

Increasing the efficiency of machines and mechanisms of the agro-industrial complex using sliding bearings with curvilinear generators of the internal cylindrical surface

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Abstract. Sliding bearings with curved internal cylindrical surfaces have great potential and can play an important role in the repair and restoration of mechanisms of the agro-industrial complex. Since their use is becoming more and more common, there is a need to improve the design of such bearings to ensure their quality use and avoid errors in research on this issue, in addition, achieving better results in this area require significant financial investments to improve the efficiency of such mechanisms. The main goal of this work is to provide recommendations aimed at eliminating errors in the processes of improving and improving the quality of sliding

Article's History:

Received: 05.08.2023

Revised: 25.10.2023

Accepted: 12.12.2023

Suggested Citation:

Sadovoy, O., Savenkov, O., Sydoryka, I., Shcherbak, Yu., & Kondratieva, A. (2023). Increasing the efficiency of machines and mechanisms of the agro-industrial complex using sliding bearings with curvilinear generators of the internal cylindrical surface. *Ukrainian Black Sea Region Agrarian Science*, 27(4), 60-70. doi: 10.56407/bs.agrarian/4.2023.60.

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bearings, as well as analyzing the functioning of machines used in the agro-industrial complex. An analytical method, a classification method, a functional method, a statistical method, and a synthesis method were used. In the course of the research, the peculiarities and differences of sliding bearings with curvilinear generators of the internal cylindrical surface were noted, errors and their causes, which are allowed during the improvement of agro-industrial mechanisms that ensure the development of the agricultural industry, were analyzed. It is important to analyze the functioning of these mechanisms in order to assess their effectiveness, development and complexity of work during the production of agricultural products. The issue of evaluating the performance of sliding bearings of this type, the expediency of using this element, their limitations during the process, the impact of limitations on the result was considered, and recommendations were proposed that would contribute to an effective mechanism for regulating the issue. It was determined that the use of sliding bearings of this type, in the process of restoring agro-industrial mechanisms, will ensure a significant increase in the productivity of these machines. The practical value of this work lies in the possibility of applying the obtained results to eliminate errors in the development and improvement of the mechanisms of the agro-industrial complex, studying the reliability of the use of sliding bearings in general, taking into account various factors, will provide a basis for recommendations on the appropriate use of these bearings

Keywords: wedging; agricultural production; shaft; deformations; repair

INTRODUCTION

The agro-industrial complex is an integral part of the economy of many countries, it unites various industries, such as the production of agricultural products, their processing, material and technical support of rural settlements, as well as the production and maintenance of mechanisms and infrastructure of the agro-industrial sector, in addition, it covers the fields of preservation, processing and sale of agricultural products. Thus, the development of the economy primarily depends on the sphere of the agro-industrial complex, which includes agricultural machine building, machine building for the food industry, agrochemistry, compound feed industry, the system of material and technical service of agriculture and land reclamation, and rural construction. In turn, the specified sphere of the agricultural industry directly depends on the efficiency of the machines and mechanisms entering it.

R. Marchuk & R. Mnatsakanov (2023) claim that the introduction of new technologies and equipment allows to increase the efficiency of the mechanisms of the agro-industrial complex and agricultural processes, reduce the consumption of energy, resources and labor, as well as improve the quality and quantity of products. Improving the mechanisms of the agro-industrial complex arises from the need to solve problems related to errors that occur at the stages of development and operation of these machines. These problems, in turn, arise in connection with the need to determine and optimize indicators at the stages of design, operation and development of equipment. In addition, the growing demand for affordable agricultural services leads to the need to reduce costs, which places certain demands on the improvement of these mechanisms.

In the study of V.A. Matviychuk *et al.* (2022) stated that the use of high-quality materials in the manufacture of sliding bearings provides higher reliability and durability in conditions of misalignment and elastic deformation of the shaft section. In this direction, it is necessary to expand the range of designs of sliding bearings, which will be specially calculated for the conditions of distortions and elastic deformations of the shaft section, which will allow to increase the number of working mechanisms of the agro-industrial complex and contribute to the modernization of production processes, and the result will be an increase in the quality of the provision of agricultural services to a high level.

V. Syrovatka (2023) states that sliding bearings do not require lubrication or lubrication equipment and can work directly on the sliding surfaces. After analysing the working mechanism of plain bearings, it was found that they show less sensitivity to external particles such as dust, which provides them with higher resistance to contamination, as a result of which plain bearings remain important components of industrial systems in many industries.

According to the results of D.V. Borysiuk *et al.* (2023), babbitt coatings on the working surfaces of plain bearings can peel or chip due to high loads or insufficient lubrication. It also indicates that stress and wear are causing cracking and ulceration of the bearing sliding surfaces. In view of this, timely maintenance, lubrication and replacement of bearings will ensure the preservation of their efficiency and reliable operation of machines and mechanisms of the agro-industrial complex.

Scientists M. Kindrachuk *et al.* (2023) note that when a liner becomes stuck between the shaft and the

bearing housing wall, the lubrication regime can be disrupted, leading to complete or partial cessation of lubrication. As a result, there is an increase in friction and an increase in temperature, which causes premature wear and damage to the bearing. Seizure of the liner can cause an unacceptable increase in pressure between the shaft and the liner. It was also not taken into account that as a result, if the shaft remains stationary in the plain bearing, the bearing may fail completely. O.V. Yeromenko *et al.* (2023) note that the most common method of restoring bearing performance is to completely replace the bearing with a new one. In this case, the old failed bearing is removed or pushed out of the bearing housing and a new bearing is installed.

The purpose of this study was to perform an objective analysis to identify problems and errors in the process of improving the efficiency of the mechanisms of the agro-industrial complex using sliding bearings, which are the basis of sustainable development of the agricultural sphere, at the current stage of development of this sector in order to formulate recommendations for their elimination. Completion of the task, which is formed on the basis of this goal, will provide an opportunity for the progressive development of innovative methods of reducing and avoiding errors in the process of increasing the efficiency of machines of the agro-industrial complex by means of the development of sliding bearings with curvilinear generators of the internal cylindrical surface.

It is worth noting that the issue of inhibiting the process of designing and improving sliding bearings is of particular importance, in connection with which it is necessary to study ways to overcome this problem and develop a certain range of recommendations, there is also a need to improve the mechanisms of the agro-industrial complex and their systems for the most efficient functioning of this process in countries.

MATERIALS AND METHODS

Theoretical studies were based on the theory of contact hydrodynamic lubrication taking into account the equation of hydrodynamic pressure at an arbitrary point of the bearing lubrication layer and the fundamental principles of mechanical engineering tribology using the approaches of theoretical mechanics and machine parts, as well as on the theory of contact strength of elastically compressed bodies. In addition, the method of assessing contact characteristics and predicting the durability of cylindrical sliding tribosystems was applied.

The application of the analytical research method made it possible to identify and isolate problems related to the operation of machines of the agro-industrial complex, which are used in the processes of production

and processing of agricultural products. With the help of a statistical method, the indicators that help to understand the number and causes of errors in the improvement of sliding bearings, which are the basis of the sustainable development of agricultural mechanisms, the implementation of improving the operation of these mechanisms, the prospects for using these bearings, and the development of the stability and productivity of machines of the agro-industrial complex in the process of processing products were considered.

Applying the functional method, a detailed analysis of the role and essence of sliding bearings with curvilinear generators of the internal cylindrical surface was carried out at different levels of development of machines of the agro-industrial complex. The advantages and disadvantages of their operation were also identified, and the influence of the functioning of agricultural mechanisms on the material and technical support of rural areas was analysed. With the help of the structural-functional method, trends, factors and models aimed at improving sliding bearings were considered, and effective options for solving problems related to design errors, improving the maintenance of machines of the agro-industrial complex and its components were identified and analysed. In addition, the methods of improvement and innovation of mechanisms were studied in order to reduce inaccuracies in their functioning and to optimize indicators at the stages of development. Applying the deduction method, the concept of "increasing the efficiency of machines and mechanisms of the agro-industrial complex by using sliding bearings with curved internal cylindrical surface" was revealed by identifying its characteristics, which are necessary for a complete analysis of the work and solving the problems of this process, in particular, regarding the introduction of sliding bearings with curved internal surfaces cylindrical surface.

By applying the synthesis method, the obtained indicators of theoretical analysis and practical experience were summarized and considered in order to identify recommendations aimed at solving problems and achieving progressive growth of the process. Special attention was paid to improving the quality of development of mechanisms of the agro-industrial complex and reducing errors. Predictive models and design solutions were also presented for the component elements, in particular for plain bearings, which perform an important function in this process. Thanks to the methods of logical and functional analysis, the theoretical component of the work was revealed. They provided an opportunity to consider in more detail the concept of "sliding bearings with curved internal cylindrical surfaces".

These methods made it possible to characterize the peculiarities and principles of the functioning of the agro-industrial complex and the process of processing agricultural products. In addition, the complexity of the operation of mechanisms in agricultural processes and their impact on meeting the needs of the population and user requirements was analysed. As a result, the purpose of applying the methods was to study and consider recommendations regarding the feasibility of improving sliding bearings and using this mechanism.

RESULTS AND DISCUSSION

To ensure reliable processing of agricultural products and efficient operation of the mechanisms of the agro-industrial complex in various areas of the agricultural industry, progressive development of the production of sliding bearings is necessary. Special attention should be paid to the improvement of their components, in particular to accurate design and modelling, since these bearings are widely used in the mechanisms of the agro-industrial complex, which will contribute to increasing the production potential of agricultural machines. It is important to choose the right type of bearing for specific operating conditions. Plain bearings have unique characteristics and may be suitable for certain types of loading and operating conditions. Proper lubrication is essential for bearing reliability. It is necessary to take into account the type of lubricant or oil and the intervals between oil changes. Before refilling a bearing with babbitt, certain preparatory procedures must be performed, for example, the previous layer of babbitt must be removed to provide a clean surface for the new fill. A. Guo *et al.* (2015) emphasize that bearing surfaces must be thoroughly cleaned of dirt, rust, grease, and other contaminants. This can be done using special solvents, cleaning solutions or other cleaning methods.

As of 2023, it is important to solve the problem of errors that occur during the development, improvement and modelling of the mechanisms of the agro-industrial complex. These errors have a direct impact on increasing the production potential of the agricultural industry, the reliability of service provision and the safety of processing, and special attention should be paid to the efficiency of the mechanisms in remote areas and the further development of the use of these machines in the agricultural sector. The replacement of cylindrical surfaces with elliptical ones ensures better operation of the sliding bearing against distortions and elastic deformations of the shaft, and also reduces the risk of shaft jamming. However, reducing the effects of shaft seizing in plain bearings is limited and may not result in significant performance improvements. Many factors affect the reliability and performance of a bearing,

and shaft seizing is just one of them. Antifriction alloys (babbitt), consisting mainly of tin and lead, are widely used in the production of sliding bearing liners. These alloys are known for their excellent anti-friction and lubricating properties, making them an ideal choice for use in bearings where it is important to ensure reliable operation at the metal-to-metal contact surface. S. Woo *et al.* (2023) note that babbitt has high lubricity and can effectively lubricate sliding surfaces.

In the field of machines of the agro-industrial complex, it is necessary to conduct an analysis and identify the root causes of errors during agricultural processing. Further resolution of these reasons is aimed at improving the quality of material and technical support. The anti-friction alloy must have high wear resistance to prevent serious mechanical damage and guarantee a long service life of the sliding bearing. In addition, this material must have sufficient resistance and strength to withstand the loads that occur during the operation of the bearing and prevent its deformation and damage. To solve the problem of jamming of the shaft in a sliding bearing, which consists of a housing, a liner, a lubrication groove and an opening for the supply of lubricant in the housing, on the internal cylindrical surface of which flat elements (ordinary bearings) are replaced by curved elements with a radius of curvature:

$$R = \frac{l^2}{8\Delta S}, \quad (1)$$

where l – the length of the bearing; $\Delta S = 0.010$ – 0.030 mm – the value of the curvature parameter of the product in the end sections of the bearing.

Figure 1 shows a model of a conventional plain bearing.

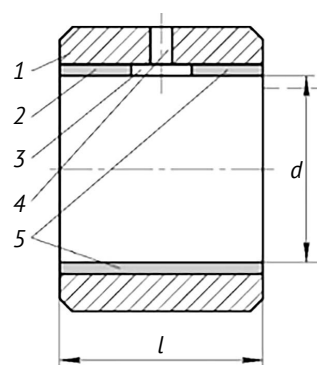


Figure 1. Design of a conventional sliding bearing

and a rotating section of a shaft loaded with a radial force
Notes: d – the diameter of the sliding bearing; l – the length of the sliding bearing; 1 – body; 2 – insert; 3 – grooves for lubrication; 4 – hole for supply of lubricant; 5 – rectilinear side internal cylindrical surfaces

Source: compiled by the authors

Figure 2 shows a section of a rotating shaft under the action of a radial force.

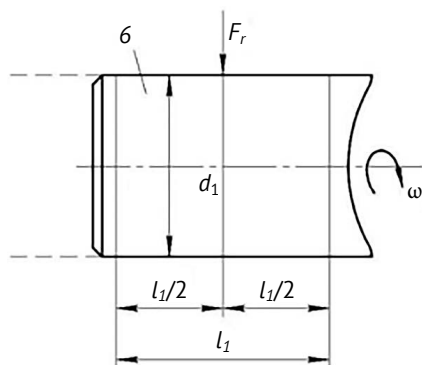


Figure 2. Section of the rotating shaft (6) loaded with radial force

Notes: d_1 – the diameter of the shaft, with $d_1 < d$; l – the length of the sliding bearing; F_r – radial force; ω – the angular speed of the shaft

Source: compiled by the authors

Figure 3 shows a model of a sliding bearing with a curved product of the internal cylindrical surface, which is characterized by a constant radius of curvature.

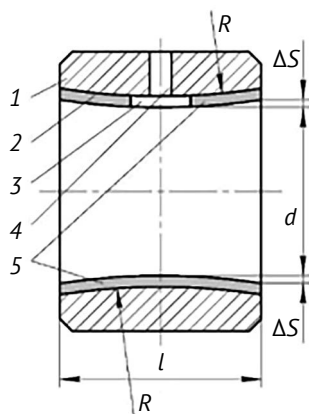


Figure 3. The design of a sliding bearing with a curved product of the internal cylindrical surface, which is characterized by a constant radius of curvature

Notes: d – the diameter of the sliding bearing; l – the length of the sliding bearing; R – the radius of the curved product of the internal cylindrical surface of the sliding bearings; ΔS – the value of the measurement of the curvilinear product in the transverse sections of the sliding bearing; 1 – body; 2 – insert; 3 – grooves for lubrication; 4 – hole for supply of lubricant; 5 – curved side internal cylindrical surfaces

Source: compiled by the authors

Y. Henry *et al.* (2015) noted that the development of new methods for solving the tasks of eliminating errors in the development, design and improvement of sliding

bearings to increase the potential of the mechanisms of the agro-industrial complex in the agricultural sector currently has enormous progress and prospects. Alloys for the manufacture of liners must have the ability to retain lubricant on the surface to ensure lubrication of parts in contact during movement. This reduces friction and wear and improves bearing performance. A plain bearing works by causing a certain section of the shaft, which is within the length of the bearing, to rotate at a certain angular velocity. This area interacts with the bearing's internal bearing surface, causing a radial load on the plain bearing.

If in the improvement of machines of the agro-industrial complex, which are the basis of sustainable development of the agricultural sector, start using modern electronics and computerized data processing of transport footnotes, this will help to significantly increase the capabilities of these processes and mechanisms, as well as increase the demand for their use in many areas. S. Wadhwa & A. Chauhan (2023) noted that the adhesion between the babbitt layer and the base has a decisive effect on the performance of the bearing. Insufficient or unreliable adhesion can lead to problems such as babbitt delamination and delamination, resulting in reduced functionality and reduced bearing life. Optimal adhesion is achieved by using appropriate methods of surface preparation and interaction of materials. In most cases, the shaft is subjected to elastic deformations, which leads to its skewing relative to the sliding bearing. This skewing of the shaft has the effect of its clamping by the internal cylindrical surface of the bearing.

The task of effective management of the technological regimes of the mechanisms of the agro-industrial complex and their problems with the application and development of innovative parts and devices for use are gaining more and more relevance and practical value in many countries. Sliding bearings, which consist of a housing, a liner, a groove for lubrication and an opening for supplying lubricant, have the disadvantage of pinching the attached shaft under the action of radial loads. W. Zhang & B. Zhu (2023) determined that the shaft moves elastically during operation, which adversely affects the reliability and functionality of the bearing and, in most cases, leads to bearing failure. Pinching occurs when the shaft is subjected to radial loads, moves and presses on the internal surface of the bearing. This can be caused by incorrect or insufficient clearance between the shaft and the bearing, or insufficient rigidity of the bearing design. When the shaft is pinched in the sliding bearing, the shaft contacts the insert in the end sections. This leads to a violation of the lubrication conditions, an increase in the pressure between the shaft and the liner and, as a result, to the loss of bearing support.

In this complex process, reviewing the causes of errors in the improvement of sliding bearings with curvilinear generating internal cylindrical surfaces, which increase the potential of machines of the agro-industrial complex in the agricultural sphere, and their solution acquires special importance, since the development of this process and their mechanisms in the world is one of the urgent problems of modern times. C.I. Papadopoulos *et al.* (2014) noted that heavy plain bearings are subjected to high mechanical loads, high pressure and friction. This imposes special requirements on the materials used for the manufacture of bearings and their components. One of the important factors is the tribotechnical properties of materials. A low coefficient of friction leads to low wear and improved operational characteristics of the bearing. Materials must also have high wear resistance and withstand high loads. In the technical solution, it is shown that a sliding bearing with curved elements and a liner (Fig. 3) has special properties compared to rectilinear elements and an insert (Fig. 1). When the shaft is distorted within its elastic deformation during free rolling, jamming occurs in the sliding bearing, which is caused by the cross section of the shaft.

Very often, the processing and execution of proper processes in the system of mechanisms of the agro-industrial complex has certain errors, which impairs the efficiency of these vehicles for use in the agricultural sector. Changing the geometry of the liner can have a significant impact on the bearing capacity, service life and stability of shaft rotation in the lubricant layer. I. Terra *et al.* (2023) indicated that optimizing liner geometry improves pressure distribution and reduces jamming between the shaft and liner. This results in an improved lubricating film, reduced friction and wear, and increased bearing life. In addition, the liner geometry can be changed to affect load distribution and improve uniformity on the bearing surface. This reduces stresses caused by unbalanced loads and contributes to increased bearing reliability. The proposed sliding bearing (Fig. 3) meets the requirements and has stable performance, regardless of various types of distortions and elastic deformations of the shaft.

The elimination of errors in the improvement of sliding bearings is not fully resolved. In the agricultural sector, sliding bearings are used in tractors, combines, planters, sprayers and other agricultural machinery. In forestry, they are used in logging machinery such as logging machines, logging cutters and saws. The proposed sliding bearing differs from existing bearings in that the contact between the shaft and the liner is in the form of a point engagement instead of a linear engagement. This leads to significantly lower specific

loads on the bearing, as the large force is distributed over a limited contact area.

Mechanisms of the agro-industrial complex and their components are often used due to their efficiency and low cost of operation. As of 2023, there is increasing interest in this process in many countries to increase agricultural potential. The use of sliding bearings with curved internal cylindrical surfaces allows to significantly increase the efficiency of machines and mechanisms in the agricultural sector. The main advantage of such bearings is that they avoid jamming of the shaft in the bearing, which can occur when using bearings with straight raceways. Jamming of shafts in bearings can cause serious problems such as seizing, wear, failure and reduced system performance. Thanks to the curved internal cylindrical surface of the bearing, the contact with the shaft occurs at a point or on a very small area, which allows the load to be distributed over a limited area. Thus, the bearings can withstand high loads with a minimum specific load, maintaining performance and extending the life of the shaft without constant maintenance and repair.

The economic effect of the introduction into the composition of machines and mechanisms is expected due to a significant increase in the service life of the sliding bearing, which does not clamp the shaft section due to elastic deformations. To simplify calculations, it should be taken into account that the calculation of sliding bearings is based on the determined load factor $K_p = (p \cdot \psi^2) / (\mu \cdot \omega)$, according to which the curve $l/d = 0.2-0.9$ (Fig. 4) characterizes the relative length of the bearing, the relative eccentricity $\chi = 2e/\delta$ and the minimum thickness of the lubricating layer are determined by:

$$h = (1 - \chi)\delta/2, \quad (2)$$

where $p = F/l$ – conditional pressure, MPa; F_r – the radial force acting on the bearing, N; l , d – length and diameter of the bearing, respectively, mm; $\psi = 0.8 \cdot 10^{-3} \sqrt{V}$ – relative clearance in the bearing; V – shaft speed, m/s; μ – the absolute viscosity of the oil, MPa s; ω – angular speed of the shaft, 1/s; $\delta = \psi \cdot d$ – radial clearance in the bearing, mm; e – eccentricity.

Thus, the existing method of calculating sliding bearings is graphic and characterized by a sufficiently high error. The points of rupture of the lubricating layer and the maximum pressure are located symmetrically relative to the central line. In this regard, the angle $\varphi_2 = 180^\circ + \varphi_{min}$, where φ_{min} – the angle characterizing the position of the end of the pressure distribution curve relative to the minimum thickness of the lubricating layer. The angle ψ_0 (Fig. 5) is called the load angle and characterizes the degree of loading of the sliding bearing.

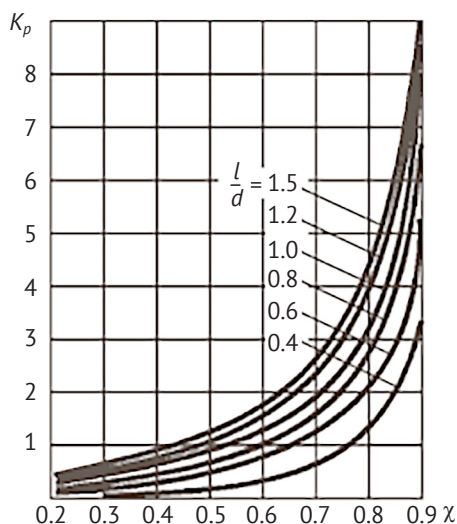


Figure 4. Stress load diagram of a sliding bearing

Source: compiled by the authors

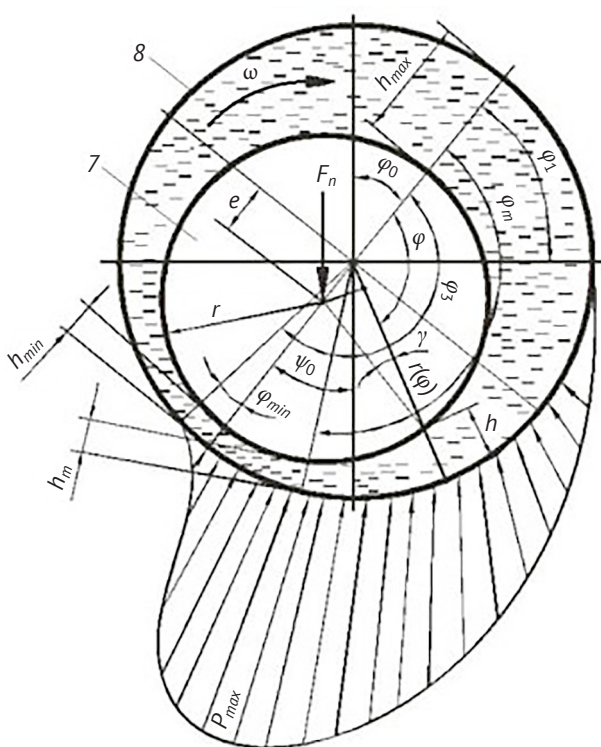


Figure 5. Rotating shaft (7) in sliding bearing (8)

Source: compiled by the authors

B. Vinod *et al.* (2023) note that in recent years, many countries have made significant progress in the development of design and modelling methods for improving machines and mechanisms of the agro-industrial complex, this direction has received considerable attention and undergone significant improvements. To reduce the specific load on the sliding bearing with

curved elements, a design with a curved shape of the internal cylindrical surface of the liner is used. This geometry results in a point contact between the shaft and the liner, which distributes the load over a larger contact area. This distribution helps to reduce the specific pressure and improves the distribution of load forces on the bearing.

In achieving optimal productivity of the mechanisms of the agro-industrial complex and increasing the potential of the agricultural sector in countries, the qualification of personnel and timely diagnostics of equipment are of great importance. The main advantages of sliding bearings with curved contact surfaces are their reliability and service life. The curvilinear shape of the raceways provides an even distribution of the load over the contact area between the shaft and the liner, which reduces the specific load and increases the efficiency of the bearing. This design also reduces the impact of distortion and elastic deformation of the shaft, ensuring reliable operation of the bearing even under variable operating conditions. Based on the results of research by A. Xu *et al.* (2023) concluded that the use of plain bearings with curved raceways can improve the vibration and acoustic performance of the system. This is achieved due to several factors. First, in sliding bearings with curved contact surfaces, vibration is reduced because the shaft rolls more smoothly and without shocks. The curved geometry of the raceway provides a point contact between the shaft and the trunnion, which results in a smoother movement of the shaft. As a result, harmful vibrations in machines and equipment can be reduced, especially at high speeds and under heavy loads.

A. Soni *et al.* (2023) determined that the implementation of sliding bearings with curved raceways in machinery and equipment has significant economic benefits. One of the reasons for the longer service life is the absence of jamming of the shaft due to elastic deformation. In conventional plain bearings, the shaft and liner interact along the contact line, resulting in elastic deformation that can lead to shaft seizing, surface wear, and reduced bearing life. In radial thrust bearings, these problems are minimized because the point contact reduces the effect of elastic deformation, ensuring stable operation over a long period of time. In addition, maintenance and replacement costs are lower due to the longer life of plain bearings. This confirms the fact that the data of the authors' work coincide with modern trends in the field of designing and modelling methods for improving the mechanisms of the agro-industrial complex. In the modern world, great attention is paid to taking into account all factors that affect the quality of these works in

order to increase the potential of the agricultural sector. However, this work did not take into account that an important feature is the longer service life of sliding bearings, which in turn reduces the risk of accidents and unexpected stops in the event of bearing failure.

Researchers R. Phiri *et al.* (2023) determined that when designing sliding bearings, a load factor is used to determine the relative bearing length, relative eccentricity, and minimum thickness of the lubricant layer. This load factor is usually determined using a graphical method. Depending on the type of bearing and the specific situation, the appropriate load curve is selected. The curve shows the relationship between the relative length of the bearing, the relative eccentricity and the minimum thickness of the lubricant layer. But for a more correct operation of sliding bearings and mechanisms of the agro-industrial complex, it is necessary to carry out an inspection of buildings on a permanent basis, due to which the potential of the agricultural sector in the countries will soon reach high values. There are differences with this work in that the author did not notice exactly the importance of the features of using this type of sliding bearings.

D. Martins *et al.* (2023) note that such curves as load curves, stress loss curves, and load capacity curves are known in graphical methods of calculating sliding bearings. These curves are used to determine the required bearing parameters, such as relative length, relative eccentricity, and minimum grease layer thickness. However, this task is complex and may introduce some error. In addition, the graphical method requires the identification and interpretation of points on the curve. This can lead to errors in subjective assessments and determination of parameters. In this work, the results of the characteristics of sliding bearings were analysed and more precisely considered, so the results can be supplemented by the fact that the increase in the potential of the agricultural sector directly depends on the improvement and innovation of agricultural services and the provision of high-quality service to the machines of the agro-industrial complex and their mechanisms.

J. Pichler *et al.* (2023) showed that due to the limitations and inaccuracies of the existing graphical methods of calculating sliding bearings, it is necessary to develop new, simplified methods. More accurate results can be obtained without the use of graphs with the help of analytical models and mathematical formulas. This includes consideration of factors such as elastic deformation, bearing design parameters and operating conditions. However, the authors pointed out and considered that currently the use of computer programs and

numerical methods allows modelling the behaviour of sliding bearings with different input parameters, which allows obtaining more accurate results and reduces subjectivity. It can also be noted that this is due to the fact that experimental tests on real bearings provide valuable data for improving calculation methods, because of this there is a difference between this work and the work of the specified author.

M. Mitra *et al.* (2023) state that relative eccentricity is defined as the distance between the centre of the bearing and the centre line of the shaft as a percentage of the bearing radius. It is used to estimate the degree of deviation from the ideal centre of the bearing. The relative eccentricity ranges from 0 to 100%, where 0% corresponds to the ideal centre and 100% to the maximum eccentricity. Changing the angle and relative eccentricity can affect load distribution, contact forces, friction and bearing wear. The determined values of the angle and relative eccentricity allow to analyse the parameters affecting the operation and reliability of the bearing, such as specific pressure, contact angle and distribution of lubricant. Research findings that this parameter is important in the design and calculation of plain bearings to account for eccentricity and to ensure proper loading and functional characteristics of the bearing should also be included. In order to achieve improvement in the design and modelling of methods for improving the mechanisms and machines of the agro-industrial complex, as well as to reduce errors in sliding bearings during complex technological processes, it is necessary to pay attention to two aspects: increasing funding and improving the qualifications of employees, as well as introducing new technologies. The main goal of these measures is to improve the quality and efficiency of the process of improving the mechanisms and machines of the agro-industrial complex, as well as to reduce the risk of errors.

CONCLUSIONS

Sliding bearings with curved internal cylindrical surfaces have a constant radius of curvature, which distinguishes them from rectilinear inserts with straight surfaces, which are used to regulate the shaft when it is skewed within the limits of elasticity. In bearings with curved bearing surfaces, when the shaft axis bends, the cylindrical surface is not pinched, which allows free rolling. The obtained results indicate that sliding bearings with curved elements of the internal cylindrical surface have a stable radius of curvature, which allows them to avoid pinching when the shaft is deflected within its elasticity. The proposed sliding bearings have a point contact

of the shaft with the insert and are characterized by lower specific load values compared to known sliding bearings. This paper reviewed and presented recommendations for eliminating errors in the processes of designing and implementing mechanisms of the agro-industrial complex. It was also carefully analysed technological processes in sliding bearings, errors and problems that are allowed during the functioning of agricultural product processing processes, and the introduction of effective tools that allow solving these issues and preventing errors was proposed. In order to improve the machines of the agro-industrial complex, sliding bearings were considered, which expand this resource base by introducing sliding bearings with curvilinear generators of the internal cylindrical surface, which have a constant radius of curvature, demonstrate stable performance, increased service life and improved vibroacoustic characteristics. It was considered that with the help of introduction of sliding bearings with curvilinear generators of the internal cylindrical surface with a constant radius of curvature, it is possible to increase the efficiency of the work of

machines, mechanisms and aggregates in agriculture. The research successfully completed the assigned task, including the analysis of the problems of improving the mechanisms of the agro-industrial complex, the development of ways to improve the processes of the mechanisms, as well as the identification and proposal of methods for eliminating errors in the process of improving the efficiency of the machines of the agro-industrial complex. All this will help increase the potential, competitiveness and quality of agricultural services. Analysed modern approaches to the problems of improving sliding bearings will try to respond to modern needs for further prospective use of the mechanism. Future research will be aimed at creating and implementing innovative mechanisms in the agro-industrial complex in order to promote the agricultural sector.

None.

ACKNOWLEDGEMENTS

CONFLICT OF INTEREST

None

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Підвищення ефективності машин і механізмів агропромислового комплексу застосуванням підшипників ковзання з криволінійними твірними внутрішньої циліндричної поверхні

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Анотація. Підшипники ковзання з криволінійними твірними внутрішніми циліндричними поверхнями мають великий потенціал і можуть відігравати важливу роль у ремонті та відновленні механізмів агропромислового комплексу. Оскільки їх використання стає все більш поширеним, виникає необхідність у поліпшенні розробки таких підшипників, щоб забезпечити їх якісне використання та уникнути помилок при дослідженні цього питання, крім того, досягнення кращих результатів в цій області вимагають значних фінансових вкладень для підвищення ефективності таких механізмів. Основною метою цієї роботи є надання рекомендацій, спрямованих на усунення помилок у процесах покращення та підвищення якості підшипників ковзання, а також аналіз функціонування машин, що використовуються в агропромисловому комплексі. Було використано аналітичний метод, метод класифікації, функціональний метод, статистичний метод, метод синтезу. У ході проведення дослідження відзначено особливості та відмінності підшипників ковзання з криволінійними твірними внутрішньої циліндричної поверхні, проаналізовано помилки та їх причини, які допускаються під час покращення агропромислових механізмів, що забезпечують розвиток сільськогосподарської галузі. Важливе значення має аналіз функціонування даних механізмів з метою оцінки їх ефективності, розвитку та ускладнення роботи під час виробництва сільськогосподарської продукції. Розглянуто питання оцінки роботи підшипників ковзання даного типу, доцільність використання цього елемента, їх обмеження під час процесу, вплив обмежень на результат, було запропоновано рекомендації, які сприятимуть ефективному механізму регулювання питання. Було визначено, що використання підшипників ковзання даного типу, у процесі відновлення агропромислових механізмів, забезпечить суттєве підвищення продуктивності цих машин. Практична цінність цієї роботи полягає у можливості застосування отриманих результатів для усунення помилок у розробці та вдосконаленні механізмів агропромислового комплексу, вивчення надійності застосування підшипників ковзання в загальному, з урахуванням різних факторів, надасть основу для рекомендацій щодо доцільного використання цих підшипників

Ключові слова: заклинювання; сільськогосподарське виробництво; вал; деформації; ремонт