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SOME TRIBOLOGICAL ASPECTS OF CONSTRUCTION MACHINES AND EQUIPMENT

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ABSTRACT

Maintenance is perhaps the most important factor in ensuring the resistance of construction equipment. Greasing construction equipment is an essential stage in keeping equipment in optimal operating condition and extending its lifespan. This process involves applying a specialized lubricant to critical components of the equipment. Ignoring this important task can lead to premature wear of key components, equipment damage, and loss of productivity. Important lubrication points are those that require special attention, as they are the most exposed to wear and damage. These include contact areas between components, as well as areas where there is constant movement or friction. The paper presents some tribological aspects of construction equipment.

KEYWORDS: tribology, wear, frictional torques, tribosystem lubrication of construction machines

1. INTRODUCTION

Since Tribology is the science of interactions, it is important to study the main aspects related to the geometric interactions of the links between the elements of a mechanical system. In this sense, the interaction becomes frictional torque and the geometric, kinematic and dynamic parameters govern the nature of the tribological processes - friction, wear and lubrication - in correlation with the lubricant and the materials of the elements in contact.

Friction and wear at the interactions level are in correlation, on the one hand, with the kinematic and dynamic parameters at the interactions level and, on the other hand, with the presence of the lubricant, of abrasive particles, as well as with the characteristics of resistance of the surfaces of the elements in contact.

Lubrication or greasing processes, with beneficial effects on friction and wear are in correlation with kinematic and dynamic parameters on the one hand and on the other hand, they are limited by temperature, environmental conditions and degree of contamination.

The complex inter-conditioning processes in the field of tribology impose that the design of friction torques requires optimization problems with the simultaneous achievement of some minimum friction, with minimum wear and acceptable lubricant thicknesses, so that the reliability of each torque leads to high reliability for the whole mechanical system.

The vast majority of breakdowns in mechanical systems are based on damage to the links (frictional torques), damage that comes from ignorance of the tribological processes that take place, from the use of incompatible pairs of materials, from the use of lubricants inadequate for the operating conditions, from non-observance of the periodicity of lubrication, etc.

At the same time, at the level of industrial-type systems, where dozens or hundreds of mechanical equipment operate simultaneously, Tribology tries to get involved, prophylactically, by developing computer assistance programs for all processes of lubrication, repairs, revisions, controls, so as to avoid accidental shutdowns of machines - in fact one of the main levers of increasing the productivity of industrial activities.

Currently, all countries with a developed economy have achieved powerful laboratories in the tribological field, specialized in tribological issues and whose role is to investigate tribological phenomena in mechanical torques. There are laboratories specialized in the study of tribological phenomena, such as the study phenomena from fluid lubrication, the study of dry friction phenomena, the

study of the wear phenomenon, as well as laboratories specialized in study of the behavior of lubricants, the study of lubrication at high pressures, the study of friction and lubrication in aerospace conditions, etc.

The diversity of mechanisms, component parts of various machines and equipment, led to the appearance and study of a very large number of friction torques. Frictional torques are defined as assemblies of two or more bodies in contact subject to a relative movement of sliding, rolling, pivoting or a combination of them. Frictional torques are of particular importance in the evolution of tribological phenomena.

The multitude of friction torques determined their classification based on the type of contacts and their number. According to this classification, friction torques are divided into four classes [1], [2], [3]:
- Class I - superior torques with point contact;
- Class II - superior torques with linear contact;
- Class III - inferior torques with contact on the cylindrical and spherical surface;
- Class IV - inferior torques with contact on the flat surface.

2. TRIBOLOGICAL GENERALITIES REGARDING CONSTRUCTION MACHINERY

Economic development involves, among other things, the realization of an important volume of construction activities, which is why the process of modernizing the existing park of such products as well as the development of research for the creation of new machines and equipment is happening simultaneously with the improvement of construction technologies. It is a continuous and permanent process.

The following fundamental principles are considered in this activity:
- increasing labor productivity;
- consumptions reduction;
- raising the level of performance;
- increasing safety in operation;
- increasing the degree of technicality and automation;
- improvement of ergonomic parameters.

To achieve the desired objectives are used modern calculation and design methods regarding component tribosystems.

An important moment in the evolution of construction machinery was the introduction and development of hydraulic drives which offer compared to classic mechanical transmissions, a number of advantages including:
- simplification of actuation schemes simultaneously with the reduction of weight and dimensions construction of machinery;
- the possibility adjustment without speeds step and the realization simple of changing the direction of rotation or moving;
- convenient possibilities for handling work equipment, convenient location of control elements;
- the development of large or very large forces or moments with the help of rotary or rectilinear hydraulic motors with very small dimensions compared to the elements used in electrical or mechanical drives, etc.

Each construction machine, regardless of the specificity of the works performed, is characterized by the defining functions, understanding by these functions, the technical availability deliberately created, to realize certain phases within a technological process. The means and procedures for performing the functions are directly influenced by the principles and methods of taking energy from the source, by the intermediate transformations to which it is finally transferred to the active organ of the machine or to machine, in other words these functions are performed through connections of tribosystems specific.

In principle, the basic scheme of a construction machine is structured as in fig. 1, in which:
1 - energy source;
2 - the system transmission of energy capable of modeling energy parameters;
3 - the working organ;
4 - the adjustment and control system which in some cases is also provided with a reverse connection 4.1;
5 - resistance structure.

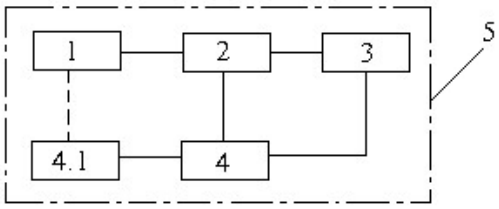

Figure 1 Scheme of a construction machine

Except for the resistance structure, all other components can be considered tribosystems with different complexities.

In general, the operating cycle of construction machines contains acceleration, braking, reversing moving and stopping phases thus subjecting the component elements to variable loads that can cause both accidental failures and failures due to wear.

3. TRIBOLOGICAL ASPECTS RELATED TO THE LUBRICATION OF CONSTRUCTION MACHINES

As previously shown, a construction machine is composed of a number of main components of which only the resistance structure cannot be categorized as a tribosystem. In general, the rest of the sub-assemblies are fixed on this structure, rigidly,

between them and the chassis, no kinematic torques are formed.

The rest of the components within the machine assembly can be considered tribosystems. The designer has the obligation to provide and recommend, in the equipment documentation, the tribological aspects related to the field of exploitation [1].

The designer has to know from the beginning the type of the friction torque, which of the surfaces is permanently loaded and which is only periodically, the types of wear specific to the machine and its operating conditions.

It is necessary that the design and operation proceed in such a way that seizure does not occur and wear is minimal; generally, these effects are obtained by interposing a sufficiently thick lubricant film and by using surfaces with reduced but optimal roughness. To reduce the friction, when it is possible, the sliding friction is replaced with the rolling friction.

Reduction of heating and losses of power can be obtained by using air as a lubricant. The designer must not lose sight of the interaction of the parameters and the thermal effects which, for example in bearings, internal combustion engines, etc. acquires an important weight. At the same time, a selective effect must be taken into account due to the varied working conditions of the same type of machine organ used in different industries.

In operation and maintenance, a permanent concern is required, on a scientific basis, regarding the stress of the machine, the improvement of lubrication, the management of lubricants and the rigorous analysis of possible defects.

It imposed the development of technical and technological solutions through new tribological research and, at the same time, a permanent concern regarding the training of specialized personnel at different levels. The most important aspects followed in the tribological research are: obtaining optimal tribological conditions in the operation of machine parts, especially regarding the choice of materials, t he choice of lubricant and the organization of greasing and combating wear.

The tribological aspects related to the execution part of the machine or equipment are taken into account by the designer during the elaboration of the execution documentation and are usually in accordance with the recommendations in the specialized literature.

These aspects are not specific to the machine itself, being general problems, they will not be treated as such than where a certain tribosystem is specific. It is about the tribological aspects regarding:

- dimensioning;
- the choice of materials torques;
- thermal and thermochemical treatments;
- processing precision and surface quality;
- general prescriptions for assembly.

The simplest kinematic torques used in construction machinery are of the planar joint type and they are component elements of tribosystems that are generally called work equipment. These torques are part of class III according to the adopted classification. For these torques lubrication systems and indications are prescribed regarding the periodicity of lubrication and the type of lubricant used. Lubrication must be ensured daily given the fact that these torques are not provided with protection systems against the penetration of water, air and impurities from the atmosphere. For lubrication, individual lubrication systems are provided for small machines and centralized lubrication systems for big ones, to which access is more difficult. For all cases, it is used as a lubricant, the grease lubrication being a boundary lubrication.

In most cases at construction machinery, the actuation of the equipment is made by linear hydrostatic motors - hydraulic cylinders. Their assembly within the kinematic torques is realized by spatial, spherical joints, for which are provided the same lubrication conditions as for the planar joints presented previously.

In the vast majority of construction machines, they are hydrostatically or hydrodynamically actuated and have mechanical tribosystems as the final element in the kinematic chains. These tribosystems are generally made up of gear reducers, gear boxes, drive axles which usually includes many types of kinematic torques. These tribosystems include kinematic torques of all kinematic classes, of which I consider that the most important ones to be those of class I: a varied range of bearings and of class II, also a varied range of gear transmissions. These being tribosystems for general use, there is no detail of the kinematic torques used.

The important problem which needs to be solved for these cases is the choice of the lubrication system and a lubricant which will give satisfaction for all the classes of torques used.

In the technical books of these machines, indications are given regarding the periodicity of changing lubricants and the types of recommended lubricants. When establishing the periodicity, it is taken into account that not all of these tribosystems have a continuous operation during the operation of the machine [1].

Another category of tribosystems widespread at construction machinery is represented by the hydraulic apparatus: hydraulic motor, rotating hydraulic fittings, remote control distributor, hydraulic distributor and pump with axial pistons. These include kinematic torques of the most diverse types that can be classified according to the accepted classifications by the specialized literature. The problem that arises in this case is that of the lubrication of the tribosystem. This, in all cases, is centralized by means through a hydraulic agent which has very good lubricating properties.

In the lubrication schemes are provided recommendations both regarding the periodicity of the oil change and regarding the types of oils. Mainly, the difference between these oils and those that are mainly used for lubrication only is the low level of foaming hydrostatic installations that do not allow operation with foaming oils.

It is worth noting an aspect, frequently encountered especially in the case of construction machinery, which cannot be treated as a kinematic torque, but which forms a tribosystem with serious implications on this machinery. It is the case for construction machinery such as excavators, loaders, crushers whose basic function is to act on soil. The interaction between the working body of these machines and the soil can be considered a very important frictional torque, this assembly can be defined as a tribosystem. In the case of crushers, the crushing chamber is protected against wear by armor. These armors are made of manganese steel resistant to abrasion wear.

4. CONCLUSION

Lubricants prevent or reduce wear and corrosion of moving parts by eliminating friction and reducing operating temperatures. Wear is one of the costliest problems faced by machine operators and can lead to longer downtime and significant maintenance costs.

If key components of a machine are not properly lubricated, they can suffer irreparable damage. In addition to wear and corrosion, inadequate friction can lead to overheating of components and, ultimately, their failure. All of this can lead to additional costs through the need to replace or repair components. In addition, a machine or equipment that is not operating at its maximum capacity can affect the products or services offered, leading to delays in product delivery and increased customer dissatisfaction.

Therefore, greasing of the machines is crucial to extending longevity and increasing its performance.

The tribological instructions regarding the normal operation of a construction machine are summarized in the technical book of the machine drawn up by the designer and made available to the user.

The designer draws up a so-called lubrication scheme in which, for each of the important tribosystems, he recommends the periodicity of the lubrication as well as the quality of the recommended lubricant.

Since there is no express recommendation on how to write lubrication instructions, each designer has dealt with the problem based on his own experience.

It should be noted that for the indicated products, the recommendations made in the technical books regarding the quality of lubricants are consistent with the recommendations formulated by the manufacturer of the petroleum products through the product catalog.

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