

Factors for Increasing the Regeneration Efficiency of Cotton Regenerators and Their Analysis

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Abstract

This article analyzes the operational efficiency of 1RX, RX, RX-1, and 2RX-M cotton regenerators, widely used in cotton ginning enterprises, in relation to waste composition. Based on experimental results, it is substantiated that an above-normal content of cotton pieces in the waste separated from the UXK cleaning system reduces the regeneration efficiency of existing regenerators. Based on this analysis, proposals have been developed to increase regeneration efficiency by improving the quality of waste loosening and the separation of cotton pieces during the regeneration process.

Keywords: Cotton regenerator, 1RX, UXK cleaning system, waste, cotton pieces, regeneration efficiency, cleaning efficiency, loosening, doffing drum.

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1. Introduction

The issue of ensuring the efficiency of technological processes, reducing product losses, and producing high-quality fiber at cotton ginning enterprises is of critical importance. In particular, the use of regenerators to reprocess seed cotton pieces discharged with waste during the cleaning process and to extract fiber from them holds a significant place in practice.

In practice, the axial-flow cleaners used in cotton ginning lines are called regenerators because they often perform a regenerative function rather than a cleaning one. Such equipment includes the 1RX, RX, RX-1, and 2RX-M regenerators used in the PLPX flow-line cleaning system developed in the 1980s [1].

However, in recent years, a decrease in the operational efficiency of existing regenerators has been observed due to changes in waste composition, namely an increase in the proportion of fine trash in the waste and an increase in the amount of cotton pieces. Therefore, it is necessary to analyze the variation in the regeneration process depending on waste composition and to substantiate directions for design improvements.

1RX regenerators are characterized by their installation on the pneumatic transport line of the PLPX flow-line cleaning system and their operation on a vacuum basis [2]. Initially, the waste entering these regenerators consisted mainly of large trash and cotton pieces, with a relatively low proportion of fine trash.

Under these conditions, the 1RX regenerator operated at a capacity of 1 ton per hour, achieving a regeneration efficiency of up to 95%. The cleaning efficiency was up to 80%, depending on the amount of trash in the waste.

However, under production conditions, as the waste composition changed, the regenerator's operating modes became imbalanced. It was observed that cotton pieces were not distributed in a sufficiently thin layer across the drum's working surface, resulting in a reduced rate of engagement with the saw teeth. This situation leads to a decrease in regeneration efficiency.

In known sources [3], to improve the regenerator design, it has been proposed to position the inlet and outlet pipes of the pneumatic feeder oppositely, to use an additional air intake system with an air-regulating damper, and to direct the material flow using a deflector elbow.

Furthermore, one of the grate bar sections is equipped with triangular-profile grate bars. Although these solutions serve to direct material flow and control airflow, it has been observed in practice that they cannot fully ensure stable regeneration efficiency under conditions of high cotton piece content in the waste.

This is because when there are many cotton pieces in the waste, they tend to stick together and move in a compacted state. This restricts the process of engagement with the drum teeth and slows down the intensive separation of trash in the cleaning zone.

In research conducted by Borodin P.N. [4, 5], the use of a metal-bladed drum was proposed to solve the problem of rapid wear and short service life of brush drums.

In studies on the metal-bladed drum, a decrease in mechanical damage to the seed was observed when the clearance between the blade and the saw was increased from 5 mm to 15 mm. However, it was also noted that this led to an increase in the amount of free fiber. For this reason, metal-bladed drums were not widely implemented in production.

In subsequent research, a rubber-metal plank doffing drum was developed to overcome the shortcomings of the brush drum [6]. As a result of laboratory experiments, it was found that at a drum rotation speed of 960 rpm, a clearance of about 2-5 mm between the tip of the plank and the saw tooth is optimal.

According to experimental results, the separation coefficient for Grade I industrial cotton decreased from 99.7% to 97.2% when the moisture content was between

8-11%. It was determined that as moisture increases, the separation coefficient can drop to as low as 94%. This indicates that moisture has a significant impact on the regeneration process.

At the same time, it is emphasized that the function of the separating drum is not only to increase separation efficiency but also to enhance the cleaning process by evenly distributing cotton fibers from the waste along the drum's working surface.

Based on analyses and observations of the equipment's operational processes, the main reasons for the decrease in regeneration efficiency in existing 1RX regenerators were identified as follows:

1. The dense feeding of the waste mass, causing cotton fibers to stick together.
2. Insufficient loosening and spreading of the waste, which prevents the cotton from being distributed in a thin layer across the drum's working surface.
3. A limited ginning process on the saw teeth, due to the uneven flow of material.
4. A reduction in the intensive shedding of impurities through the grate bars, as the material moves in a dense state.
5. The occurrence of transit movement due to the pneumatic transport air stream, meaning a certain portion of the waste passes through without being acted upon by the working components.

It was found that these factors have a cumulative effect, reducing the regeneration efficiency from 95% down to 84-86%.

Based on the results above and an analysis of the current situation, the following proposals are considered appropriate for increasing regeneration efficiency:

1. Enhancing the waste loosening and distribution system.

When there is a high content of cotton fibers in the waste, it is necessary to separate the clumped fibers through mechanical loosening before feeding them to the drum. This creates the conditions for the uniform distribution of cotton on the drum's working surface.

2. Improving the design of the separating drum.

Taking into account the rapid wear of brush drums and their limited efficiency, it is necessary to optimize the

design of rubber-metal plank drums and select their operating parameters according to the waste composition.

3. Adapting operating modes to account for the effects of moisture.

Experimental results have shown that the separation coefficient decreases significantly with an increase in moisture. Therefore, the regenerator's operating modes (rotational speed, clearances) should be designed to be adjustable based on moisture levels.

4. Limiting the transit bypass of the cotton stream.

In the regenerator's design, waste bypassing the working components due to the air stream reduces regeneration efficiency. Therefore, it is advisable to ensure material movement through a forced mechanical transfer.

5. Enabling control over the regeneration frequency.

Due to the variable composition of the waste, it is necessary to control the residence time of the cotton in the cleaning zone and its degree of reprocessing in the regenerator. This can be achieved through screw conveyor systems or recirculation mechanisms.

2. Conclusion

The analyses and production experiments conducted have shown that the primary cause of the problem is the dense feeding of cotton fibers from the waste and their insufficient distribution on the drum's working surface. As a result, engagement with the saw teeth worsens, and the intensive separation of trash and impurities is reduced.

Therefore, to increase regeneration efficiency, it is advisable to implement waste loosening, improve separating drums, adapt operating modes to account for the effects of moisture, and introduce mechanical conveyance systems that limit transit bypass.

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