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RATIONALE FOR THE TECHNOLOGICAL PROCESS OF RESTORATION OF WORKING SURFACES OF JOININGS OF ROLLING BEARINGS

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The article examines the processes that occur during the operation of the mating surfaces of machine parts, and analyzes the factors that influence their operational characteristics. Zokrema, the specificity of the vicorization of polymer materials in the process of updating the seating shafts and housings under the forging rollers was observed. The completeness of the separation of technological processes aimed at increasing the wear resistance of the working surfaces of these parts has been demonstrated.

Theoretical dimensions are presented that allow one to determine the basic parameters of the repeated bending of shafts, housings and rollers by rolling ways to compensate for changes in geometric dimensions of the surface after operation. It is indicated that the durability of the work depends to a large extent on ensuring the inviolability of the roller rings, which includes their checking. For this purpose, the necessary tensions at the landings, plastic deformation of micro-irregularities on the surface of the parts have been ensured, and methods of wear compensation have been introduced.

The advantages of the use of polymer materials, which are characterized by high physical and mechanical strength, in technological processes of folding and updating parts have been analyzed. The use of polymer compositions makes it possible to reduce the wear on the surface of parts and their surfaces, such as reducing rubbing, as well as increasing the development of fretting corrosion. Protective, polymer coatings perform the function of microshock absorbers, reducing stress in contact areas and increasing the durability of working surfaces.

The problem of choosing the optimal type of polymer materials and the maximum permissible gap and tension in the couplings, which will ensure the unbreakability of the rings and durability before they are tested, is carefully examined.

The robot has identified the main directions of further investigations, regardless of the importance of the power of polymer materials, which will ensure the greatest durability of the device during different types of use. The research results indicate the promise of high-quality polymer materials for increasing the wear resistance of working surfaces and extending the service life of robotic machines and equipment.

Key words: *hardening rollers, durability, wear, renewal, polymer materials.*

Eq. 4. Fig. 2. Ref. 9.

1. Problem formulation

In the context of a constant increase in the intensity of motor transport equipment, an increase in its power and speed of movement, as well as in connection with the constant increase in the Ukrainian market of foreign high-value machines, the problem of high-quality repair of shaft seats for rolling rollers is becoming more important.

Therefore, scientific research on the development, improvement and implementation of technologies for restoring the seats of parts using polymeric materials is becoming particularly relevant.

2. Analysis of recent research and publications

The wear resistance of the working surfaces of parts is one of the main factors affecting the service life of machinery and equipment [1]. Accordingly, the level of demand for spare parts is often economically unjustified due to the low durability of parts.

To understand the processes that occur during the operation of mating surfaces, we analyze the factors that affect the performance of parts: first, these are the power and kinematic parameters of operation (pressure on the working surfaces, the speed of relative movement of the mating surfaces, etc.); secondly, the nature of friction (with or without lubrication; friction of rest, sliding, rolling, or rolling with slipping); thirdly, the type of lubrication (boundary, hydro- or gas-dynamic); fourthly, parameters characterizing the physical and mechanical properties of the surface layers of parts (hardness, elastic modulus, shape deviation, roughness, presence of a hardened layer, stress state, etc.); fifthly, the influence of external conditions and environmental properties (temperature, humidity, exposure to aggressive liquids, etc.).

The durability of rolling stocks, in most cases, depends on the fit formed when connecting the rings to the housing parts or shafts [2]. An increase in the gap or weakening of the tension between the seating surfaces due to their wear leads to a deterioration in the load distribution between the rolling elements, and subsequently to a decrease in the service life of the corresponding assembly units due to the misalignment of the shaft axes, increased vibration, and increased dynamic loads [3].

The basis for the development of technological processes to increase the wear resistance of the working surfaces of shafts (housings) for rolling stock is their lower hardness during manufacturing and restoration (during manufacturing, the hardness is 48...54 HRC, during restoration - 18...24 HRC [4]) compared to the hardness of the rolling stock ring itself (up to 62 HRC).

It should be noted that today, due to the development of the chemical industry, a number of polymeric materials with the necessary physical and mechanical properties have been created [5, 6]. This makes it possible to use them both in the formation of assembly units and in the process of restoring the fit of parts joints.

In particular, in repair production, the manufacturer applies polymeric materials to the threaded surfaces of bolts on new parts of the repair kit, whether it is the brake system bolts or flywheel mounting bolts (Fig. 1).

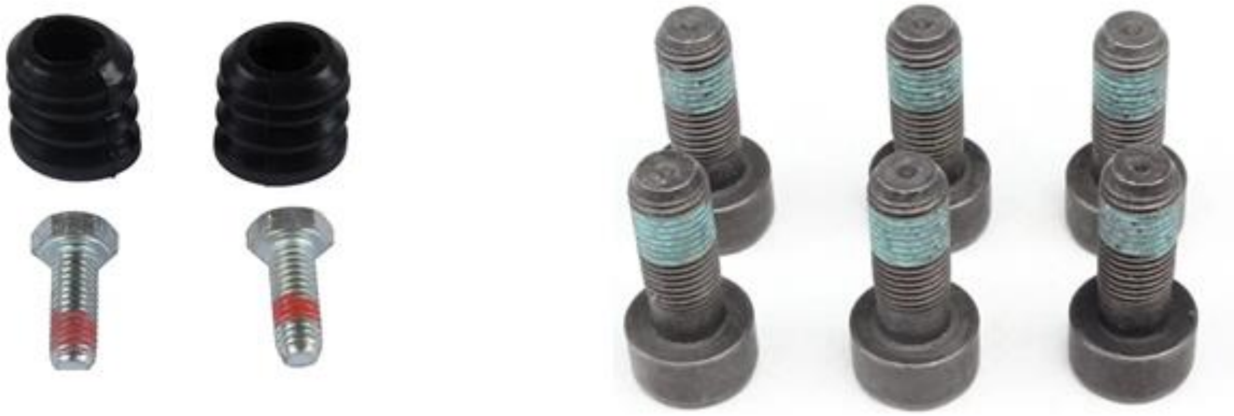

Fig. 1. Examples of the use of polymeric materials on threaded surfaces

The use of these materials is also due to the fact that the use of polymer compositions does not require the use of expensive technological equipment [7] and is a technological process with low capital investment.

3. The purpose of the article

Substantiation of the technological process of restoring the working surfaces of motor vehicle parts for rolling rollers with polymeric materials.

4. Results of the researches

In the process of forming a composite unit, a fixed connection is ensured when the roller is installed on the shaft with tension. The calculated tension value is determined based on the condition [8]:

$$N_{розр.} = N_{min} + 1,2\left(R_{ZD} + R_{Zd}\right), \quad (1)$$

where $N_{min} = d_{min} - D_{max}$ – the minimum recommended fit tension, which depends on the minimum shaft diameter and maximum bore diameter; R_{ZD}, R_{zd} – is the height of the microroughness, respectively, for the inner ring of the roll and the shaft.

The dependence considered assumes that when pressing the roll rings, the roughness of the shaft and bore changes, which will be up to 60 % of the initial height of the irregularities. However, it should be noted that when pressing on a part that has a lower hardness than the roll ring, the micro-irregularities are plastically deformed, and as a result, the calculated tension value is reduced.

In tension fits, the amount of change in the initial microroughness of the shaft and bore can be determined by the following relationship:

$$\Delta R_Z = 2\left(k_b R_{ZD} + k_d R_{Zd}\right), \quad (2)$$

where k_b – a coefficient that takes into account the amount of crushing of the roll's micro-irregularities (k_b = 0,1…0,2); k_d – a coefficient that takes into account the amount of crushing of micro-irregularities of the part (k_d = 0,6…0,8).

Dependence (2) implies a change in the height of the micron irregularities of the roller hole by 20% (the hardness for steel ШХ15 is 58...62 HRC), and the shaft or hole with a hardness of 48...54 HRC - up to 80% of the original.

It should be noted that during the repair operations of motor vehicles, shafts, bores and rollers are often used after operation. Accordingly, the reuse of shafts, holes and rollers is possible provided that the size of the shaft seating surface for the rolling roller should be increased by the amount of change in microness after pressing and unpressing the joint.

The total change in micron irregularities after pressing the roller onto the shaft does not exceed 12...15 microns (at R_{Zd} = 20 microns i R_{ZD} = 5 microns).

One of the causes of malfunction of the shaft-inner ring connection is the weakening of tension during operation due to changes in the microgeometry of the rolling elements and ring raceways. Accordingly, to reuse rolling stock, it is also necessary to compensate for the change in the micro-irregularities of the rolling elements and their inner and outer ring raceways by the amount of the change in micro-irregularities:

$$\Delta R_{Zb} = 2k_{\boldsymbol{b}}\left(R_{Ze.r.} + 2R_{Zt.r.}\right), \quad (3)$$

where $R_{Ze.r.}$, $R_{Zt.r.}$ – is the height of microroughnesses, respectively, of rolling elements and rolling raceways.

To realize condition (1), taking into account dependencies (2) and (3), provided that the shafts (housings) and rolling elements are reused, it is necessary to compensate for the decrease (increase) in surface dimensions according to the following dependence:

$$\Delta R_Z = 2\left(k_b R_{ZD} + R_{Ze.r.} + 2R_{Zt.r.}\right) + 2k_d R_{Zd}, \quad (4)$$

Thus, given that rolling rollers are standard products for which dimensional changes are not allowed, it is possible to compensate for the total change in surface dimensions only by:

- increasing the size of the shaft by restoring technological operations;
- reducing the size of the hole by restorative technological operations;
- applying polymeric material to the outer ring;
- application of polymeric material to the shaft.

If the surfaces of the rolling elements on the shaft or in the housing are connected with a gap, the ring starts to rotate immediately under load and wear products accumulate. The occurrence of fretting-corrosion processes is manifested in the presence of red-brown thin stripes [9] (Fig. 2).

Therefore, it can be assumed that the presence of a polymer coating on the surface creates conditions under which the course of fretting corrosion processes is slowed down. The polymer coating located in the depressions of micro-irregularities is a micro-shock absorber, as it is in a state of hydrodynamic compression. This leads to an increase in the durability of the working surfaces of the rolling mill parts, and ultimately, to an increase in the durability of the composite unit of the technical object.

Thus, the main condition for ensuring the durability of working surfaces is to prevent the rollers from turning, since the operating time before the ring starts to turn determines the durability of the joint.

The main factor that will determine the feasibility of using polymeric materials in the assembly of rolling mill parts is the maximum allowable gap (tension), which will ensure resistance to ring rotation. However, this requires further theoretical and practical research. Further research is also required to select the type of polymeric material that will ensure the greatest durability both when assembling the rolling mill parts and when restoring the joints.

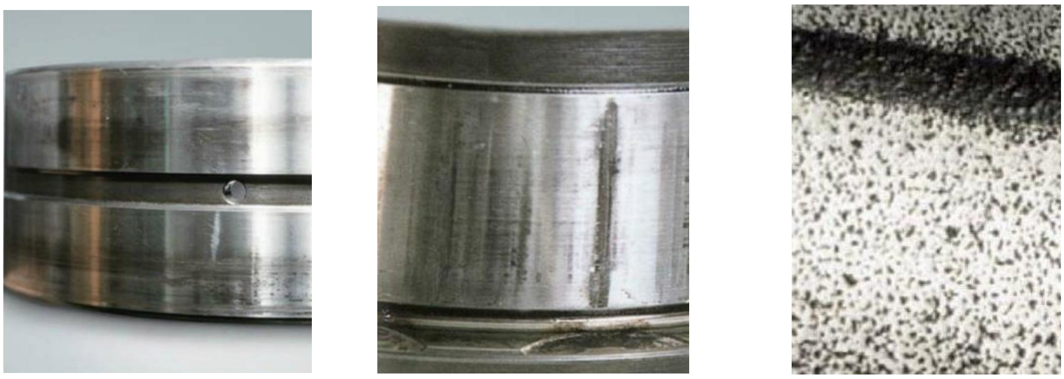

Fig. 2. Appearance of fretting-corrosion processes in rolling mills [7]

5. Conclusions

This paper substantiates the possibility of using polymeric materials in technological processes of restoring the working surfaces of parts of rolling rollers of motor vehicles. The expediency of using polymeric materials in the assembly of the corresponding machine units is also noted. Consequently, the use of polymeric materials will reduce the wear of working surfaces and increase their durability.

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ОБҐРУНТУВАННЯ ТЕХНОЛОГІЧНОГО ПРОЦЕСУ ВІДНОВЛЕННЯ РОБОЧИХ ПОВЕРХОНЬ З'ЄДНАНЬ ВАЛЬНИЦЬ КОЧЕННЯ

У статті розглянуто процеси, що відбуваються під час експлуатації спряжених поверхонь деталей машин, і проаналізовано чинники, які впливають на їх експлуатаційні показники. Зокрема, досліджено особливості використання полімерних матеріалів у процесі відновлення посадочних місць валів та корпусів під вальниці кочення. Обґрунтовано доцільність розроблення технологічних процесів, спрямованих на підвищення зносостійкості робочих поверхонь цих деталей.

Представлено теоретичні залежності, які дозволяють визначити основні параметри повторного використання валів, корпусів і вальниць кочення шляхом компенсування змін геометричних розмірів поверхонь після експлуатації. Визначено, що довговічність роботи спряження значною мірою залежить від забезпечення нерухомості кілець вальниці, що виключає їх провертання. Для цього розраховано необхідні натяги у посадках, враховуючи пластичне деформування мікронерівностей поверхонь деталей, а також наведено методи компенсації зносу.

Проаналізовано переваги використання полімерних матеріалів, які характеризуються високими фізико-механічними властивостями, у технологічних процесах складання та відновлення деталей. Використання полімерних композицій дозволяє зменшити знос поверхонь деталей завдяки їх властивостям, які зменшують тертя, а також уповільнюють розвиток фретінг-корозії. Зокрема, полімерні покриття виконують функцію мікроамортизаторів, знижуючи напруження у зонах контакту та підвищуючи довговічність робочих поверхонь.

Окремо розглянуто проблематику вибору оптимального типу полімерних матеріалів та максимального допустимого зазору або натягу у спряженнях, які забезпечують нерухомість кілець та стійкість до їх провертання.

У роботі запропоновано основні напрямки подальших досліджень, зокрема з визначення властивостей полімерних матеріалів, які забезпечують найбільшу довговічність спряжень при різних умовах експлуатації. Результати дослідження вказують на перспективність використання полімерних матеріалів для підвищення зносостійкості робочих поверхонь та розширення ресурсу роботи машин і обладнання.

Ключові слова: *вальниці кочення, довговічність, знос, відновлення, полімерні матеріали.*

Ф. 4. Рис. 2. Літ. 9.

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