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# STUDYING SOME PHYSICAL AND MECHANICAL PROPERTIES OF COTTON SEEDS

Tukhtabaev Sanjarbek Tashpulatovich
Docent in School of Ecology and Security,
Tashkent Institute of Textile and Light Industry

Gapparova Mahfuza Abdusalimovna
Docent in School of Ecology and Security,
Tashkent Institute of Textile and Light Industry

Abdazimov Shavkat Khakimovich
"Technospheric Safety", Ph.D., Associate Professor of the
Department Tashkent State Transport University

**Abstract**
Based on theoretical studies, models of the process of sorting seeds and cleaning them from impurities in a vertical air flow of variable cross-section were obtained. The nature of the pattern of the separation process has been established depending on the geometric dimensions and masses of the studied fractions, where the dominant factor is the aerodynamic properties of the studied fractions.

**Keywords:** Fraction, mass, pubescence, windage, friction coefficient, angle of repose, arching, lifting force, soaring speeds, puny and full-fledged seeds.

## Introduction

All these parameters together influence the quality indicators of the sorting process. Therefore, for the further development of effective devices for cleaning and sorting seeds with elements of regulation and optimization of their parameters, the need arose in conducting a number of additional studies to study and clarify some physical and mechanical properties of cotton seeds.

The basic physical and mechanical properties of cotton seeds have been deeply studied in the works of S.P. Kagalovsky [1], as well as in the works of many other researchers [ 2, 3, 4, 5, 6].

The main physical and mechanical characteristics of cotton seeds, which are necessary to create a seed sorter, include weight, pubescence, windage, values of the coefficient of friction on various surfaces, as well as the angle of repose to eliminate the conditions of arch formation in the elements of the seed sorter.

However, in theoretical studies, the values of the main parameters were taken on the basis of general statistical parameters of some averaged values, which cannot be a sufficient condition for the development of a pneumatic seed sorter for sowing seeds, the values of which have a certain scatter in the degree of pubescence and correlate to a large extent with the coefficient of friction of the seeds and the speed of their soaring. In connection with the above, an objective need arose to establish some physical and mechanical properties of pubescent seeds and weeds in order to further develop a vertical pneumatic seed sorter.

**Research on the influence of the geometric parameters of pubescent seeds and weeds on their soaring speed in a vertical air flow**

Theoretical studies and findings have shown that to achieve effective sorting it is necessary know the soaring speed of each sorted particle. As is known, in the total mass of seeds there are mature, immature, puny seeds, as well as light and heavy weeds, which have different soaring speeds.

It has been established that the soaring speed of a seed depends on its shape, surface condition, density, windage, mass, and geometric dimensions.

As is known, the soaring speed is the speed of the air flow at which the weight of the particle is balanced by the lifting force it creates [2]:

$$V_K = \sqrt{\frac{g \cdot M}{K \cdot \gamma \cdot S}},$$

where: g - gravity acceleration, m/s$^2$. ;

M - particle mass, kg. ;

$\gamma$ - air density, kg/m $^3$. ;

K- drag coefficient. ;

S - area of particle projection onto a plane perpendicular to the direction of relative velocity (Midsection section), m $^2$.

Weed seed particles vary significantly in shape (S), mass (M), surface condition (K), etc., which creates favorable conditions for their separation according to aerodynamic properties in sorters that implement the principle of separation in a vertical air flow.

The seed is separated from impurities in a vertical chamber as follows. At an air flow speed greater than the speed of soaring weeds, but less than the speed of soaring seeds, impurities are carried away along with the air flow and are deposited in the cyclone, and the seeds, due to differences in soaring speeds, are suspended, while the heavier ones settle to the bottom of the chamber.

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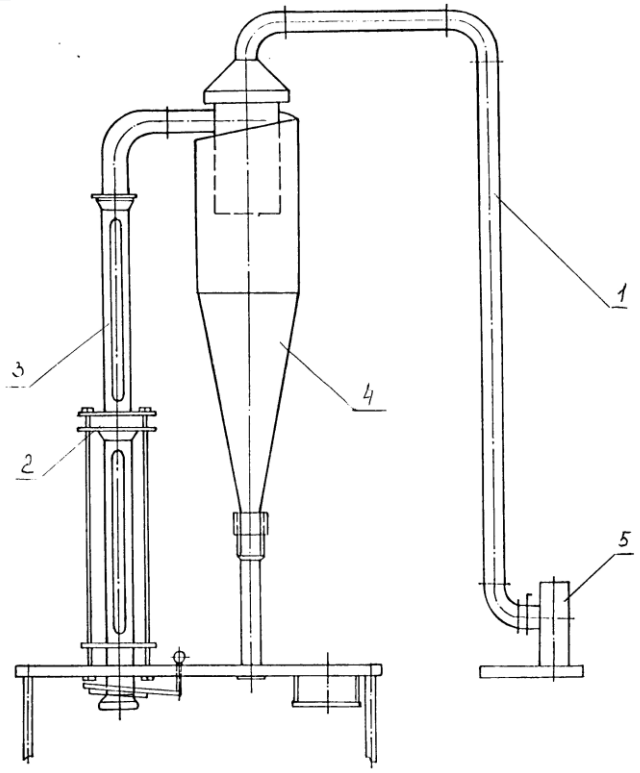
Therefore, to develop a pneumatic seed sorter, it is necessary to have clear recommendations on the soaring speeds of light, puny and full-fledged seeds, as well as data on the soaring speeds of weeds.

To determine the speed of soaring of seeds and weeds, an experimental setup was assembled, shown in Fig. 1. It consists of pipeline 1, grid 2, working section 3, sedimentary chamber 4 (cyclone), and fan 5. The working section is made of transparent organic glass in the form of a pipe 1300 mm long with an internal diameter of 40 mm. The air movement in the installation is created by a fan, in front of which a damper is installed to smoothly regulate the air flow, and therefore its speed in the work area.

In the experiments, we used puny, full-fledged seeds with varying pubescence, as well as weeds selected manually from the total mass.

The experimental technique was as follows: mature seeds were laid in an even layer on grid 2, then they turned on the fan, which, by sucking out air, created a certain air flow speed at the work site. Smoothly adjusting the damper, we increased the air speed until the seeds began to rise up, at a certain moment they are in a suspended state (orbital speed).

**Installation diagram for determining particle soaring velocities**




Rice. 1 1 - pipeline, 2 - mesh, 3 - working area, 4 - sediment chamber (cyclone), 5 - fan (not specified).

на рабочем участке. Плавно регулируя заслонку, увеличивали скорость воздуха пока семена не начинали подниматься вверх, в определенный момент они находятся во взвешанном состоянии (скорость витания). Sequentially, puny, immature seeds were placed on the mesh and, gradually increasing the air speed, their soaring speed was determined. The soaring speeds were determined for various seeds, light weeds and heavy trash.

Table 1 shows the results of experiments to determine the soaring speeds of various factions. Experiments were carried out in five repetitions with a confidence level $P \geq 0,95$.

Research has also established [2, 3] that fractions of weeds and puny seeds with the same soaring speed can vary significantly in size. This is explained by the difference in the volumetric masses of weeds - organic and mineral particles, which differ in mass and, with the same size, can have different soaring speeds.

As can be seen from Table 1, the degree of residual pubescence significantly affects the rate of soaring of seeds. The less pubescence, the greater their soaring speed.

**Table 1 Faction soaring speeds on a bench installation**

| № experience | Hairiness of seeds, % | Micromanometer reading | Pv - velocity pressure, mm.water.st.. | Soaring speed, m/sec. |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| 1. | 0.2 | 29.0 | 5.8 | 9,73 |
| 2. | 0.4 | 27.0 | 5.4 | 9,39 |
| 3. | 0.6 | 25.5 | 5.1 | 9,12 |
| 4. | 0.8 | 25.0 | 5.0 | 9,03 |
| 5. | 1.0 | 24.0 | 4.8 | 8,85 |
| 6. | 1.3 | 22.0 | 4.4 | 8,43 |
| 7. | 1.5 | 19.5 | 3.9 | 7,98 |
| 8. | 1.6 | 19.0 | 3.8 | 7,87 |
| 9. | 2.7 | 18.0 | 3.6 | 7,66 |
| 10. | 3.4 | 17.0 | 3.4 | 7,45 |
| 11. | 4.0 | 15.0 | 3.0 | 7,0 |
| 12. | 5.3 | 13.0 | 2.6 | 6,51 |
| 13. | 7.0 | 11.0 | 2.2 | 5,99 |
| 14. | 9.0 | 9.0 | 1.8 | 5,42 |
| 15. | 11.5 | 7.01 | 1.4 | 4,78 |

To determine the rates of soot (mineral impurities) that occur in the total mass of seeds, pebbles of different sizes and weights were studied. The experimental results showed that their soaring speed is significantly higher than the soaring speed of seeds and other impurities, which must be taken into account when developing a sorter.

Table 2 The speed of soaring of heavy weeds.

| № experience | Weight of pebble, gr. | Micromanometer reading | Pv - velocity pressure, mm.water.st.. | Soaring speed, m/sec. |
|---|---|---|---|---|
| 1 | 0.77 | 115.0 | 23.0 | 19.37 |
| 2 | 0.99 | 126.0 | 25.2 | 20.28 |
| 3 | 1.61 | 135.0 | 27.0 | 20.99 |
| 4 | 2.11 | 139.0 | 27.8 | 21.30 |

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