

to climate change, unstable weather conditions, and production risks were identified, and prospects for increasing the efficiency of crop cultivation under current conditions were outlined.

Keywords: winter barley, sown areas, agricultural production.

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INCREASING THE WEAR RESISTANCE OF FRICTION BEARING UNITS OF AGRICULTURAL MACHINERY BASED ON A COMPREHENSIVE TRIBOLOGICAL APPROACH

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Abstract: The paper considers the problem of reliability of friction bearing units of agricultural machinery, which largely determines the durability of machines in difficult operating conditions. The main factors affecting the wear of surfaces under friction conditions were considered and analyzed, namely: the influence of loads, temperatures, speed modes and aggressive environments. The need for a systematic approach to increasing wear-resistant characteristics, which includes improving lubricants, the quality of friction surfaces and sealing of units, is proven. A research methodology is proposed, which is based on a combination of theoretical modeling and experimental tribotechnical tests taking into account the influence of technological environments. The results obtained can be used to increase the resource and efficiency of operation of agricultural machines.

Keywords: agricultural machinery, bearing assemblies, wear resistance, tribology, lubricants, friction, wear, sealing, surface layer, machine life.

In modern mechanical engineering, the durability of units and assemblies largely depends on the wear resistance level of the surfaces of bearing units included in their design. Insufficient wear resistance of friction surfaces leads to premature failures, which may occur already at 27–63% of the total service life of mechanisms. In such cases, maintenance and repair costs exceed manufacturing costs by 2–3 times. Wear processes are accompanied by changes in the geometric parameters of the surfaces that form the bearing units.

The main operational features of bearing units in agricultural machinery are determined by the influence of loads, temperature factors, rotational frequency, sliding or rolling speeds, as well as the high aggressiveness of the environment in which they operate. This contributes to the development of various types of wear, including abrasive, hydroabrasive, and corrosion-abrasive wear, leading to reduced performance and significantly affecting the service life of units and mechanisms as a whole.

The wear-resistant characteristics of bearing units are determined by the quality of process media, particularly lubricants, geometric accuracy, surface roughness parameters, and the physico-mechanical properties of surface layers formed during manufacturing and altered during operation. In addition, the improvement of operational characteristics of machines and mechanisms is constrained by the lack of comprehensive approaches to evaluating wear processes in the presence of a lubricating medium as a “third body,” as well as by imperfections in lubrication and sealing systems.

At present, issues related to the study and improvement of the design of bearing units in agricultural machinery, the implementation of effective lubricants, and the development of adaptive lubrication systems remain highly relevant. These factors contribute to reducing friction and preventing wear of contacting surfaces. One of the most important and relevant areas is the development of effective sealing elements that prevent lubricant leakage and the ingress of abrasive particles into the friction zone.

The methodological basis of the research is the study of regularities in the change of friction surface geometry, the structure of surface layers, thermal processes occurring under load during operation, contact conditions, and the influence of the lubricating medium. Considerable attention is paid to determining the physico-chemical properties of lubricants and establishing the principles governing the influence of friction and wear mechanisms based on modern tribological theories.

The problem of improving wear-resistant characteristics of friction pairs is complicated by the continuous advancement of agricultural machinery designs and the increase in operational loads, speeds, temperatures, and exposure to aggressive environments. This necessitates the development of innovative scientific approaches to analyzing wear processes in friction pairs of units and mechanisms.

It has been established that the destruction of surfaces of bearing unit components mainly occurs in surface layers and is accompanied by changes in the geometric shapes of contacting surfaces. Mechanochemical processes occurring in the contact zone significantly affect the nature of friction and wear intensity, altering the interaction conditions of surfaces.

Thus, the wear-resistant characteristics of bearing units are determined by a set of factors, namely: surface quality, the presence and properties of the lubricant, the efficiency of heat removal and wear debris evacuation, as well as the level of sealing of the unit and mechanism.

Experimental studies have shown that the service life of friction pairs in bearing units is often shorter than the overall service life of the mechanism. Friction processes occurring under load are accompanied by complex physico-mechanical phenomena, which complicates their theoretical description. Contact between friction surfaces occurs in the presence of process media, particularly lubricants, and is accompanied by combined loading, resulting in the formation of wear particles of various sizes.

Increasing the wear-resistant characteristics of friction pairs is possible by minimizing negative factors and applying modern comprehensive measures: ensuring a stable supply of lubricant, increasing the tightness of components and assemblies, and strengthening the contact surfaces of parts.

The proposed research methodology involves the integration of theoretical and experimental approaches to improve the service life of bearing units in agricultural machinery. A distinctive feature of the approach is the analysis of the influence of individual elements of the tribosystem on overall wear resistance.

Theoretical studies focus on modeling wear and friction processes of surfaces at different stages of operation, namely initial start-up, steady-state operation, and shutdown, taking into account geometric and physico-mechanical parameters of surfaces and material properties. Particular attention is given to wear analysis at the micro-level and the influence of the stress-strain state.

Experimental studies are based on bench tribotechnical testing, which allows accelerated evaluation of wear resistance characteristics of bearing units under real operating conditions, considering the effects of lubricating and aggressive media. Laboratory studies of lubricant properties after use are also conducted.

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Анотація: У роботі розглянуто проблему надійності підшипникових вузлів тертя сільськогосподарської техніки, яка значною мірою визначає довговічність машин у складних умовах експлуатації. Були проаналізовані основні чинники, що впливають на зношування поверхонь в умовах тертя, а саме: вплив навантажень, температур, швидкісних режимів та агресивного середовища. Доведено необхідність застосування системного підходу до підвищення зносостійких характеристик, що включає вдосконалення мастильних матеріалів, якості поверхонь тертя та герметизації вузлів. Запропоновано методологію досліджень, яка базується на поєднанні теоретичного моделювання та експериментальних триботехнічних випробувань з урахуванням впливу технологічних середовищ. Отримані результати можуть бути використані для підвищення ресурсу та ефективності експлуатації сільськогосподарських машин.

Ключові слова: сільськогосподарська техніка, підшипникові вузли, зносостійкість, трибологія, мастильні матеріали, тертя, зношування, герметизація, поверхневий шар, ресурс машин.