NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY
[IJIERT] ISSN: 2394-3696 Website: ijiert.org
VOLUME 8, ISSUE 11, Nov. -2021

STUDY OF THE TRIBOLOGICAL CHARACTERISTICS OF A POROUS IRON-BASED ANTIFRICTION ALLOY

Norkhudjayev F. R.
Materials Science Department, Tashkent State Technical University

Mukhamedov A. A.
Materials Science Department, Tashkent State Technical University

Nabiyev B. N.
Andijan Institute of Mechanical Engineering

Sharipov M. Z.
Materials Science Department, Tashkent State Technical University

Mengaliyev F. A.
Materials Science Department, Tashkent State Technical University

ABSTRACT

The paper presents the results of a study of the tribological properties of an antifriction iron-based alloy with pyrite added to the charge under conditions of self-lubrication in comparison with an iron-graphite antifriction alloy.

Keywords: antifriction alloy, pyrite, coefficient of friction, wear rate.

I. INTRODUCTION

It is known that the methods of powder metallurgy have made it possible to develop a large number of antifriction materials, including iron-graphite antifriction materials, which successfully replace bearing materials based on bronzes and babbits. At the same time, the service life of friction units equipped with sulphided iron-based materials is significantly higher than that of bronzes and babbits, as well as materials based on bronze. [1].

At present, in Uzbekistan, at the Department of Materials Science, Tashkent State Technical University, an anti-friction material based on iron powder with pyrite containing an additive in the charge, which is a waste product of the Almalyk mining and metallurgical plant, has been developed. Research carried out [2,3]. It was found that the optimal composition of the charge in terms of mechanical properties is a composition consisting of 97% - iron powder, 2% elemental graphite and 1% - pyrite.

In this regard, it was of interest to study the tribological properties of the developed alloy.

II. OBJECTIVE OF STUDY

The objects of study were: coefficient of friction, operating temperature, wear resistance, bearing performance under specified conditions. The friction machine MI-1M with axle-box friction was chosen for the anti-friction tests.

The load of the top carriage dump is transferred to the block through the ball entering the blind drilling of the mating parts. This scheme ensures self-alignment of the axle box on the roller due to the rotation of the entire system around the ball, which excludes the axle box skew in the plane of rotation. The axle boxes were made from cut out bushings with a diameter of 30 mm and a height of 10 mm.

Sample sleeves were prepared in two compositions: without pyrite and with 1% pyrite. The axle boxes samples were prepared in one batch, were sintered under the same conditions and had a ferrite-pearlite structure of the base and a chemical composition with respect to carbon. To determine the friction temperature, a special hole was prepared in the axle box into which the chromel-copel thermocouple junction was inserted all the way and was firmly held there by a small wooden wedge. Temperature readings were recorded using a millivoltmeter. The thermocouple was calibrated using a glass thermometer with a scale from 2000 ^{0}C. In slowly heated oil with a measurement interval every 5 degrees.

III. RESULTS

In fig. 1-2 presents data on the coefficients of friction and operating temperatures obtained for samples of both compositions, based on long-term tests, depending on the operating conditions.

In Figures 1-2, these data are presented in the form of graphs of the dependence of the coefficients of friction - F and operating temperatures - T on the sliding speed and load.

When considering the graphs, attention is drawn to a slight decrease in the values of the friction coefficients in the zone of low loads and then, after passing the minimum, an increase (the presence of a minimum on the curves of the friction coefficients depending on the load was also observed by other authors [54, 56]). This behavior of the friction coefficient can be explained on the basis of the concept of the dependence of the friction force on the area of actual contact of friction surfaces, which, with increasing pressure, increases not proportionally to the latter, but with a lag. Consequently, both the friction force and the coefficient of friction, as the ratio of the friction force and the load, will decrease until signs of dry friction appear at individual points of contact.

The minimum coefficient of friction for iron-graphite lies at 200 MPa, and for iron-graphite with pyrite - at 300-400 MPa, i.e. shifts to the area of heavy loads. This indicates that the boundary friction condition for iron graphite without pyrite inclusions, i.e. the transition from boundary friction to semi-dry friction in iron-graphite with pyrite occurs at loads 1.5-2 times higher than those of iron-graphite.

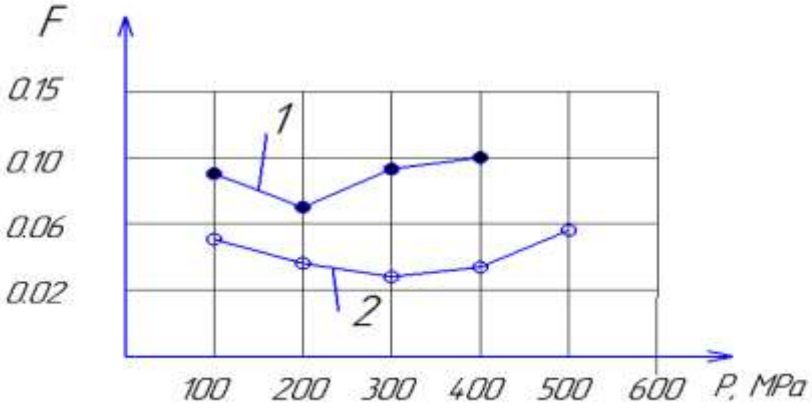

Fig.1. Change in the coefficient of friction, "F" during sliding friction of a porous antifriction alloy based on iron, without pyrite and with pyrite, depending on the load. Sliding speed 0.7 m / s.

1 – Iron-based antifriction alloy without pyrite

2 – Antifriction iron-based alloy with a pyrite content of 1%.

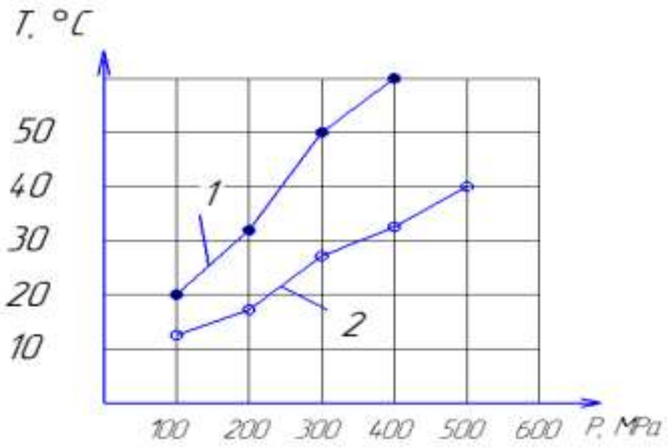

Fig.2. Temperature change during sliding friction of a porous antifriction iron-based alloy without pyrite and spirit, depending on the load.

Sliding speed - 0.7 m / s.

1 – Iron-based antifriction alloy without pyrite

2 – Antifriction iron-based alloy with a pyrite content of 1%

In order to determine the magnitude of the wear of the porous iron-based antifriction alloy with the addition of pyrite, a wear rate test was carried out.

Axleboxes made of porous iron graphite with 1% pyrite content at various loads and sliding speeds 0.3; 0.7; 1.17 m / s (Figure 3-4). Investigation of the graphs shows that the values of specific wear of samples made of iron-graphite without pyrite in all modes exceed the values of specific wear of samples made of iron-graphite with 1% pyrite additive by 1.5-2.0 times. This difference is especially pronounced at a sliding speed of 1.17 m / s, at which the samples of iron-graphite work for a short time and with great wear to determine the influence of the scale factor on the wear process, separate tests were carried out of whole iron-graphite bushings without and with a pyrite content. With sliding friction of porous iron-graphite bushings on hardened steel axle boxes, the wear value takes on a minimum value when the alloy contains 1% pyrite. This fact can be fully attributed to the anti-seize properties of sulfides in iron graphite with pyrite additives. Under sliding friction test conditions without additional lubrication, the relatively stable operation of the bushings breaks down rather quickly in an alloy without pyrite additives. This is due to the exhaustion of the possibility of working in the self-lubrication mode, when the lubricant released from the pores ends. If there are sulphides in the alloy structure, then the scuff resistance significantly increases, the operating time without scuffing increases significantly.

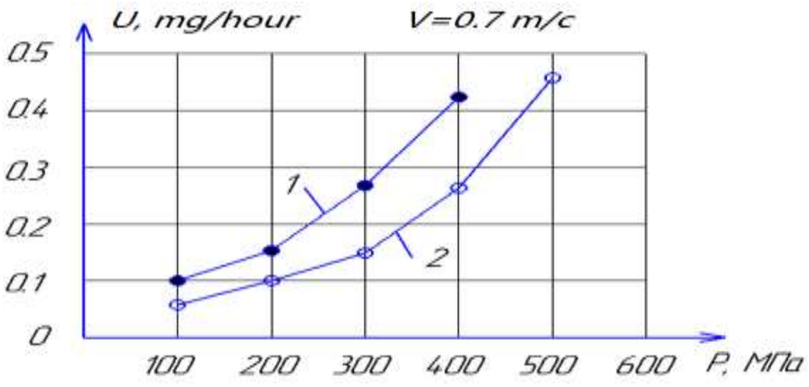

Fig.3. Influence of the load on the wear rate of the axle box made of a porous iron-based antifriction alloy. Sliding speed - 0.7 m / c.

1 - Iron based antifriction alloy without pyrite;
2 - Iron-based antifriction alloy with a pyrite content of -1%.

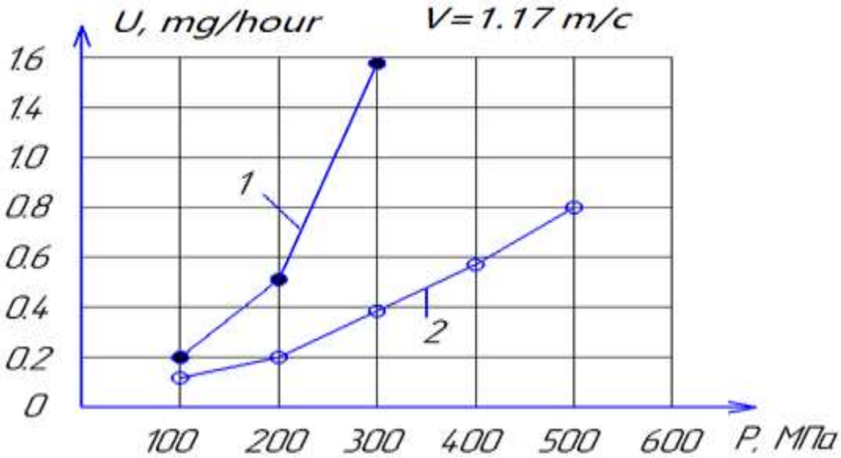

Fig.4. Influence of the load on the wear rate of the axle box made of a porous iron-based antifriction alloy. Sliding speed - 1.17 m / c.

1- antifriction, iron-based alloy without pyrite;
3 – antifriction iron-based alloy with a pyrite content of 1%.

CONCLUSION

As a result of laboratory tests for friction and wear of porous iron-graphite with 1% pyrite in the structure, when operating under lubricity conditions, in comparison with porous iron-graphite without pyrite, it was revealed:

1. The coefficient of friction, as one of the main indicators of antifriction in porous iron-graphite with pyrite inclusions under all test conditions, is 2 times lower than that of porous iron-graphite.
2. Operating temperatures of friction for iron-graphite with pyrite inclusions in all cases turned out to be lower than the operating temperatures of porous iron-graphite under similar test conditions.
3. The minimum of friction coefficients on graphite graphite graphs with pyrite inclusions is shifted towards higher loads (300-400 MPa) compared to the minimum for iron graphite (200 MPa). This suggests that the conditions of boundary friction in iron-graphite with pyrite inclusions persist up to loads 1.5-2 times higher than those of iron-graphite.
4. The wear (mg / hour) of samples made of iron-graphite with inclusions of pyrite, in comparison with the wear of iron-graphite samples when tested under the same conditions, turned out to be 1.5-2 times less.

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