Design of YJ17 Cigarette Machine Stem and Thread Separation Triple Air Separation Device

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Abstract: In response to the problem of incomplete separation of tobacco stems during the secondary air separation of the YJ17 type coiling machine, which caused tobacco to fall into the tobacco stem box along with the tobacco stem during collision, resulting in waste, a self-designed set of three air separation devices for tobacco stems effectively reduced tobacco consumption. Each machine per shift can save about 2.5 kilograms of tobacco, creating benefits for the enterprise.

Keywords: YJ17 cigarette maker, stem tobacco, tobacco, tertiary air separation device

Ⅰ. Introduction

The concept of lean production management aims to eliminate various wastes, optimize resource allocation, and improve efficiency and benefits. It extends the concept and methods of lean improvement by constructing a long-term mechanism for lean management work, applying continuous improvement methods of lean management, and achieving maximum value creation with minimal investment. When cigarette production enterprises promote lean management production management activities, they compare key indicators, identify waste in the production process, and use lean tools to carry out improvement activities[1]. In practical improvement, eliminate waste, reduce costs, provide efficiency, and achieve the true connotation development of the enterprise.

The research status of stem stick separation at home and abroad is that there are many types of cigarette equipment at home and abroad. Although each cigarette unit itself comes with a device for separating stem sticks and tobacco, the separation effect is really poor, and there are a large number of mistakenly removed tobacco, which needs to be recycled. At the same time, separating too many or too few stem sticks can have a huge impact on the quality of cigarettes and also cause excessive waste of enterprise costs[2]. The so-called stem stick separation is the use of a method to remove the stem sticks from the original machine and further remove and separate them from the tobacco. At present, there are many methods for separating two different substances, most of which rely on the different properties of the two substances themselves.

The YJ17 cigarette maker comes with a secondary air separation device for tobacco stems and cut tobacco, which completes the separation of tobacco stems and cut tobacco through two air selections.

The secondary sorting device for stem tobacco mainly consists of a feeding hopper, a wind deflector, adjusting screws, inclined blocks, and a secondary sorting wheel installed in the feeding port. The separated tobacco is directly adsorbed onto the suction belt of the air chamber body. In order to reduce tobacco waste, a new type of stem separation device is studied using the method of separation during movement, which will recycle the recycled tobacco; By increasing the vertical lifting distance between tobacco stems and tobacco, the separation of tobacco stems can be achieved[3]. However, there is little research on the use of positive pressure blowing to separate tobacco stems and cut tobacco again. Therefore, by designing a set of stem separation devices, the suspension time of the stem in the air is increased, so that the dispersed tobacco is sucked into the air chamber again, achieving the third separation of the stem.

The research and development of the YJ17 cigarette unit (hereinafter referred to as the cigarette machine) third stem separation device project is based on the requirements of lean production management activities in the tobacco industry, and is a special improvement project carried out by cigarette production enterprises themselves around the annual goals proposed by the tobacco industry. It focuses on the characteristics of the tobacco stem separation mechanism in cigarette machines and tackles the phenomenon of high silk content indicators in 10000 cigarette stems in current cigarette production[4]. It was found that the stem separation system of the cigarette machine is designed to control the silk content in the stem by changing the negative pressure airflow size of the stem channel through the airflow adjustment plate below the stem channel. However, in production, the airflow control valve of the stem cannot meet the lean target of the production enterprise for the silk content in ten thousand cigarette stems within its adjustment range. The original design of the equipment is insufficient and lacks foresight, which restricts the reduction of production costs, affects equipment production efficiency, and increases employee labor intensity.

In summary, there are many separation methods for two or more substances (including two), and the selection of separation methods for stem sticks, stem blocks, and tobacco must consider the quality of the separated tobacco and the entire tobacco. From the current cigarette manufacturing process, reducing the number of stem sticks in cigarettes is mainly controlled through the stem stick removal device provided by the tobacco supply device of the cigarette machine and the MIDAS for detecting tobacco segments. Although many domestic and foreign enterprises and scholars have conducted varying degrees of research on stem stick separation, some conclusions have also been obtained from experiments, which have played an important role in the development of stem stick separation devices. However, there are still certain shortcomings:

(1) There are many types of cigarette units, and the technical workers of major cigarette factories only study and improve the stem stick separation system under specific units in their own factories. When applied to other units, the effect is not obvious, which can easily cause problems such as blockage of the air selection channel, severe tobacco breakage, higher content of stem stick removed tobacco, and significant differences in separation effects. Therefore, specific methods should be required for each unit.

(2) Although major cigarette factories have applied for many patents, they have not been applied in practice, and most of the existing stem stick separation devices are independent. They only separate the usable tobacco from the stem sticks through the separation system for recycling[5]. They have not been

able to directly introduce the separated tobacco into the supply system and directly carry out cigarette production. At the same time, the separation device has a large appearance, complex structure, and high cost Additional maintenance and upkeep work are required, as well as a longer wind selection path, which can easily cause moisture loss and breakage of recycled tobacco, affecting the intrinsic quality of the cigarettes. (3) At present, research is only focused on the stem separation device of the original tobacco supply machine in the cigarette unit. By changing some of the structures and process parameters of the first and second stage stem separation devices, the separation effect can be improved. Although some results can be obtained, most of them are obtained through years of experience and observation of the worker master, and the requirements for the worker's ability are relatively strict, Although some structural adjustments can ensure a decrease in the stem stick rate in cigarettes, sometimes it cannot guarantee the silk content in the separated stem sticks. At the same time, the cigarette unit is a complex and interrelated system, and changing the structure of the original unit itself is difficult, and it will have a certain impact on the performance of the entire cigarette unit. Installation and maintenance are inconvenient, expensive, and affect the overall aesthetics. (4) The separation of stem tags is mostly achieved through wind separation, and there is little research on the flow field inside the wind separation device. The changes in the internal flow field of the air separation device directly affect the separation effect. Identify the changes in the internal airflow field and optimize the structure reasonably. When conducting further flow field analysis, the internal flow field also includes stem sticks and tobacco particles. Although there have been calculations for gas-solid two-phase flow modeling, most of them consider the material as spherical particles, ignoring the collision between particles and the collision between particles and the wall, which will cause deviation in analyzing the gas-solid separation effect inside the separator. Meanwhile, in the entire separation system, most devices are connected through pipelines, which are also important for energy loss, particle flow patterns, and changes in flow fields inside the pipelines. Reasonably designing the connecting pipelines ensures the quality of tobacco and tobacco.

II . Problem Analysis

Based on the original two air separation system functions of the YJ17 cigarette machine and the personnel arrangement of the cigarette production enterprise, personnel were not arranged to separate the waste stems in the subsequent process of removing them from the cigarette machine. All waste stems removed by the cigarette machine, including the tobacco cut in the stems, will be directly treated as waste. According to statistics, the average silk content in the current stem of a certain brand of cigarettes produced by a cigarette manufacturing enterprise is 1.06 1g/10000 cigarettes, compared to the historical best indicator of 0.93g/10000 cigarettes. The cigarette machine has a production capacity of 3.4 million cigarettes per shift, with 2 shifts per day and 260 days per year. A total of 10 cigarette machines waste approximately 1876 kg of tobacco annually. The waste caused by removing tobacco from waste stems in the production of YJ17 cigarette machines is very obvious, which restricts the reduction of production costs and the improvement of equipment efficiency for enterprises. The negative pressure air of the YJ17 cigarette machine's secondary air selection stem separation device is provided by the air chamber body of the suction molding system. After the tobacco is suspended and lifted, it is taken away by the suction ribbon, and the debris from the tobacco stems falls into the

tobacco stem box. The problems include the following two aspects:

One reason is that the stem baffle is difficult to control the primary sorting of stem fibers. After a wind separation, the tobacco enters the suction channel under the drive of the high-speed rotating throwing roller. During this process, if the adjustment position of the stem baffle is too high, a large amount of stem will be sucked into the air chamber, causing many quality defects in the produced cigarettes that have been punctured by the stem. If the position of the stem baffle is adjusted too low, a large amount of tobacco will be thrown into the spiral stem return mechanism and transported to the feeding port of the secondary sorting device. In the case of incomplete stem separation, it will increase production costs and cause waste. The second reason is that the cut tobacco that falls into the tobacco stem box is relatively heavy. The secondary air separation of the YJ17 type coiling machine is only partially completed on the right side of the rear body, with a vertical suction duct width of only 110mm. There are many collisions between the stem and tobacco, and the air separation effect is poor, resulting in incomplete stem separation. Many tobacco leaves fall into the stem box along with the stem during the collision. It was found on site that a large proportion of tobacco leaves are contained in the stem box.

III. Improvement Methods

The development of the third stem and silk separation device for YJ17 cigarette maker utilizes the difference in suspension speed between stems and silk, and uses airflow separation. Assuming the airflow velocity is v, the force of the airflow on the particles is R, and the particle gravity Q=mg, according to Newton's formula R=K （ γ/ g) F (C- ν) 2=K ρ F (C- ν) 2: γ Is the air density, Kg/m3; ρ Is the air density Kg ''s2/m4; C is the absolute velocity of particles, m/s; F is the windward area, m2; K is the resistance coefficient. Due to the different external dimensions of tobacco and tobacco stems, i.e. F, and the different gravity Q, the critical suspension velocities of the two are different. Therefore, as long as the separation airflow velocity v satisfies v0<v<vO stems, tobacco and tobacco stems can be effectively separated.

After clarifying the separation theoretical basis used for the third stem and silk separation device, a vertical airflow simulation blow test method was used to test the stem and silk content of a certain brand produced by 10 # cigarette maker. After a vertical airflow simulation blow test, under the premise of qualified cigarette quality, 50% of the simulated data was less than the improvement target value set by the cigarette enterprise of 0.663g/10000 cigarettes. It can be inferred that it is indeed feasible to install the YJ type cigarette machine's third stem separation device to produce high silk content in the stems of ten thousand cigarettes.

The three-stage separation device for stem and silk is mainly composed of four parts: middle note device, quick connector of blowing device and air duct. Its working principle is that the positive pressure air enters from the air inlet, regulates the air pressure through the pressure regulating valve, and then the positive pressure air comes out from the air inlet. The common pressure is measured by the pressure gauge, and then comes out from the air outlet to enter the blowing device. The three-level separation device for tobacco stems is installed on the lower right side of the straight channel. Through uniform positive pressure air, the most dense and rapidly moving tobacco stems in the channel are blown away[6]. This not only maximizes the dispersion of high-density tobacco clusters, but also blows the scattered tobacco after collision upwards, blowing the tobacco that is about to fall into the tobacco stem box up

for a distance. The tobacco is sucked into the air chamber under the action of negative pressure air. However, the truly heavy tobacco stems still cannot be sucked into the air chamber and fall into the stem box, ultimately achieving the third separation of stem fibers. The stem content can be easily controlled through a pressure regulating valve according to production process requirements. A small air chamber with an inner diameter of 6.8mm is designed inside the blowing device, and six uniform holes with an aperture of 1mm are designed outside the shaft. Positive pressure air enters the small air chamber and blows out from the six uniform holes to form a positive pressure airflow, achieving the purpose of loosening and dispersing tobacco clusters. As shown in Figure 1.

Figure 1. Schematic diagram of structure

IV. Conclusions

After the processing and installation of the third stem separation device parts, the maintenance worker verified the effectiveness of the YJ17 cigarette machine's third stem separation device. After the third use of the stem separation device, the silk content in the stem was 0.583g/10000 wen. Tracking tests were conducted on the stem content in the tobacco produced by the YJ17 cigarette maker. The conclusion was that there was not much change in stem label removal before and after the activity, and the stem content in the tobacco was 0, which meets the production process standards of cigarette enterprises. This improvement is indeed effective.

By using a three-level stem separation device, the tobacco content in the stem box of the YJ17 cigarette maker is significantly reduced. After calculation, one machine producing two shifts a day can save about 2.5 kilograms of tobacco, reduce consumption, and save production costs for the enterprise. At the same time, it also reduces the labor intensity of workers, improves the effective operation rate of equipment, reduces the risk of product quality hazards, and protects consumer rights and interests

The whole stem-label separation system is divided into three levels, and each level is very important. Because the movement of the separated stems and cut tobacco in the separation device is affected by many factors. The influence of air flow field on cut tobacco and stem labels, the impact of collision between cut tobacco and stem labels, the layout of connecting pipes and the influence of transportation process all make the separation process of each stage of stem labels a complex gas-solid two-phase flow movement process. Therefore, there are many problems in the theoretical analysis of the movement of cut tobacco and stalks in the separation device. According to the actual operation requirements of enterprises, the stalk separation system can be further explored and analyzed in the following aspects to make up for the shortcomings of this paper. The main results are as follows:

(1) Although the stalk-label separation device is small, its structure has a great influence on the separation process because the cut tobacco and the stalk-label are too small. This paper only selects the

main structural factors to analyze and study it, and the arrangement and spacing between the guide blocks in the diversion area may affect the separation effect, so it can be considered to be studied in the later stage.

(2) In the simulation, due to the irregularity of cut tobacco and stems, several groups of quantitative particle models can be added in the later stage to improve the model, so that there is more than one shape of cut tobacco and stems, and the physical parameters are closer to the actual situation of the enterprise, which improves the accuracy of numerical simulation results and truly conforms to the experimental results.

(3) During the experiment, only the separation efficiency of cut tobacco and the final rolling quality of cigarettes were statistically analyzed. It is difficult to measure the movement law of cut tobacco and cut tobacco directly and accurately in the whole three-stage separation system. Later, we can explore new experimental methods to measure the movement law of cut tobacco and cut tobacco during separation, which will lay a certain foundation for theoretical research on gas-solid two-phase flow in tobacco industry and verify the accuracy of numerical simulation results.

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