

Studying the composition of dust-mixed waste emitted by the technological process of cotton ginning plants

Fayzullo Husanboy-ugli Rakhimov
f.rahimov95@mail.ru

Nodira Abdusalomovna Rejapova
Muhammad-Babur Abdalbakiyevich Karimov
Namangan State Technical University

Abstract: Cotton primary processing technology involves several sequential processes, the primary objective of which is to produce high-quality fiber and fiber products, as well as seeds. These processes, like many other industrial processes, generate waste and dust, which impact the environment. This article provides information on these wastes, their components, and their environmental impacts.

Keywords: cyclone, drying, cleaning, fiber waste, mineral impurities, organic impurities, uluk, cotton, fiber, dust, lint

Introduction

Comprehensive measures are being consistently implemented worldwide to introduce new approaches to solving problems arising from technical and technological processes in the field of environmental protection. These measures aim to ensure environmental safety, improve the environmental situation, prevent the harmful effects of dust, toxic gases, and waste emitted by industrial enterprises on human health, and create favorable conditions for improving the standard and quality of life [1]. Decree No. UP-81 of the President of the Republic of Uzbekistan dated May 31, 2023, "On measures to transform the sphere of ecology and environmental protection and the organization of the activities of the authorized state body" defines a number of tasks for the application of administrative fines for violations of environmental requirements in the collection, transportation, placement, disposal, storage, recycling, processing and sale of industrial, household and other waste, as well as the discharge of solid household and construction waste in undesignated places and the discharge of liquid household waste, with a tenfold increase in the amount of fines, ensuring the environmental sustainability of regions and intersectoral coordination.

Materials and Methods

During the production process at cotton gins, large quantities of hazardous waste are released into the environment from the processing equipment.

The primary processing of cotton generates large quantities of dust, which pollutes production facilities and the surrounding air, worsens working conditions for

workers and employees, and can lead to occupational diseases, particularly silicosis. The issue of dust control at cotton gins is of paramount importance, especially due to the increasing contamination of machine-harvested cotton [2].

The composition of dust emitted during the technological process at a cotton gin varies. At the beginning of the primary processing of cotton, dust containing a large amount of mineral fractions is emitted into the air. The dust emitted during subsequent processing of cotton - the extraction of fiber and linters - is dominated by organic matter: seed coats, leaf particles, and other parts of the cotton plant, as well as fibers contained in waste. At the end of the process, for example, in the linting, pressing, sorting, and seed stripping departments, the dust released into the air primarily consists of fibrous particles with a mixed shell.

According to analysis, a single cotton gin produces 150-350 tons of fibrous waste annually, depending on the industrial grade. Non-recoverable waste accounts for 5,000-6,000 tons, of which 70-90% is organic waste. This waste serves as raw material for use in agriculture as livestock feed. During the primary processing of cotton, three types of dust particles are released, consisting of the following fractions:

- a) mineral particles ranging in size from 0.1 to 0.2 mm;
- b) impurities ranging in size from 0.1 to 0.315 cm, consisting of crushed pieces of cotton stems (bolls, stems, peduncles, leaves);
- c) short fibers of varying lengths - most typical for grades III-IV ranging from very long to a few microns in length. Large particles up to 0.4 mm wide have a high rotation speed, fly to a height of 8-11 m, and sink within 3-5 seconds, and are therefore not classified as dust [3].

Analysis of Research Results

During the primary processing of cotton, waste from processing machines contains large amounts of fiber (up to 30-40%) used in the textile industry. The characteristics of this waste are presented in Table 1.

Table 1

Description of Fiber Waste

Waste removal vehicles	Name of waste	Waste characteristics
Gins and fiber cleaners of all brands, machines for cleaning ginned seeds, regenerators, fiber condensers	Fibrous waste	The residual mass of cotton seeds (uluk), consisting of interconnected and free fibers and organic and mineral impurities
Momic condensers, cyclones, seed cleaners (machines for processing seeds before the second and third linting).	Bammik waste	A mass of short fibres consisting of dust and small impurities, mostly shorter than 3 mm, entangled with each other.

Cotton processed in the ginning section of the drying and cleaning shop, located at the beginning of the ginning process, is cleaned of mineral dust. The dust content of such cotton can be relatively high - 10-30 mg/m², but this dust can contain up to 40-50% mineral matter.

When processing low-grade cotton, the dust content in the room reaches 40 mg/m², but the mineral content in the dust decreases to 13-16%.

In the ginning section, dust generated during the separation of fibers from the seeds and air processed by the cotton pneumatic conveying system are released into the atmosphere. This air contains dust that could not be released in the drying and cleaning shop, as well as dust generated during cotton cleaning in ginning machines [4]. The dust is fibrous, with a smaller amount of mineral fractions. The fine fractions consist primarily of crushed debris particles. The harvesting method (manual or carding) affects the total amount of dust in the cotton, its fineness, and the distribution of each fraction of debris particles (short fiber, mineral particles, and others). Primary cotton cleaning also does not affect particle shape.

Dust fineness, that is, the quantitative composition of particles of various sizes in the dust. When transporting grades I and II cotton by air, the air transport system is well-developed; the composition of dust emitted from the air varies depending on the harvesting method - hand or machine. Dust emitted during the transport of grade I cotton, harvested by hand, contains approximately 2% fiber fractions. These are primarily full-length fibers. When transporting machine-harvested grade I cotton by air, the fiber fraction increases to 3%, and in dried and cleaned low-grade cotton (grades III and IV), it reaches 40-50%.

When transporting hand-picked grade I cotton by pneumatic transport, the fine dust fraction (20 to 25 μm) content is 24%. When transporting machine-harvested cotton, this fraction is reduced to 13-14 percent (due to the cotton being harvested by a cotton picker). When transporting low-grade machine-harvested cotton (grade IV), the content of such particles in the exhaust air does not exceed 4%.

Thus, the transition to machine harvesting and transportation of cotton without bins contributes to improved sanitary and hygienic conditions at cotton ginning plants [5]. The dispersed composition of dust at the source of dust emitted in large quantities has a wide range. Therefore, when calculating the effectiveness of dust collection factors at cotton ginning plants, it is necessary to take the dispersion factor into account; otherwise, errors typical of determining the characteristics of dust-collecting air cleaners may occur. One of the existing methods for cleaning and recycling waste at cotton ginning mills' processing stations is the cleaning and compaction of irreversible waste along all process lines, cracking it in specialized units, and recycling certain types of waste into animal feed after appropriate cleaning and thermal treatment in drum dryers [6]. Both waste recycling methods are outdated, require additional vehicles for waste collection and removal, and greenhouse gases released during waste cracking are harmful to the environment.

Conclusions

Dust emitted into the atmosphere by process equipment contains a certain amount of harmful substances - from 18 to 1200 mg/m² - and is dispersed by the wind. Dust masses turn into power lines, destroy trees, and pollute nearby houses and running water.

This requires radically changing the entire process or individual stages, and improving the design of the waste cleaning machine to remove small impurities. Fiber separation from cleaned waste is simplified, allowing for the recovery of a specific amount of fiber. This, in turn, will become another important factor in increasing the efficiency of enterprises.

References

1. Международный консультативный комитет по хлопку, Вашингтон, Из Секретариата ICAC, <https://icac.org/>, email secretariat@icac.org, 1 сентября 2018 г.
2. Б.Алиев "Совершенствование устройства для отделения прядильных волокон из хлопковых отходов" Диссертация. Доктор философии по техническим наукам. Наманган 2020 г.
3. М.Султанов Диссертация. Доктор философии по техническим наукам. Наманган 2020 г.
4. А.Мирзаакбаров "Повышение эффективности устройства для отделения волокон от отходов" Презентация. По присуждению ученой степени доктора философии по техническим наукам на основе патента на изобретение без защиты диссертации. Наманган 2024 г.
5. Ф.Рахимов, Н.Гадаев, Х.Косимов, Р.Мурадов Теоретические исследования о воздействии хлопка и тяжелых смесей на стены рабочей камеры дробильщика камня // Семантический универсальный журнал по инновационному образованию, Том 2 Выпуск 3, Год 2023 ISSN: 2835-3048 <https://univerpubl.com/index.php/semantic>.
6. Х.М.Хурамова, Х.Исаханов, Р.Мурадов, Ф.Рахимов Изменения энергопотребления при экстракции кусков хлопка в усовершенствованном регенераторе. AIP Conf. Proc. 3304, 030030 (2025) <https://doi.org/10.1063/5.0269104>. 22 июля 2025, 04:36:30. 030030-1- 030030-6 с.