

Mini crusher-shredder for farms

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Abstract. The purpose of the study is to substantiate the parameters of a mini crusher-shredder for processing coarse feed stalks in farms. The feasibility of using a mini crusher-shredder for processing coarse feed in the conditions of farms and farms with a small number of animals, which has a rotary-type shredder that combines the operations of grinding and crushing, is justified. The research uses the laws and rules of mathematical statistics, mathematical planning of experiments, and the methods given in existing regulatory documents. Experimental studies were carried out to study the influence of the rotor parameters of the mini crusher-shredder on its quality performance. A compact crusher-shredder has been developed, which has a good visibility of the working bodies, high reliability and quality of work due to zoo technical requirements. Experimental studies have established that when using a hammer of a flat-turned shape with a lower sharpening and a rotation angle of 60 or more, high-quality grinding of the stems is provided.

Keywords: *animal husbandry, coarse feed, crusher-chopper, rotor, splitting, grinding.*

1. Introduction

Animal husbandry in Uzbekistan is one of the most important branches of agriculture. In this regard, special attention is paid to providing the livestock industry with feed, while special importance is attached to the cultivation of forage crops. Therefore, Uzbekistan is conducting research on the development of energy and resource-saving technologies and technical means for tillage, seeding and harvesting forage crops and their primary processing.

Much attention is paid to the development of animal husbandry in private subsidiary farms, farms and farms with a small number of animals. Numerous farms

with a small number of cattle (cattle) and sheep are organized in the Republic. To date, the number of cattle in the republic has increased dramatically and is more than 7.4 million. Of these, 6.9 million or more than 90% comes to the share of personal subsidiary and farms.

In our Republic, coarse feed is mainly used for feeding animals, i.e. corn stalks, alfalfa hay, straw and wild-growing stalked crops. However, due to poor cooking food using primitive (cutting the stems) and ineffective (grinding with obsolete equipment) ways of increasing feed waste due to its low consumption and operating.

One of the necessary and required conditions for the successful management of industrial livestock is not only a stable feed base, but also the use of modern methods and techniques for preparing feed, ensuring their most effective use.

The most important source of feed proteins for animal husbandry is coarse feed. However, in order to improve the quality and digestibility of coarse feed, it is necessary to process them.

It is known that the development of small livestock farms and farmer farms is closely associated with the preparation of quality food at a lower material.

The solution to the problematic issue of livestock eliminate the above drawbacks predetermines the necessity of the work aimed at the development of the mini crusher, shredder, providing improvement of quality of feed preparation of coarse stems of forage crops, as well as reducing operating costs.

The purpose of the study is to substantiate the parameters of a mini crusher-shredder for processing coarse feed stalks in farms.

2. Methods

In accordance with the task of creating a rational design of the crusher-shredder, as well as to justify the main parameters and operating modes of the crusher-shredder, complex experimental studies were conducted.

Studies of the process of processing coarse feed were carried out in the laboratory and field conditions. The main provisions of OST-70.19.2-83 "Testing of agricultural machinery" were used as a methodology for conducting research. Machinery and equipment for the preparation of feed. Research programs and methods". The repetition of experiments with each variant was taken five times.

The stalks of corn, which is the main coarse feed, were selected for the research. Stem samples taken to determine the quality were weighed on a VLKT-500A scale. Before starting the experiments, the humidity of the stems and their size and weight indicators were determined. The evaluation criteria for the quality of the machine were: the quality of grinding (C_i), the cleavage of the stems (R_s). The choice of the shape of the rotor hammers was evaluated based on the condition of better embed ability in the crushed mass and the implementation of the technological process with fewer technological failures of the machines.

Experimental studies on the interaction of coarse feed stalks depending on the parameters and operating modes of the rotor were carried out on a specially made stand. The working bodies of the stand are driven by a three-phase asynchronous motor via a V-belt transmission. The working rotor is driven by an electric motor through a pulley, which changes the speed of rotation. The rotor speed can be adjusted by replacing the pulleys within $900-1500 \text{ min}^{-1}$. The design of the stand provides for the possibility of easy replacement of working bodies.

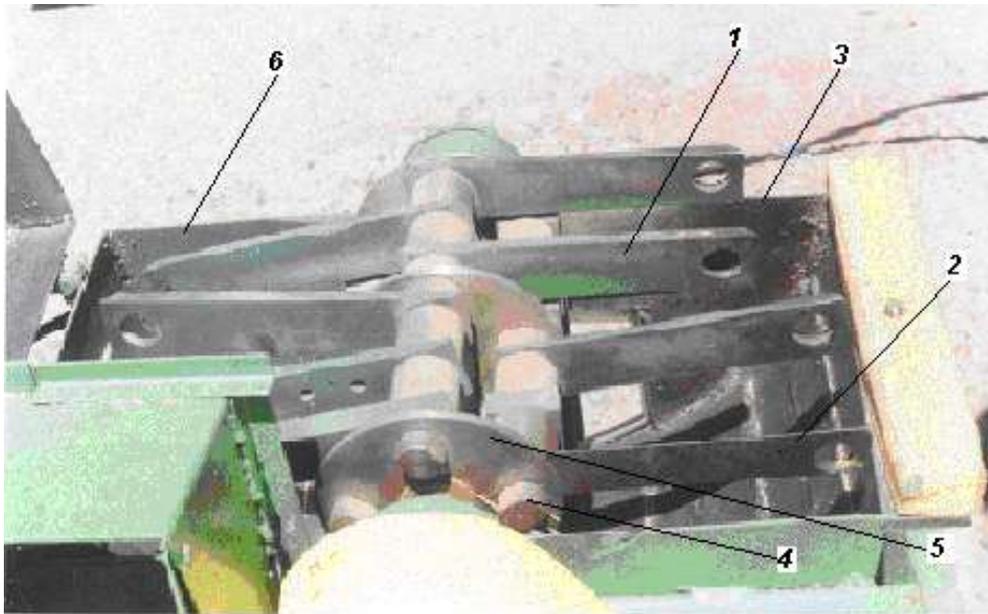


Figure 1. General view of the rotor: 1 – hammer; 2– knife; 3 and 6– rotor body; 4 – axis; 5 – flange

The rotor consists of a shaft on which three disks of steel sheet with a thickness of 8 mm are mounted. The disks on the periphery have holes that serve to secure the hammers with a threaded connection. Fixing the hammers with bolted connections allowed changing the diameter of the rotor from 0.4 to 0.6 m and the number of hammers from 12 to 24 pieces of various options.

2. Results and Discussion

Selection of the shape and angle of rotation of the rotor hammers. The selection of the optimal type and shape of the rotor hammers of the crusher-shredder was carried out by comparative tests. The choice of the working shape of the rotor hammers was evaluated based on the conditions of better embed ability in the supplied mass of stems and the implementation of the technological process, with as few technological failures as possible.

For a comparative study, the following forms of rotor hammers were selected: straight, straight with a sharpened lower part, turned, each of which was straight.

A comparative evaluation of the operation of different versions of the rotor hammers was carried out under the same conditions and operating modes. The results of the experiments are presented in Table 1.

Table 1. Performance indicators of the crusher-shredder with different shapes of hammers.

Name of indicators	Values of indicators		
	Form of hammers		
	flat straight	straight to the lower shank	flat turned
1. Time of drawing of the supplied mass, c	4,2	4,0	2,8
2. Time of passage of the mass, c	5,6	3,8	1,7
3. Reverse blowing of the mass, %	92,8	98,1	93,2
4. Grinding, %	94,5	89,3	84,9
5. Cleavage, %			

From these experiments, it can be seen that the worst indicators for the time of dragging the supplied mass (4.2 s), the passage of the mass (5.6 s) and the reverse blowing of the mass (31.4%) were obtained when the crusher-shredder with a flat cross-section shape of the rotor hammers.

This phenomenon is explained by the low degree of embed ability of the hammers in the feed mass and the poor transportability of the crushed mass by this type of

hammers, since they create an air flow not in the direction of the mass exit, but in the direction of the feed tray.

Slightly better performance is obtained when the rotor works with a straight hammer with a lower sharpening. So, with the same feed and operating mode, the time of dragging and passing the mass is 4.0 and 3.8 seconds, respectively, and the reverse blowing of the mass is 18.7%.

This is due to the fact that the lower sharpening of the hammers contributes to the creation of an air flow towards the discharge window and a larger number of processed stems come out of the discharge window.

The best indicators for these three evaluation criteria were obtained with flat-turned hammers with a lower sharpening, while the dragging time is 2.8 s, and the mass passage time through the device is 1.7 s. The reverse blowing of the mass almost did not occur.

The improvement of dragging, passing and blowing of the mass with the rotor hammers turned is explained by the fact that the hammers having this shape better capture the supplied mass and create an excellent air flow towards the mass exit, as well as sufficiently throw the processed mass into the discharge window of the crusher-shredder.

In addition, these variants of hammers were compared by the shredding and splitting of the stems.

Of the compared variants of the working bodies on the criteria of atomization and the split, the best results are hammers with the cross-sectional shape of a flat straight and direct with bottom sharpening, these values are respectively 92,8 and atomization of 98.1%, and the split - 94,5 and 89.3%. When operating the rotor with flat turned hammers, these indicators were 93.2 and 84.9%.

Analyzing the data obtained, it can be noted that although the first and second types of hammers have a higher value of shredding and splitting of the stems than the third option, but they are not significant.

However, the third version of the hammers performs the technological process better and processes the stems much faster. Therefore, this type of working body was chosen by us for further research in order to determine the optimal parameters and operating modes of the crusher-shredder.

The rotor hammers not only grind and split the stems, but also move the processed mass to the exit part of the discharge window. Therefore, the angle of rotation of the hammers significantly affects the efficiency of the process of moving and transporting the crushed mass. At the same time, it is necessary to find such an angle of rotation of the hammers that the quality of work on transporting the crushed mass is satisfactory. Otherwise, the crushed mass at small angles of rotation is blown out through the feed window and complicates the work of the feeder, and at large angles-the mass is pinched inside the working chamber, which leads to its faces.

The results of comparative tests of straight, straight with bottom sharpening and flat-turned forms of rotor hammers showed that the best performance is provided by flat-turned hammers with bottom sharpening. The obtained data (Fig.1) show that with an increase in the angle of rotation of flat-turned hammers with a lower sharpening from 30 to 90, the quality of grinding and splitting of stems increases, respectively, from 78.6% to 84.6% and from 86.4% to 87.5%. Increasing the angle of rotation of the hammers to 120 led to a decrease in these indicators and they are 82.3 and 85.5%, respectively.

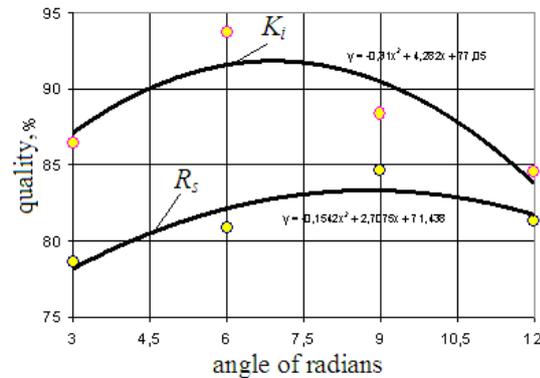


Figure 1. Influence of the angle of rotation of the hammer on the quality of grinding and cleavage

This is due to the fact that with an increase in the angle of rotation of the hammers from 30 to 90, the impact on the processed mass improves. However, a further increase in the angle of rotation of the hammer leads to a rapid movement of the processed mass and the working bodies do not have time to fully grind and split it in the working chamber.

Conclusions

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