CRANKSHAFT AND PLAIN BEARINGS PHENOMENON OF FRICTION

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Annotation:

The article discusses the smallest reduction in friction loss in the smallest value of the coefficient of friction between the crankshaft and plain bearings. Contacting surfaces different influence of friction state plain bearings between the bushing they are dry, semi-dry, liquid and semi-liquid and the significance of the coefficient of friction. Including the state plain bearings between the bushing temperature influence on friction especially on semi-dry and semi-liquid state. How to avoid seizure, rubbing surfaces how much not to exceed the coefficient of friction.

Keywords: Temperature, crankshaft, plain bearing, friction coefficient, wear, seizure, heat, oil layer.

КОЛЕНЧАТЫХ ВАЛОВ И ПОДШИПНИКОВ СКОЛЬЖЕНИЯ ЯВЛЕНИЕ ТРЕНИЯ

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Аннотация:

В статье рассматривается наименьшие уменьшение потери на трение в наименьшую величину коэффициента трения между коленчатого вала и подшипники скольжением. Соприкасающимися поверхностям разные влияние трения состояния подшипники скольжении между втулкой они являются сухое, полусухое, жидкостное и полужидкостные и значимость коэффициент трении. В том числе состояния подшипники скольжении между втулкой температура влияние на трение особенно на полусухое и полужидкостное состояние. Как избежать заедания, трущихся поверхностей насколько не превышать коэффициент трении.

Ключевые слова: Температура, коленчатый вал, подшипник скольжения, коэффициент трения, износ, заедание, тепла, масляной слой.

Introduction. The possibility of liquid lubrication formation in friction units was proved and explained by the famous Russian scientist N. P. Petrov. Professor N. P. Petrov proved that oil layers have different speeds. Later, the hydrodynamic theory of lubrication was not only confirmed, but also developed by the works of N. E. Zhukovsky, S. A. Chaplygin, O. Reynolds, A. Sommerfeld, N. I. Mertsalov, A. K. Dyachkov and others.

The operation of a bearing is accompanied by the release of heat as a result of friction between the bushing and the part rotating in it. Useful work is expended to overcome friction, which, in turn, is a product of human muscular energy, the thermal energy of an engine or electric motor, etc., and is applied to one of the bearing components to set it in rotation. Therefore, friction is a harmful phenomenon for bearings not only because it requires energy, but also because it is the cause of wear of the rubbing parts.[1]

The main reason for wear of plain bearings of crankshafts is accompanied by heat release as a result of friction arising between plain bearings and crankshaft. Design is necessary to think over and provide the best operation of the bearing without excessive friction losses and with the smallest possible wear, but still concerns affect friction.[2]

Study. It is always useful and beneficial to reduce friction in bearings.

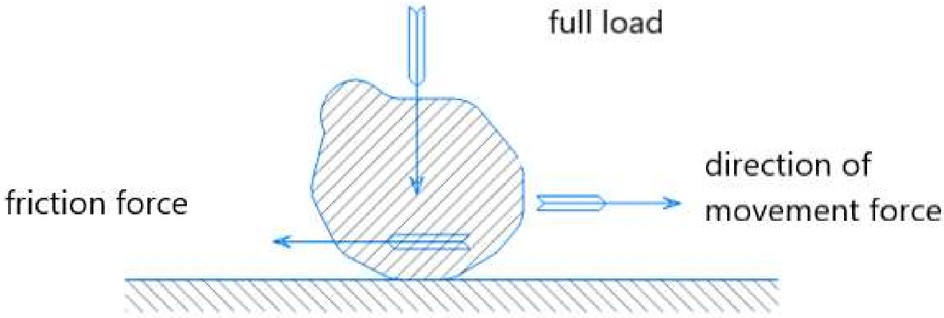

Fig. 1.1 Payload and friction force

Friction losses are taken into account by the friction coefficient, which is equal to the ratio of the force of resistance to movement (friction force) to the applied load (Fig. 1.1).

To obtain the lowest friction losses, it is necessary to achieve the lowest value of the friction coefficient. Rubbing surfaces are never completely smooth; each of them always has, even if very small, protrusions and depressions. They are shown in a greatly enlarged form in Fig. 1.2

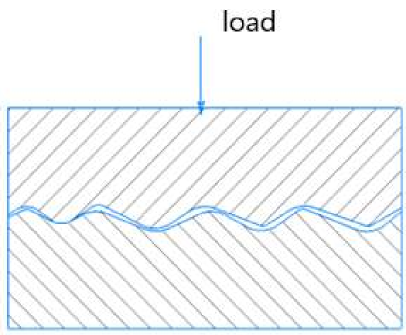

Fig. 1.2 Scheme of transfer of friction forces load

When two mating surfaces are stationary and one of them is pressed against the other, the projections of one enter the depressions of the other. A kind of engagement of the surfaces is obtained. To start the movement of one surface on the other, it is necessary either to cut off the projections that have entered the depressions, or to squeeze them out of the depressions (elastically deform). To do this, it is necessary to apply a certain force to one of the mating bodies. That is why when starting from a place, it is always necessary to apply a force greater than when moving.

If there is no lubrication between the contacting surfaces in the form of lubricating oil, moisture or other friction-reducing film, then the friction is called dry. Dry friction is characterized by the highest coefficient of friction. If there is a partial layer of lubricating oil, moisture or other liquid between the contacting surfaces, but mainly there is direct contact of the material of the rubbing bodies, then the friction is called semi-dry. Note that dry friction can only be obtained artificially, by special cleaning of the rubbing surfaces; in practice, even in the absence of lubrication, the rubbing surfaces are covered with at least a layer of moisture deposited from the atmosphere. And in a modern car - a layer of oil deposited from oil vapors evaporated from adjacent, lubricated parts of the car.Most dry materials have coefficient of friction valuesfrom 0.3 to 0.6Values outside this range are rarer and may have a coefficient as low as 0.04. A value of zero would mean no friction, an unobservable property.

The coefficient of semi-dry friction is if between the contacting surfaces there is mainly a layer of lubricant and only partial direct contact of the material of the rubbing bodies (without separation by a layer of lubricant), then such friction is called semi-liquid.Semi-dry friction occurs in non-steady-state operating conditions, as well as with very poor lubrication. Friction coefficient for semi-dry and dry friction0.1-0.5.

The coefficient of semi-liquid friction is less than that of semi-dry friction. Some machine parts operate under semi-liquid friction conditions, and most parts operate under semi-liquid friction conditions when starting up. If there is a layer of lubricant over the entire surface between the contacting surfaces, completely separating them from each other, then such friction is called liquid. Liquid friction is the best for the operation of machine parts. The change in friction coefficients along with the change in friction conditions is easily explained. Thus, oil in the cavities of rubbing bodies prevents the free placement of protrusions in them. Therefore, the resistance to squeezing out protrusions from the cavities decreases with semi-dry and then semi-liquid friction and disappears altogether if friction becomes liquid.Semi-fluid friction.Most plain bearings operate under semi-fluid friction conditions, in which most of the surface is separated by a layer of lubricant, but individual elements of the surface are in contact. The coefficient of friction is 0.008-0.08.

Temperature has a very great influence on friction in general and especially on semi-dry and semi-liquid friction. If a completely freely entering shaft is inserted into a bushing, given a corresponding load and set in rotation, then at first the shaft will rotate relatively freely in the bushing. Then, as the temperature increases, from the heat released during friction, the temperature of the friction surfaces will increase faster and faster, the resistance to rotation will begin to increase. Finally, it will become so significant that in order to remove the shaft from the bushing, into which it entered freely during installation, it will be necessary to use a puller, i.e. to squeeze the shaft out of the bushing with great force. This phenomenon is called seizing or welding, because on the squeezed out shaft one can often see particles of the bushing, tightly adhered and attached to its surface, as if welded to it. The same can be seen on the bushing, to the surface of which particles of the shaft are welded, as it were.

To avoid seizure, it is necessary to ensure sufficient heat dissipation from the rubbing surfaces and eliminate the possibility of direct contact (without an oil layer) of most of the rubbing surfaces.

With liquid friction, all the projections of both rubbing surfaces are separated by a layer of oil, therefore, there can be no wear of the rubbing surfaces, and the friction coefficient is the lowest. Therefore, the area of liquid friction is the most advantageous for the operation of the bearing.Liquid frictionis provided if the lubricating fluid completely separates the rubbing surfaces, i.e. the friction between solids is replaced by friction between particles (molecules) of the liquid. Liquid friction is most favorable for the operation of the rubbing pair, since it reduces the power consumption to overcome friction by 10-15 times, wear and heating of parts are sharply reduced, the friction unit can withstand higher loads. The operation of the friction unit, and, consequently, the machine as a whole, becomes not only longer, but also more reliable. Therefore, when designing and creating machines, as well as during their operation, it is necessary to strive to ensure the liquid mode of operation of the rubbing pair.[3]

In liquid friction, the entire load from one rubbing surface to another is transferred through the oil layer, i.e. without direct contact of metal with metal. For this, the oil layer must be able to fully bear the applied useful load. To achieve such operation of the bearing, it is necessary to know the laws of formation of the bearing capacity of the oil layer.

For fatigue failure to occur in a high-strength material without wear or seizure, the hydrodynamic characteristics (clearance, lubricant viscosity and very low surface roughness) must beensure a sufficient minimum thickness of the lubricating film to prevent metal-to-metal contact.

Conclusion. The phenomenon of the listed friction coefficients: dry, semi-dry, semi-liquid and liquid friction, the phenomenon of seizure:

- the coefficient of semi-dry friction is less than dry frictioncoefficient of frictionfrom 0.3 to 0.6 andwith semi-dry friction0.1-0.5;

- friction coefficient 0.008-0.08;

- To avoid seizing, it is necessary to ensure sufficient heat dissipation from the rubbing surfaces and eliminate the possibility of direct contact (without an oil layer) of most of the rubbing surfaces.

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