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Scientific Planning for Effective Methods of Aspiration Systems and Energy Efficient Designs of Separation Devices

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Abstract: In this article, scientific researches were carried out on the preparation of plant seeds for processing, improvement of existing devices that meet the current requirements, creation of aspiration and separation processes and devices for the size and mass of seeds, creation of devices with low energy consumption.

Keywords: seed, raw materials, aspiration, separation, resource saving, modernization, diversification, energy, soy, oil.

The article entitled Experimental study of aspiration cleaning processes of soybean seeds presents the results of studying the processes of aspiration cleaning of soybean seeds (grain) in the developed experimental device. The description of the design of the improved combined separator with an optimal aspiration system was given. The method of planning experiments was used to study the processes of aspiration cleaning and fractionation of soybean seeds (grain).

Based on the analysis of the constructions of the aspiration device for cleaning from mixtures and the conclusions obtained from the analysis results, the aspiration system of the combined separator for leguminous and spiky plant grains was improved.

The speed of entering the pneumoseparation channel of products was $V_п$=0,5 m/s. The parameters of particle transformation are presented in Table 1.

Product parameters

Table 1.

Product	$\rho_п$, кг/м^3	$\bar{V}_{вит}$, м/с	$d_э$, м
Shadow	720	30,6	0,007
Medium natural waste release	520	4,4	0,0009
Emission of light natural waste	260	2,3	0,0005

In this case, the mass share of light and medium natural waste output did not exceed 1.0%, respectively.

Figure 1 shows the trajectories of model particles in a closed air system.

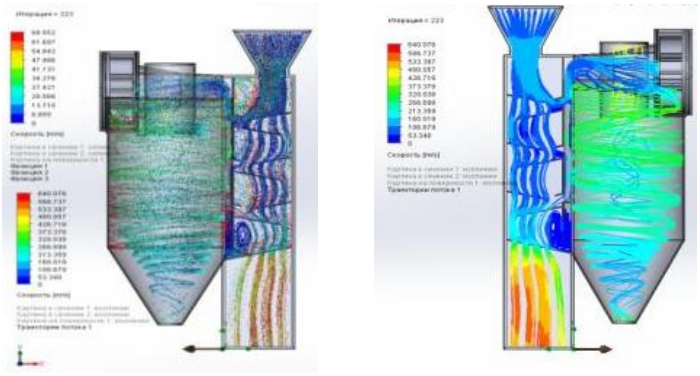

Figure 1. Movement trajectories of particles in the field of air flow velocities

Using computer modeling, the values of the main physical parameters for the aerodynamic scheme of the combined separator device were obtained, and the design and quality analysis of the aspiration process of the improved combined separator device was carried out.

An overview of the combined separator with an optimal aspiration system is presented in Fig. 2. The combined separator consists of raw material (grain) incoming hopper 1, perforated racks 2, primary aspiration channel 3, aspiration electric motor 4, cyclone 5, frame 6, sieve for separating large impurities 7, supply shaft 8 and electric motor 9.

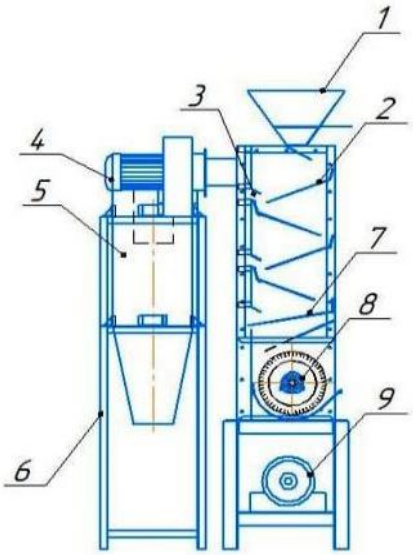

Figure 2. Aspiration system of the combined separator

1. Supply hopper, 2. Perforated racks, 3. Primary aspiration channel, 4. Electric motor, 5. Cyclone, 6. Frame, 7. Sieve for separating large impurities, 8. Supply shaft

The design of the experiment was carried out according to the method of conducting a complete factorial experiment (TFE 23).

When separating soybeans from mixtures by mass:

supply air speed: lower value - z_1^-=3,5 m/s; high value - z_1^+=5,5 m/s; slope angle of shelves in the aspiration working zone: lower value -z_2^-=10^0; high value - z_2^+=18^0; volumetric consumption of soybean grains: z_3^-= 0,004 м^3/с; z_3^+= 0,008 м^3/с.

The lower and upper values of the indicated factors were determined during the preliminary experiments.

The degree of purification of the mixture y was taken as the output factor (in %).

As a result of calculating the coefficients, the following regression equation was obtained (5):

$b_j = t_{кр} \cdot S_{koef}$ (5)

b_0= 94,250; b_1=-0,750; b_2=0,833; b_3=1,833; b_{12}=-0,167; b_{13}=-0,167; b_{23}=0,083

Calculated value of Fisher's criterion $F_{расч}$=0,148. So, $F_{расч}$=0,148<$F_{табл}$=2,8, which confirms the adequacy of the obtained regression equation of the studied process of cleaning soybean seeds (grains).

By transferring the values of influencing factors to natural size, a mathematical model with natural values of influencing factors was obtained:

$Y= 89,2105 – 0,75z_1 + 0,20825z_2 + 366,6z_3$ (6)

Using this equation, it is possible to find the optimal values of the factors at which the output value y of the soybean seed (grain) aspiration process will be maximum (Figures 18, 19, 20).X_1:= 4,5

$f(y,z): = 89,2105 – 0,075x_1 + 0,20825y + 366,6z$

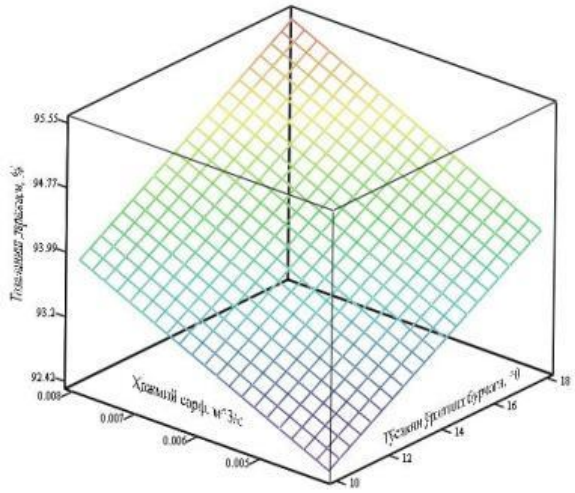

Figure 3. The graph of the dependence of the volume consumption of the degree of shade cleaning and the angle of installation of the sieve rack

y_1 = 14,0

$f(x,z) = 89,2105 – 0,075x + 0,20825y_1 + 366,6z$

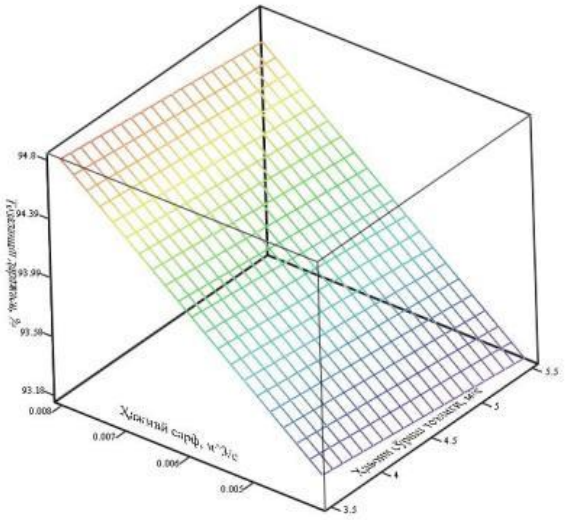

Figure 4. The graph of the dependence of the degree of shade cleaning on the volume consumption and the rate of air absorption

z_1: = 0,006

$f(x,y) = 89{,}2105 - 0{,}075x + 0{,}20825y + 366{,}6z_1$

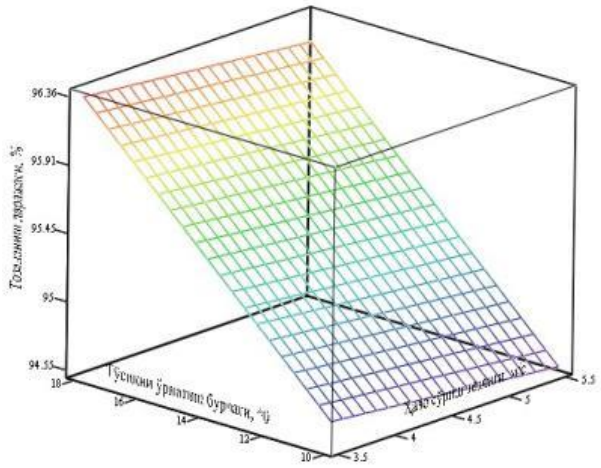

Figure 5. The graph of the dependence of the level of shade cleaning on the angle of installation of the sieve rack and the speed of air intake

The technical-economic description of the optimized system of aspiration cleaning of soybean grains of the article describes the improved construction of the combined separator for dispersed materials, in which it is explained that the grain material is simultaneously cleaned from various impurities and fractionated according to grain mass and flight speed. Economic efficiency indicators of the improved combinatorial separator were calculated.

An overview of the improved separator is shown in Figure 6.

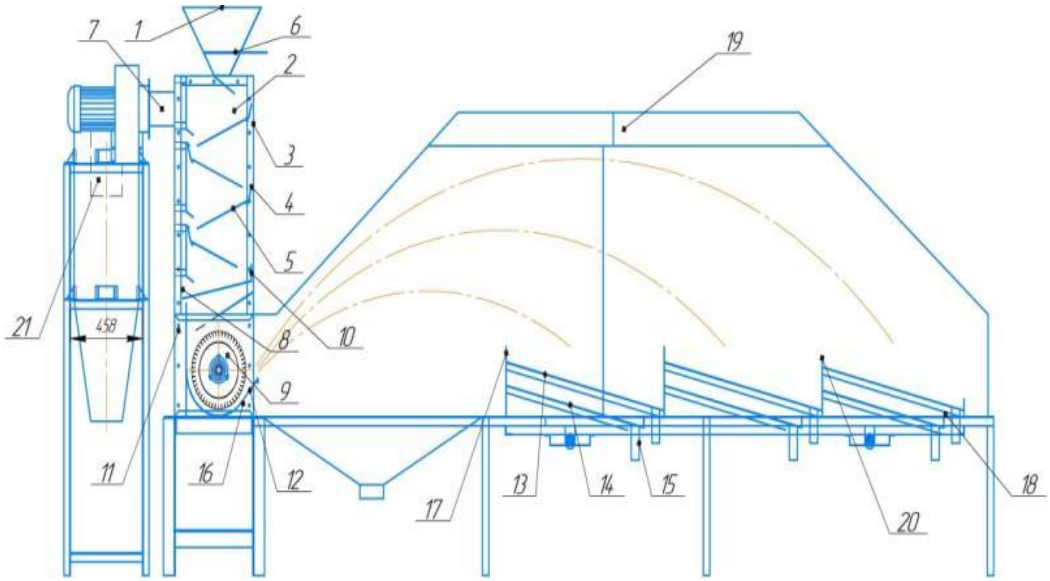

Figure 6. Overview of a combined separator with optimal aspiration parameters

The task of improving the design of the separator is to completely clean legumes and cereals from other impurities and separate them into fractions according to their mass.

The combined separator consists of a supply device, grain mixture separation and fractionation chambers.

The supply device of the separator is a receiving chamber 1 equipped with side walls 2, 3, perforated shelves 4, 5 obliquely installed on its side walls and an initial aspiration channel 7 at the outlet directed to the side wall, a loading device 6 and a supply shaft installed in the lower

part of the receiving chamber, respectively 9 also includes a container 11 for collecting large heavy mixtures.

The separation chamber, the cyclone 21 and the grain mixture fractionation chamber are made in the form of a distributor in the form of a supply shaft, under which a guide plate 12 is installed, the sections are divided into two sections by barriers 20, inclined sieves 13 and plates 14, 15 are installed in the sections. The supply shaft 9 is attached to the combined separator frame. The supply shaft and fan gear are driven by a 1.5 kW electric motor with a belt drive.

The distribution of grain along the length of the combined separator chamber was determined at a distance of up to 4.5 m at a rotation frequency of 420 rev/min and a guide angle of inclination a=450 (Table 3). As a result, in the above parameters, the maximum flight length of soybean seeds (grain) is 4.5 m, and the lifting height is 1.25 m; At 370 rpm, these indicators are 4.0 and 0.91 m, respectively (Table 3).

Table 2. Distribution of plant seeds in the working chamber of the combined separator

№	Rotational frequency of the supply shaft, rev/min.	Sections and length of the combined separator chamber, m								
		9	8	7	6	5	4	3	2	1
		0,1-0,5	0,5-1,0	1,0-1,5	1,5-2,0	2,0-2,5	2,5-3,0	3,0-3,5	3,5-4,0	4,0-4,5
1	420	-	-	72,6	111,2	114,3	116,7	118,1	120,8	122,3
2	370	-	82,7	91,6	113,7	115,4	117,5	119,3	121,2	-
3	320	78,2	105	111,7	115,2	116,9	118,8	120,3	-	-
4	270	103,8	110,9	114,7	116,3	117,8	119,2	-	-	-

Table 3. Distribution of seed flight length, lift height and supply shaft rotation frequency in the working chamber of the combined separator

№	Rotational frequency of the supply shaft, rev/min.	Grain elevation height, h, m	Grain elevation height, h, m
1	420	1,25	4,5
2	370	0,91	4,0
3	320	0,77	3,5
4	270	0,65	3,0

In analyzing the distribution of soybean seeds along the length of the combined separator chamber, the soybean seeds are cleaned from various impurities and fractionated by mass at the values of the tilt angle of the guide shaft up to $\alpha=45^0$and the rotation frequency of the supply shaft n=420 rev/min.

By increasing the efficiency of the combined separator, separating high-quality soybean grains into fractions, the additional production of soybean oil is 4502.0 tons, in which the economic efficiency is 36.0 million. soums, and conditional annual economic efficiency is 80.2 mln. soums, the payback period of capital investments is 0.9 years.

CONCLUSION

In the proposed method, the degree of purification of raw materials was increased to 98.3% and the energy consumption was reduced by 2 times; extraction efficiency of soybean grains sorted for seed increased by 3.0-3.5%; During the research, the oil level of sorted soybean seeds (grains) was on average 16.2%, and in the current compared method it was 14.5%; released and put into production. The production test of the improved combined separator has been carried out, and the expected economic efficiency indicator is 80.2 mln. amounted to soum.

LITERATURE

1. Kuzibekov S.K., Barakaev N.R. Pishchevaya tsennost pri ispolzovanie soi v pishchevyx tselyak // Kompozitsionnye materialy, 2018. -№1.-C.33-36. [02.00.00. #4]
2. Kuzibekov S.K., Barakaev N.R. The effect of primary purification on the quality of soybean oil // Composite materials, 2018. -#1. -C.112-116. [02.00.00. #4]
3. Kuzibekov S.K., Barakaev N.R. The unique chemical composition of seed oil ensures the reliability of industrial processing // Kompozitsionnye materialy, 2019. -№2. -C.132-135. [02.00.00. #4]
4. Barakaev N.R., Kuzibekov S.K. Investigation of flow hydrodynamics in the process of aspiration cleaning of soybean seeds (grain) on a computer model // Harvard Educational and Scientific Review: Har. Edu.a.sci.rev. 0362-8027. Vol.2. Issue 2 Pages 10-14. 10.5281/zenodo.7057555. 2022. [05.00.00. #4]
5. Barakaev N.R., Kuzibekov S.K. Research on energy and resource-saving technologies for the purification of plant raw materials // International Journal of Advanced Research in IT and Engineering: ISSN: 2278-6244. Impact Factor: 7.436. 2022.6.N.R.Barakaev., S.K.Kuzibekov., A.N.Rajabov., M.T.Kurbanov. Improvement of the design of mobile equipment for post-harvest processing of agricultural crops // Journal of Critical Reviews: ISSN- 2394-5125 Vol 7, Issue 14, 2020.