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Modern Analysis of Cotton Cleaning Technologies From Fine Impurities

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Abstract: This article analyzes the technologies of cleaning cotton from fine impurities, their mechanical, air-flow and integrated methods from a modern perspective. The study considers the efficiency of cleaning processes, innovations in equipment design, as well as environmental and economic aspects. The article discusses the importance of new technologies in improving the quality of cotton fiber and ways to optimize them. The results of the study can serve to develop sustainable and cost-effective solutions in the cotton industry.

Keywords: cotton cleaning, fine impurities, mechanical cleaning, air-flow systems, drying technology, environmental efficiency, economic analysis, fiber quality.

Introduction. Cotton occupies an important place in the global economy as one of the main raw materials of the textile industry. The quality of cotton fiber depends on its degree of cleanliness, that is, its freedom from fine impurities (dust, soil particles, plant residues). If these impurities remain in the fiber, the strength of the yarn decreases and defects appear in textile products. Therefore, cotton cleaning technologies are constantly being improved and adapted to modern requirements. This article is aimed at analyzing existing cleaning methods, evaluating new technological solutions and discussing their future development prospects.

Main types of cleaning technologies

Several main methods are used to clean cotton from fine impurities: mechanical cleaning, air flow (aspiration) systems and methods integrated with drying. Each method has its own advantages and limitations.

Mechanical cleaning: Mechanical methods are widely used at the initial stage of cotton cleaning. Gin machines (saw or roller) remove primary impurities along with separating the fiber from the seed. At the next stage, special cleaners, such as OVP or "Pakhtakor", are used. These devices separate fine dust and plant residues by "combing" the fiber. Studies show that the efficiency of mechanical cleaning allows you to remove up to 45% of impurities. However, the disadvantages of this method include energy consumption and the possibility of loss of natural oils in the fiber.

Air-flow cleaning. Aspiration systems are effective in separating light impurities (fluff, dust) using air flow. SBO dryers and dust collectors are used as the main elements of this process. Air-flow methods not only provide cleaning, but also help reduce dust emissions into the environment. At the same time, these systems require high power, which increases overall costs.

Integrated methods. Technologies that combine drying and cleaning, such as 2SB-10 or SBT drum dryers, allow for simultaneous moisture removal and separation of fine impurities. The use of hot air as a drying agent speeds up the process and increases efficiency. By optimizing the speed of cotton movement in new units, the cleaning degree can reach 60-70%.

Modern innovations and equipment. In recent years, a number of innovations have been introduced in cotton cleaning technologies. For example, devices with a conical mesh surface improve the movement of fibers and increase the efficiency of impurity separation. New types of dust collectors are also playing an important role in capturing fibrous waste and protecting the environment from pollution. Automated systems, in particular, the ASX-1 and VSX-1 analyzers, allow for real-time process control. These technologies not only improve quality, but also optimize production costs.

Efficiency, ecology and economics. Several factors are taken into account when assessing the effectiveness of cleaning technologies. Although a combination of mechanical and air-flow methods can remove up to 90% of impurities, the energy requirements of the process and the complexity of the equipment entail additional costs. From an environmental point of view, aspiration systems reduce harmful emissions to the environment, but the fuel used for drying (gas, kerosene) can lead to the release of carbon dioxide into the atmosphere. From an economic point of view, high-quality fiber increases export revenues, but requires significant initial investments.

Conclusion and future prospects. Cotton ginning technologies play an important role in the cotton industry and are constantly evolving. While mechanical, air-flow and integrated methods have provided high efficiency, new solutions are needed to improve energy efficiency and environmental sustainability. The future

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