Research on adjusting size proportion of cut tobacco

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Abstract. For solving the applicability of size proportion of cut tobacco under the Internet environment, the device adjusting size proportion of cut tobacco needs to be developed including a feeding belt conveyor, a tobacco regulating device, a discharging belt conveyor, a guiding groove and a fixed bracket. Among these devices the feeding belt conveyor adopts two-way control of size proportion of cut tobacco without adjusting the choice; the device adjusting size proportion of cut tobacco consists of a feed roller of tobacco, a Uniform roller of tobacco and a Cut tobacco roller, mainly by adjusting the feeding roller of tobacco, Cut tobacco roller speed difference and gap adjustment to control size proportion cut tobacco. Application test was made in Henan tobacco corporation. The results showed that: the gap between the feeding roller and the broken roller are the significant factors in proportion of long stands rate, middle stands rate, short stands rate and small particles rate. The long stands rate is positively associated with the gap, the rest are negatively correlated with the gap, the rotational speed of cut tobacco smoothing roller, cut tobacco feeding roller, Cut tobacco cutting roller has certain effect on proportion of long stands rate, middle stands rate, short stands rate and small particles rate and cannot be ignored in practical work. Conclusion: This design can improve the structure of the cut tobacco through the gap between the cut tobacco feed roller and the cut tobacco break roller. How to quantify the specific effect requires special research.

With the deepening of the Internet + strategy, the Chinese cigarette market is trending towards segmentation, differentiation, and personalization. Many companies have responded to supply-side structural reforms and proposed the development of “Internet +”-based customized cigarette products to stimulate consumer desire and tap Market potential. Tobacco adaptability is a key factor in achieving customized production [1]. The effect of tobacco structure on the quality index of single cigarette after rolling, hardness, absorption resistance and other quality indicators and the operating efficiency of cigarette machine equipment are becoming more and more obvious [2-6]. The unit studied the influence of cut tobacco structure on the quality of finished cigarettes. In the rolling process, the condition of the incoming shredded tobacco is the main influencing factor of the rolling quality. Tobacco structure is the key influencing factor [7]; when the cut rate of tobacco is 82%, and the ratio of cut length and middle cut is 4:1, the overall quality index and stability of cut tobacco are good [8]. By consulting relevant information, there is currently no equipment capable of adjusting the structure of tobacco shreds online.

1. Problem analysis
At present, the production line uses sliced tobacco as the raw material for processing to produce rolled tobacco suitable for rolling. Among the evaluation indicators for cut tobacco, there are only indicators...
such as the whole cut tobacco rate, the broken cut tobacco fraction, the filling value, and the moisture content, among which the whole cut tobacco fraction includes the cut tobacco fraction and the middle cut tobacco fraction. And the proportion of cut tobacco in tobacco is too large to affect the applicability of tobacco. The main steps in the processing and manufacturing process of the production line include the resurgence of tobacco, the feeding of tobacco, cutting, drying, blending, and flavoring. Some domestic cigarette manufacturers use fixed-length cutting technology to reduce the proportion of cut tobacco in cut tobacco, but there is a problem of increased crushing [9]. In addition, there is no method or equipment for adjusting or controlling the structure of the shredded tobacco in each of the above processes.

2. Equipment structure

2.1. Design ideas
There are two main methods for turning cut tobacco into short cut tobacco, namely tearing and cutting. According to the previous experiments, it is concluded that the use of sharp blades for cutting will cause greater fragmentation [10]. This topic uses a tearing method, mainly using a pair of rollers for tearing. The cylindrical roller with roller nails runs in reverse differential speed through the power and transmission device, and the speed of both can be adjusted by a frequency converter. The gap between the two cylindrical rollers is adjusted so that the shredded tobacco is subjected to the tearing force of the roller nails when passing through the gap, thereby tearing the cut tobacco and cut tobacco. The effect of the short A subsubsection. The paragraph text follows on from the subsubsection heading but should not be in italic. cut tobacco is controlled by the difference between the rotation speed of the two rolls and the gap between the two rolls. The working schematic diagram is not shown in Figure 1.

![Equipment structure](image)

1. low speed roller 2. high speed roller

Figure 1. Equipment structure.

2.2. Equipment structure
As shown in Figure 2, The equipment consists of a feeding bidirectional conveyor belt, a cut tobacco breaking device, a reverse falling hopper, a discharging belt conveyor, and a support. The feed conveyor belt is designed as a two-way belt conveyor. One direction conveys the shredded tobacco to the cut tobacco breaking device, and the other direction can directly enter the discharging belt conveyor through the reverse falling hopper without the cut tobacco breaking device. It can be based on the structure of different brands of tobacco It is convenient to choose whether or not to perform cut tobacco break processing, which increases the flexibility of equipment application. The whole device adopts the upper and lower two-layer design, which effectively reduces the equipment footprint.
The cut tobacco breaking device is mainly composed of three rollers arranged in parallel and horizontally, such as a uniform roller, a cut tobacco feeding roller and a cut tobacco breaking roller. The evenness roller and the feed roller have the same turning direction. It is mainly used to evenly thin the tobacco and increase the speed of the tobacco. The cutting roller and the feeding roller are in the opposite direction and have a rotation speed difference. When the shredded tobacco reaches the cutting roller, the longer cutting tobacco is interrupted by the impact and tear between the cutting roller and the feeding roller. The gap between the wire-breaking roller and the wire-feeding roller and the rotation speed of the three rollers can be adjusted to adjust the effect of wire-breaking, so as to adjust the structure of the shredded tobacco.

The outer surface of the cut tobacco roller and the cut tobacco feeding roller is provided with the same needle plate. The needle plate is composed of a base and a needle. The cross section of the base is a fan ring. The outer circle has the same radius, and the roller needle is fixed on the base along the normal line, and the base is provided with a T-shaped screw hole. The base and the roller are connected by bolts. The outer surface of the even roller and the feed roller are composed of 72 identical needle plates. Each needle plate has 160 roller needles, and the needles are evenly arranged.

The outer surface of the cut tobacco breaking roller is provided with 1520 roller nails arranged along the axial spiral line. The screws are conical and the lower end is threaded. They are fixed to the outer surface of the roller by screw connection. Body, the upper part is a tapered nail tip, and the tip of the nail tip transitions from a circular arc.

3. correlation analysis

3.1. Experimental design

3.1.1. Index (y) design. The index (y) is the whole the production line rate Tc and the shredded rate Tsh, the cut tobacco shredded rate ≥78%; the shredded rate ≤3%.

3.1.2. Index (y) design. The main mechanism of the device includes a leveling roller, a cut tobacco feeding roller, and a cut tobacco cutting roller, and the structure of the shredded tobacco is controlled by adjusting the gap between the cut tobacco feeding roller and the cut tobacco cutting roller. The working status of each of the above mechanisms will affect the change of the index (y). Therefore, the uniform roller frequency (Hz), the feed roller frequency (Hz), the break roller frequency (Hz), the feed roller and the break roller All influencing factors (x) of the gap are designed for experiments.

3.1.3. Index (y) design. Level design of each factor

Under the premise that the level of each factor [11-15] satisfies the normal operation of the equipment (without material blocking under certain flow conditions), the horizontal design of the four
factors is carried out under the broadest possible principle. Three levels were designed using the limit value plus the center point, namely: lower limit value, average value, and upper limit value. During the production process verification, when the running frequency of the even roller, cut tobacco feeding roller, and broken cut tobacco roller is less than 35Hz, the phenomenon of material blocking is easy to occur [16], set the lower limit of the running frequency to 25Hz. According to the national industrial electricity 50Hz technical standard, set the upper limit of the running frequency to 50Hz. Take the central value of the upper and lower limits of 35Hz as the center point; cut tobacco feeding roller and cut tobacco breaking The gap level of the roller is designed according to the minimum value, center value and maximum value of the adjustable range of the mechanical design. The results of orthogonal factor level are shown in Table 1.

| Table 1. Orthogonal factor level table. |
|----------------------------------------|
| Factor                                | Level | Center |
|----------------------------------------|-------|--------|
| gap                                    | small | Medium | Large |
| Frequency of even roller (Hz)          | 20    | 35     | 50    |
| Frequency of cut tobacco feeding roller | 20    | 35     | 50    |
| Broken roll frequency (Hz)             | 20    | 35     | 50    |

3.2. Determination of physical properties of cut tobacco

The physical structure of the stem was measured according to YC / T178-2003 "Method for Measuring the Tobacco Thread Fragment and Broken Fraction".

3.3. Experimental data and analysis

According to the four-factor three-level orthogonal experimental design, the experimental data obtained through experimental testing are shown in Table 2.

| Table 2. Experimental datatable. |
|----------------------------------|
| Standard sequence | running sequence | cut tobacco rate (%) | medium cut tobacco rate (%) | short cut tobacco rate (%) | broken cut tobacco rate (%) |
|-------------------|------------------|----------------------|-----------------------------|----------------------------|-----------------------------|
| 18                | 1                | 50.69                | 25.30                       | 21.29                      | 2.72                        |
| 16                | 2                | 55.72                | 22.32                       | 19.47                      | 2.49                        |
| 5                 | 3                | 50.22                | 25.79                       | 21.36                      | 2.63                        |
| 13                | 4                | 53.26                | 24.44                       | 20.06                      | 2.24                        |
| 10                | 5                | 52.87                | 24.82                       | 19.99                      | 2.32                        |
| 1                 | 6                | 44.82                | 27.26                       | 24.73                      | 3.19                        |
| 17                | 7                | 48.60                | 26.01                       | 22.36                      | 3.02                        |
| 14                | 8                | 55.84                | 22.55                       | 19.27                      | 2.34                        |
| 19                | 9                | 49.57                | 26.12                       | 21.73                      | 2.58                        |
| 2                 | 10               | 54.67                | 24.03                       | 19.17                      | 2.13                        |
| 11                | 11               | 48.49                | 26.58                       | 22.20                      | 2.73                        |
| 9                 | 12               | 44.52                | 27.88                       | 24.28                      | 3.32                        |
| 6                 | 13               | 54.44                | 23.80                       | 19.52                      | 2.23                        |
| 8                 | 14               | 58.57                | 21.66                       | 17.75                      | 2.02                        |
| 15                | 15               | 45.49                | 28.17                       | 23.41                      | 2.93                        |
| 7                 | 16               | 56.43                | 22.87                       | 18.67                      | 2.03                        |
| 12                | 17               | 51.91                | 24.81                       | 20.65                      | 2.63                        |
| 3                 | 18               | 53.14                | 24.40                       | 20.06                      | 2.39                        |
| 4                 | 19               | 52.51                | 25.31                       | 19.90                      | 2.28                        |
Table 3. Comparative data sheet.

| Items            | cut tobacco rate (%) | medium cut tobacco rate (%) | short cut tobacco rate (%) | broken cut tobacco rate (%) |
|------------------|----------------------|-----------------------------|----------------------------|----------------------------|
| Minimum          | 54.67                | 24.03                       | 19.18                      | 2.13                       |
| Maximum          | 45.49                | 28.17                       | 23.41                      | 2.93                       |
| Equipment inlet  | 54.80                | 23.73                       | 19.27                      | 2.21                       |

It can be seen from Table 3 that there is no significant change in the structure of the cut tobacco under the condition of the minimum processing strength; the cut tobacco ratio of the structure of the cut tobacco under the condition of the maximum processing strength has decreased by 9.3 percentage points, and the rate of the middle cut tobacco has increased by 4.4 percentage points. The short cut tobacco rate increased by 4.1 percentage points and the broken cut tobacco rate increased by 0.72 percentage points. Without the significant increase in the broken cut tobacco rate, the cut tobacco rate had a significant downward trend.

According to the experimental data, the arrangement diagram and normal distribution diagram of the effect of tobacco structure change were drawn, as shown in Figure 3-7.

**Figure 4.** long stands rate of Standardization effect, Pareto diagram and normal distribution.

**Figure 5.** middle stands rate of Standardization effect, Pareto diagram and normal distribution.
This equipment realizes the function of adjusting the structure of cut tobacco in the production process online, automatically and on a large scale. It can be seen from Figures 4-7 that the relationship between the various adjustable parameters of the equipment and the structure of the shredded tobacco is as follows: the gap between the feed roller and the broken roller is a significant factor affecting the cut tobacco rate, medium cut tobacco rate, short cut tobacco rate, and broken cut tobacco rate. Among them, the cut tobacco rate has a positive correlation with the gap, and the medium, short, and broken rates have a negative correlation with the gap. The influence of the cut tobacco rate and the broken cut tobacco rate is not significant, but it can be seen from the arrangement diagram that it also has a certain effect, which cannot be ignored in actual work.

4. Conclusion
Conclusion and discussion: This design can improve the structure of the cut tobacco through the gap between the cut tobacco feed roller and the cut tobacco break roller. How to quantify the specific effect requires special research.

References
[1] Qin Rong, Wang Jibin, Liu Jun, et al. 2016 Discussion on the promotion of "Internet +" action plan and supply-side structural reform in China's tobacco industry [J] Market Forum (9) 64-69
[2] Bao Shuyang, Yang Jin 2011 Adaptability improvement and research of Chinese brand cigarettes produced by M5 cigarette maker [C] // 2012 Shanghai Tobacco System Excellent Academic Papers
[3] Fan Shengxing, Fan Linhui, Ou Yamin, et al. 2011 Improvement of tobacco shred quality evaluation method [J] China Tobacco Journal 17(2) 25-28
[4] Fan Shengxing, Fan Linhui, Ou Yamin, et al. 2010 Application of Analytic Hierarchy Process in the Evaluation of Tobacco Quality [C] // Tobacco Technology Symposium, Industrial Committee of China Tobacco Society 45-46-47-48
[5] Pu Shaoqing, Gao Changjiang 2018 Optimizing tobacco production equipment to improve the quality of tobacco [J] Shandong Industrial Technology (13)

[6] Li Chao, Liu Xiuming, Qin Yunhua, et al. 2017 Quality trend analysis of cigarette shreds based on volatile characteristic components [J] Tobacco Science & Technology 50(11)

[7] Liu Guodong, Wang Xufeng, Li Xiangyang 2015 Effects of cut tobacco processing parameters on the processing resistance and filling value of tobacco cut tobacco [J] Henan Agricultural Sciences 145-148

[8] Lin Hui, Du Jinsong, Li Bin, et al. 2014 Thermophysical properties of tobacco leaves based on TPS method and establishment of thermal conductivity prediction model [J] Henan Agricultural Sciences 155-160

[9] Li Qiong, Song Shiqiang 2017 Analysis of the effect of cut-length cutting process on cigarette making [J] Equipment Management and Maintenance 108-109

[10] Yang Zunwei 2015 Analysis on Improving the Lifting Method of Feeder to Reduce Fragmentation [J] Science and Fortune 7(33) 232-232

[11] Yan Keyu, Chen Tinggui 2002 Effect of Formulated Fertilization Technology on Yield and Quality of Flue-cured Tobacco [J] Henan Agricultural Sciences 31(9) 31-32

[12] Liu Shan, Hu Hongli, Chen Hui 2013 Optimization of Ultrasonic Extraction Technology of Total Flavonoids in Gentiana gentian by Response Surface Methodology [J] Henan Agricultural Sciences 42(1) 148-151

[13] Luo Mingfu 1983 Application of Experiment Design in Forestry Lecture 5; Orthogonal Experiment Design and Statistical Analysis [J] Henan Agricultural Sciences 12

[14] Zhao Huina, Lei Bo, Pan Wenjie, et al. 2013 Effects of different organic nutrient solutions on growth and physiological characteristics of tobacco seedlings [J] Henan Agricultural Sciences 42(1) 38-42

[15] Zhao Facheng, Chen Rongjiang, Miao Zisheng, et al. 2011 Study on the effect of fertilization of peanut nitrogen, phosphorus and potassium "3414" in the eastern area of Xinxiang City [J] Henan Agricultural Sciences 40(11) 67-70

[16] Xie Jian, Zhai Jianzheng, Wang Jianwei, et al. 2014 Tobacco structure adjustment equipment: CN103734900A [P]