A Method of Characterizing the Filling Power of Cut Tobacco Through the Cigarette Maker Parameters

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Abstract. Filling power is one of the important parameters to characterize the physical structure of cut tobacco. At present, the detection method of cut tobacco filling power cannot reflect the true filling power value of tobacco in real time and accurately, so an intelligent online filling power detection method of the cigarette machine is designed. According to the mechanical position of the suction forming part and the position parameters of the suction belt of the cigarette maker, the linear regression relationship between simulated filling power value and standard filling power value was obtained, the regression relation is applied to the cigarette manufacturing process, then calculate filling power value of cut tobacco in real time. This method has the following advantages: 1. in real time; 2. reflecting the abnormality of tobacco structure in the cigarette manufacturing process when the filling power exceeds a certain range; 3. realizing the linkage between the change of cigarette cut tobacco structure and the physical indicators of cigarettes, then guaranteeing the stability of mainstream smoke chemical indicators and sensory intrinsic quality.

1. Introduction

The cut tobacco filling power is determined by the filling power of different components (leaf, cut stem, expanded tobacco, etc.). The cut tobacco filling power is the most important factor affecting the physical indicators of cigarettes (weight, draw resistance, ventilation, etc.), the mainstream smoke chemical indicators (tar, nicotine, carbon monoxide, etc.) and the quality of the sensory (aroma, irritating, etc.). [1-6] When the weight, circumference and accessories of the cigarette (Cigarette paper permeability, etc.) are unchanged, the draw resistance of the cigarette is determined by the cut tobacco filler power. The relationship between cut tobacco filling power value and cigarette draw resistance is positively correlated.

In the manufacturing process of cigarettes, when changing the cut tobacco batches, there is often a large change in the filling power of tobacco. The weight of the cigarette does not change with the cut tobacco filling power, resulting in a large difference in the center value of the draw resistance, the chemical index of the smoke and the quality of the sensory. [7-11]

1.1 Filling power existing measurement method

At present, the cigarette industry enterprise measures the filling power value of cut tobacco by using the sampling test method and compressing the cut tobacco to evaluate the filling power. In the tobacco manufacturing process, a certain weight of cut tobacco is taken into a cylindrical container of a certain volume, a certain pressure is applied, the volume after compression is measured, and the filling power value of the cut tobacco is obtained by dividing the weight of the cut tobacco.
1.2 The lack of filling power existing measurement method

The first, the test method belongs to the sampling test. The higher the product quality level, the more difficult it is to find problems from the current sampling ratio. According to the sampling ratio of the filling power of most current cigarette industrial enterprises, for 8000kg leaf batch, the maximum detection frequency is about 10 times per batch, each test is 10g, and the sampling ratio is about 1:80000.

The second, due to the characteristics of the tobacco itself, and the uniformity of blending, so the test results are easily affected by sample sampling. For example, factors such as the tendency of the cut tobacco to fall during sampling, even in the case of on-line detection, also have this problem.

The third, affected by the limitations of tobacco sampling, the filling power value of the cut tobacco detected by this sampling method can only represent the filling power in the tobacco making process, but the tobacco is still transported by the feeding machine after the storage, the wind power feeding of the pipeline, the cutting and separation of the stems, resulting in a large difference between the detected value and the filling power before the cigarette maker rolls the tobacco.

2. Method Design

2.1 Working flow

- Measuring the mechanical distance of cigarette maker type suction molding
- Establish the relationship between simulated filling power value and suction belt production position
- Obtaining the production data of the suction belt under the gradient of each cut tobacco filling power value
- Establish the relationship between simulated filling power value and suction belt production position

Fig. 1 Working Flow

2.2 Method principle

2.2.1 Measuring the mechanical distance of cigarette maker type suction modelling

The filling power of cut tobacco refers to the volume of tobacco shred per unit weight after a certain period of time under a certain pressure. In the process of cigarette making, in the case of the same cigarette specifications, the filling force of the tobacco is closely related to the weight of the cigarette. At present, cigarette makers are generally equipped with a cigarette weight control system. When the filler filling power changes, the direct characterization is that the actuator moves up and down, and the indirect characterization is the volume change at the instant. The volume change is related to the following factors and can be calculated by the following mathematical model.

By measuring the distance from the limit of the suction belt to the lower board, the distance b from the position of the lower board to the trimmer disk, the distance between the upper and lower limits of
the suction belt c and the width d of the suction belt, then the relationship between the position of the trimmer disk and the volts of the suction belt are obtained.

The mathematical expression of the suction belt volts P and the distance of suction belt and trimmer disk y is as follows:

\[ y = a - c + b + 0.27 * (7 + P) \]

### 2.2.2 Establish the relationship between simulated filling power value and suction belt production position

According to the length L and the weight W of the mouthless cigarette, get the relationship between the simulated filling power value and the position of the suction belt. The mathematical expression is as follows:

\[ Z = L \times d \times y \times 0.001 / W \]

### 2.2.3 Obtaining the production data of the suction belt under the gradient of each cut tobacco filling power value

Take standard filling power tobacco samples, gradient of 0.1 cm³/g per interval, with at least 15kg per gradient sample, then add the tobacco samples to the VE part of the cigarette maker, carrying out a sample for each type of filling power value of the cut tobacco, calibrating the weight control system of the cigarette maker, setting a target weight of the cigarette brand.

Start up the cigarette maker, the fluidized bed troughs using air jet to guide the cut tobacco into the suction chutes and further on to the suction rod conveyor. The suction rod conveyor conveying the tobacco rods into the garnitures of the SE part of the cigarette maker, the density of the endless cigarette rod is continuously measured by the microwave sensor with every second increment. If the actual and target weights do not correspond, the weight control system calculates a new suction belt position.

In this process, the actual position of the suction belt is always changing with the actual weight of the tobacco rods, collecting data of the actual suction belt position of the cigarette maker.

### 2.2.4 Establish the relationship between simulated filling power value and suction belt production position

Export the data of the actual position of the suction belt of the cigarette maker and filtered out the invalid data. The position data of the trimmer disk is calculated according to the formula in the second step, and the simulation value of the filling power is calculated, then the linear regression relationship between the simulated filling power Z and the standard filling power S can be obtained. When the cigarette brand is in production, the filling power value of the actual cut tobacco is calculated in real time according to the simulated filling power Z.

The data acquisition frequency is averaged once per 100 cigarettes, and the data delay of the position and weight of the suction belt is pre-processed according to the distance between the trimmer disk and the weight sensor.

### 2.3 Application affection Method principle

In order to verify the accuracy of the method, the cut tobacco sampling can be used to verify the effect. The instrument used is the Borgwaldt Dosimeters DD 60A with a sample size of 10 and 15 groups.

The result is as follows:

| Sample Group | Filling power calculated (Online in cigarette maker) | Filling power measured (Offline, use DD 60a) | deviation rate |
|--------------|----------------------------------------------------|------------------------------------------|---------------|
| 1            | 5.15                                               | 5.13                                     | 0.39%         |
| 2            | 5.35                                               | 5.28                                     | 1.33%         |
|   |   |   |   |
|---|---|---|---|
| 3 | 5.06 | 5.11 | -0.98% |
| 4 | 5.31 | 5.29 | 0.38% |
| 5 | 5.19 | 5.23 | -0.76% |
| 6 | 5.22 | 5.19 | 0.58% |
| 7 | 5.25 | 5.21 | 0.77% |
| 8 | 5.18 | 5.16 | 0.39% |
| 9 | 5.13 | 5.21 | -1.54% |
| 10 | 5.03 | 5.20 | -1.37% |
| 11 | 5.14 | 5.13 | -1.57% |
| 12 | 5.11 | 5.21 | 0.19% |
| 13 | 5.22 | 5.27 | -1.92% |
| 14 | 5.25 | 5.33 | -0.95% |
| 15 | 5.03 | 5.09 | -1.50% |

Average accuracy / / 0.96%

3. Conclusion
Based on the above method of tobacco filling power measurement method, according to the type of cigarette maker, measuring the limit position of the trimmer disk and the distance of the suction belt, then establish the relationship between simulated filling power value and suction belt production position. Comparing with the deviation rate with the offline test result is less than 2%. Finally, the cigarette filler filling power value can be measured through the position of the cigarette maker in real time, and the target weight of cigarette can be quickly adjusted according to the tobacco filling power, guaranteeing the quality of the physical and chemical indicators and the quality of the sensory.

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