to the micro-controller, then the micro-controller will achieve the heating device power and duty cycle control by the relay on-off controlling to adjust the baking temperature.

For humidity control, thresholds can be set. When the humidity reaching the threshold, the humidity must be reduced by getting rid of moisture through the exhaust fan to ensure the aroma and quality of tea. At the same time, the tuning parameters have been adjusted by using Matlab/Simulink simulation experiments on the temperature and humidity control system.

## 5. Conclusion

In this paper, the effects of tea baking on the quality of tea were described in detail. Through the analysis and optimization of the existing baking machine structure, a new type of baking machine suitable for wulong tea baking is designed, and the overall structure and thermostat intelligent control system of baking machine are introduced in detail. The mechanical structure of this baking machine is more simple and reasonable, and can use the heat of the inlet and outlet, more energy saving and environmental protection. The temperature control part adopts fuzzy PID control, which can improve the accuracy and response speed of temperature control and reduce the dependence of baking operation on skilled experience.

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