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**THEORETICAL ANALYSIS OF METHODS FOR CLEANING COTTON FROM  
FINE IMPURITIES**

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**Annotation:** *The article discusses methods for removing fine impurities from raw cotton, methods of impurity separation, and provides an analysis of existing cotton cleaning techniques.*

**Keywords:** *Fine impurities, cleaning, cluster, enterprise, cotton cleaning, cotton, strategy, size, fiber, moisture content, cotton plant, harvesting, machine, plant, impurity, saw-toothed drum, drum, efficiency, mass, percentage, method, mesh surface, airflow, drying, raw material.*

Introduction. Today, a cluster-based approach has been introduced in the Republic of Uzbekistan for the cultivation and processing of raw cotton. Cotton ginneries are currently integrated into these clusters and constitute an essential part of the production chain. This chain encompasses the entire process, from the cultivation of raw cotton to the production of finished products.

The Development Strategy of New Uzbekistan for 2022–2026 sets forth a number of objectives, including “continuing the industrial policy aimed at ensuring the stability of the national economy and increasing the share of industry in gross domestic product, while increasing the volume of industrial production by 1.4 times” [1]. The implementation of these objectives requires ensuring that raw cotton is processed into finished products while preserving its quality characteristics throughout the entire production process.

Sample and approach. As cotton reaches maturity, the leaves and branches of the cotton plant begin to dry out, become brittle, and easily break into small fragments. These fragments mix with the opened cotton bolls and contaminate the raw cotton [3]. During manual harvesting, the degree of cotton contamination largely depends on the harvester's attentiveness, whereas during mechanical harvesting, it primarily depends on the timely and high-quality implementation of artificial defoliation of cotton plants.

Depending on their origin, impurities found in cotton can be classified into organic matter and solid foreign materials. Organic impurities include parts of the cotton plant, such as leaves, branches, boll fragments, flower petals, and other plant residues. Solid foreign materials include stones, sand, soil, clods, and similar materials. During mechanical harvesting, there is a high probability that such solid foreign materials may also become mixed with the harvested cotton.

In terms of size, foreign impurities present in cotton can conventionally be divided into two groups. Fine impurities include particles with dimensions of approximately 8–10 mm,



whereas coarse impurities include particles larger than 10 mm. In terms of their adhesion to cotton, impurities can be classified as passive (inert) and active impurities [4].

Passive or inert impurities are located on the surface of cotton tufts and can be easily separated from the cotton by light shaking. Active impurities, however, are more difficult to remove from cotton. In order to separate active impurities from cotton, they must first be converted into a passive state. Therefore, when selecting cotton-cleaning equipment, it is necessary to consider the nature of the impurities and the manner in which they are attached to the cotton.

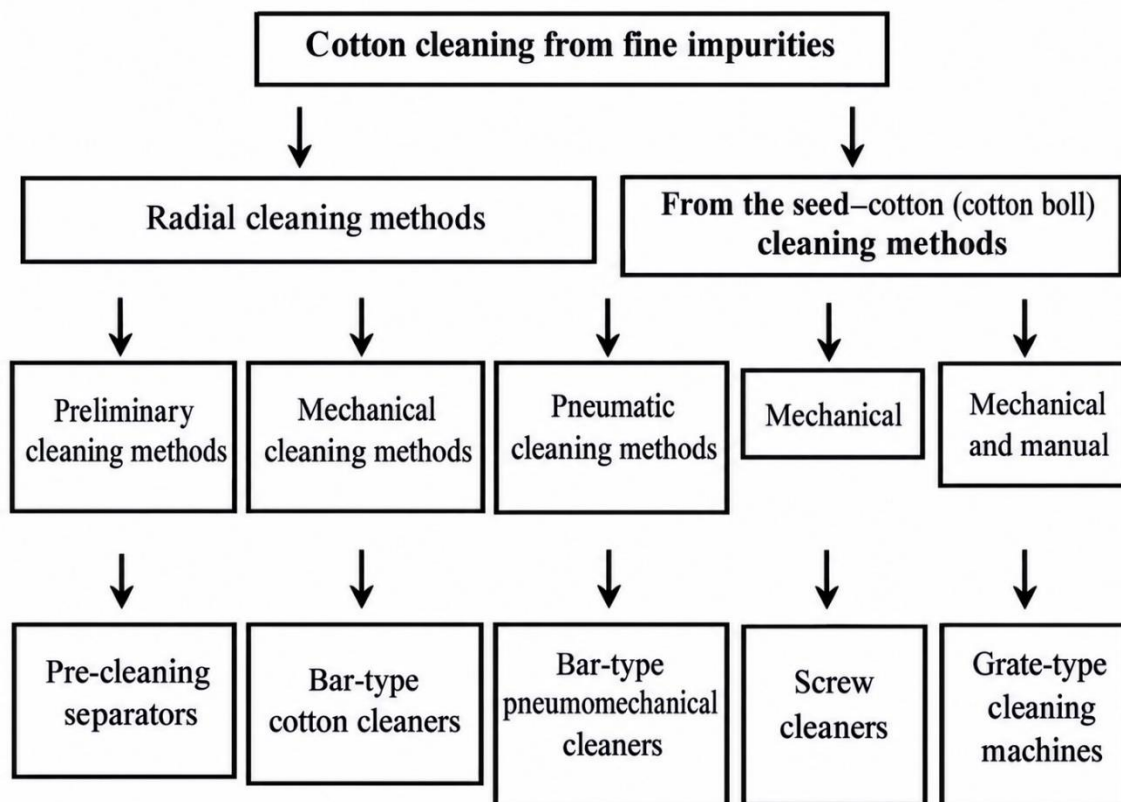


Figure 1. Classification of cotton cleaning machines for the removal of fine impurities

When selecting the types of equipment required for separating various impurities from cotton, consideration of their physical and mechanical properties is a key factor. Cotton cleaning machines consist of sections equipped with spiked drums and saw-toothed drums. Fine impurities are removed in the sections with spiked drums, whereas coarse impurities are separated in the sections equipped with saw-toothed drums [5, 6]. Cotton cleaning equipment is evaluated in terms of its processing capacity and cleaning efficiency. The cleaning efficiency of the equipment is determined as a percentage by the ratio of the mass of impurities separated from the cotton fed into the equipment to the mass of the cotton, as follows:

$$K_M = \frac{C_1 - C_2}{C_1} 100\%$$

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where  $C_1$  and  $C_2$  represent the impurity levels of cotton before and after the cleaning process, respectively. The cleaning efficiency of cotton-cleaning equipment is significantly influenced by its processing capacity, as well as by the moisture content and impurity level of the cotton. The processing capacity of the equipment is increased in accordance with the operating conditions corresponding to its maximum cleaning efficiency. When the moisture content of cotton is reduced to the normal level, the cleaning efficiency increases, facilitating the separation of foreign impurities from the cotton. When cotton with a moisture content exceeding the normal level is subjected to cleaning, not only does the cleaning efficiency of the equipment decrease, but the occurrence of additional defects in the cotton fibers also increases.

Cotton-cleaning equipment and the methods used for cleaning cotton are considered separate aspects of the technological process.

Main methods and techniques of cotton cleaning

Impact method: Cotton is subjected to mechanical impact by means of spiked drums, which facilitates the separation of hard and fine particles contained in the cotton. In this process, spiked drums are the primary working elements used in cotton ginning and cleaning plants for removing fine impurities, such as leaf fragments, small twigs, soil particles, and dust, from raw cotton. By impacting and loosening the cotton and conveying it along perforated or mesh surfaces, spiked drums facilitate the separation of both coarse and fine particles.

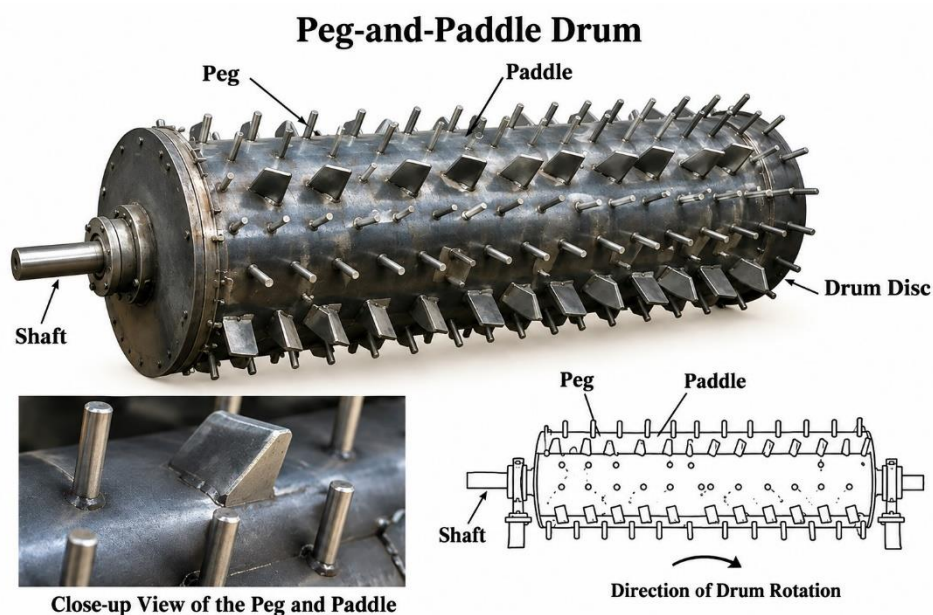
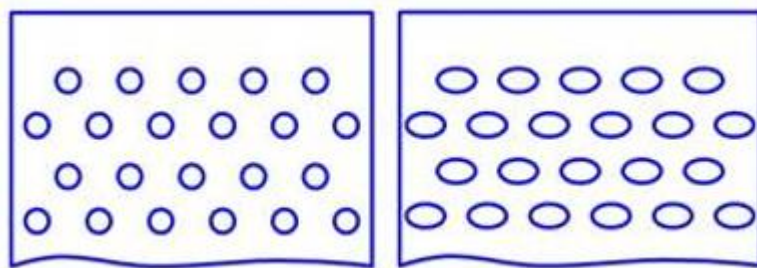


Figure 2. General view of the spiked drum

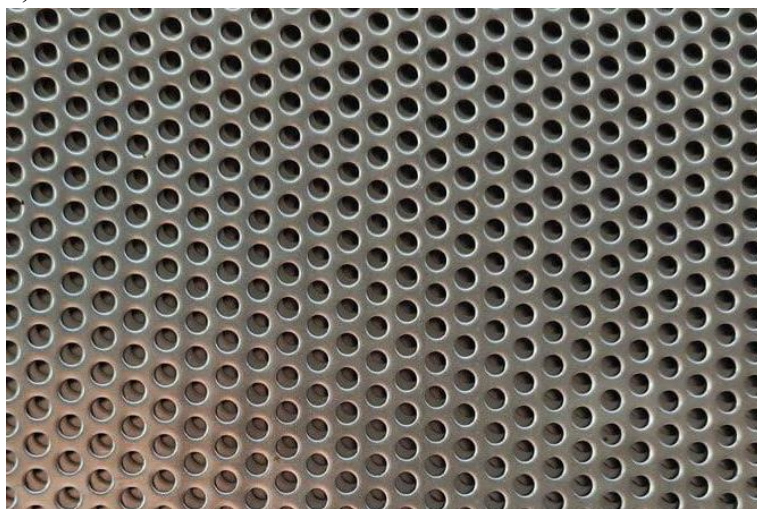
Dragging and friction method: Cleaning is performed by moving particles trapped between the fibers along mesh surfaces. During this process, raw cotton is dragged along a mesh surface (grid bars) by means of spiked drums. As a result of collision and friction, fine impurities such as leaf fragments, husks, and soil particles are separated from the cotton

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fibers and fall through the openings of the mesh surface, while the cleaned cotton fibers are conveyed to the subsequent processing stage.



a)



b)

Figure 3. General views of the mesh surface: a) schematic view; b) photographic view

**Aerodynamic method:** Separation of lightweight impurities and cotton tufts using an air stream. This method is based on the differences in the aerodynamic properties of cotton tufts and impurities, particularly their air resistance and weight. Under the influence of the air stream, lightweight cotton tufts and fine impurities are conveyed through a duct and separated from the air and from one another by means of specially designed separator grates (screens).

#### Stages of cotton cleaning

Raw cotton is initially conveyed to drying drums to reduce its moisture content.

**Removal of fine impurities:** Soil, sand, and small plant residues are removed by passing the cotton through sections equipped with spiked drums.

**Removal of coarse impurities:** Stem fragments, seed particles, and other coarse impurities are separated using saw-toothed or toothed cylinders.

**Conclusion.** The analysis presented above demonstrates that cotton can be cleaned using various methods. When applying these methods in the cotton-cleaning process, particular attention should be paid to maintaining the quality of the cotton fibers and preventing fiber damage. Therefore, our future research will focus primarily on the development and application of modern robotic technologies for removing impurities from cotton while preserving fiber quality.



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