concentration of WSe₂ in a composite material intended for operation in air under dry friction conditions at sliding speeds of 0.05-3.0 m/sec is 10-20 wt.%.

CONCLUSIONS

1. A study was made of the physicomechanical and antifriction properties of Fe-WSe₂ composite materials produced by hot pressing.

2. It was established that by subjecting precompacted specimens to hot pressing at 700°C it is possible to obtain material with a residual porosity of 1-3% (at WSe₂ contents ranging from 5 to 30 wt.%) and high mechanical properties.

3. The best antifriction properties in operation in air under dry friction conditions at sliding speeds of 0.05-3.0 m/sec are exhibited by composite materials containing 10-20% WSe₂.

LITERATURE CITED


EFFECT OF THE PARTICLE SIZE AND AMOUNT OF NONMETALLIC ADDITIONS ON SOME PROPERTIES OF A SINTERED BRONZE-BASE FRICTIONAL MATERIAL*

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UDC 620.178:621.894

Series-produced iron-base sintered materials (FMK-11 and MKV-50A†) are at present being successfully used in heavily stressed units in which the mating parts are made of an alloy case iron (such as ChNMKh). In moderately stressed units, however, their use causes severe wear of the mating components, which are generally made of gray cast iron.

Bronze-base materials (such as MK-5), which are widely employed in transmissions, clutches, and other devices operating with a lubricant, are incapable of securing the required value of coefficient of friction. In this connection, an investigation has been carried out at the Institute of Materials Science with the aim of formulating a tin bronze-base frictional material suitable for the dry frictional units of vehicles.

*Paper presented to the Third All-Union Seminar on Constructional Materials.
†FMK-11 is produced from a charge containing 64 Fe, 15 Cu, 9 graphite, 3 silica, 6 barium sulfate, and 3 wt.% asbestos. Other materials referred to in this article are MK-5, produced from a charge containing 66-74 Cu, 9 Pb, 9.5 Sn, 4 Fe, and 7 wt.% graphite, ChNMKh, a Ni-Mo-Cr cast iron, and SCh21-40, a gray cast iron. The composition of MKV-50A is not known — Translator.

Dry units incorporating sintered bronze-base materials already have extensive application abroad, in particular, in the United States, Britain, and Czechoslovakia [1]. The frictional materials employed in these units contain, apart from a metallic matrix (bronze), solid lubricants (graphite, lead, and certain sulfides) and refractory abrasive components (oxides, minerals, carbides, and some intermetallic compounds) designed to enhance their frictional properties. The most commonly used frictional addition is silica. Its particle size varies, according to literature data, within a wide range, from 20-40 [2-4] to 60-160 [5-8] or even 830 μ [9-11]. The preferred particle shape of the frictional additions is acute-angled [12]. This applies not only to silica but also to other substances, for example, ceramic materials [10, 11].

In the work described below a study was made of the effect of the particle size (in the range 30-100 μ) and amount of silica added to a bronze-base material on the latter's frictional characteristics. To the composite chosen for investigation, containing (in wt.%) 9 Sn, 9 Pb, 4 Fe, and 7 graphite, remainder copper, were added various amounts of silica (the α-quartz modification) of different particle sizes. Specimens for friction and wear tests were prepared from standard powders by sintering for 2 h under a pressure of 10 kg/cm² in a hydrogen atmosphere at a temperature of 700 ± 20°C. To obtain subsieve silica fractions, the powder used was fractionated by the sedimentation method. Coarse silica fractions were ground in a vibratory mill, as a result of which the particles acquired an acute-angled, almost equiaxed shape.

Preliminary tests were carried out in an MIFI-1 laboratory friction machine under conditions characteristic of the operation of the dry clutch of a heavy motorcycle and of the stopping brake of a medium-sized tractor (figures in parentheses), namely: specific work 45 (19) kg-m/cm², specific load 4 (10) kg/cm², sliding speed 12.0 (5.5) m/sec, starting temperature 100°C, and coefficient of mutual contact 0.69.

In the course of the friction and wear tests the following parameters were recorded or calculated: friction torque, axial load, sliding speed, bulk temperature of the mating part, mean and maximum coefficients of friction and their stability, and the rates of wear of the specimen and the mating part. Wear measurements were made with a micrometer at fixed points with an accuracy of ± 10 μ. Values of coefficient of friction were determined by processing plots of instantaneous friction torque.

TEST RESULTS

The results of the tests carried out in the MIFI-1 friction machine on specimens of frictional materials containing the same quantities of silica particles of different sizes in unit volumes of their matrices are given in Table 1. It will be seen that even the smallest amount of silica added to the composite material reduced its wear. With increase in particle size (at the same number of particles in unit volume of the metallic matrix) the coefficient of friction (both its mean and maximum values) increased, but the wear resistance of the material remained satisfactory. The best frictional properties and wear resistance were exhibited by material 205, containing 13.8% of silica with a particle size in the range 80-100 μ. Its coefficient of friction and wear resistance proved to be 1.5-2 times higher than those of the standard MK-5 material. Compared with FMK-11 material it was found to be four times more wear-resistant, with about the same value of coefficient of friction.

The frictional and wear properties of material 205 (FOB) were studied in tests performed in an IS-1 inertia stand by the method described in [13]. After tests on FMK-11-Sch21-40 and FOB-Sch21-40 frictional pairs conducted under the conditions of operation of planetary and stopping brakes signs of frictional abrasion were found on the surfaces of the elements. The microgeometry of the surfaces had changed, and was characterized by a Class 3 or 4 finish for the FMK-11-Sch21-40 pair and a finish of not worse than Class 6 for the FOB-Sch21-40 pair. The braking torque as a function of braking time steadily decreased for the FMK-11-Sch21-40 pair, but remained very stable over practically the whole length of the braking track for the FOB-Sch21-40 pair.

In tests simulating the operation of tractor brakes, the results of which are summarized in Table 2, the coefficient of friction of the FOB-Sch21-42 pair was found to be slightly lower than that of the FMK-11-Sch21-40 pair, but its value nevertheless lay in the prescribed range (0.30-0.35). On the other hand, the overall wear resistance of the FOB-Sch21-40 frictional pair under the conditions of operation of both the stopping and planetary brakes substantially (by a factor of 10-18) surpassed the wear resistance of the FMK-11-Sch21-40 pair. Apart from this, the stability of the coefficient of friction of the FOB-Sch21-40 pair was 10-15% greater.

In the light of the results obtained in this investigation it is clearly desirable that field tests should now be carried out on the FOB-Sch21-40 frictional pair in the transmission of the Pavlodarsk Tractor Factory's DT-75M tractor.