https://doi.org/10.1051/e3sconf/202341302045

Justification choice parameters material input receiving and distributing device in the horizontal type air grain cleaning machine

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Abstract. The paper presents studies to determine the angle of inclination of the surface from the coefficient of friction for organic glass in an air grain cleaning machine. Earlier studies of the physico-mechanical properties of grain seeds have shown that for steel, the angle of descent of wheat is 36.2 – 37 degrees at a humidity of 15%-16%.

1 Introduction

The minimization of grain damage during post-harvest grain cleaning is determined by several factors. Firstly, damaged grain has a lower quality, which reduces its value. This is due to damage to the grain shell, which serves as a natural protection against external factors and preserves its resource value. Secondly, grain damage can lead to the loss of its germination ability and ultimately to a decrease in the yield of the next season.

This is particularly important for agricultural enterprises involved in industrial-scale cultivation of cereal crops. Thirdly, damaged grain can become a source of various diseases and insects. This will lead to additional costs for grain processing and disinfection and may result in additional crop losses. Therefore, minimizing grain damage during post-harvest grain cleaning is an important task for agricultural enterprises and helps to increase production efficiency and improve product quality, which can be achieved with the help of grain cleaning machines.

Grain cleaning machines are necessary for removing all types of impurities and contaminants from grain that can negatively affect product quality. They can also be used for separating different types of grain and preparing them for further processing. The use of grain cleaning machines allows for:

1. Improved product quality: removal of impurities and contaminants that can lead to product quality deterioration.

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2. Increased efficiency: grain cleaning machines can clean large volumes of grain in a short amount of time, which increases production efficiency.
3. Reduced risk of infection: regular cleaning of grain helps to prevent the risk of product contamination by harmful microorganisms.
4. Meeting market requirements: product quality significantly affects reputation and competitiveness in the market, and grain cleaning machines can help meet customer requirements.

It follows that grain cleaning machines are essential equipment for producing quality products and organizing production processes rationally. During the cleaning and calibration of wheat grain, the main material is subjected to the effects of gravity, friction, and rolling.

One of the most influential factors affecting the quality of wheat grain is the duration of friction force on the surfaces of the aspirator channel, sieve, inclined board in the separator. The shorter the duration of the impact, the more the wheat grain will retain its vegetative properties and be more resistant to harmful bacteria. Since wheat grains differ in their physical and mechanical properties, the duration of the friction force exerted on the grain will also vary. Therefore, an important criterion in the development of a horizontal grain cleaning machine is the choice of construction material.

2 Research methods.

For air cleaning of grain from lightweight impurities and dust, an air separator with a horizontal channel (figure 1) has been developed with an automated distribution device and the ability to adjust the material input speed into the aspiration channel, which has fundamentally new design differences from existing air cleaning machines. The majority of grain cleaning systems are of the vertical type, with the disadvantage being that when the grain moves in the vertical aspiration channel, particles hit the channel walls, increasing the percentage of traumatized grain. The aspiration channel is of the horizontal type.

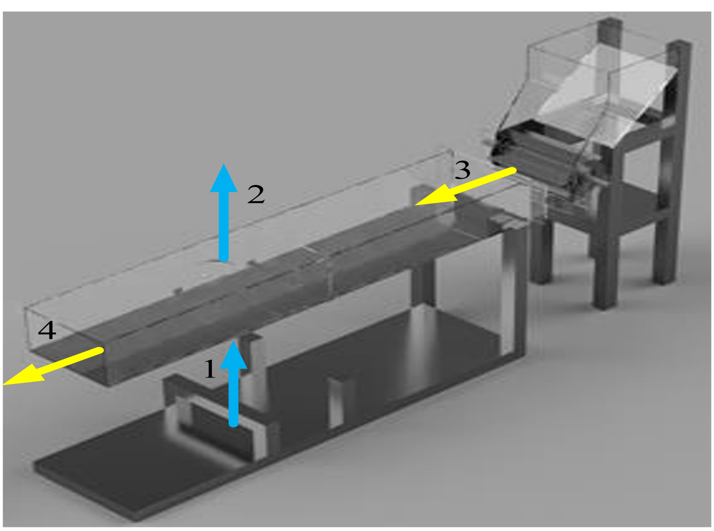

Fig. 1. General view of a horizontal grain cleaning machine.

The principle of operation horizontal grain cleaning machine (Figure 1) is as follows: the grain material requiring aspirational cleaning is fed from the receiving and distributing device into the suction channel 3, where light impurities are picked up perpendicular to the air flow for transportation to the impurity fraction, allowing for preliminary cleaning of the grain material. The material separation is achieved by a perpendicular air flow generated by the centrifugal fan 1 - air flow inlet, 2 - air flow outlet. The cleaned material at the output of the suction channel 4 is directed to the fraction with the cleaned grain.

During the movement of grain through a horizontal channel, there is friction between the grain material and the surface of the channel, which leads to damage to the main cleaned material. To prevent this, it is necessary to identify the main construction material that will affect the macro- and micro-damage to the main cleaned crop during experimental studies. Based on this, conclusions can be drawn about minimizing the injury to the grain material.

Earlier studies of the physical and mechanical properties of grain seeds 2 showed that the angle of repose of wheat is 36.2-37 degrees at a humidity of 15%-16%. We will determine the friction coefficient and angle of repose for organic glass, as this polymer has less effect on the grain material than the metal used in grain separators. The experiment was conducted using a device for determining the friction coefficient of seeds (Figure 2), and the seed moisture content was 15-16%.

Fig. 2. Device for determining the coefficient of friction of seeds

The device operating algorithm includes a formula for determining the tangent of the angle at which the measured crop deviates, which is then recorded by a capacitive sensor. The coefficient of friction is determined according to a formula 1.

$$f = \text{tg}\phi \quad (1)$$

where f - coefficient of friction, tgϕ- tangent of the friction angle.

3 The results obtained

The device for determining the coefficient of friction of seeds has a panel for input and output of information. The input panel is necessary for calibrating the inclined table, "start" and "stop" measurements, and the indication panel is necessary for displaying information about the tangent of the friction angle and the angle of inclination of the surface (Figure 3).

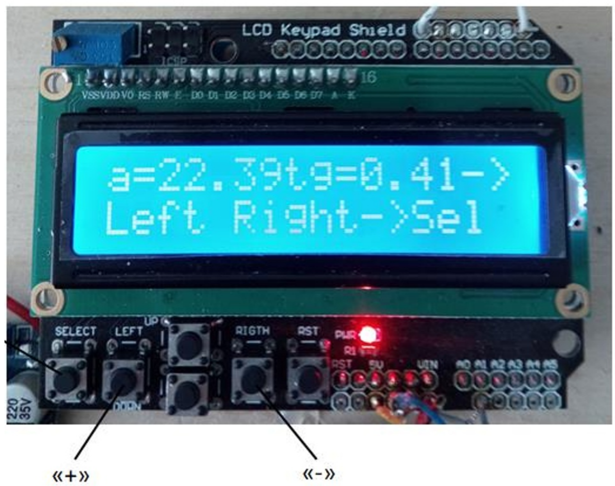

Fig. 2. Panel of indication and direction

During the research, a dependence of the beginning of movement of wheat grains on their mass and size was identified. The shape and dimensions of wheat seeds are variable and depend on both soil and weather conditions during the growing season. Having an imperfect shape, wheat seeds have different contact spots with the surface. The smaller the grain by size and mass, the smaller the angle of descent achieved before its movement, as shown in graph 1. On average, the measured wheat grain has a mass of 40-42 mg, dimensions: length - 4.0-6.6 mm, width - 1.6-4.7 mm, thickness - 1.5-3.5 mm and can be divided into three groups by size: small, medium, and large. Small seeds have a width of 1.6-2.6 mm, medium - 2.7-3.7 mm, and large - 3.8-4.7 mm. The measurement results were recorded in table 1.

Table 1. Measurement results of the device for determining the coefficient of friction of seeds

№ Experiment	tg friction angle	Grain weight, mg	The angle of inclination of the surface	Dimensions, width, mm
1	0,48	35	14,9	1,63
2	0,48	35	17,79	1,67
3	0,48	35	21,93	1,70
4	0,49	36	22,34	1,71
5	0,5	37	24,41	1,72
6	0,51	37	24,83	1,78

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7	0,52	37	24,83	1,82
8	0,52	37	25,66	1,88
9	0,53	37	25,66	1,90
10	0,53	38	26,07	1,91
11	0,53	38	26,48	1,98
12	0,53	38	26,9	2,00
13	0,53	38	26,9	2,09
14	0,54	39	27,31	2,38
15	0,54	39	27,72	2,43
16	0,57	40	28,14	2,77
17	0,57	40	28,55	2,80
18	0,57	40	28,55	2,86
19	0,58	40	28,97	2,90
20	0,58	40	29,38	3,01
21	0,59	40	30,21	3,13
22	0,6	41	30,21	3,14
23	0,61	41	30,21	3,15
24	0,61	42	30,21	3,18
25	0,62	42	31,03	3,26
26	0,62	42	31,03	3,27
27	0,63	43	31,86	3,30
28	0,64	43	32,69	3,31
29	0,64	44	33,52	3,36
30	0,65	44	33,93	3,37
31	0,66	44.5	33,93	3,42
32	0,66	45,5	34,76	3,45
33	0,66	45,5	34,76	3,55
34	0,67	45,8	35,17	3,57
35	0,69	46	35,17	3,66

Based on the data from Table 1, Graph 1 was constructed showing the dependence of the angle of inclination of the surface on the coefficient of friction.

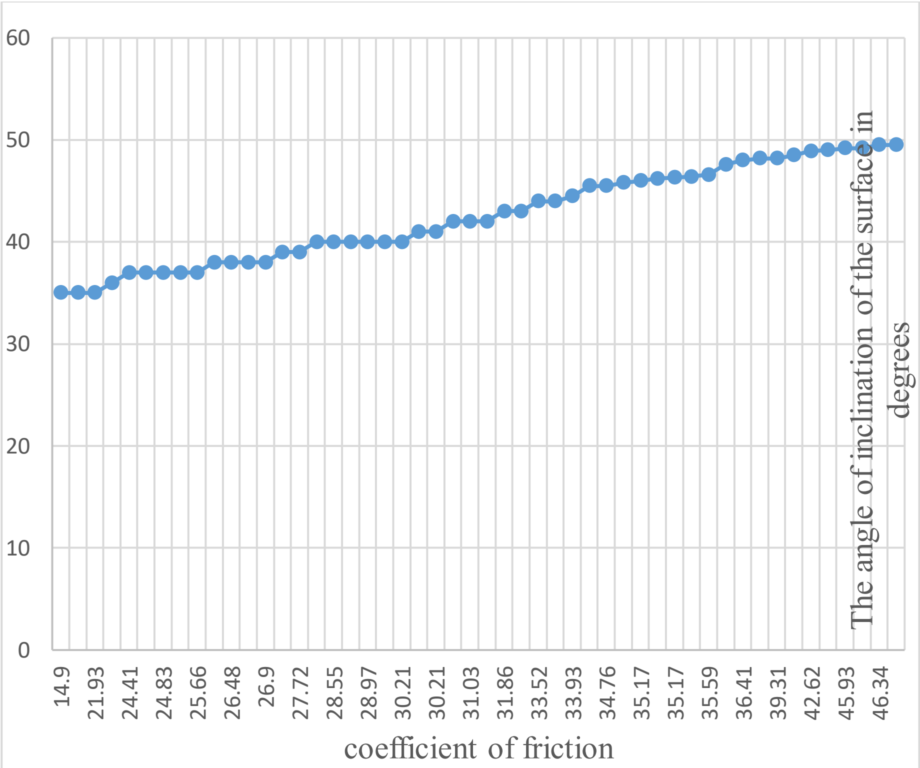

Fig. 1. Graph of the dependence of the angle of inclination of the surface on the coefficient of friction

After analyzing the constructed graph, it can be concluded that the angle at which grains converge for the material - organic glass is on average 32.0194 degrees (for steel - 36.2-37 degrees). Thus, the optimal inclination angle when using organic glass should be no less than 32 degrees.

4 Conclusions

During experimental research, the slope angle for organic glass was obtained, which is 32 degrees. Meanwhile, the angle of wheat attachment for steel is 36.2-37 degrees at a humidity of 15%-16%. A graph of the dependence of the surface slope angle on the friction coefficient was constructed based on experimental data. The data obtained during the experiment can be used in the creation of a laboratory horizontal type grain cleaning machine made of organic glass. Additionally, due to the transparency of the material, visual analysis during experimental research will be the most effective compared to the use of other (non-transparent) types of materials.

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