To the methodology of experimental research of the continuous-running fodder mixer

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Summary. A construction of an effective continuous-running fodder mixer is suggested. The research technique of the level of homogeneity of three-component feed mixture, obtained as a result of the work of continuous-running fodder mixer is improved.

Key words. Technical process of mixing, a degree of homogeneit, technique of experimental investigation.

INTRODUCTION

At the present time a large variety of mixers of feed materials was worked out, the most effective of which are continuous-running mixers. A large variety of designs of continuous-running mixers points to the absence of not only a unified theory of their design, but also the general methodology of their experimental study.

ANALYSIS OF THE LATEST RESEARCH AND PUBLICATIONS.

The results of the study of the theoretical foundations of design and experimental investigation of continuous-running fodder mixers are set out in the works of S.V. Mielnikov, A. A. Lapshin, A.M. Grigoriev, R.L. Zienkov, P.K. Zhevlakov, G.M. Kukty, F.K. Novobrantsev, O.V. Tsurkan, V.I. Sementsov, V.F Pershin and others [1-11, 23, 24]. The works of the above-mentioned scientists prove the following:

– the mixing or shaking is such process of moving particles of the material, at the result of which given quantity of its components will be contained in any volume of the mixture;

– devices, in which the process of mixing happens, are called mixers;

– mixers are made in the form of vertically and horizontally located continuous- and periodic-running working tools;

– working tools of mixers are called agitators;

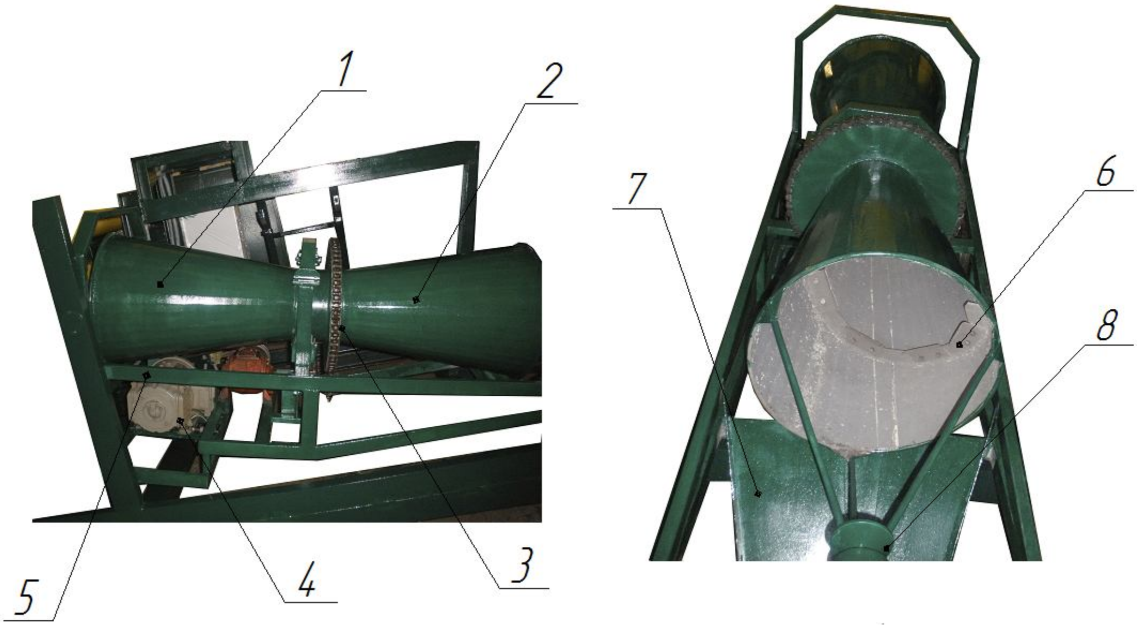
– depending on the components of feed mixtures the working tools of the following types: screw, vaned, propeller, turbine, drum etc. are taken.

– the mixing process is characterized by the degree of homogeneity.

The purpose of research is the development of the adequate technique of experimental study of effective continuous-running fodder mixers.

Research results. The scientists of Lugansk NAU have developed a new continuous-running fodder mixer (fig.). The technical novelty of this mixer is certified by the patent of Ukraine № 70668.

The mixer works in the following way. The components of the feed mixture (crushed grain, succulent and roughage fodder) are fed into the mixer with a help of proportioning devices. The front cone 1 with a help of the winding 6, situated on its inner surface catches components and sets them moving along a spiral path. The winding is equipped with L-shaped beaters with a length 100 mm, the beaters are fixed with an interval of 75 mm from one another. This allows lifting a part of the layer of the feed mixture at a height, greater than the slope of repose of its components. This effect prevents the formation of the center of the



a b

Fig. Continuous-running fodder mixer: *a* – side view;
b – view from the side of unloading of the final product; 1, 2 – front and back cone, accordingly; 3, 4 – mechanism of the mixer's drive; 5 – the movable frame; 6 – the screw winding with L-shaped beaters; 7 – the discharge chute; 8 – the supporting block.

circulation of the mixture's components and mixing is provided by the alternate change of the layers' position. Furthermore, the shape of the mixer, consisting of two truncated cones connected by a smaller base, provides a varying value of the components' angular velocity, which also has a positive effect on the efficiency of the mixing process. The winding provides two complete rotations of the material. The length of the each cone is 750 mm. The cones are connected by a cylindrical spacer plate of the length of 250 mm. The diameter of the larger base of the cones is 500 mm and of the smaller base is 250 mm.

After passing the first cone feeding stuff is additionally mixed in the symmetrically-situated second cone. The installation angle of the mixer is changed by a screw mechanism of the movable frame 5 from 0 to 25 degrees. The rotational speed of the mixer is changed with the help of the direct current motor in the range of 0 to 1500 min^{-1}. The design of the mixer allows to change the quantity and shape of the beaters of the winding, and the scheme of their installation. The ready feed mixture is unloaded through the tray 7.

The basic qualitative characteristic of efficiency of the work of any mixing aggregate, including the proposed mixer, is the homogeneity of the final product. A mixture is considered to be homogeneous if the contents of components in any part of its volume corresponds to a nominal mix proportions. The mixing efficiency, thus, the quality of the final mixture depends not only on the physical characteristics of the components (granulometric texture, shape and type of the surface of the particles, moisture, density, etc.) and arrangement of the mixer, but also on the parameters of the process itself (the mixing period, mixer's tool-point velocity, the filling degree, etc.) [1-14].

Based on the data received by leading scientists, who are studying the mixing process, we can come to a conclusion that if any component is distributed in the mixture uniformly, than other components will be distributed uniformly.

For small cattle (SC) the following composition of crumbled feed mixtures is used most often [5, p. 35]:

– 20 – 40% - straw;
– 12 – 26% – hay;
– 40 – 60% – silage and roots;
– 7 – 17% – concentrated feed.

The most hard-mixable component is concentrated feed, because it can stick to the crushed roots or spill through dry roughage fodder. Therefore, it makes sense to evaluate the efficiency of mixing in terms of the criteria of uniformity of distribution of namely concentrated feed in the mixture.

The efficiency of mixing is determined on the basis of the statistical characteristics of the mixture. Usually a coefficient of variation (relative measure of dispersion, expressed as a percentage) of the distribution of the "key" component in the mixture serves as such characteristics.

$$V = \frac{\sigma}{x} \cdot 100\% , \quad (1)$$

where: σ - standard deviation;

x - arithmetic mean of the measurable value.

$$\sigma = \sqrt{\frac{1}{n} \cdot \sum_{i-1}^{n} (x_i - x)^2} , \quad (2)$$

where: x_i - the value obtained as a result of the measurement;

n - number of experiments.

In addition, the mixing efficiency is estimated via degree of homogeneity. The degree of homogeneity of the mixture is determined by the empirical relationships of A.A. Lapshin [1, p. 259]:

$$C_0 = \frac{1}{n} \sum \frac{B_t}{B_0} \text{ at } B_t < B_0 , \quad (3)$$

$$C_0 = \frac{1}{n} \sum \frac{2B_0 - B_t}{B_0} \text{ at } B_t > B_0 , \quad (4)$$

where: C_0 – degree of homogeneity ;

n – number of samples;

B_t – part of the smaller component in the mixture, in sample;

B_0 – part of the smaller component in the nominal mixture.

The received experimental data should provide an error in percent of the mean value not more than 5%.

The error in percent of the measurements [15-21]:

$$a = m / x, \%, \quad (5)$$

where: m - absolute error of the measurements;

The absolute error of the measurements [16-21]:

$$m = x_i - x, \%. \quad (6)$$

The degree of homogeneity of the mixture is determined by the following method.

The feed mixture, consisting of three components of different mass M_1, M_2 and $M_к$ is loaded in the mixer. And the component of smaller mass $M_к$ is controlling (concentrated feed). The mixer is put into use (at a constant frequency of rotation of the working tool) and at least 5 samples from different parts of the mixer's tankage with a mass $m_П$ of 100 g each, are taken in regular intervals. Then the samples are separated into the components. The mass of the control component $m_к$ in each sample is weighed and then is written into the table 1.

Table. Results of experiments

№ of the experiment	Time of the experiment, minutes	M_1, g	M_2, g	$M_к$, g	B_o	$m_П$	$m_к$	B_t	$\frac{B_t}{B_o}$	$\frac{2B_o - B_t}{B_o}$

In the table the values B_o and B_t are determined from the formula[1, p. 259]:

$$B_o = \frac{M_к}{M_1 + M_2 + M_к} , \quad B_t = \frac{m_к}{m_П} , \quad (7)$$

where: $m_к$ – mass of the control component in the sample, kg;

$m_П$ – mass of all fodder in the sample, kg.

The results of the experiments are substituted into the formula (3) or (4) and the degree of homogeneity of the mixture is calculated. The rational values of the degree of homogeneity of the mixture are within the limits 0,85 – 1,15. The characteristic curve is made on the basis of the received data.

CONCLUSIONS

1. The qualitative characteristic of the efficiency of the feed mixer's work is homogeneity of the feed mixture, regardless of the number of its components.

2. Continuous-running feed mixers are the most promising. The working tool of the continuous-running mixer should consist of two truncated cones connected by a smaller base. This provides a varying value of the components' angular velocity, which also has a positive effect on the efficiency of the mixing process.

3. The winding, located on the inner surface of the cones should be equipped with L-shaped beaters fixed in a spaced position to each other, which will create the effect of preventing formation of the center of circulation of the mixture's components and mixing will be provided by alternate changing the layers' position.

REFERENCES

1. **Mielnikov S.V., 1978.:** Mechanization and automation of cattle farms. L.: Kolos.
2. **Koba V.G., Braginets N.V., Murusidze D.N., Niekrashevich V.F. and others, 1999.**: Mechanization and technology of manufacture of products of cattle breeding. M. Kolos.
3. **Zavrazhnov A.I., 1990.:** Mechanization of preparing and storage of feeding-stuff / A.I. Zavrazhnov, D.I. Nikolaiev. - M.: Agropromizdat.
4. **Aleshkin V.R., 1985.:** Mechanization of cattle breeding / V.R. Aleshkin, P.M. Roshchin. - M.: Agropromizdat, 336 p.
5. **Tsurkan O.V., 2004.:** Development and research of energy-saving vibrational mixer for application of premixes in feed-stuff : dissertation of the candidate of engineering sciences: 05.05.11 / Tsurkan Oleg Vasylyovych. – Vinnytsia, 155 p.
6. **Sementsov V.I., 2008.:** Ground of the parameters of the enrichment process of feed stuff with biologically active feed supplements by a centrifugal mixer: dissertation of the candidate of the engineering sciences: 05.05.11 / Sementsov Volodymyr Illich. Kharkiv, 186 p.
7. **Gvozdiev V.O., 2008.:** Ground of the production process and design parameters of quick-running screw mixer of feeding-stuff: dissertation of the candidate of engineering sciences: 05.05.11 / Gvozdiev Viktor Oleksandrovych, Melitopol, 193 p.
8. **Pershin V.F., 2009.:** Processing of bulky materials in the drum-type machines / V.F. Pershin, V.G. Odnolko, S.V Pershina. M.: Mashinostroienie,. 220 p.
9. **Revenko I.I., Rogovyi V.D., Кravchuk V.I. and others, 1999.:** Design of mechanized production processes of cattle-breeding enterprises; under the editorship of I.I. Revenko – K.: Urozhai.
10. **Belianchikov N.N., 1989.:** Mechanization of cattle breeding / N.N. Belianchikov, A.I. Smirnov. - M.: Agropromizdat,.
11. **Mzhelskii N.N., 1984.:** Handbook in mechanization of cattle farms and complexes / N.I. Mzhelskii, A.I. Smirnov. - M.: Kolos,.
12. **Diemchenko V.N., Alatoom Mohammad, 2011.:** Improvement of the process of preparing multicomponent fodder for small cattle // Scientific reporter of Tavriiskyi state agrotechnological university [Electronic resource]. - Melitopol: TDATU. Issue 1. – Book 3. - P. 35-42.
13. **Braginets N.V., Bakhariev D.N., Alatoom Mohammad, 2011.:** Requirements to preparing of feeding stuffs for small cattle // Collection of thesis reports of the international conference «Modern problems of agricultural mechanics» in memory of the academician P.M. Vasylenko October 17-18, 2011. Lugansk: ЛНАU, - P. 7-8.
14. **Braginets N.V., Bakhariev D.N., Alatoom Mohammad, 2012.:** Ground of the constructive and technological scheme of the fodder chopper-mixer for small cattle // Collection of thesis reports of the scientific-practical conference of Lugansk national agricultural university of January 19-25, 2012. Lugansk: LNAU, - P. 12-13.
15. **Zavalishin F.S., 1982.:** Methods of research in mechanization of agricultural industry / F.S. Zavalishin, M.G. Matsniev. - M.: Kolos,.- 231 p.
16. **Mielnikov S.V., 1980.:** Planning of the experiment in investigations of agricultural processes / S.V. Mielnikov, V.P. Aleshkin, P.M. Roshchin.- L.: Kolos. Leningradskoie department, 168 p.
17. **Nalimov V.V., 1965.:** Statistic methods of planning extreme experiments / V.V. Nalimov, N.A. Chernova.- M.: Nauka, 365 p.
18. **Adlier Yu.I., 1976.:** Planning the experiment in the search for optimal conditions / Yu.I. Adlier, Ye.V. Markova, Yu.V. Granovskii. M.: Nauka, 279 p.
19. **Vinarskii M.S., 1975.:** Planning the experiment in technological research / M.S. Vinarskii, M.V. Lurie. - K.: Tekhnika, 168 p.
20. **A.A. Spiridonov, N.G. Vasiliev., 1975.:** Planning the experiment at the research and optimization of technological processes. Sverdlovsk, publishing office UPI named after S.M.Kirov,. - 140 p.
21. **Borovikov V., 2003.:** STATISTICA. Art of data analysis on the computer. For professionals / V. Borovikov, the 2-nd issue – SPb.: Piter, 688 p.
22. **Mohammad Alatoom, 2011.:** Improvement of the preparation process of multicomponent fodder for small cattle. TEKA Commission of motorization and power industry in agriculture and the VOLODYMIR DAHL and East-Ukrainian national university of Lugansk. Volume XI B. – Lublin, p. 213-219.
23. **Victor Shapovalov, Yakov Nezhinskiy, 2010.:** The development and applying of flexible technical facilities is effective way of agricultural production mechanization in industry. TEKA Commission of motorization and power industry in agriculture, volume XB.
24. **Victor Belodedov, Pavel Nosko, Pavel Fil, Marina Mazneva, Grogoriy Boyko, 2010.:** Selection of batcher with horizontal disk parameters while maize sowing. TEKA Commission of motorization and power industry in agriculture, Volume XA.

К МЕТОДИКЕ ЭКСПЕРИМЕНТАЛЬНОГО ИССЛЕДОВАНИЯ СМЕСИТЕЛЯ КОРМОВ НЕПРЕРЫВНОГО ДЕЙСТВИЯ

Мохаммад Аль-Атум.

Аннотация. Предложена конструкция эффективного смесителя кормов непрерывного действия. Усовершенствована методика исследования степени однородности трехкомпонентной кормовой смеси полученной в результате работы смесителя непрерывного действия.

Ключевые слова. Технологический процесс смешивания, степень однородности, методика экспериментального исследования.