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Studies of the Fullness of Etching of Sowing Seeds on the Developed Design of A New Etcher

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ABSTRACT:
The main indicators characterizing the quality of etching are the completeness of etching and the degree of coating of the surface of the seeds with the preparation. It is also important to reduce mechanical damage to seeds and drug consumption, eliminate harmful effects on humans and the environment. Currently, the etching of cotton seeds with chemical preparations is carried out centrally in specialized seed preparation workshops at cotton gins. This article presents the data of the studies carried out as a result of which a new design of a pickler of pubescent and bare seeds with a hexagonal mixing drum was developed and manufactured. The subsequent free movement of the seed under the influence of gravity with an initial velocity directed at an angle to the horizon along the inclined tray of the etcher is considered after several strokes, the equation determining the kinetic and potential energies of the rolling seed on an inclined surface is derived. The results of experimental studies conducted on the manufactured pickling of pubescent and bare seeds are also presented.

Introduction.

According to the resolution of the Cabinet of Ministers of the Republic of Uzbekistan № 604 dated 23.12. In 2004, 31 specialized workshops were built for the preparation of sowing cotton seeds [1]. For this purpose, treaters are used, in which the application of pesticide particles to the surface of the seeds is carried out due to their mechanical mixing in the corresponding working bodies. The quality of etching, along with other factors, depends on the design and technological schemes and operating modes of the etchants. Existing seed treaters work mainly on the principle of mechanical transportation and supply of seeds to the treatment chamber, where the preparation is applied, followed by mixing and unloading the treated seeds by mechanical devices. The main disadvantages of the existing designs of treaters are the uneven distribution of seeds by weight and surface of the seeds, and an overestimated consumption of the working fluid. To date, there is not enough research on the development of a rational technology for applying disinfectants to the surface of cotton seeds. Preparation of sowing seeds is carried out after their treatment with a suspension in special machines. A seed treater is known, including a hopper communicating with it by a receiving chamber, in which, by means of an axle equipped with a counterweight and a lever, a two-section bucket is installed, and a link is mounted on the pump drive shaft, and a bracket is installed on the axle lever to interact with the link of the pump drive shaft [2, 3].

The disadvantage of this treater is that with a change in the productivity of the seed supply, it is impossible to supply the suspension corresponding to the volume of seed supply and to ensure the adjustment of the suspension supply. In addition, the probability of not getting the required dose of suspension onto the seeds poured out of the bucket increases, which causes their free passage without treatment with pesticides, while the quality of seed dressing decreases. This treater is intended for processing bulk materials only. A seed treater is known, containing a seed feeder with a hopper, a seed tube, a container for pesticides with a pipeline and a nozzle (Yubus, Spain, brand D-2-VH) [4]. The disadvantage of this treater is the manual adjustment of the suspension supply, which reduces the accuracy, the ratio of seed supply to the suspension flow rate and the

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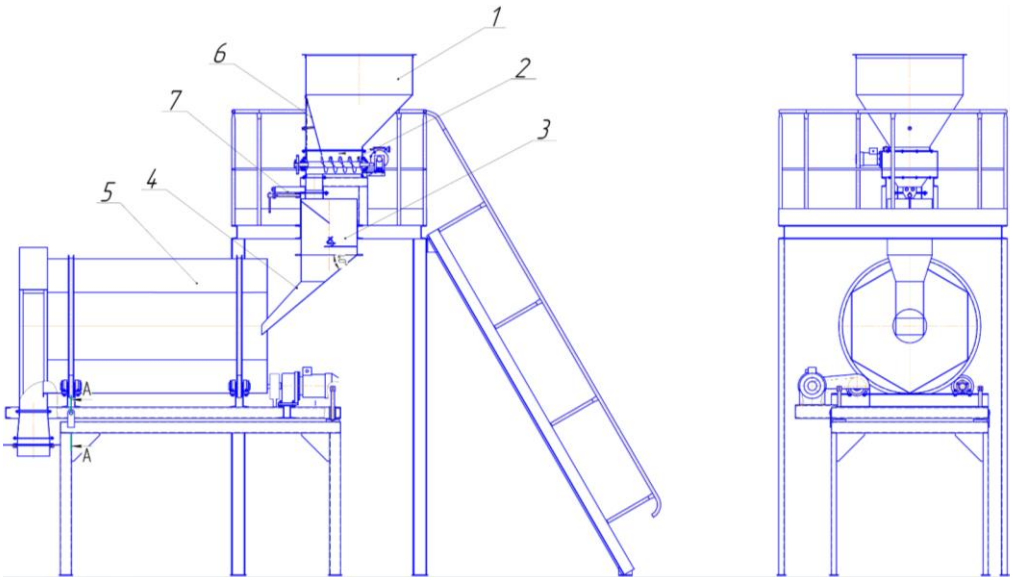
productivity of the seed feeder. The nozzle installed above the tray does not provide uniform application of the suspension to the seeds rolling down the tray. With a large capacity of the seed feeder, the layer of rolling seeds increases. Based on the foregoing, the development of a dressing agent for pubescent cotton seeds, which makes it possible to increase the uniformity and completeness of dressing, is an urgent task.

Analysis of the current state of the problem. For the dry method of pickling B.N. Emelin [5] proposed a rod treater; with this method, the drug is poorly retained on the surface of the seeds, part of the drug is lost. As noted by I.P. Maslo [6], sanitary and hygienic working conditions are deteriorating. These shortcomings are reduced by moistening the seeds and powder when dressing with the Hungarian seed dresser "Mobitox", "Stabitoks", "Mobitox-Cyclomat", "Mobitox-Super" [7]. The design features of technical means in terms of preparation preparation chambers and processing chambers, as well as the type of device for supplying the preparation and seed material to the processing chamber, have a special influence on the uniform distribution of the drug over the seed material. There are two main types of technical processing devices: flow-type machine - the supply of the drug and seed material to the processing chamber is carried out continuously; batch type machine - for a certain weight of seed material into the chamber processing, a certain measured amount of the drug is supplied. It is believed that in-line machines have higher productivity, but less uniformity of drug deposition on seed [8, 9]. For treatment of sowing cotton seeds in dressing shops of ginneries and procurement centers, dressers of various modifications are used. So, for the dressing of bare sowing seeds of cotton, the APH-5, 2-OSX, UOSX-6 dressers, as well as the complex of equipment of the KPS-15 brand and the similar complex of the KPS-19 brand are used, and for the treatment of the pubescent sowing seeds of cotton, the modernized treater UOSX- 6, SP-3M, brand I-JS-8/L (Yubus, Spain) or equipment complex KPH-6 [10, 11].

To improve the quality of treatment of pubescent and bare cotton seeds with a suspension at high productivity (4–5 t/h), a new design of the treater was developed and manufactured at «Paxtasanoat ilmiy markazi» JSC [12, 13] (Fig. 1).



Theoretical research.

Let us consider the following after several impacts, the free movement of the seed under the action of gravity with an initial velocity directed at an angle α to the horizon [2÷4].

Imagine a cotton seed in the form of a cylinder, when rolling down an inclined plane, in the first approximation, there is no slip (Fig. 2).

Let, after two "bounces" (point O_2, Fig. 2), a cotton seed (hereinafter referred to as a cylinder) presented as a cylinder with radius R and mass m roll down from a tray (inclined plane) located at an angle α with the horizon (Fig. 2). Three forces act on the cylinder: gravity P = mg, the reaction of the plane (tray) to the cylinder N and the friction force of the cylinder on the surface of the tray $F_{тр.}$=μm, where μ-is the coefficient of friction of cotton seeds on the surface of the tray.

The cylinder participates simultaneously in two types of motion: translational motion of the center of mass and rotational motion about an axis passing through the center of mass.

Since the cylinder remains on the plane during movement, the acceleration of the center of mass in the direction of the normal to the inclined plane is zero, therefore [14]:

$$P\cdot\cos\alpha - N = 0 \qquad (1)$$

The equation for the dynamics of translational motion along an inclined plane is determined by the friction force $F_{тр.}$ and the component of gravity along the inclined plane mg·sinα, will be:

$$ma = mg\cdot\sin\alpha - F_{тр.} \qquad (2)$$

where: a-is the acceleration of the center of gravity of the cylinder along the inclined plane.

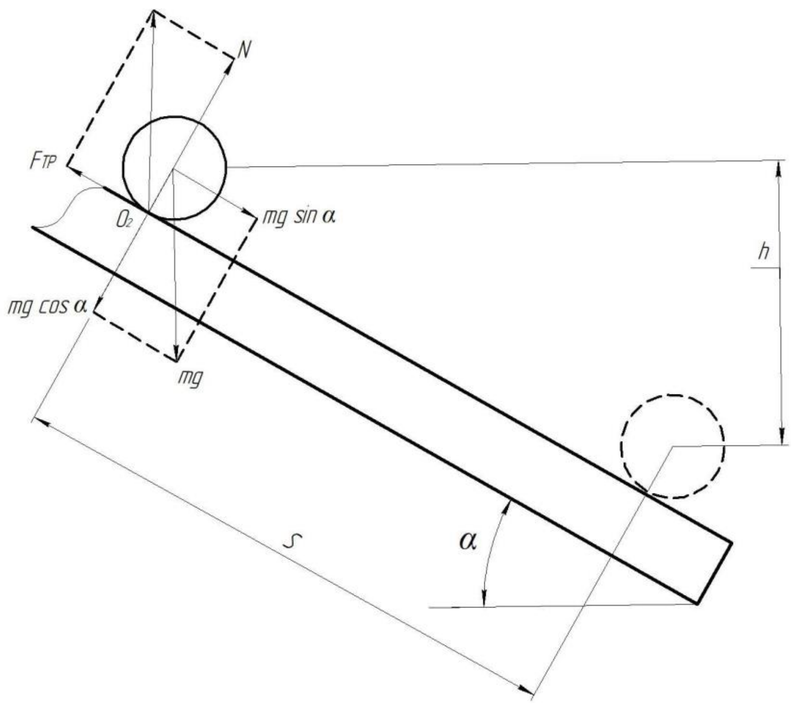


Figure 2. Free movement of the seed along the inclined plane (tray) of the treater

Then the equation of the dynamics of rotational motion about the axis passing through the center of mass has the form:

$$I\,\varepsilon = F_{тр.}R \qquad (3)$$

where: I – moment of inertia, ε – angular acceleration.

The moment of gravity about this axis is zero.

Equations (2) and (3) are valid regardless of whether the cylinder moves along the plane with slip or without slip. But from these equations it is impossible to determine three unknown quantities: $F_{тр}$, a and ε, for this one more additional condition is necessary.

In the general case, the moment of inertia of homogeneous symmetrical bodies of revolution about an axis passing through the center of mass can be written as:

$$I = kmR^2 \quad (4)$$

where: k = 0,5 for a solid cylinder (disk); k = 1,0 for a hollow thin-walled cylinder (hoop); k = 0,4 for a solid ball; for cotton seeds, obviously to k ≈ 0,7.

Consider the process from the standpoint of the law of conservation of energy. Since when a solid body rolls on a solid surface, the rolling friction force is negligible, the total mechanical energy of the rolling body is constant. At the initial moment of time, when the body is at the top of the inclined plane at a height h, its total mechanical energy will be equal to the potential one [15]:

$$W_п = mgh = mgs \cdot \sin\alpha \quad (5)$$

where: s - is the path traveled by the center of mass.

The kinetic energy of a rolling body is the sum of the kinetic energy of the translational motion of the center of mass with a speed υ and rotational motion with an angular velocity ω about the axis passing through the center of mass, those:

$$W_k = \frac{mv^2}{2} + \frac{I\omega^2}{2} \quad (6)$$

When rolling without sliding, the linear and angular velocities are related by the relation:

$$\upsilon = R\omega \quad (7)$$

Let us transform the expression for kinetic energy (15) using formulas (7) and (4) in it:

$$W_2 = \frac{mv^2}{2} + \frac{I\omega^2}{2} = \frac{mR^2\,\omega^2}{2} + \frac{kmR^2\,\omega^2}{2} = \frac{(1+k)mR^2\omega^2}{2} \quad (8)$$

Movement on an inclined plane is uniformly accelerated:

$$s = \frac{at^2}{2} \quad (9)$$

Let us transform dependence (9) taking into account (4):

$$s = \frac{at^2}{2} = \frac{R\varepsilon t^2}{2} = \frac{R\omega t}{2} \quad (10)$$

Solving equations (8) and (10) together, we obtain the final expression for determining the kinetic energy of a cylindrical body rolling along an inclined plane:

$$W_k = \frac{2(1+k)ms^2}{t^2} \quad (11)$$

Transforming expression (10), we obtain an expression for calculating the angular velocity of rotation of a cylinder rolling down an inclined tray:

$$\omega = \frac{2s}{Rt} \quad (12)$$

When rolling from the tray, taking into account the initial speed, after two hits on the tray, when falling $V_0 = V_{2\zeta}$, the seed will have a linear velocity:

$$V = V_0 + at = V_0 + tg\frac{\sin\alpha}{1 + \frac{I}{mR^2}} \quad (13)$$

The values of the angular and linear velocities can be obtained from the kinetic energy balance equation (8).

At the same time, it should be noted that if the seed rolls down an inclined plane, i.e. simultaneously participates in translational and rotational motions, then its kinetic energy at the base of the inclined plane will be equal to the sum of the kinetic energies of the translational motion of the center of mass and rotation.

Research methodology.

The studies were carried out using the existing methodological guidelines for conducting experimental studies, with mathematical processing of the data obtained.

Experimental studies.

To ensure uniform and complete coverage of the working suspension of the treater on the surface of the seeds, experimental studies were carried out to determine the mixing time and the actual seed throughput depending on the angle of inclination of the hexagonal mixing drum of the developed treater, the results of which are presented in Table 1. As can be seen from the results of the experiment (table 1), when adjusting the rotation speed of the hexagonal mixing drum 7 revolution / minutes,

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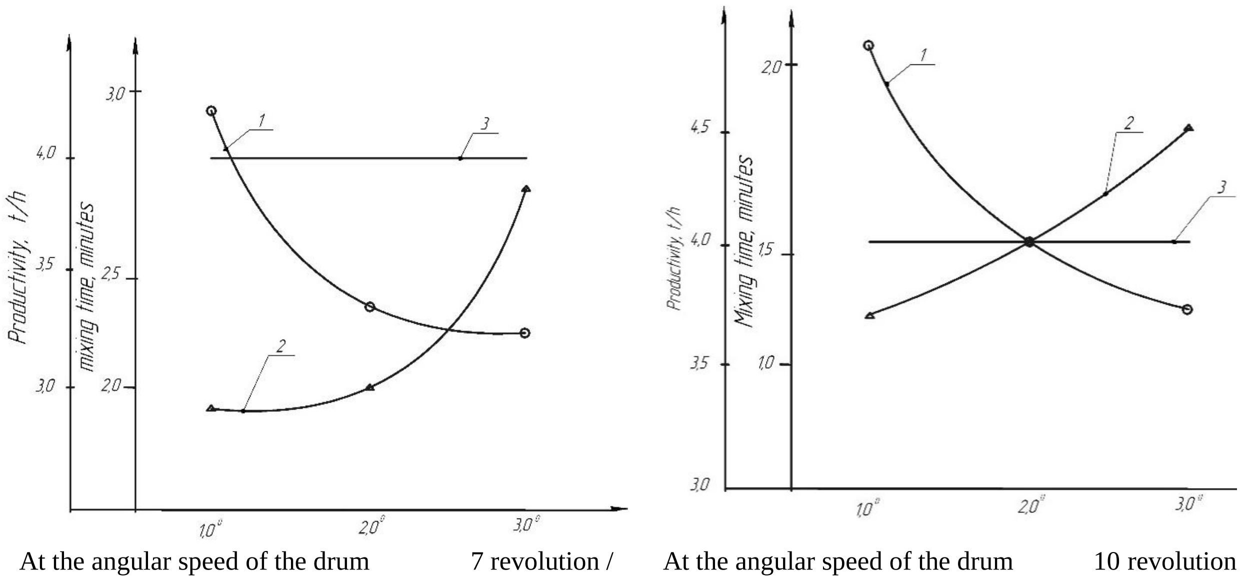
with changes in the angle of inclination of the hexagonal mixing drum relative to the horizontal plane from 1,0 to 3,0^0, the seeds do not have time to mix at a dressing capacity of 4 t/h, there is some accumulation seeds inside the drum, as the throughput of the drum is less than the required capacity of the treater.
When the drum rotation speed is set to 10 revolution / minutes, with the angle of inclination of the hexagonal mixing drum 2,0^0 relative to the horizontal plane, the mixing time was 98 seconds, while the mixing time of the seeds in the hexagonal mixing drum and the feeding of seeds into the drum are the same in performance, and the best mixing of seeds rolling with each other on additional grates assembled from round pipes and interacting with the wall of the drum, which satisfies our goal, is ensured with the duration of mixing.

Table 1.
Influence of the speed of rotation of the drum and the angle of its installation relative to the horizontal plane on the time spent by the seeds in the drum and its seed throughput

Rotation speed of the hexagonal mixing drum, revolution / minutes	Influence of the angle of its installation relative to the horizontal plane					
	for the time the seeds are in the drum, seconds			Capacity of the drum for seeds, t/hour		
	1,0^0	2,0^0	3,0^0	1,0^0	2,0^0	3,0^0
7	169	139	104	3,2	3,4	3,8
10	125	98	75	3,7	4,0	4,15
13	102	82	62	3,8	4,5	4,8

Experimental studies to determine the mixing time and the productivity of the mixing drum were carried out with fixed feeds of etched seeds into a mixing hexagonal drum in the amount of 4 tons / hour. The actual data on the performance of the hexagonal mixing drum was determined by timing the technological process and weighing the seeds coming out of the end of the hexagonal mixing drum.



At the angular speed of the drum 7 revolution / minutes

At the angular speed of the drum 10 revolution / minutes

Figure 3. Seed mixing time (1) and the actual productivity of the hexagonal mixing drum for seeds (2), depending on its angle of inclination in the horizontal surface. ((3) the feed capacity of the etched seeds into the hexagonal mixing drum is 4 tons/ hour.

As can be seen from Fig. 3, when the angle of inclination of the hexagonal mixing drum is up to 2,0^0 and at the angular speed of the drum is 10 revolution / minutes, the mixing time curves and the actual productivity of the

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mixing drum intersect at one point with the direct set productivity of the etching machine equal to 4 tons / hour. At the same time, as the results of the timing work showed, the actual productivity of the hexagonal mixing drum for seeds was 4 tons / hour. This means that the number of seeds entering and leaving the hexagonal mixing drum corresponds, so there is no accumulation of seeds inside the drum.

To confirm the above results, tests of the developed pickler with a hexagonal mixing drum were carried out in the production conditions of the workshop for the preparation of pubescent cotton seeds of the Ramitan cotton gin plant of the Bukhara region.

A prototype of the developed etchant with a hexagonal mixing drum was manufactured at “RIM Ustakhonasi” LLC, according to the justified parameters, the photos of which are shown in Fig. 4.

Figure 4. Photos of a manufactured hexagonal mixing drum as part of a pickler of pubescent cotton seeds.

The results of the tests are shown in Table 2.

As can be seen from Table 2, in order for the compared hexagonal mixing drums to have the same indicators for the completeness of etching, it is necessary to increase the consumption of the etching working suspension from 27,0 l/ton to 29,5 l/ton on the existing mixing drum. Therefore, it can be argued that with intensive mixing in an improved hexagonal mixing drum for etching each ton of pubescent seeds, 2,5 liters of working suspension is consumed less than with the existing hexagonal mixing drum.

Table 2

The actual productivity of the etcher, t/hour	Existing hexagonal mixing drum			
	Mixing time, sec	The actual yield of seeds during mixing, kg	Actual suspension consumption, l/ton	Completeness of etching, %
4,0	82,1	91,1	27,0	86,2
	82,2	91,3		86,5
	81,7	90,9		85,9
medium	82,0	91,1	27,0	86,2
	82,1	91,1		92,0

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4,0	82,2	91,3	29,5	92,8
	81,7	90,9		92,1
medium	82,0	91,1	29,5	92,3
The actual productivity of the etcher, t/hour	Advanced hexagonal mixing drum			
	Mixing time, sec	The actual yield of seeds during mixing, kg	Actual suspension consumption, l/ton	Completeness of etching, %
	87,6	96,36		92,5
4,0	88,2	96,58	27,0	93,1
	87,0	96,14		91,9
medium	87,6	96,36	27,0	92,5

Analysis of the results obtained.

From the experimental data obtained in Table 1 and Figure 3, it can be seen that when the rotation speed of the drum is set to 10 revolution/minutes, at an angle of inclination of the hexagonal mixing drum 2.0^0 relative to the horizontal plane, the mixing duration was 98 seconds, while the mixing time of seeds in the hexagonal mixing drum and the feeding of seeds into the drum coincides with the productivity, and the best mixing of seeds rolling with each other on additional mixing and interacting with the drum wall. The satisfying goal set for us is provided with a mixing duration of 98 seconds.

Conclusions.

As a result of the conducted research, the equation determining the kinetic and potential energies of the rolling seeds along the inclined surface of the developed etcher is derived. When the rotation speed of the hexagonal mixing drum is equal to 10 revolution/minutes, the number of seeds entering and leaving the hexagonal mixing drum corresponds, so there is no accumulation of seeds inside the drum. The results of determining the quality indicators of the etched seeds as a result of mixing inside an improved hexagonal mixing drum showed that with its installation angle of 2^0 and rotation speed equal to 10 revolution/minutes in fullness and uniformity of seed etching, it meets the requirements of the standard.

As the results of comparative production studies have shown, during a set of intensive mixing in an improved hexagonal mixing drum with grids assembled from round pipes, while ensuring the same completeness of etching of pubescent seeds, 2,5 liters of working suspension is consumed for each ton of pubescent seeds less than with the existing hexagonal mixing drum, which corresponds to the economy of the etcher by 0,34 liters (kg) for each ton of pickled pubescent seeds.

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