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Development of the construction of the feed mixer device of granulation line

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Abstract. In Uzbekistan, livestock, poultry and fisheries are developing in the form of small family farms, and the demand for granulated feed is increasing in them. Since the existing granulation lines are designed for large farms, small farms have to buy granulated feed from abroad. This causes them to spend more on raising livestock, poultry and fish. Based on this, research is being conducted on the development of a small granulation line for small farms. As a result of the research, a small-sized feed mixing device for the granulation line was developed. The working cycle of the device is cyclic, it has working bodies with an auger on the edge and a blade in the middle, and it ensures uniform mixing of the feed at a level of more than 95% with low energy consumption.

1. Introduction

Livestock, poultry and fisheries are one of the most important sectors of agricultural production in Uzbekistan [1-4]. Broad development of these sectors, providing our people with cheap and high-quality meat and other food products, especially in ensuring employment and increasing the income of the population living in rural areas, plays an important role [5-9].

In order to provide stable supply of meat, milk, eggs and products in the domestic consumer market, it is necessary to expand the livestock, poultry and fishery feed base, and to increase the production of competitive products in the domestic and foreign markets, and wide introduction of scientifically based methods and intensive technologies. The development of livestock, poultry and fisheries largely depends on the strengthening of their feed base [10, 11]. It is known that granulated feed is very important for livestock, poultry and fish and is one of the highest nutritional feed products [12]. Granulated feeds are produced on special feed preparation lines [13, 14]. Currently, lines and devices for the production of granular feed in our republic are mainly imported from abroad, from Russia, China, and Turkey.



Since these techniques are intended for large livestock and poultry farms with a large production volume, they cannot be used in farms with a small number of cattle and poultry and peasant (personal assistant) farms. In addition, their metal capacity and energy capacity are large, their cost is expensive, and their import, use, and maintenance costs are high. Due to the lack of small, compact feed mixers used in small livestock and poultry farms, feed is mixed by hand. As a result, feed components do not mix well, labor costs in feed mixing are high, and productivity is low.

Based on the above, it is urgent to develop small-sized granulation lines and feed mixing devices for them, whose size, productivity and energy consumption will satisfy the farmer (personal assistant) or family livestock and poultry farms, and which are not inferior to the existing large-sized devices in terms of work quality. Considering this, research work is being carried out on the development of the granulation line and its feed mixer device.

2. Materials and methods

In order to determine the demand for granulation lines in Uzbekistan, the study of the state of livestock, poultry and fish breeding, the types of livestock being bred, the feed used in their feeding, the composition, size and indicators of the feed, based on the information of the farms engaged in feeding and feeding them and the recommendations of experts in the field of livestock was determined.

Information on granulation lines and equipment and devices used in them, including feed mixing devices, was obtained from scientific journals and Internet databases in Scopus and Web of Science. The construction of granulation lines and feed mixers used in the development of granulated feed was analyzed using SWOT methods, morphological synthesis and ARIZ methods, and their advantages and disadvantages were determined.

Selection of the optimal type of feed mixer for a small granulation line and solutions related to the construction of the working parts used in it are based on the suggestions and recommendations of farmers engaged in livestock, poultry and fishery, based on the condition of mixing various feed components and additives used in the production of granulated feed with water in a short time in an optimal ratio was developed. It was also taken into account that the energy, metal and material consumption of the mixer to be developed should be minimal.

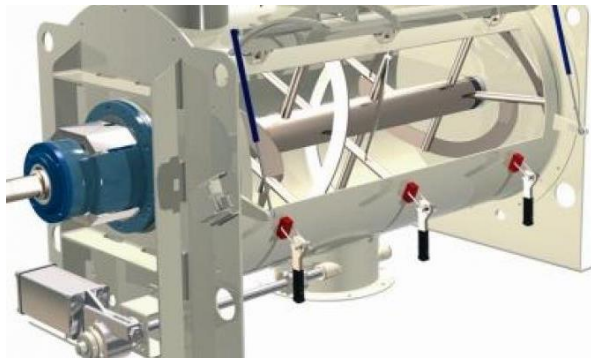
3. Results and discussions

The mixers in the granulated feed production lines are devices designed for uniform and homogeneous mixing of different feed components, which are transferred in the form of separate portions or layers in a certain quantity. It is intended to obtain a mixture of one component and other components in a specified ratio in any part of the feed coming out of the device by mutually distributing and mixing volatile and other materials with different physical and mechanical properties. The product obtained after mutual mixing is in the form of a complex multicomponent mixture. The main quality indicator of the mixture is uniformity. Homogeneity of the mixture means that the amount of components in any part of its volume does not differ from the prescribed recipe for the preparation of the mixture.

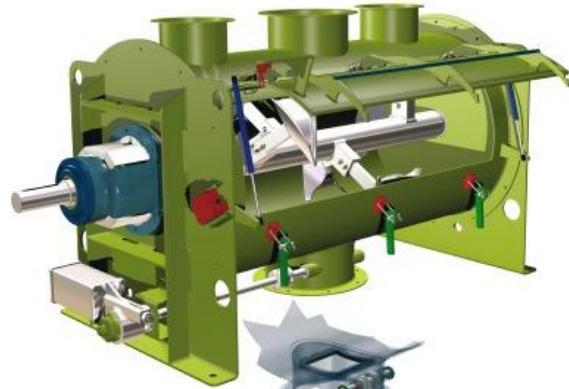
The quality of feed mixing depends on many factors, the main of which are:

- density of mixed components;
- shape and particle size of mixed materials;
- humidity of mixed products;
- adhesion properties of particles of mixed components;
- accuracy of standardizing mixed components;
- coefficient of internal friction of the mixed components.

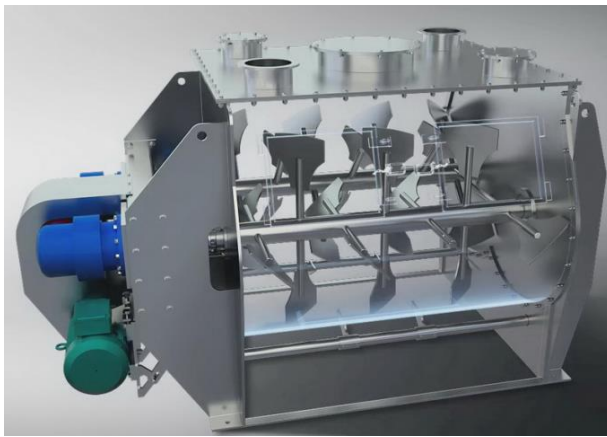
Taking into account these factors, several types of feed mixers have been developed for quality feed mixing (Fig. 1).



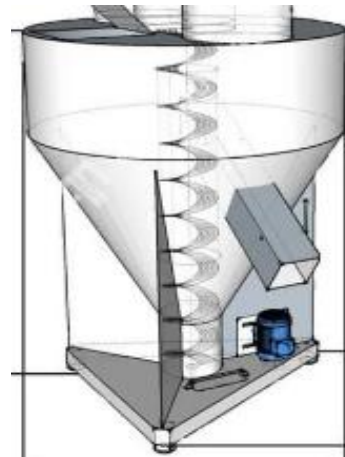
a) horizontal with one shaft screw



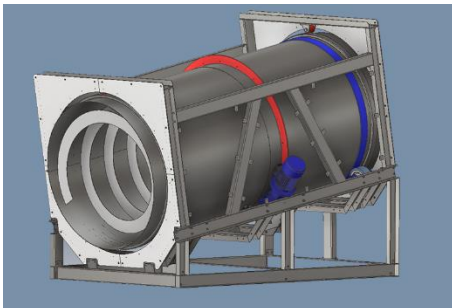
b) horizontal with one shaft plow



c) two-shaft horizontal with a blade



d) one-shaft, vertical with auger



e) rotating drum slope



f) vibrating screen

Figure 1. Types of mixers

These feed mixers can be classified according to some characteristics as follows:

- mixing liquid feed (figure 1, a, b, c), mixing thick feed (figure 1, a, b, c), and mixing dry feed (figure 1, d, e, f), universal (figure 1, a, b, c).
- depending on the work cycle: continuous (figure 1, d, e, f) and periodic (figure 1, a, b, c);
- depending on the method of impact on the product: mechanical (figure 1, a, b, c), gravity (figure 1, d, e), vibration (figure 1, f);
- depending on the type of working bodies: auger (figure 1, a, d), bladed (figure 1, c), drum (figure 1, e) and belt (figure 1, a);
- depending on the number of rotating shafts: one shaft (figure 1, a, b) and two shafts (figure 1, c);
- depending on the location of working bodies: horizontal (figure 1, a, b, c), vertical (figure 1, d) and oblique (figure 1, e, f);
- depending on the movement of nutrients in the mixer: circulatory (figure 1, a, d, e) and chaotic (figure 1, b, c, f).

According to the data, the homogeneity of the mixed feed is in the range of 80-85% in the continuously working types of these feed mixers, and it is higher than 95% in the periodic ones. Depending on the type of working bodies, auger mixers handle only dry feed, and paddle, drum and belt mixers are universal.

Because granulated feeds are mainly formulated from concentrated feeds and nutritional additives, mixing uniformity must be high. Based on this, we have determined the following requirements for a feed mixer to be developed for a small-scale granulation line:

- mixing uniformity of feed should be at least 95%;
- feed should not be scattered around when mixed;
- the feed mixing device must mix the feed quickly and qualitatively;
- the volume of the feed mixing device should be up to 1.0 m³;
- the mixing process should be 3÷5 minutes;
- the process of automatically unloading feed from the feed mixing device should be 3 minutes;
- it is necessary to ensure the possibility of adding up to 15% of liquid components to the feed mixing device;
- the structure of the feed mixing device should be light;
- it should be possible to use the feed mixing device at 1 phase (220 volts);

If we take into account that mainly dry feed is mixed in the granulation line and partially (about 5%) water, oil and other liquids are added to them, then it is desirable for the feed mixer to be designed for a high level of mixing to be periodic and the working body to be bladed.

Based on the results of the above research and based on the specified requirements, a structural-technological scheme of a small-scale feed mixing device for a granulated feed production line designed for small livestock, poultry and fishery farms was developed (figure 2).

Feed mixer mixing hopper 1, shaft 2, screw part of the shaft 3, spade (blade) part of the shaft 4, bearing 5, worm reducer 6, electric motor 7, frame 8, mixer cover 9, feeding hole 10, feed discharge hatch 11, liquid The components consist of a hole 12 and an agitator wheel 13.

During the operation of the mixer, the main dry feed is fed from the hole 10, and the liquid and additional components from the holes 12 into the mixing hopper 1, and the shaft 2 is driven by the electric motor 7 through the worm gear reducer 6. The auger part of the shaft 3 constantly pushes the feed towards the center, and the paddles mounted on the shaft intensively mix the feed. The degree of mixing of the feed is monitored through the mixer cover 9, and the mixed feed is poured through the discharge hatch 11.

All working parts of the mixer are mounted on a single frame 8, and rollers 13 are also installed on it to move the mixer from one place to another.

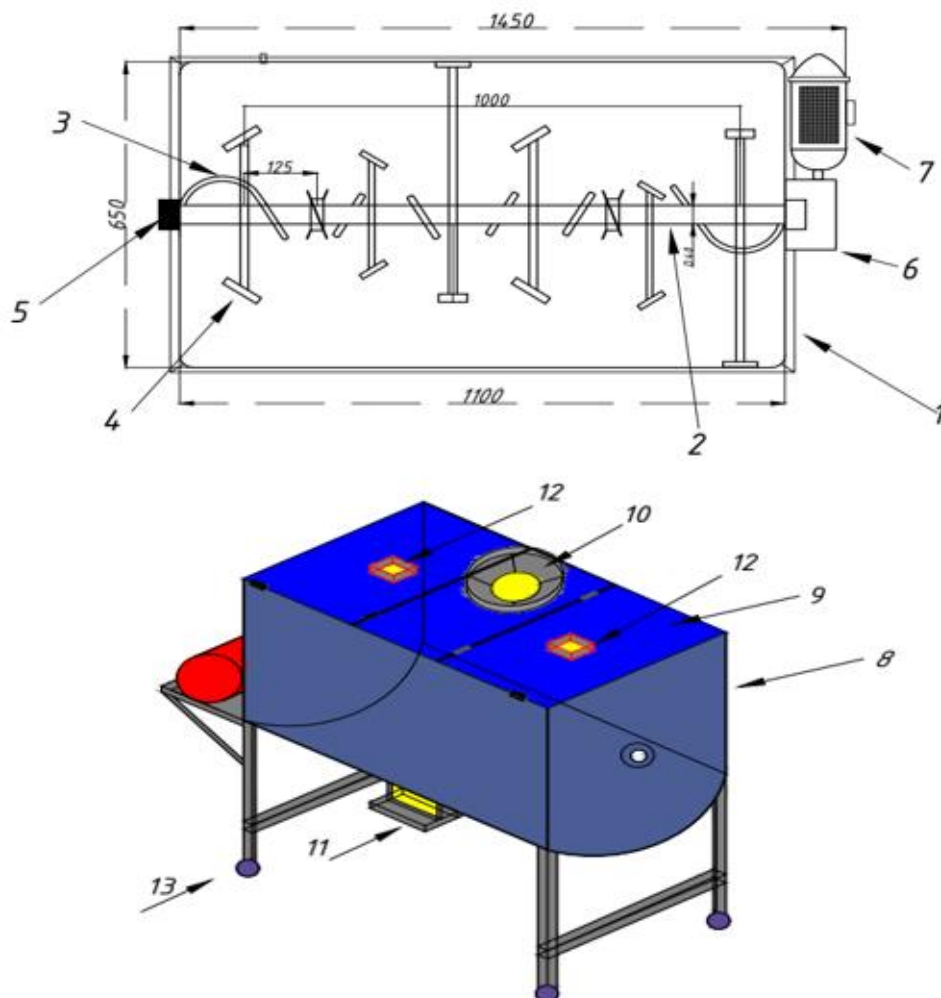


Figure 2. Scheme of a small-scale feed mixer

Now, based on the developed scheme, a pilot copy of the device is being prepared, and theoretical and experimental studies are being conducted to justify the optimal parameters of its working parts and operating modes. At the end of the research, economic tests of the device will be conducted, the quality of work and technical and economic indicators will be determined and it will be put into production.

4. Conclusions

The role of granulated feed in the diet of livestock, poultry and fish is important. Due to the small size of livestock, poultry and fishery farms in Uzbekistan, it is not possible to use granulation lines and their devices developed for large farms. Based on this, a small-scale feed mixing device was developed for the granulated feed production line, which is designed for small livestock, poultry and fish farms. When using this device, high-quality mixing of feed is achieved, saving energy and resources.

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