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RESEARCH REGARDING THE IMPROVEMENTS OF TRIBOLOGICAL BEHAVIOR AT THREE CONE BITS BEARINGS

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Abstract: *Sliding bearings at three cone bits are lubricated in heavy conditions. To improve tribological behavior were made samples of bearings materials with implants with antifriction materials with different rapport between implant and free base material in the presence of different greases. Antifriction material has a grater dilatation coefficient than base material. If the implant dimension is too small, the solid lubricant capability to cover the base material does not assure a proper friction coefficient. If the implant dimension is too grate the external load could not be supported. On Amsler A135 were establish the proper implant rapport, measuring friction coefficient and wear. Was also established the behavior of the greases containing P.T.F.E. In a second phase of the tests was designed and realized a device for testing three cone bits bearings at real axial loads. With SPIDER 8 device and inductive traducers we establish the friction coefficients and the temperature at friction surface depending on implants dimensions and grease lubricant type.*

Keywords: *three cone bits bearings, friction coefficient, temperature*

1. INTRODUCTION

In hydrocarbons, but not only, wells, a great importance has drilling bits. This complex device works at great deep supporting loads, especially at fast drilling, grater than 300 kN and speed over 500 r.p.m., [1]. At drill bit active surfaces we have abrasive, erosive, corrosive, adhesive and impact wear at variable loads. These working heavy conditions are rarely meet in surface industry, so construction, materials and technology used at drill bits manufacturing have to solve many problems.

In order to improve durability at drill bits, paper present the results and the solutions to raise the durability at three cone bits sliding bearings. In Figure 1 we could see that sliding bearings 5 and *6* is close of sealing *3*. It's very important that lubricant to not be contaminated with drilling fluid. Because properties of rubber used at sealing are maintained till 80^0C the temperature in sliding bearings must not exceed this temperature.

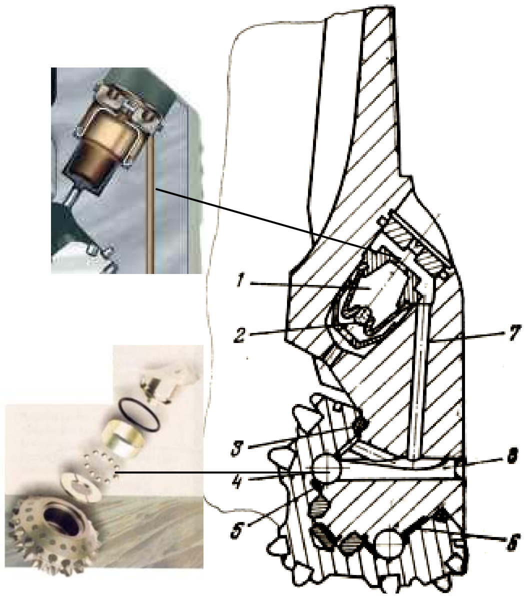

Figure 1. Sealing and lubrication of bearings

To diminish friction coefficient are used copper implants, [2,3]. Loading capacity of sliding bearings depends of surface cover capacity of copper implants. Grease lubricant type is also important above wear and friction behavior. In this order this work establish the proper implant rapport and the behavior of a new lubricant grease above wear, friction coefficient and temperature at three cone bits sliding bearings.

2. EXPERIMENTS

On universal testing machine type Amsler A135 were establish the speed and grease influence, measuring friction coefficient, wear and temperature. Was also established the behavior of the greases containing P.T.F.E. In a second phase of the tests was designed and realized a device for testing three cone bits bearings at real axial loads. With SPIDER 8 device and inductive traducers we establish the friction coefficients and the temperature at friction surface depending on implants dimensions and grease lubricant type.

2.1. Experiments on Amsler machine

The samples presented in Figure 2, [4,5] were made of:

-shoe material 20MoCrNi06 (0,17...0,23%C, 0,60...0,90%Mn, 0,20...0,35%Si, 0,35...0,65%Cr, 0,35...0,76%Ni, 0,20...0,30%Mo, S and P max.0.025%, Cu max. 0.3%) with implants of copper;

-cylinder surface layer of METCO Stellite 20.

On shoe surface were made implants of copper as is presented in Figure 3, [3].

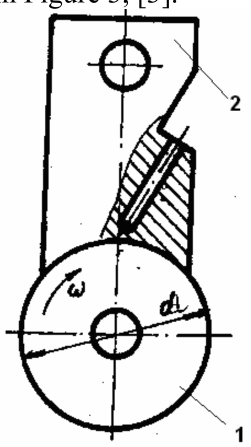

Figure 2. Amsler samples
1-cylinder (d_i=30; 40; 60 mm); 2-shoe

Temperature was measured with a thermocouple type J and a multimeter type APPA 306. The thermocouple was inserted in the shoe sample close to the friction surface (Fig.2).

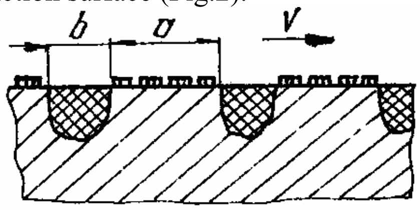

Figure 3. Implants on shoe surface

The testing conditions were:

- normal load 1250 N at wear tests;
- cylinder rotation speed 200 r.p.m;
- lubricant: classical grease;
  new grease with P.T.F.E.

In Figure 4 are presented the results for friction coefficients.

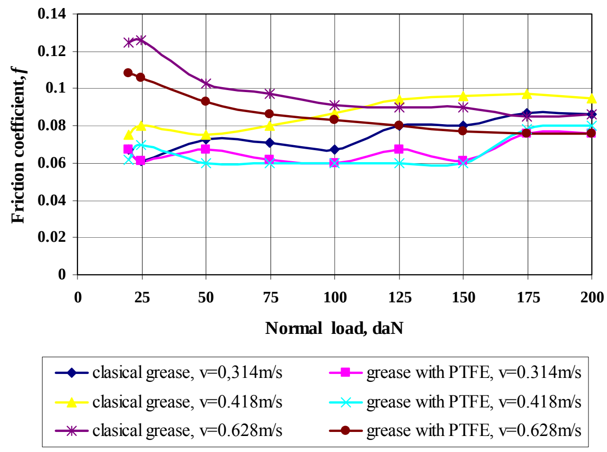

Figure 4. Friction coefficient vs. normal load

The cylinder samples diameters were 30 mm, 40 mm and 60 mm. The capability of shoe copper implants to cover the cylinder surface is maximum at the minimum tested diameter. As it is shown in Fig.4 the friction coefficients are smaller at 0.314 m/s (diameter 30 mm) and in the presence of new grease with P.T.F.E.

Figure 5 represents the gravimetric wear curves at sliding speed of 0.418 m/s.

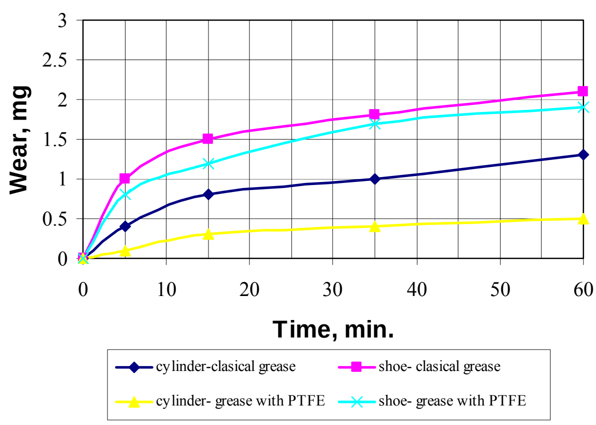

Figure 5. Wear curves at sliding speed of 0.418 m/s

Similar wear curves were obtained at 0.314 m/s and 0.628 m/s. The wear values are smaller at minimum sliding speed (friction length is smaller) and in the presence with new lubricant grease.

In Table 1 are presented the temperature results.

Table 1. Temperature results on Amsler shoe sample

Sliding speed, v_a, m/s	Lubricant	Time, min.	Temperature, ^0C
0.314	Clasical grease	60	82
	Grease with PTFE		76
0.418	Clasical grease		84
	Grease with PTFE		81
0.628	Clasical grease		88
	Grease with PTFE		83

From the values presented in Tab. 1 it could be observed that temperatures were smaller in the presence of new grease with P.T.F.E. powder. Because the lubrication was realised manual, in an open system, the obtained temperature values were rather over the recommended values.

2.2. Experiments on a device for testing three cone bits bearings at real axial loads

Plan axial sliding bearing has the purpose to support the entire axial load which action on cone during the drilling.

In Figure 6 is represented the construction of the axial sliding bearing and in Figure 7 the relative position of the copper implants depending on the zone covered with stellite, [2,3].

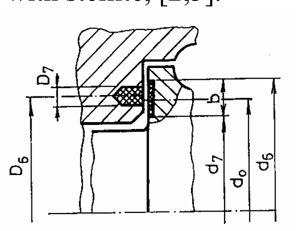

Figure 6. Construction of axial sliding bearing

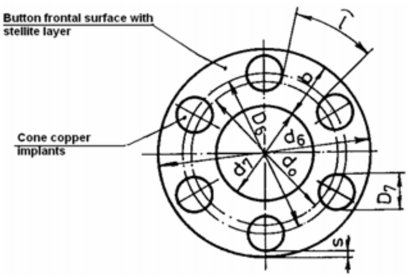

Figure 7. Relative position of implants

Taking account that:

n represents the implant number;

l- distance between two implants;

$K = \frac{l}{D_7}$ the covering coefficient.

In Table 2 are presented the dimensions for axial sliding bearing drill bit type S– 8 ⅜ GJ.

Table 2. Dimensions of axial sliding bearing

Type and drill dimension	d_6 mm	d_7 mm	b mm	d_0 mm	D_6 mm
S – 8 ⅜ GJ	50	35	7.5	42.5	45
	D_7 mm	n implants	l mm	K -	s mm
	5	6	18.55	3.71	0

To evaluate the friction coefficient and temperature was designed and realised a device as shown in Figure 8, [2].

Figure 8. Device for testing three cone bits axial sliding bearings

Axial load and friction torque are measured using two strain gauges and a strain traducer type SPIDER 8 and Catman Easy soft program. Temperature was measured with a J type thermocouple. Figure 9 shows the samples dimensions, [2].

Were tested samples with 6, 8 and 12 copper implants at an axial load of 5000 N and rotation speed of 120 r.p.m. in the presence of classical grease and new grease with P.T.F.E.

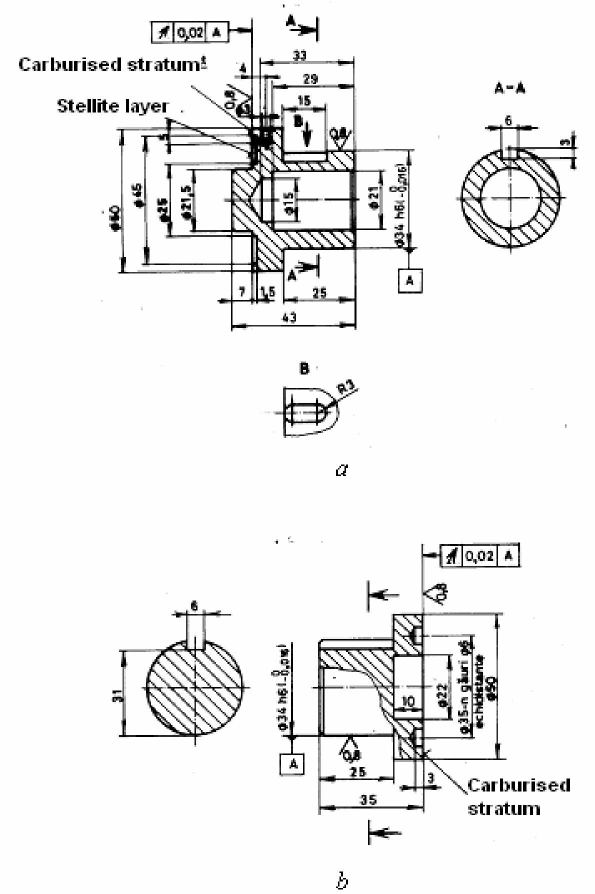

Figure 9. Samples dimensions:
a – fixed sample button type with stellite layer;
b – mobile sample type con with implants.

In Figure 10 is represented the friction coefficients results at couple button with stellite layer and cone carburized and with 8 copper implants in the presence of grease with P.T.F.E. and in Figure 11 was used the classical drill bit grease.

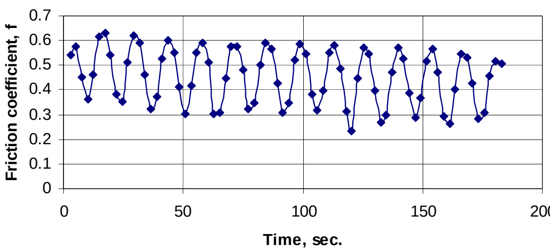

Figure 10. Friction coefficient at couple materials with 8 copper implants and grease with P.T.F.E.

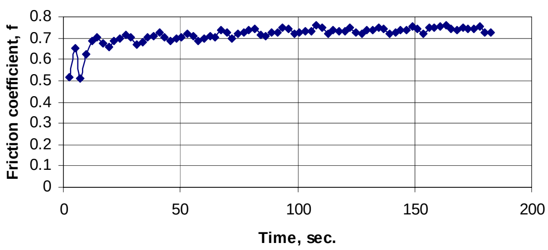

Figure 11. Friction coefficient at couple materials with 8 copper implants and classical drill bit grease

In Figure 12 it is shown the temperature variation at couple button with stellite layer and cone carburized and with 8 copper implants in the presence of grease with P.T.F.E. and in Figure 13 the medium was classical drill bit grease.

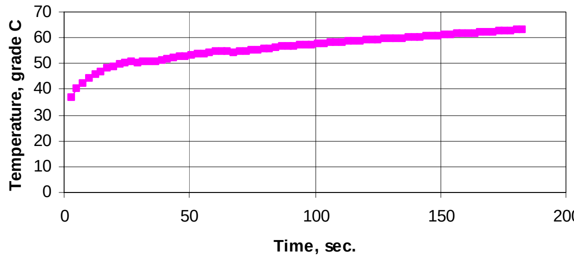

Figure 12. Temperature variation at couple materials with 8 copper implants and grease with P.T.F.E.

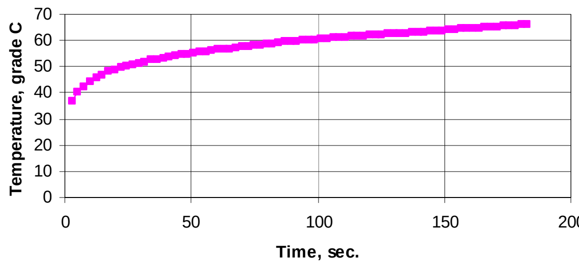

Figure 13. Temperature variation at couple materials with 8 copper implants and classical drill bit grease

Similar results were obtained at different tests conditions and are presented in Table 3.

Table 3. Friction coefficients and temperature results

Materials couple	Lubricant	Friction coefficient	Temperature
Carburized stratum/ Stellite layer	Classical grease	1.30	80
	Grease with P.T.F.E.	0.87	70
Carburized stratum with 6 implants/ Stellite layer	Classical grease	0.90	67
	Grease with P.T.F.E.	0.82 – 0.87	63
Carburized stratum with 8 implants/ Stellite layer	Classical grease	0.75	66
	Grease with P.T.F.E.	0.3 – 0.6	62
Carburized stratum with 12 implants/ Stellite layer	Classical grease	0.55 – 0.80	74
	Grease with P.T.F.E.	0.75	70

3. CONCLUSIONS

Main conclusions resulted after the tests are:

- using P.T.F.E. powder in the actual drill grease to obtain a new grease the friction coefficient and temperature at the friction surface were reduced;
- in the presence of actual drill grease the friction coefficient rise;
- in the presence of drill grease with P.T.F.E. the friction coefficient decrease with a tendency to stabilize at a smaller value than at the friction starting;
- temperature rise with a smaller gradient in the presence of drill grease with P.T.F.E.;
- copper implants on frontal carburised surface of axial sliding bearing diminish friction coefficient and temperature;
- at drill bit 8 3/8 GJ for the three types of implants number, the best solution was with 8 copper implants when were obtained the smallest values for friction coefficient and temperature;
- friction coefficient at drill grease with P.T.F.E. powder has important variation due to forming and disbonding the Teflon layer.

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