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RESOURCE-SAVING TECHNOLOGY FOR INCREASING THE LIFE OF BALL BEARING FIXED JOINTS OF TRACTORS AND AUTOMOBILES

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Abstract: The article shows that the premature failure of a fixed assembly with a ball bearing in agricultural machinery is due to the elliptical shape of the outer ring of the bearing, which leads to an incorrect distribution of the force acting on it between the balls, which leads to a decrease in its service life. At the same time, the factors affecting the strength of a fixed assembly with a ball bearing when the diameter of the covering part is smaller than the diameter of the covered part (non-lubricated assembly) is lost using a press force are studied, and the main method of increasing the friction force is selected. The effect of using heating the covering part or cooling the covered part, applying a galvanic coating to the surfaces of the assembly and other methods is presented. However, due to the complexity of the proposed methods, the need for expensive equipment and the long recovery time, a simple, inexpensive, non-complex technology for increasing the friction coefficient, the technology of using anaerobic sealants, is presented.

Key words: tension, fixed joint, bearing, service life, strength, crevice, fretting-corrosion, galvanic coating, oil, service life, friction coefficient.

Introduction. Currently, 267 thousand agricultural machines are involved in technological processes in the fields of farmers of our Republic. 38 percent of them are already obsolete. The costs of their repair are increasing to ensure their serviceability. Therefore, scientific research work is being carried out to improve existing technologies for their repair.

Analyses have shown that currently the service life of these agricultural machinery depends on the service life of their main element, ball bearings, which are 2000...3000 engine hours. This indicator is much less than the required 12000...14000 engine hours. Scientific studies conducted to study the cause of this situation show that under the influence of load, the strength between the outer wheel of the bearing and the housing, and the inner wheel and the shaft decreases. As a result, when its amount is less than the friction force in the rolling paths of the balls, the bearing wheels begin to rotate relative to the installation location. As a result, a gap is formed between the housing and the outer wheel of the bearing and the shaft and the inner wheel of the bearing, and its amount increases steadily. This leads to an incorrect distribution of the force acting on the bearing between the balls. As a result, the load on the center ball of the bearing increases and its service life decreases. For example, if a 208 bearing is installed in the housing with a gap of 0.095 mm, its service life decreases by 1.4 times, and with a gap of 0.139 mm, it decreases by 1.8 times compared to the calculated one.

To increase the service life of bearing assemblies, it is necessary to study the causes of the wear mechanisms of the bearing rings.

The author of the work [3] explains the wear mechanism in two stages: wear begins with the crushing of small protrusions on the stationary mating surfaces under the influence of a changing force. At the same time, the mating surfaces are plastically deformed and small protrusions are crushed and separated from the deformed parts of the surfaces in the form of particles. In the second stage, as a result of the weakening of the bearing, the mating surfaces begin to slide relative to each other, which leads to the formation of a gap between the mating surfaces and its rapid increase.

The author of the work [4] explains the rotation of the bearing rings and the appearance of a gap in the surfaces on which they are mounted as the main reason for the lack of sufficient rigidity of the shaft and housing surfaces on which the ring is mounted. The gap appears as a result of the accumulation of plastic deformations between the mating surfaces under the influence of cyclic loading on the surfaces.

The author of the work [5] considers that the cause of the deterioration of solid contact surfaces and their rotation relative to each other is fretting corrosion, which is caused by mechanical and chemical factors occurring on the mating surfaces. If the beginning of this process is determined by the mechanical factor, the cause of the deterioration of fixed mating surfaces under the influence of force, shock and vibration, then the chemical factor occurs as a result of the activation of corrosion processes in the friction zone.

Fretting corrosion is a special type of wear that occurs as a result of the displacement of fixed mating parts relative to each other with a very small amplitude. The cause of this type of excitation is vibration, dynamic loading, periodic bending and twisting of the mating parts.

The intensity of the deterioration of fixed mating parts under the influence of fretting corrosion depends on the parameters of external mechanical influences, physical factors and the environment. Of these, external mechanical influences have a great influence on the wear rate of the surfaces of the fixed parts.

Analysis of scientific research studies conducted to study the causes of damage to fixed joints with ball bearings showed that the main causes are fretting-corrosion and relative rotation of the wheels to the mounting location.

Therefore, in order to increase the service life of fixed joints with ball bearings, it is necessary to increase their mounting strength.

Problem statement and research method. Currently, when forming fixed joints with ball bearings, the inner wheel of the 208 bearing is assembled on the shaft with tension (the difference between the diameters of the covering and covering parts) and the tension is applied to the mating surfaces with anaerobic sealant and press force. The disadvantage of this method is that the roughness of the joining surfaces is cut off, which leads to insufficient strength. This disadvantage is overcome by heating the parts to be covered to a special maximum heating temperature of 260...280°C, and cooling the parts to be covered to the lowest cooling temperature (-196°C).

The pressure depends on the amount of tension. When forming a fixed joint with a ball bearing, as the amount of tension increases, the radial clearance between the inner and outer rings of the

bearing decreases and the coefficient of friction that resists the rolling of its balls on the wheel track increases. As a result, the bearing heats up and the strength of the rings decreases, leading to premature failure. In addition, the strength of the joint decreases due to plastic deformation in the covering part with increasing tension. In this case, it is necessary to pay attention to increasing the coefficient of friction to form a strong joint according to formula (1). Several scientific studies have been conducted in this regard [3,4,5].

According to data [3], the strength of non-lubricated joints depends on the method of their assembly, in particular, if the mating surfaces are treated with MoS2, i.e., molybdenum disulfide lubricant MoS2, the pressing force during assembly is reduced by 30%, while the roughness on the surfaces of the mating parts is preserved, allowing the joint to be reassembled.

In order to increase the lubrication life of non-lubricated joints, the authors [1] showed that the method of heating the parts before assembly gives good results. For example, when assembling using the method of heating the mating part or cooling the mating parts, the strength of the joint increases by 2...2.5 times compared to the usual assembly method. Because in this method, the roughness on the surfaces of the mating and mating parts is not cut off and polished. In order to preserve the physical and mechanical properties of the parts in these technologies, the lowest cooling temperature should not exceed (-196° C) and the maximum heating temperature should not exceed 260...280° C.

When assembling fixed joints using the cooling method, the friction coefficient is f= 0.314...0.535.

When assembling the part by heating the covering, the friction coefficient is 0.222...0.454. These indicators are more than 2 times higher than in the mechanical method.

It is known that the friction force in a fixed joint depends on the physical and mechanical processes on the contacting surfaces of the joined parts.

The strength of the joint can be effectively increased by technological preparation of the interaction of the contacting surfaces of the parts. For this purpose, it is necessary to form a galvanic coating on the surfaces of the joined parts. As a result, the strength of the fixed joint increases sharply (3...7 times), and the coefficient of friction reaches f = 0.75.

These methods require complex and expensive equipment, are expensive, and do not fully provide the contact surface of the covering and covered parts. Therefore, these problems can be solved using anaerobic sealants.

Anaerobic sealants are multicomponent liquid compositions that have the ability to remain in air for a long time without changing their properties, and at a temperature of 20...25° C they quickly harden on the surface of the parts to be repaired and form a strong polymer.

The technology for restoring fixed joints with ball bearings with these sealants includes the following. To clean the surfaces to be repaired from oil, they are wiped with a cotton swab dipped in acetone and dried. An anaerobic sealant is applied to the dried surface and the parts are assembled by leveling with a brush, and if the diameter of the gap to be repaired is more than 0.05 mm, special centering devices are used. As soon as the sealant hardens, the centering device is removed and the compound is heated to completely harden.

In the restoration of a fixed joint with a ball bearing, a fixed joint of the "shaft-bearing" type, restored with anaerobic sealant UG-8, was taken as the object of research. To determine the strength of the repaired surfaces, an IM-4A type breaking machine was used. The machine's speed and loading speed are 0.1 mm/min.

Results. The conducted studies showed that the strength of the fixed joint depends on the amount of tension or the gap between the parts before repair.

When the fixed joint of a ball bearing shaft was assembled with tension without sealant, its strength increased linearly with increasing tension (Fig. 2), that is, at a tension value of 10 μm, the breaking force was 4.95 kN, and at 20 μm, it was 6.75 kN. If this joint was assembled with the same values of tension and anaerobic sealant, then the joint strength was 22.5 kN and 23 kN, respectively, and the joint strength increased by 5.3 times in the first case and 3.4 times in the second.

If you pay attention to the figure, when a fixed joint is assembled with tension and sealant, the change in strength is very small, which means that when a fixed joint is assembled with tension and sealant, the parts of the mating surfaces that remain untouched are filled with sealant, forming a molecular bond between the parts. As a result, due to the one hundred percent bonding between the surfaces of the covering and the covered parts, the friction coefficient f approaches 1.

Studies have shown that with an increase in the thickness of the sealant on the surfaces of the parts, its strength decreases. For example, the strength of surfaces repaired with UG-8 sealant was 17.2 kN when the gap was 0.1 mm, 15 kN when it was 0.2 mm, and 10 kN when it was 0.45 mm.

Conclusion. So, the strength of a fixed joint with a ball bearing depends on the assembly method, and by heating the mating part or cooling the mating part before assembly, the strength increases by 2 times and the friction coefficient reaches I = 0.5. If the mating surfaces are coated with a coating by galvanic method, the friction coefficient can be increased to 0.75. However, although these methods give good results, they require complex, expensive equipment. To solve this problem, it is recommended to use anaerobic sealants when forming a fixed joint. If a sealant and a sealant are used, then the breaking force of the formed fixed joint increases by 3.4...5.4 times with an increase in the sealant, and the friction coefficient approaches f 1, but its strength decreases with an increase in the thickness of the sealant between the mating parts. Therefore, it is recommended to repair cracks up to 0.18 mm in the fixed joint with UG-8 sealant.

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