УДК 539.538 (045)

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METHOD OF MATERIAL RESEARCH AT LOW SPEEDS SLIDING

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There has been developed the unit which gives the possibility to carry out the tests at low speeds sliding. It is possible to test different materials in the wide range of loadings in different environments and temperatures with registration of friction coefficient.

Introduction. One of the ways of technical level increasing and increasing of quality of the machinery construction products is providing the parts of machine and assemblies of modern machinery with reliability and durability.This problem is especially actual for friction assemblies, because 80% of machine's parts, mechanisms, instruments and technological equipment break down is caused by destroying of working surfaces.

Nowadays being is being developed and exploited a huge variety of testing equipment in manufacturing, they are machines for testing the material on stretching and compression, bending, share, torsion, wear, impact, devices for determination of hardness elastic constants of materials, means for technological testing of materials, investigation of climatic factors, etc. Developing of units for carrying out the investigations of assemblies and separate parts for wear resistance gets the first-priority importance for different machines and mechanisms exploited at hard working conditions.

The important reason that should be taken into account while developing the friction machines is the economy and overall dimensions of the unit. Specimens for the friction must have as small dimensions as possible, but also be sufficient enough for necessary type of friction implemented by the unit.

During the investigations it is necessary to carry out the development of the procedures in correspondence with two requirements. On

the other hand imitation of sliding friction under the laboratory conditions must approach the conditions in the real structures. On the other hand the procedure must give the possibility to carry out the comparison with received data of other works [1].

Analysis of the investigations and published works. Recently a lot of modern literature [2–5] has been devoted to the elaboration of the test procedure for the wear resistance of different coverings and metals. Improvement of existing and developing of the new test procedures of different constructional materials for friction and wear is one of the most relevant ways of tribotechnical reliability increasing of different machines and mechanisms.

The analysis of the sources [2; 1] shows that in general there are reviewed the most widespread procedurs of tribotechnical investigations, that include the determination of the actual contact area, characteristics of friction surface microgeometry and also the structure and property at surface microvolumes of materials friction pairs. [2]. There is given information on standard test procedures often used, for friction and wear, on basic procedure plans, requirements and methods of assessment of tribotechnical characteristics and also on non-standard test procedures, their possibilities and concrete fields of use, that is often used [3].

Fretting [6] is one of the most widespread defects that appear in the aviation engineering assemblies. Damage from the fretting is met almost in any mobile or nominally immovable connection, the parts of which are under vibration or subjected to the influence of repeated and variable loadings, sufficient for the appearance of relative movements.

There are many different points of view on what produces the greatest influence on the pairs of friction or damage in the result of fretting or damage as a result of sliding friction.

Problem formulation. Development of materials and coverings test procedure in the conditions of butt sliding friction at low speeds sliding.

Test procedure. It is necessary to take into account that the wear from the sliding friction and fretting are different types of surface wear and it is necessary to make a comparison based on certain criteria. As comparative criteria the way of friction and mean speed of sliding of specimen were chosen [7].

On the base of the unit for materials testing for fretting MFK-1 the unit for material testing for sliding friction was developed. The unit

allows to carry out the comparative tests of steels, alloys, coverings, composit materials at low speeds of sliding in different liquid and gas environments at different temperatures.

The feature of the unit is the replacement of reciprocating motion of collet of MFK-1 unit in which a tested specimen is fastened on the directed rotation with the set speed.

The unit fretting tests is designed by the scheme contact of plane-plane in accordance with GOST 23.211-80. Essence of the procedure is that a cylindrical movable specimen (tested specimen) which comes into contact with a butt end with an immobile cylindrical specimen at the set pressure is set in reciprocating motion with set amplitude and frequency.

The appearance of the unit for materials testing for the sliding friction is represented on a fig.1. The unit works in the following way (fig.2): electric motor *2* transmits the rotation motion to the reduction gear box *3*. Frequency of rotation and amount of revolutions is registered by the instrument *1*. Reduction gear box *3* by means of crank *4* transmits the motion to the tested specimen *5*.The immovable specimen *6* fastened in a self-centering collet *8*, set on the movable stock shaft *9*. The loading of the specimen is carried out by a loading device *12, 13*. The value of axle loading on specimens is registered by the dynamometer of ZIP 02-79 type - DOSM-3-0,2 (GOST 2283-79) with the limits of measuring from 0,2 to 2 kN. Registration of the friction force is made by an instrument NO71.5M *11* through the amplifier 8-ANCH-7M 10 with the help of strain beam *9*.

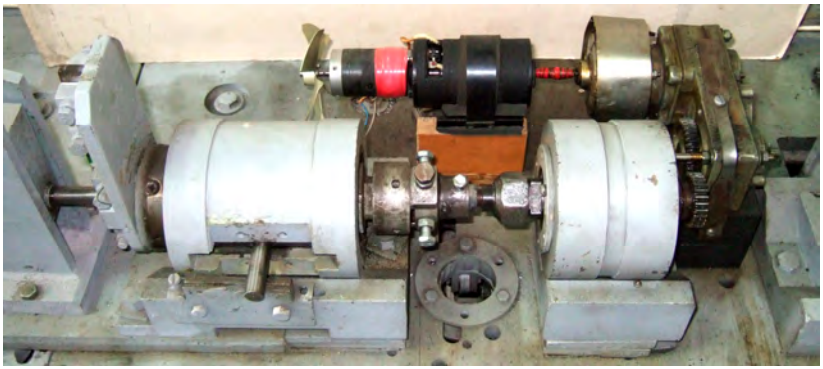


Fig. 1. The appearance of the unit for materials and coverings testing at the low speeds of sliding

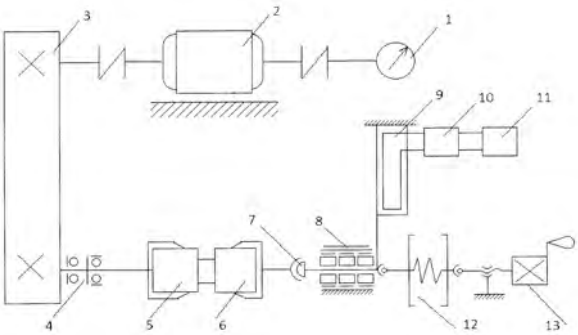
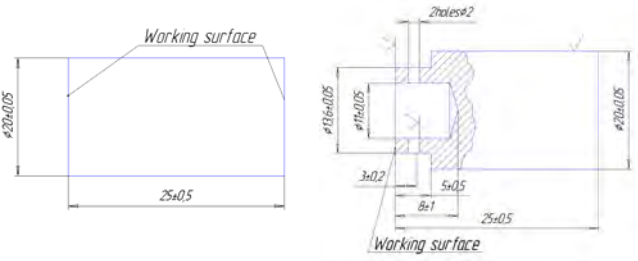


Fig. 2. Scheme of the unit for material testing at low speeds of sliding: *1* – revolution counter; *2* – electro motor; *3* – reduction gear box; *4* – crank; *5* – movable specimen; *6* – unmovable specimen; *7* – self-centering collet; *8* – movable stock; *9* – strain beam; *10* – amplifier; *11* – registration equipment; *12* – dynamometer; *13* – loading device

Large advantage of the developed unit is a complete accordance of specimens for tests on unit MFK-1 with a unit for materials testing at friction sliding. It gives a certain economic effect and adequacy of comparison of wear results from fretting with the results of wear from the sliding friction. Specimens for tests are represented on a fig. 3 and they are cylindrical rollers with the diameter of 20 mm manufactured from a necessary alloy or steel. The conjugation of the tested specimens is carried out on a surface, being the closed ring with the nominal contact area of 0,5 sm^2, internal diameter of 11 mm and external diameter of 13,6 mm.

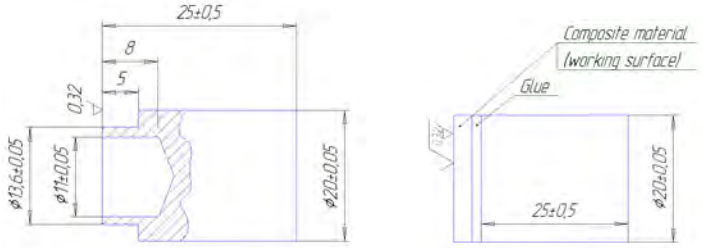


a *b*

Fig. 3. The scheme of the specimens for materials and coverings testing in liquids and gas environments: *a* – specimen, *b* – tested specimen

The presented specimens enable to carry out the experiments at different liquids and gas environments. The present openings on the

tested specimen are intended for more fast access of working environment to the internal cavity of friction specimens. During the materials and coverings testing in air without liquid and aggressive gas environments it is possible to produce specimens without openings. During the tests of composite materials it is necessary to paste the cut out by necessary form fragments of composition materials to the butt ends of specimen (fig.4). During the tests of the wearproof sheetings it is necessary on the workings surfaces of specimens and if necessary tested specimens to apply the layer of wearproof coverage.



a *b*

Fig. 4.The scheme of the specimens for composite materials testing:
a – tested specimen; *b* – specimen

For the tests of materials in different liquids and gas environments the special chambers are developed (fig. 5, fig. 6).

For the materials testing in liquid environments the special heating chamber is used, that provides the possibility of supply and withholding liquid environments in the contact area of the specimens, The scheme of the chamber for metals and coverings tests in liquid environments is represented on a fig.5.The specimens for tests *1, 2* fastened in the unit collets, set in the round openings of chamber *4*, provided with the sealing *7*, manufactured from heat-resistant rubber. The leakage of working environment from a chamber is prevented with a help of sealing regulators *6*.

The control of the temperature of working environment is provided by a thermocouple and pointer of temperature *9* with accuracy ±2 C, working range of temperatures of chamber 0…200 C. The set temperature of tests is achieved with the help of a heating element *5* and temperature regulator *10*.

A chamber allows to carry out the experiments in oils and plastic greasings at the temperature from 0 to 200 degrees. Heating is carried

out by the increase of tension on latra *10* and heating of nichrome coil *5*. The control of temperature of the liquid environment is carried out through the temperature sensor *8* and milliammeter *9*. The impermeability of the chamber internal cavity is carried out with the help of two rubber temperature and oil resistant sealings *8*.

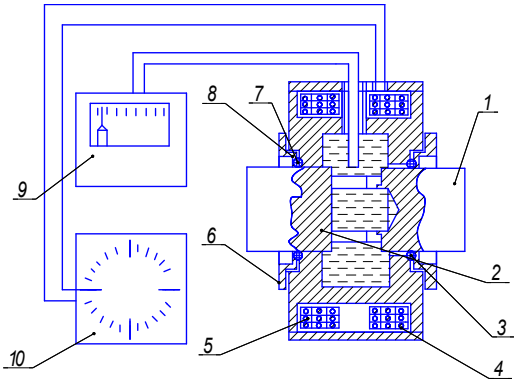


Fig. 5. The chamber for the materials and coverings testing in different liquid environments and temperatures: *1, 2* – tested specimens; *3* – lubricating materials; *4* – frame of the chamber; *5* – heating element; *6* – sealing regulator; *7* – sealing; *8* – thermocouple; *9* – pointer of temperature of liquid environment; *10* – temperature regulator

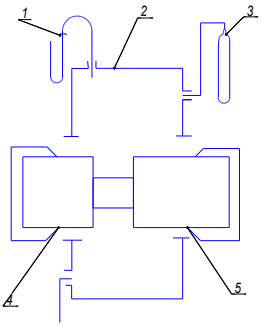


Fig. 6. The chamber for the materials and coverings testing in different gas environments: *1* – manometer; *2* – chamber; *3* – vessel with gas; *4, 5* – tested specimens

The scheme of materials testing in different gas environments is presented on a fig.6. A chamber is put on the specimen *2*, through which the gas is skipped. The surplus pressure of gas in a chamber is con-

trolled by an aquatic manometer *1*. During carrying out of the experiments a gas chamber must be cleaned from air by blowing off by the tested gas, equal to 15-20 volumes of chamber, that provides its complete cleaning. The chamber allows to carry out the experiments in the environment of nitrogen at negative temperatures to -50 degrees.

Measurings of specimens wear can be carried out with the help of profilograph-profilometer by the removal of profilogram of 8 equidistant areas of specimen working surface in radial direction concordantly to GOST 23.211-80 fig.7.

We determine wear of specimen h_j by the formula:

$$h_i = \frac{\sum_{1}^{8} h_i}{8}.$$

where: h_i is the distance of friction path on the profilogram between the middle lines of profile of initial and working surface concordantly to GOST 2789-73.

Important advantage of wear determination by the linear method is that the size of wear does not depend on a specific weight of material and possible changes of mass of specimens.

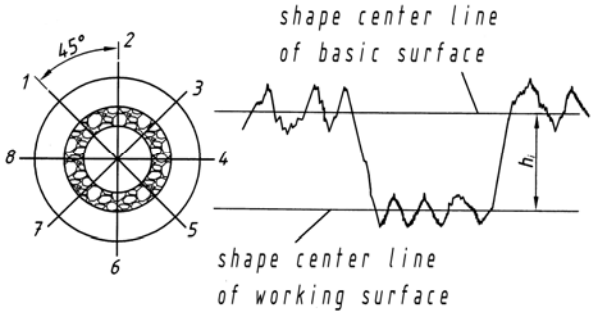


Fig. 7. Scheme of specimens wear determination

Thus, the unique unit for materials wear resistance testing at the friction of sliding is developed. The unit enables to carry out the comparative tests of friction of sliding and fretting of steels, alloys, coverings and composite materials in different liquid and gas environment. Using the standard specimens for fretting - GOST 23.211-80 the unit allows to provide tests in the range of loading from 1 to 40 MPa and in the wide range of sliding speeds.

Conclusions:

1. There is the possibility of carrying out of comparative tests between fretting and sliding friction at the use of identical ways of friction, speed of sliding and specific pressure.

2. The unit for testing of materials for sliding friction at low speeds of sliding in different liquid and gas environments is developed.

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УДК 539.538 (045)

Хімко А.М., Краля В.О., Якобчук О.Є., Бородій В.М. **Методика досліджень матеріалів при низьких швидкостях ковзання** // Проблеми тертя та зношування: Наук.-техн. зб. – К.: Вид-во НАУ «НАУ-друк», 2009. – Вип. 52. – С.45–52.

Розроблено установку, що дозволяє проводити випробування за малих швидкостей ковзання, випробовувати різні матеріали в широкому діапазоні навантажень у різних середовищах за температур з реєстрацією коефіцієнта тертя.

Рис.7., літ.: 7 найм.

Стаття надійшла до редакції 16.10.09.