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Ways to Increase the Efficiency of Drum Gins in the Primary Processing of Cotton

Kodirov Mirzobek Rahimbergan's son
Student of Namangan State Technical University
qodirovmirzobek@icloud.com

A B S T R A C T
This article analyzes technological and constructive approaches aimed at increasing the efficiency of drum gins used in the primary processing of cotton. Practical calculations and experimental results are presented based on the energy consumption, friction forces, quality level of fiber products and waste volume generated during the cotton ginning process. According to the results of the study, it was found that choosing the optimal range of drum speeds, coordinating the gap between the toothed drum and separators, as well as using Teflon-coated working surfaces can increase machine productivity by 12–15%. It is also noted that the introduction of automated control systems ensures production stability while maintaining the quality of cotton fiber.

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Introduction

The cotton industry is one of the leading sectors of the economy of Uzbekistan, and the chain of cotton cultivation, primary processing and transformation into a finished product consists of interconnected technological stages. In this chain, the primary processing of cotton, in particular, the gin process, serves as the main technological link. With the help of gins, fiber is extracted from the seed cotton, which is of great importance as a finished raw material for the textile industry. It is at this stage that the cost of the crop, the quality of the fiber product and production efficiency are determined.

In recent years, the increase in the volume of cotton cultivation, the increase in the volume of raw material exports, and the expansion of the share of local processing of cotton are increasing the demand for gins. At the same time, the variability of cotton varieties, the fineness of fibers, and the increase in technological load negatively affect the efficiency of existing gins. In particular, issues of drum gins, their constructive solutions, the mechanism of action of working elements and the interaction of the material are of urgent importance.

According to analyzes, the average productivity of currently used drum gins is 300–400 kg of seed cotton per hour. At the same time, heat generation during machine operation, high friction forces, and the percentage of fiber damage remain high. For example, in some old modification machines, the fiber damage rate is around 15–18%, which directly affects the fiber quality and product price.

Based on modern engineering and technological approaches, it is possible to increase the efficiency of drum gins, reduce energy consumption, and improve the quality and yield of fibers obtained from cotton. In particular, optimizing the drum speed, using Teflon, polymer or composite coatings to reduce friction between the material and the working surface, and introducing automated monitoring and control systems are the main directions in this regard.

In addition, equipping drum gins with modern energy-saving engines at manufacturing plants and electronically controlling their rotation frequency allows them to operate in a mode appropriate to the

characteristics of each batch of cotton. This not only increases productivity, but also the quality of cotton fiber.

Therefore, this article analyzes technological and constructive proposals, practical experiences and scientific approaches aimed at increasing the efficiency of drum gins. The main focus will be on reducing technical losses at the stage of primary cotton processing, optimizing energy consumption, and increasing the quality and yield of fiber products.

The role of drum gins at the stage of primary cotton processing is extremely important, with the help of which high-quality fiber is extracted from seed cotton. The success of the ginning process directly depends on the design solutions of the machine, the speed of operation, the consistency of the drum movement, the friction forces between the material and the working surfaces, and energy efficiency. According to an analysis of currently used drum gins, their average productivity is around 300–400 kg of seed cotton per hour, and technological losses (fiber damage, waste percentage, energy consumption) are significantly high.

According to experiments, during the processing of existing gins, an average of 15–18% of the fibers are damaged, which negatively affects the breakability, length and elasticity of cotton fibers. As a result of high friction on the working surfaces of the machine (especially the surfaces of the drum and separator), overheating of the material, tearing of fibers and dust formation are observed. This not only reduces the quality of the product, but also reduces the service life of the machine. The reasons for this can be attributed to the presence of metal surfaces of the main moving parts, excessive drum speed, and insufficient operation of the cooling systems. In order to increase efficiency, several design and technological proposals were tested in practice. First of all, the optimal distance between the drum and the separator was determined as 1.2–1.4 mm, which served to reduce the friction force during fiber separation and avoid fiber damage. Also, the efficiency of cotton ginning showed the highest results when the drum rotation speed was maintained in the range of 700–900 rpm. On the contrary, when operating at speeds above 1000 rpm, the level of fiber breakage and dust generation increased sharply.

Another important innovative approach is the introduction of Teflon coatings on the drum and working surfaces. This coating helped to reduce friction by up to 28%, preventing fiber sticking to the working surfaces. Due to the smoothness of the Teflon coatings, the amount of heat generated in the machine decreased by an average of 5–7°C, which served to reduce the thermal load of the machine. During the 20-hour experiment, the fiber damage rate on gins with Teflon-coated drums decreased to 11.2%, while on machines with conventional metal surfaces this figure was 16.7%. This difference is especially important in the production of high-quality fiber.

In addition, the introduction of automated control systems on drum gins also has a positive effect on efficiency. Using sensors and microcontrollers, the drum rotation, surface temperature, vibration level and cotton flow are monitored in real time and automatically adjusted. This system helps to prevent machine malfunctions, optimize energy consumption and reduce waste. In a drum gin with such a system, energy consumption decreased from 9.4 kW to 7.8 kW per hour, and the amount of fiber produced increased by an average of 12%.

Environmental approaches are also important due to the excessive generation of dust during machine operation, which pollutes the production environment. For this purpose, dust-collecting filter units were integrated into drum gins. Experiments have shown that in machines with a filter system, dust emissions into the external environment were reduced by 60%, which not only improves working conditions, but also ensures compliance with sanitary hygiene standards.

All the above-mentioned proposals and practical studies show that an integrated approach is necessary to increase the efficiency of drum gins. Only when constructive modifications, material selection, automation and environmental protection are carried out together, technical losses in the primary processing of cotton are reduced, energy consumption is reduced, and product quality is increased.

Conclusion

The conducted analysis and experiments show that an integrated approach is important to increase the efficiency of drum gins. Maintaining the drum rotation speed within the optimal range (700–900 rpm),

coordinating the distance between the drum and the separator, and introducing Teflon or other smooth coatings on the working surfaces significantly reduces the percentage of cotton fiber damage, reduces the volume of waste, improves fiber quality, and reduces energy consumption.

Also, by integrating automated control systems into gins, it is possible to control machine operating parameters in real time, prevent accidents, and ensure production stability. Experimental results show that such measures can increase machine efficiency by an average of 12–15% and reduce energy consumption by 15–20%. In conclusion, the process of primary cotton processing can be made more technically and economically efficient by modernizing drum gins, optimizing technological parameters, ensuring environmental safety, and introducing automation.

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