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MODERN RESEARCH REGARDING THE SOFT MATERIAL OF STUFFING BOX PACKINGS-TRIBOLOGICAL BEHAVIOUR

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S u m m a r y
The work comprises some experimental results obtained through the research of the materials utilized to the construction of the tightening. Here are presented the research methods for the determination of the work's parameters in various simulated regimes and the equipment used for this purpose. There are also given indications regarding to the relationships between the principal parameters by work, presented through diagrams and conclusions.

Keywords: *tightening materials, wear, functional performances*

1. GENERALS

The stuffing box packing used for shafts belong to the classical types of tightening which, even at the present time, still one widely used in many branches of economy.

These tightening raise important problems from the tribological point of view. Compared to other types of tightening for machine parts in motion, the stuffing box packing undergo a relatively strong straining at the contact surface between the shaft and gasket. In these conditions high value friction forces appear, which lead, on one hand, to energy by friction.

It seems obvious from what has been said above that in the case of tightening with gaskets of soft materials the problems of tribological aspects of their working should be studied very closely.

This requires the performing of minute research of these aspects taking into consideration all the functional parameters. This work also becomes a problem of optimization of the work of the tightening as, from the tribological point of view, aiming at diminishing of friction results in the decrease of the contact pressure between the shaft and the gasket which leads to the loosening of the tightening and fluid leakage.

The rate of wear of the tightening with soft gaskets for shafts and especially the problem of friction and wear of the tightening gasket in the context of the variation of the different functional parameters were studied in detail in another work [5].

Concerning the aspects of the friction and wear process, separately presented in the papers [2], [3] and [4], the present work aims at the synthetic presentation of these aspects in the context of their correlation with the process of ensuring the tightening.

In the literature on the subject [1] one can find only rare specific reference to the friction and wear processes of the tightening with soft gaskets on which the respective problems cannot be analyzed.

This reason, as well as the problem of energy consumption by friction, generated the idea of a thorough research, with strong experimental bases, of the friction and wear processes in the case of soft tightening for shafts.

2. RESEARCH METHODS

In the frames of the general methodology of the research of the effectiveness and rate of wear of the stuffing box packings elaborated by the author in [5] the research method, mainly of the friction and wear process, is based on repeated tests in similar conditions of certain types of gaskets made of soft materials, the cycles being resumed with changes of some functional parameters. In this way, one can examine the influence of each parameter on the respective processes.

Out of the examined materials most widely used for gaskets, asbestos cord impregnated with Teflon or P.T.E.F. (noted in the paper with A.T.) and asbestos cord impregnated with graphite (noted in the paper with A.G.) should be taken into consideration.

The tests were performed on an installation capable of stimulating all the exploitation conditions of a tightening with gaskets of soft materials.

Figure 1 represents the block diagram of the "Installation for tribological tests". The installation is all-original and this is patented as invention in Romania.

The installation is made up of a shaft 2, supported up the rolling bearing 1 and up this can be mounted a busting by variable diameter which is the shaft of tightening. A hydraulic force group G.F.H. through the moment transducer T.C., and move in the sleeve 5 which materialized the tightening box actuates this.

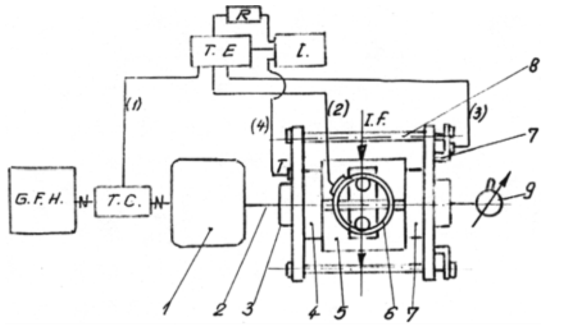

Fig. 1

This sleeve is sectioned up longitudinal direction, on a part is articulated and on opposed part is mounted the dynamometer 6 for measuring of the radial pressure between the gasket, shaft and tightening box. In the sleeve is mounted the ring of gasket, which is pressed by two steadies 4, through three rods 8. The axial force is measured by tensometric methods through elastic consoles 7.

The following parameters can be measured:

- the friction force between the shaft and gasket with the transducer T.C. by the tensometric methods;
- the axial tightening force with the elastic consoles by the tensometric methods;
- the radial tightening pressure between the gasket and shaft with dynamometer ring by the tensometric methods;
- the temperature in the neighborhood of the shaft-gasket contact by termocouple inserted in the gasket near the contact zone;
- the rotation of the shaft with the tacho-meter 9.

Through introduction of the semnals of the friction force and of the radial pressure from the tensometer in the logical by the ratio element can be determined the friction coefficient.

As in its real functioning a tightening gasket can work in various friction regimes, three were established and realized on the simulator:

A - friction regime with dry gasket;

B - friction regime with gasket with exterior lubrication in the absence of the work fluid;

C - friction regime with gasket and work under atmospheric pressure.

By means of the electronic tensometer connected to a slow recorder one can obtain simultaneously the diagrams of the variation in time of the friction force, the axial tightening force and the temperature of the contact.

For the wear and durability tests the gaskets were used till the total loss of their elastic qualities i.e. till they could no more ensure the tightening, irrespectively of the tightening force.

In order to illustrate the connection between the friction process of ensuring the tightening and also the tightening gasket the author defined in [5] and [6] the non-dimensional term "tightening capacity":

$$C_e = P_f / P_a \qquad (1)$$

which represents the ratio between the pressure of the tightened fluid and the axial tightening pressure in the condition of a null leakage flow by tightening.

It was experimentally established that the tightening capacity decreases with time, because of the loss of the properties of the gasket material to transmit the axial force on the transversal direction. This process is characteristic for the visco-elastic materials and takes place because of some physico-chemical and mechanical agents.

In this respect it becomes interesting to analyze whether this process of losing the tightening capacity is due only to the continuous exterior straining or whether the friction process influences it, too.

3. EXPERIMENTAL RESULTS

Through the research is had in view the following objectives:

- the influence of the materials of the gasket and of the shaft and the roughness of surface of the shaft on the friction force;

- the influence of the various parameters (the couple by materials, the temperature of the contact shaft-gasket, the regime of friction) on the coefficient of friction.

The established of these influences have in view the realization of the best. regime by work with the minimum friction and the maximum tightening.

By the statistical interpretation of the experimental data obtained for the illustration of the variation in time of the friction force. Figure 2 presents the variation diagram of the friction force in certain specific conditions.

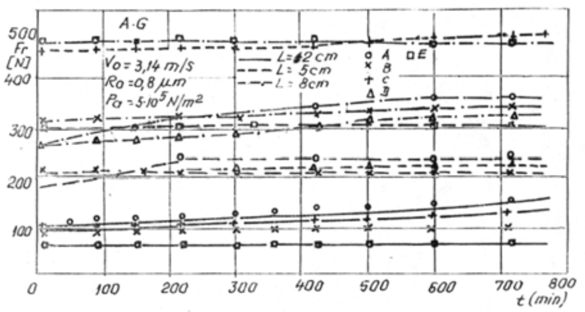

Fig. 2

After starting when the friction force has its value 1.5 i.e. two times than that of regime, the value of the friction force remains approximately constant, then it has a tendency of increasing. The time after which the increase begins tightening. The most favorable case, from this point of view, is the C-regime in which the tendencies of increase are the least.

An interesting fact is that with the increase of the length of the tightening the working force increases more at the lubricated gasket than at the dry one. This may be explained thus. Because of the lubricated gasket, the friction between the walls and the gasket being smaller, the transmission of the force on axial direction is better accomplished and the resultant of the radial pressure of tightening being higher.

The length of the tightening acts in the sense of increasing the friction force as, together with the increase of the tightening length also increases the resultant of the radial pressure of tightening which, at the coefficient of friction, makes the friction force increase. The values of the variations, as well as the form of the curves, depend on the friction regime, the most favorable being the one with gasket lubricated from the exterior.

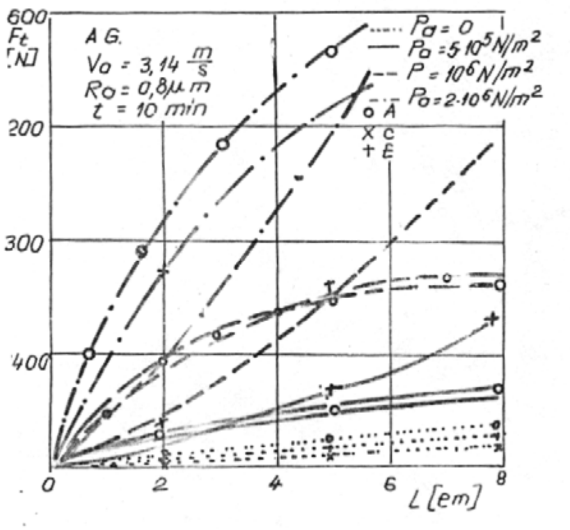

Fig. 3

The variation of the axial pressure is directly proportional to the variation of the friction force. From Figure 4 results a linear dependence of the friction force on the axial pressure, the slope of the straight lines increasing together with the tightening length and also depending on the friction regime.

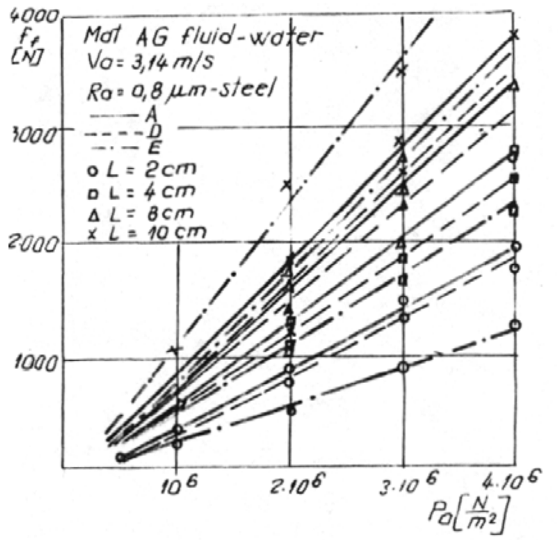

Fig. 4

The friction force also presents important variation with the material and the roughness of the shaft. From Figure 5 result non-linear increases of the friction force with the roughness of the friction force values also depending on its material and on the friction regime. Thus, in the case of the shaft of cast iron and especially with low roughness (below R_a= 1,6 m), the value of the friction force is half of the value for steel in the same conditions.

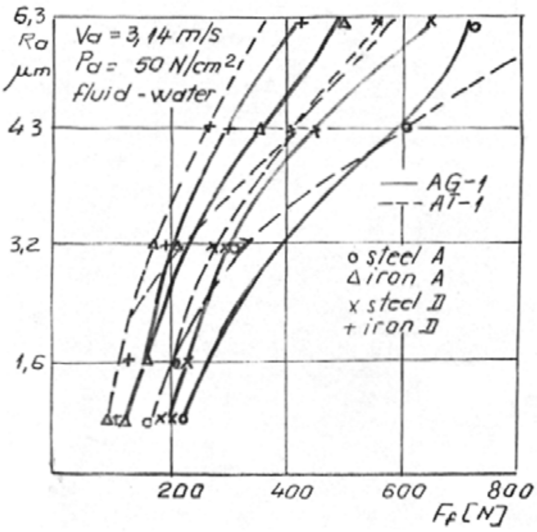

Fig. 5

By examining the dependence of the friction coefficient on the temperature of the shaft-gasket contact, one notices that in some termal areas depending on the material of the gasket, the coefficient rises with a certain value after which it fixes at a value (Figure 6). It is very important to establish the areas of the stabilization of the friction coefficient, this being one of the criteria of choosing the materials according to the regime of work. The material and the roughness of the shaft are determinant agents of the variation of the friction coefficient for all friction regimes. In the diagrams of Figure 7 one can clearly notice a substantial rise of the coefficient μ with the roughness of the shaft and distinct differences of values in the case of the shaft made of cast iron compared to the shaft made of steel. Hence, other criteria of choosing the shaft-gasket couple of materials result.

Directly connected with the friction process is the wear process of the elements of the tightening. In the paper [6] are presented some specific aspects of the wear met in the case of the tightening with soft gaskets. The wear of a gasket of soft materials is a complex process in which are at work on one hand, the reducing and consequently, the loss of the tightening capacity on the other hand, the abrasive wear.

It was experimentally found out that in time, the tightening capacity undergoes a process of continuous decreasing till a certain moment when the gasket can no longer perform its task of tightening.

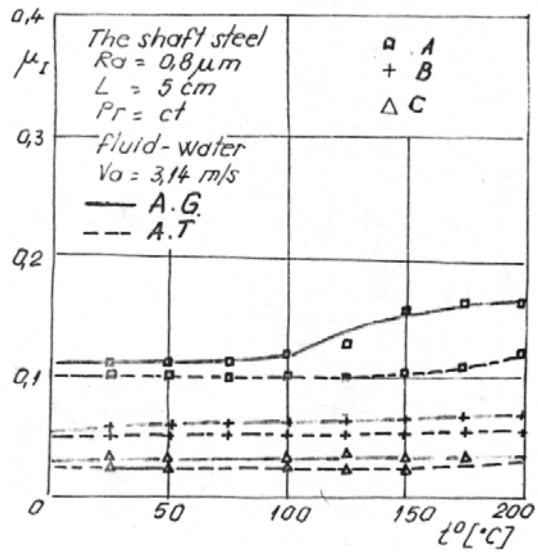

Fig. 6

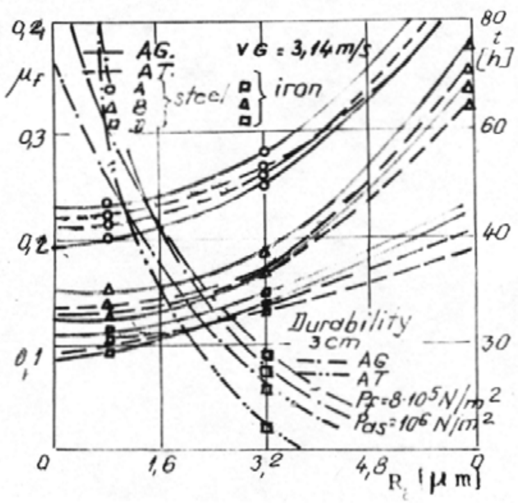

Fig. 7

4. CONCLUSIONS

The friction force generated at the contact between the shaft and the gasket increases proportionally to the length of the tightening, the increase of the exterior axial pressure and the increase of the fluid pressure between certain limits. Also, one may observe important variations of the friction force depending on the shaft-gasket couple of materials, the roughness of the shaft, as well as the friction regime in which the tightening acts.

Essential variations of the friction force with the gliding speed do not occur.

The friction force in the context of its connection with the tightening capacity and with other functional parameters represents the main subject of the studies of the optimization of the work of the tightening with soft gasket.

The coefficient of friction between the shaft and the gasket does not present considerable variations with the tightening length and radial pressure. Its values depend mainly on the materials of the shaft-gasket couple, the state of the shaft surface, the friction regime and the contact temperature.

The wear of the gasket made of a soft material is a complex process at the basis of which lies the modification of some physical properties of the material as well as the removing of particles from the contact surface.

5. REFERENCES:

[1] Falticeanu Constantin: Contributions to the Study of Efficiency of Seals Dynamic Contact, Doctorate Paper, Iasi, 1978

[2] Falticeanu Constantin: The Research of Friction Process of Stuffing Box Packings Obtained on the Tribological Tester, Bulletin "Tribotehnique '82", Ploiesti, 1982

[3] Falticeanu Constantin: Experimental Results of the Research of Friction and Wear Processes of Stuffing Box Packing for Tightening of Shafts, Bulletin "Eurotrib '81", Warsawa, 1981

[4] Falticeanu Constantin: The Conclusion on the Friction and Wear Processes of the Stuffing Box Packings, Bulletin University Dunarea de Jos, Galati, 1993

[5] Falticeanu Constantin: The Tribology of Tightenings with Soft Gasket for Shafts, Bulletin "Yarofri - 94", Yaroslav, 1994

[6] Falticeanu Constantin: Tribological Research of the Soft Materials Utilized to the Constuction of the Tightening, Bulletin of the 5th International Conference of Material Science, Iasi, 1998