Calculation of the Amount of Grain Moving Inside the Grinding Chamber

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Abstract: In the world, resource-saving technologies for grinding grain feed and preparing full-value feed from it and technical means for their implementation are being produced. In particular, special attention is paid to high-quality grinding, energy and resource-saving devices by bringing grain feedstuffs such as wheat, barley, corn grain and soot to the same granulometric composition. From this point of view, in this research work, it is important to process cereal feed by mechanical grinding method, to develop devices that implement it, to justify their technological work process and parameters of working parts. The purpose of the research is to develop devices that grind grain feed at the level of the specified requirements at low costs and justify their parameters. Based on this, the amount of grain moving in the "air-particle ring" in the grinding chamber was calculated, and the amount of grain particles moving in the "air-particle ring" was calculated to be msl=0.025 kg. When the hammer of the hammer mill is working, the amount of fractions up to 1 mm in the crushed grains is 3%, the amount of fractions up to 1-2 mm is 87.6%, and the amount of fractions larger than 2 mm is 9.4%.

1 INTRODUCTION

Currently, the state attaches great importance to the development of livestock breeding in our republic. In the strategy of agricultural development of the Republic of Uzbekistan for 2020-2030, the establishment of family livestock and poultry farms and strengthening of their feed base is defined as one of the main tasks (Astanakulov et al., 2021a; Astanakulov et al., 2021b; Kovalev et al., 2023a; Kovalev et al., 2023b; Kovalev et al., 2024). It is known that with the establishment of livestock and poultry farms, the demand for concentrated feed increases (Astanakulov et al., 2022; Astanakulov et al., 2023; Kovalev et al., 2023a; Kovalev et al., 2023b; Ikonnikova et al., 2023; Yablokova et al., 2024). Because one of the main ways to increase the productivity of livestock is to feed them with soft fodder, that is, fodder obtained by processing nutritious grains (Sattarov et al., 2023; Borotov et al., 2023a; Borotov et al., 2023b).

The 2022-2026 program for the development of the livestock industry and its industries in the Republic of Uzbekistan is a priority goal of the rapid development of the livestock industry and its industries, the stable supply of food products to the population of the republic, and the expansion of production opportunities. and focusing on setting tasks (Shomirzaev et al., 2022; Mamatov et al., 2022). Today, there are a total of 18,032 livestock farms in our republic, of which 7,614 cattle farms, 3,263 sheep and goat farms, 142 sheep farms, 52 camel farms,

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1,163 poultry farms, 4,829 fish farms, 715 1 was established in the field of beekeeping and 254 in the direction of rabbit breeding.

Ensuring food safety at the expense of increasing the production of livestock products, wide introduction of modern methods of production, thereby creating an added value chain, development of the livestock industry and its branches, as well as modern information and communication technologies in this field and organization of effective use of scientific achievements, rapid development of the livestock industry, providing the population with cheap and high-quality meat and other food products, preparation of high-quality feed is an integral part of efficient livestock farming.

2 MATERIALS AND METHODS

According to the research methodology for the theoretical study of the technological process of the hammer grain crusher, the interaction between the hammer and the grain inside the grinding chamber should be modeled. The results of theoretical studies and one-factor experiments to determine the factors affecting the working process of a hammer grain crusher device, which performs grinding, showed that the number of revolutions of the hammer with a lever, the working surface of the hammer, as the size of the grinding chamber is affected by the diameter of the sieve mesh and the gap between the sieve and the hammer.

Based on the above analysis, the combined effect of the recorded parameters and operating modes of the grain grinder on the grain grinding process and, on this basis, determining their optimal values was carried out using the methods of mathematical planning of multifactorial experiments.

3 RESULTS AND DISCUSSION

The amount of grain moving in the "air-particle ring" in the crushing chamber can be determined as follows, according to the expression recommended by S.V. Melnikov, the speed of hammers that ensures crushing in one stroke (Fig. 1).

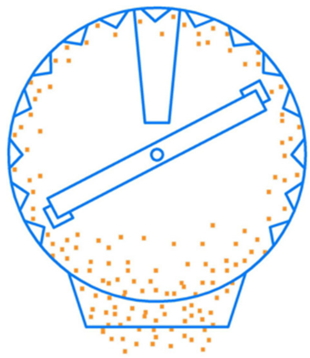

Figure 1: Grain grinding process.

$$v_{ud} = \sqrt{k_d \sigma_{ch} \ln(a / x_1) / \rho}. \quad (1)$$

here

a – grain length, m;

x_1 – length of the undeformed part of the grain after impact, m;

ρ – grain density, kg/m^3;

k_d – dynamic grinding coefficient of the grain, k_d=1,6-2,0

σ_{ch} – grain strength limit, N/m^2.

We can reduce the above expression to the following form

$$\frac{a}{x_1} = \exp\left(\frac{\rho v_{ud}^{\ 2}}{k_d \sigma_{ch}}\right) \quad (2)$$

Based on the specified impact speed, we express the following relation

$$\lambda_1 = \exp\left(\frac{\rho v_{ud}^{\ 2}}{k_d \sigma_{ch}}\right) \quad (3)$$

In this case, the deformation of the grain under the influence of the free impact of the mallet

$$a - x_1 = a\left(1 - \frac{1}{\lambda_1}\right) \quad (4)$$

Based on this, the number of blows that should be given to ensure complete grinding of the grain is as follows.

$$z_{ud} = \frac{a}{a - x_1} = \frac{\lambda_1}{\lambda_1 - 1} \quad (5)$$

According to the calculation according to this expression, the grain receives 3 blows in sections II and III in the first half revolution of the hammer after entering the grinder.

Ungrinded grain particles move in additional circulation along the "air-particle ring" inside the grinding chamber. In this case, the grain particles receive 2 blows from the hammers of the grinder for each additional rotation. If the grain needs to receive 9 shocks for complete grinding, then the grain particles need to rotate 3 more times along the "air-particle ring".

In turn, the grain particles rotate in the following amount while they are inside the grinding chamber

$$n_{dz} = \frac{z_{ud} - 2}{2} \tag{6}$$

In that case, the amount of grain particles moving in the "air-particle ring" is equal to the following

$$m_{sl} = \frac{\pi q (z_{ud} - 2)}{\omega_{sl}} \tag{7}$$

here ω_{sl} – angular velocity of the "air-particle" layer, m/s;

q – the speed at which grains are transferred to the grinding chamber, kg/s.

4 CONCLUSIONS

The optimal values of the parameters of the working parts and operating modes of the food grain grinding device are as follows.

1. For barley grains σch=7MPa; ρ=1300kg/m^3, the speed of the hammer to crush them u=40,2 m/s; its radius of gyration r=0,215 m; the radius of the grinding chamber and kd =1,8; q=0,03 kg/s if there is, then the speed that ensures crushing of grains in one stroke of the mallet vud=20,1m/s, angular velocity of the "air-particle" layer ωsl=83,75rad/s, the number of blows that ensure complete grinding of the grain zud=25 and the amount of grain particles moving in the "air-particle ring" should be equal msl=0,025kg.

2. During the hammer rotation of the hammer mill, the amount of fractions up to 1 mm in the crushed grains is 3%, the amount of fractions up to 1-2 mm is 87.6%, and the amount of fractions larger than 2 mm is 9%. 4%, and the grinding model was 1.34.

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