STUDY REGARDING THE FRICTION INSIDE THE BUSHINGS

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Abstract: *Knowing the frection parameters represents an essential issue regarding the tribological research of the bushings, because the frection always appears in the moment when there is a relative motion between the surfaces that are in contact. The present paper reveals the main theoretical aspects of the frection inside the bushings.*

Key words: *bushings, the friction, the friction coupling, the friction coefficient.*

1. INTRODUCTION

In the process of functioning of a bushing the friction produces prejudices and that is why it should be restricted. The friction consumes energy, reduces the output and produces wear, leading to the quick deterioration of the mechanical systems. The energy used within the friction is being dissipated under the form of heat at the level of the friction coupling and also in the environment. Thus we must take in consideration both during the state of designing as well as in that of exploiting the bushings, so as for the energy losses resulted from the friction to be minimal, in order to ensure the highest production conditions.

The friction appears in the absence of the lubricant (dry friction) or in the partial or complete presence of it (limited, mix, elastohydrodynamic, hydrodynamic or hydrostatic friction etc.) [1, 3].

The friction phenomenon is characterized by a multitude of parameters.

Among of which, a very important one is *the friction coefficient*. The friction coefficient μ is being determined with the help of the relation (01):

$$\mu = \frac{F_f}{N} \qquad (1)$$

F_f is the friction force;

N is the normal reaction force.

The friction coefficient depends upon: the materials used for the semi coupling, the rugosity of the surfaces, the greasing conditions, the direction and the way of processing the surfaces in contact, the relative sliding velocity, the temperature etc.

The friction coefficient might be: a static friction coefficient μ_s, a dynamic friction coefficient μ_c.

The static friction coefficient appears at the border between motion and rest, so it appears at the starting point.

The dynamic or kinetic friction coefficient shows a particular importance, especially in the case of friction coupling at which the starting and the stops are quite frequent.

Because of the multitude of factors that interfere in the friction process, the calculus relations, in order to determine the friction coefficients are very complex and difficult to solve.

For this reason it is important to determine the friction coefficient on an experimental way but with a great precision.

In this way, there have been conceived, deigned and produced several gadgets, with the help of which we can determine, with great precision the friction coefficient, both for the dry friction as well as in the presence of some lubricants, for any type of material pairs.

The effective measuring precision of the friction coefficients has three decimal fractions; we also mention that in the specific technical literature these coefficients are given generally speaking, with a precision of one or two decimal fractions.

2. THE FRICTION WITHIN THE BUSHINGS

2.1. GENERAL DATA

The friction is a complex process that has a molecular, mechanical and energetically nature that appears between the surfaces of the two bodies found in contact during a relative motion.

The friction is being characterized by the friction force that has an opposite direction to the motion.

The friction requires a certain waste of energy that dissipates itself under the form of heat, at the level of the friction coupling and also in the environment.

Thus, tribology indicates the solution that must be taken in consideration both in the designing stage as well as in the stage of exploitation of the gadgets, as for the energy losses to be minimal when aiming for a high reliability.

The friction reduces the output, increases the wear and leads to a rapid deterioration of the mechanical systems.

The study of the friction phenomena has two purposes: to establish the materials, the greasing and working conditions that can ensure minimal friction losses, to calculate the forces and the moments developed by the interactions as a consequence of the friction process; all these, together with the normal interact ional forces, form the basic elements involved in the dynamical analysis of the already studied mechanical systems.

2.2. THE FRICTION COUPLINGS

The friction coupling is an assembly made out of two or several bodies in contact, having a relative sliding, rolling, swiveling motion or certain combinations of the ones mentioned above [1, 3, 4].

The friction coupling has the purpose of transmitting the motion, the friction or the moment that started with the engine element to the leading one. The transmission of the energy flow is being made through the help of the friction surfaces. Regarding things from this point of view, if we have references to the interaction between the surfaces, we are facing a tribological system.

Contrary to the theory of mechanics, that divides the kinematical couplings into five classes according to the number of limited freedom degrees. In tribology the classification is being made taking in consideration the type of contacts and the number of apparent or nominal contacts.

2.3. THE DRY FRICTION

The dry friction is being characterized by the direct contact of the surfaces in a relative motion. Between these surfaces there is no lubricant.

Practically speaking, such a situation is rarely met because of the friction coupling surfaces there are usually oxides, reaction products, water under the form of small drops, oil molecules coming from the handling and cleaning of the pieces, dust particles and all sorts of impurities.

The experimental research has been made on couplings without introducing lubricant between them. The way in which the bushings behaved during this type of friction has been thoroughly studied.

Thus, when not introducing lubricant (be it liquid, solid or gaseous) between the friction coupling and the friction itself, we can easily witness the friction in a natural environment (in the presence of air) the dry friction becomes *technical*. This term is being used in order to make the distinction from the dry theoretical friction that can be obtained in a lab, in vacuum or in a protected environment.

2.4. THEORIES REGARDING THE DRY FRICTION

Several statements have been made regarding the nature of the dry friction [1, 3]. From this point forward we will briefly present the modern theories that concern the dry friction.

a) The mechanical theory: the friction force is the result of the use of energy that is imposed by the climbing of the microroughnesses (see figure 1 and calculate it with the relation 2):

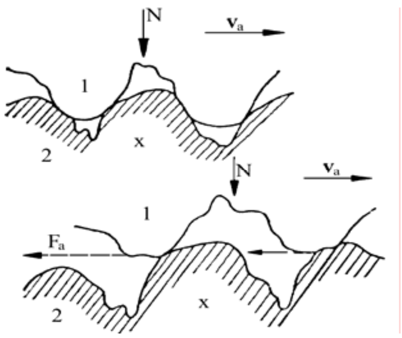

Fig. 1 The endurance in sliding F_a when climbing the rugosity

$$F = \sum_{i=1}^{n} f_i \tag{2}$$

b) The molecular adhesion theory: at the level of roughnesses in contact there is a molecular interaction that opposes to the relative motion (see figure 2):

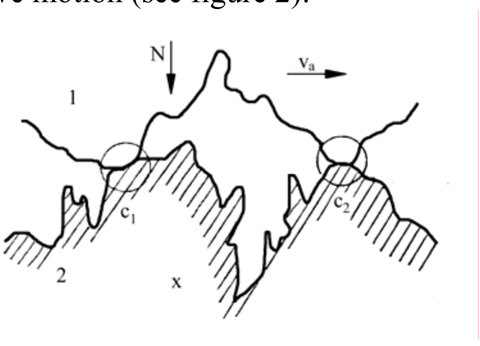

Fig. 2 The sliding resistance caused by the molecular adhesion (C_1, C_2, … , C_n)

The friction force is being calculated with the help of the relation no. 03:

$$F = \sum_{i=1}^{n} C_i \tag{3}$$

The adhesion of the roughnesses does not depend upon the rugosity, but upon the nature of the materials and upon the pressure of contact. The friction is smaller when the metallic surfaces are covered with fine layers of oxides. The total friction force equals the sum of the elementary forces that defeat the molecular bonds established between the bodies found in a sliding contact.

c) The microjonction theory: in the process of sliding, the vertexes of the roughnesses are bonding, and for the relative motion to continue, the breaking of the microjonctions is required (see figure 3).

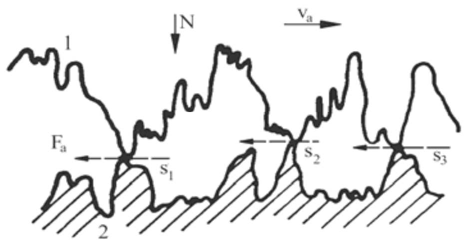

Fig. 3 The advancing endurance F_a resulted from the blending of the micro welding (S_1, S_2, …, S_n)

The total force equals the sum of the elementary breaking forces of the micro weldings, accordingly to the relation no. 04:

$$F = \sum_{i=1}^{n} S_i \tag{4}$$

d) The elastical and plastical deformations: the friction force is determined by the energy used in order to deform elastically and plastically, the roughnesses found in contact. The deformation under the action of the tangent and normal forces takes place both in height as well as in the direction they move in order to contribute to the growth of the real contact extent (se figures 4 and 5).

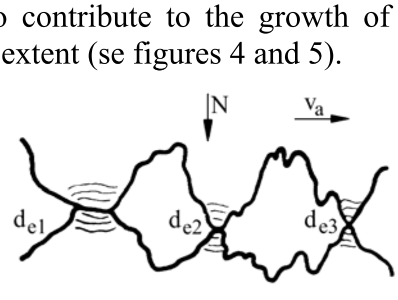

Fig. 4 The energy used within the elastic deformation (d_{e1}, d_{e2}, … , d_{en})

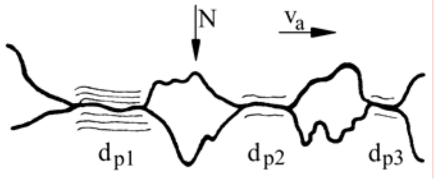

Fig. 5. The energy used within the plastic deformation (d_{p1}, d_{p2}, …, d_{pn})

e) The cuantic theory: in the friction process, the energy is being transfered from one surface to the other through the help of energetic cuants, that also produce a material transfer, but also one of wearout (see figure 6).

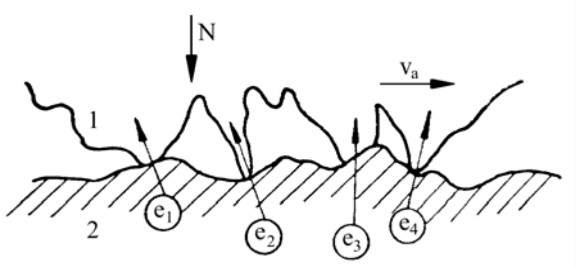

Fig. 6 The passing of the energetical cuants (e_1, e_2,…, e_n) from surface no.2 to surface no.1

f) The electrostatic theory: the friction force is determined by the apparition of a difference in electric potential between the surfaces found in motion, caused by the reciprocal transfer of electrical charge (see figure 7).

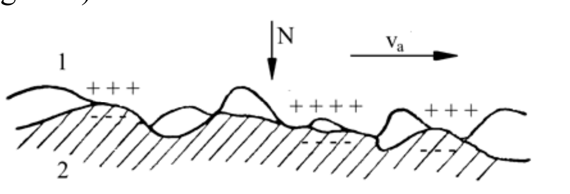

Fig. 7 The formation of electrostatic potential zones

Every theory taken aside does not completely characterize the friction force. The local conditions of contact, the nature of the materials, the velocity of motion, the local temperature, the material transfer from one surface to the other etc., directly modify the scale of the friction force. In the situations created, we can accept that the friction is the result of the action of several processes, one of them being predominant.

The research made both theoretically and experimentally have shown that the friction is accompanied by different other phenomena: heating, wear out, use etc. and for a thoroughly evaluation of the friction coefficients there have to be mentioned new theories that are regarding: the temperature, the real interaction of the surfaces, the molecular absorption, the distortion of the materials in contact etc.

3. CONCLUSIONS

From the fact presented above there can be drawn a series of conclusions.

The friction force depends upon a complex of factors: the normal charge, the sliding velocity, the type of contact, the quality and the rugosity of the surface, the type of materials in contact, the rigid or the elastic character of the surfaces, the superficial temperature and also the presence of some particles on the friction surface (lubricant, impurities etc.).

The friction coefficient, just like the friction force, is influenced by several factors, one of the most important being the state of the surfaces (the micro geometry and the physio-chemical properties of the superficial layers) [2, 3].

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