Small universal unit for preparing, transporting and distributing liquid feed in small pig farms

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Abstract. The article focuses on the advantage of liquid mixed feeds in the use of mixed feeds for small farms and farms. The analysis of the scientific research works devoted to the problems of transportation and distribution of liquid mixed feed using pipelines showed that the physical and mechanical and rheological properties of such feeds have not been fully studied, and special feed pumps designed for the transfer of liquid mixed feeds with high viscosity have not been created. The article describes the structure and principle of operation of the small-sized liquid mixed feed preparation, transfer and distribution unit created by the authors. All equipment included in the unit has been modernized considering the peculiarities of small farms. Based on the results of the study, the necessary conclusions were drawn.

1 Introduction

Feed and feeding conditions have little effect on the success of fattening pigs. Underfeeding of animals, inadequate diet, especially in terms of protein, vitamins and minerals, lead to a decrease in growth, lengthening of the fattening period, overspending of feed per unit of production and its rise in price [1].

A characteristic feature of the forage base of small farms of subsidiary plots, family and rental farms, as well as farms is the use, along with generally accepted compound feed, of a significant amount of feed of their own production: root crops, combi silos, green mass, as well as food waste from public catering enterprises [2].

Applying such feeds is especially effective in the preparation of liquid mixed feeds. However, there are no aggregates for the preparation, transfer and distribution of small-scale liquid mixed feeds, which are produced taking into account the specific characteristics of small farms and farms. Improvement of small-sized aggregates with low energy and metal consumption, high performance, based on modern technologies, requires careful study of physical-mechanical and rheological properties of feed with high accuracy. However, the physico-mechanical and rheological properties of mixed feeds depend on their type and composition, and they change as a result of processing. Liquid mixed feeds can be viscous or viscoplastic depending on their dispersion state. Such a state of feed is determined based on their consistency, that is, the ratio of dry feed to water. For example,
the moisture content of freshly cut blue grass is 80%. If 1:0.25 ratio of blue grass is added to the feed mixture consisting of water and combikorma with a moisture content of 76.5, the moisture content of the mixture will reach 79-80%, and the flowability will decrease several times. Or, if blue grass is added to a mixed feed consisting of water and combifeed with a moisture content of 80-83% in a ratio of 1.0:0.25, its fluidity will be the same as that of a liquid porridge feed with a moisture content of 72%. The consistency of mixed feed depends on the type, size and number of its components, and its internal structure and the interaction of the components depend on the chemical composition, biochemical parameters, temperature, dispersed and aggregate state, and rheological properties of the mixture. Therefore, these factors must be taken into account when designing a complex unit for the preparation, supply and distribution of liquid feed mixtures for farms.

2 Materials and methods

The reliable operation of the unit and their suitability for normal operation under certain conditions is determined by the characteristics of the feed mass, that is, its physical and mechanical properties. The main physical and mechanical properties of low moisture liquid feed mixtures that affect the characteristics of the aggregate are viscosity, ultimate shear stress, density, moisture content and concentration.

Plastic viscosity and ultimate shear stress can be determined by two methods: using a rotational viscometer and based on head losses in pipes. Humidity, moisture content in the feed was determined by drying a sample of the feed sample according to a known method. The sample was dried in an oven at 100–105°C to constant weight. The constant weight was considered reached if the difference between two weightings did not exceed 0.0003g. The concentration of feed mixtures was determined by sampling feed mixtures of a known volume from the mixer, followed by removal of moisture, drying and weighing the dry residue. The temperature of the feed mixtures was determined with a mercury thermometer. The pumps were tested using a well-known technique [3].

3 Results

Solving this important problem, we have developed and researched a “Small-sized universal unit for the preparation, transportation and distribution of liquid feed on small pig farms” (figure 1). The unit consists of a hopper for receiving and storing feed 1, a screw conveyor 2, a lobe pump 4, a steamer-mixer 5, a staple conveyor 6, a grinder-paste-preparer 7, a whey supply pump 8, a tank for receiving and storing whey 8, a feed line 10 and feeders with ball valves 11. The technology for preparing and distributing feed mixtures is as follows: whey is pumped from the tank into the mixer and the mixer is turned on, at the same time, compound feed and crushed juicy and green fodder are fed from the hopper to the same auger. After 15-20 minutes of mixing, the finished feed is pumped into the feed conduit by pumps. To equalize the pressure in the feed line, the pump is equipped with a safety valve 12. In case of excess pressure, the valve is activated, and the pump is switched on for recirculation. Feeding troughs are supplied with feed mixture through taps mounted on feed gates. Their operator opens manually, while visually normalizing the amount of feed entering each feeder. Manual control of the cranes allows you to change the amount of feed in each machine, depending on their eating, the number of animals, as well as carry out fractional feeding. Considering the insignificant time spent on the distribution of feed in the feeders, it is irrational to mechanize or automate the process of opening and closing taps on small farms.
This unit is designed for small farms and is used for preparing, feeding and distributing liquid feed mixtures consisting of green mass, combisilos, root crops that are produced by the farms themselves, as well as bards, pulp and compound feed. “The use of a small-sized unit on small pig farms makes it possible to reduce metal consumption by 2 times, the energy intensity of the technological process by at least 3.5 times and increase labor productivity by 2 times compared to existing feed shops” [4]. However, the performance of the unit depends on the design of the pump used to supply liquid feed mixtures. It should be noted that the existing centrifugal and fecal feed pumps are unsuitable for supplying feed mixtures of low humidity, which include juicy green components [5].

**Figure 1.** Small-sized universal unit for cooking, transportation and distribution of liquid feed in small pig farms.

**Figure 2.** Improved rotary feed pump with screw feeder: 1-case; 2-feed element (plate); 3-shaft; 4-rotor; 5-additional camera; 6-flow separator; 7 screw feeders; 8-boot neck.
They can be used for transporting fodder mixtures with a moisture content of 73% or more without including succulent and green fodder [6]. Real pumping technology is always based on centrifugal pumps, the efficiency of which decreases with a change in speed, as well as with a change in head and flow. To reduce the power consumed by the pump, another type of pump is needed [7]. Rotary pumps compared to a conventional artificial lift pump, volumetric efficiency and energy savings are obvious advantages [8].

Considering the above, we have developed a rotatory feed pump with forced feeding. All novelties of the pump are protected by a patent (patents of the Republic of Uzbekistan: No. 5149 "Pump for supplying liquid feed mixtures", Patent No. 5150 "Kormonasos") [9-10]. According to the device and principle of operation, this pump belongs to a rotary pump. Rotary pumps are the most commonly used pumps where shear sensitivity, viscosity, low flow, etc. preclude the use of centrifugal pumps [11].

4 Discussion

The study showed that, when the pump delivery with a decrease in moisture initially, to about 68% for concentrate rations, 74% for grass paste feed mixtures and 72% for root concentrate diet mixtures, it increases, and then decreases sharply (figure 3.) [12]. At a pressure in the pressure line of 0.4 MPa, a decrease in the moisture content of the feed mixture below 68% leads to a drop in pump flow, for example: for a mixture with a moisture content of 68%, the pump flow is 29.6 m$^3$/h, and for mixtures with a moisture content of 62% and 65%, respectively, 23.5 and 27.2 m$^3$/h. The supply of the lobe pump for feed mixtures with green paste with a relative humidity of 68% is 26.0 m$^3$/h, and for feed mixtures of a concentrated and concentrate-root crop ration at the same humidity, it is 29.6 and 28.2 m$^3$/h, respectively. With a further increase in the moisture content of feed mixtures of a concentrated diet of more than 75% by diluting it with water, the pump flow decreases, and the pump can also operate with cavitation. This is due to an increase in pressure losses inside the pump due to an increase in leakage from the discharge chamber to the suction chamber through the gaps. When supplying feed mixtures with green paste and moisture up to 80% and without paste with moisture up to 75%, the value of these leaks is insignificant, that is, the difference between theoretical and experimental data is no more than 3%. With an increase in the moisture content of feed mixtures of more than 80%, the value of this difference increases, for example, when water is supplied, these discrepancies reach 15…18%.

![Figure 3](https://doi.org/10.1051/bioconf/20237101056)
The required pump power at the same flow rate increases with an increase in their concentration by 25 \ldots 30\% compared to the required power for transporting water. Pressure losses in feed pipelines consist of two components: pressure losses along the length and local losses. Local losses include pressure losses at the inlet and outlet of the pipe, losses at bends, feed gates, and similar places.

As a result of the studies carried out, additional data on linear pressure losses were obtained depending on the composition of the feed mixtures and the pump flow. Figures 4 and 5 show the dependence characterizing the change in pressure losses in pipes with the pump flow and the moisture content of feed mixtures. Comparison of the values of specific pressure losses in pipes during the flow of feed mixtures with and without grass paste shows that the pressure losses of mixtures at a ratio of 1: 0.25 with a moisture content of 80\% are similar in value loss of feed mixtures without grass with a moisture content of 68 \ldots 70\%.

When transporting feed mixtures through a pipeline with a flow rate of 30 \text{m}^3/\text{h}, linear pressure loss for feed mixtures with green paste at a moisture content of 80\% will be 0.019 105 Pa/m, and for feed mixtures without green paste, linear pressure loss at the same humidity is 0.012 105 Pa/m. This data shows that the pressure loss at the same humidity, but for different concentrations of feed mixtures, is not the same. It should be noted that today the development of science and technology requires the automation of all processes, and it is recommended to produce many new types of equipment. But the question of clear instructions for farmers to use these new practices remains open. The only solution to this problem is to digitize farmer education. To this end, it is recommended to organize online educational platforms for farmers, create electronic educational resources for them, use project methods aimed at scientific and creative thinking in training.
5 Conclusion

Experiments have shown that with this pump it is possible to pump through pipes liquid feed mixtures with a moisture content of 74% or more under a pressure of 0.4 MPa, consisting of mixed fodder, green mass, combisilo and root crops with a capacity of up to 30 m$^3$/s. If the compound feed consists only of water and compound feed, the pump can pump liquid compound feed with a moisture content of 68% or more.

The performance of pumps when supplying feed mixtures must be determined considering the rheological properties of feed mixtures, which mainly depend on their concentration. From this we can conclude that it is advisable to evaluate the performance of pumps by the concentration of transported feed mixtures, and not by moisture. The increase in pressure loss with an increase in the concentration of feed mixtures is explained by the fact that during the flow of such feed mixtures through pipes, most of the solid particles accumulate in the lower part of the pipeline. This leads to an increase in pressure losses in the pipeline and to a decrease in the supply and speed of feed mixtures in the pipeline. In addition, the increase in losses is caused by friction between the liquid phase and the solid particles of the feed, as well as the friction of the solid particles of the feed from the pipe wall.

References

1. Dorman L I 1975 Variations of Galactic Cosmic Rays (Moscow: Moscow State University Press) 103
2. Knyazev K I 1979 Intensive meat feeding of pigs (Moscow) 222
5. Rakhimov O, Eshev S, Rakhmatov M, Boymurodov F and Rayimova I 2021 Improved pump for transporting liquid feed mixtures through pipes on farms. E3S Web of Conferences 263 04046
6. Roth E 1989 Hachlesefiir Sauenhalter und Schweinmaster Agrar 40(9) 66-69
7. Dokukin V P 2005 Improving the efficiency of the pipeline hydro transport system, SPGGI (TU) St. Petersburg 105