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TESTS OF MEDIUM-TEMPERATURE GREASE "NATOL-P-1" ON ROLLER-FRICTION TEST MACHINE

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ABSTRACT

The tests of medium-temperature consistent grease "NATOL-P-1" on the advanced roller friction test machine SMC-2 showed a high efficiency of this grease at high specific loads, which allows to use it in the sheet metal production. It is pointed out by results of the industrial tests on the metallurgical enterprises of Ukraine and Russia.

Keywords: grease, medium-temperature consistent grease "NATOL-P-1", roller friction test machine SMC-2

1. INTRODUCTION

Ther antiwear properties of greases are measured with the help of the four-ball machine of friction under a friction unit load of 40 kg-f. However, the specific load (pressure) during the experiment, which usually lasts for 1 hour, changing in a very wide range due to the fact that the contact area as wear increases many times. Most often, the spot diameter of the wear at the end of the test is 0.3-0.6 mm. As the 3 balls are fixed, the total area (for example, when the wear spot diameter is 0.5 mm) is 0.196 $mm^2 \cdot 3 = 0.588$ mm^2. The specific load (the pressure) is 3330 kg-f/cm^2. Whereas the initial-time loading is about 30570 kg-f/cm^2. In our opinion, these non-stationarity conditions in the load unit distort the data on the wear and tear. It is more corectly to determine the wear of the stationary unit load.

2. EXPERIMENTAL INVESTIGATION

The stationary loads may be provided using the roller-friction test machines. We used a modernized and computerized roller-friction test machine SMC-2. The use of computer and the stepper motor allow to set and maintain a specific load, during the entire experiment, to determine the coefficient of friction, the wear and tear of the friction surfaces, the points of friction (scoring), the noise in the friction zone in different frequency bands, the temperature in the contact area. The upgraded machine can automatically control the friction force loading, may set the trip distance of the friction pairs (the length of support track of the friction pairs), may set and adjust the temperature mode of the lubricant, may fix a given time for the cycles.

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The machine is equipped with an electronical-mechanical protection of the loading drive of the friction unit. The control unit is equipped with a diagnostic mode control of all sensors. The data obtained in the friction machine is electronically stored and it may be used for further statistical processing.

In the roller-friction test machine SMC-2, there are several friction modes under schemes:

- roller-roller (rolling friction),
- roller-roller with 10% slippage (a friction characteristic of the rolling bearings),
- roller-roller with 30% slippage (a friction characteristic of the rolling bearings),
- roller-chock (sliding friction).

For larger bearings used in the rolling equipment of metallurgical production, the most appropriate treatment for friction testing of greases is the scheme roller-roller with 10% slippage.

For this equipment, we have developed a medium-temperature grease "NATOL-P-1", working in the high-loaded rolling friction units, at temperatures up to 200-250°C and under difficult (severe) conditions, including water and scale intrusion into the friction units. This grease can be used instead of the grease grade "Shell Albida HD2" of the company «Shell», especially designed for such friction units.

The grease grade “NATOL-P-1” may be putted or pumped. It is very resistant to leaching with hot water.

The composition of grease grade "NATOL-P-1" is (wt%):

– Litol-24	– 81.5
– polyisobutylene (P-10)	– 2.0
– industrial oil (I-20A)	– 4.0
– molybdenum disulfide (Tech Fine Crade-200)	– 3.0
– graphite (brand P)	– 6.0
– aerosil (brand AM-1-300)	– 0.5
– special sulfur-phosphorus additive	– 3.0

The grease grade “NATOL-P-1” is a medium- and high-temperature grease. We have developed this grease with the use of special sulphur-phosphorus antiwear, antiseizure and anticorrosive additives [1–8].

We have carried out the comparative tests of grease grade “NATOL-P-1”, manufactured by Scientific-Production Enterprise “NATOL” (Moscow, Russia, Reutov) (www.natol-oil.ru) and grease grade “Shell Albida HD2” of the company Shell, at three specific loads: 200 kg/cm^2, 400 kg/cm^2 and 600 kg/cm^2 (20 MPa, 40 MPa and 60 MPa, respectively). The loads of 400 kg/cm^2 and 600 kg/cm^2 correspond to the time-dependent impact loads in rolling bearings of the rolling mill.

The tests were carried out under the scheme roller-roller with a 10% slippage. The diameters of both rolls were 45 mm. The material of roller tested was steel 45, the hardness HRC was 62÷64, the width was 10 mm. The material of the roller-rider was hardened steel 45, hardness HRC was 51÷52, the width – 12 mm, the grease temperature was 100°C. The roughness of the rubbing surfaces was R_a=1.25 μm (∇7). The load on the friction unit was applied by the stepper motor and set by the computer. The load on friction unit was 17.7 kg-f, 71.0 kg-f, and 159 kg-f (in the four-ball machine, the friction load was 40 kg-f) that corresponded to the unit load in the contact zone (the radial normal contact stress in the middle line of the two rollers, $\sigma_{pressure}$) of 200 kg/cm^2, 400 kg/cm^2 and 600 kg/cm^2.

After 50 000 revolutions of the test roller, measured by the revolution counter (the run through the wearing surface was 7065 m), the measurement of wear was made by weighing the test rollers after the thorough cleaning in white spirit, then in toluene or in solvent N647 and subsequently drying for 5 minutes at 250°C in a drying box SNOL 67/350 “Termolab” (TU U 31.6-30676394.001-2002). The samples weighting was carried

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out on an analytical damper balance VLR-200, 2nd class, GOST-19491-74 with an accuracy of 0.05 mg (error Δ0.075 mg).

The tests of grease "NATOL-P-1" were carried out in comparison to the grease grade "Shell Albida HD2" used in the high-loaded friction units.

For each experiment, we performed three measurements and got the average result. The test results are shown in Table 1 and Figure 1.

Table 1. The results of comparative tests

№	Grease	The wear load on the friction unit, kg-f/ wear unit load in the contact zone (contact stress) kg-f/sm^2		
		17.7/3010	71.0/6032	159/9029
1	NATOL-P-1	4.2	8.9	26.8
2	Shell Albida HD2	4.35	10.7	38.2

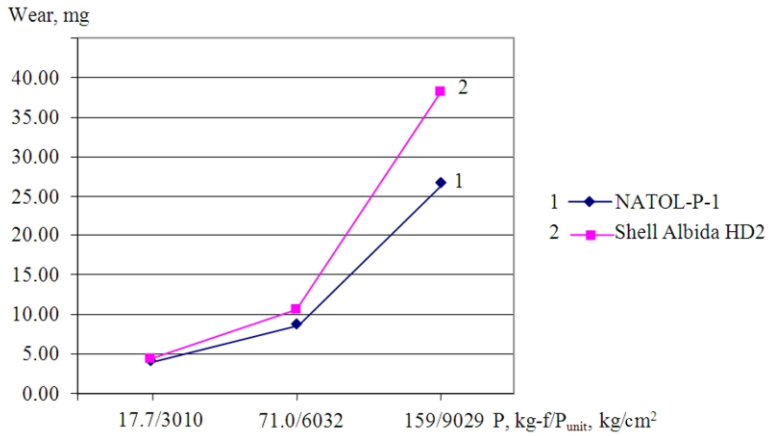

Fig. 1. The results of the comparative tests

Based on these experimental results, it can be seen that at relatively low loads on the friction unit, both grease grades, "Shell Albida HD2" and "NATOL-P-1", have almost the same high antiwear properties. At high loads that occur during the operation of the rolling equipment for non-stationary friction with the critical unit loads, the antiwear properties of grease "NATOL-P-1" of company "NATOL" are more higher than 1.4 times than the antiwear properties of grease "Shell Albida HD2".

The grease grade "NATOL-P-1" underwent the industrial tests at JSC "Tagmet" (Taganrog, Russia) in the tube-rolling shop on line number 2 and at "Arcelor Mitall" (Krivoy Rog, Ukraine) in the roller bearing block of the coil conveyor of the mill PS-150-1.

At JSC "Tagmet" in TPC on line number 2, the tests of grease grade "NATOL-P-1" were carried out in the bearing of the mill stand number 6 of the mill PQF.

On April 15, 2010, the roll chocks № 114, 115, 203, 204, 205 and 206 of the bearing of the mill stand number 6 were disconnected from the centralized lubrication systems, pumped with "NATOL-P-1" and placed in the mill PQF.

On April 24, 2010, the mill stand number 6 was removed from the mill. On April 26, 2010, the bearings were opened. The visual inspection of the bearings showed that the quantity of residual grease was in the range of 60 to 90% of the entry-level, the consistency of grease worked for nine days, had not changed; in contact with water, the grease grade did not emulsify.

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This grease grade worked under difficult (severe) conditions: high stress, scale and water presence.

Consumption of grease "NATOL-P-1" for 9 days in mill stand number 6:

The initial filling of the six bearings is equal to 72 kg of grease.

Centralized lubrication or additional pumping was not carried out.

Total: 72 kg of grease grade "NATOL-P-1".

In these bearings, it is used the grease grade "Mobilux EP2". The grease grade "Mobilux EP2" is fed through a centralized lubrication system, the lubrication cycle being 20 minutes, the amount of lubrication per 1 cycle is 5 cm^3. The PQF mill stands were aditionally pumped two times per week, the consumption of lubricant in 1 bearing is approximately 6 kg. Since the cooling roll is made by water, the grease grade "Mobilux EP2" reacts with water and emulsifies, the grease loses its lubricating properties, changes the texture and a portion of the grease flows out. So that the lubricating film between the rubbing surfaces is broken and the bearing is poorly lubricated.

Consumption of grease "Mobilux EP2" for 9 days in the mill stand number 6:

The initial filling of six bearings is equal to 72 kg of grease.

Centralized lubrication is equal to 26.24 kg of grease.

Additional pumping is equal to 36 kg of grease.

Total: 134,24 kg of grease "Mobilux EP2".

According to the results of the tests, we may formulate the following conclusion: the tested grease "NATOL-P-1" has a significant resistance to high loads, does not react with water and does not emulsify. In contrast to the grease grade "Mobilux EP2", the grease "NATOL-P-1" does not change consistency and corresponds to all technological requirements for the lubrication under these severe conditions. The lubricant consumption is reduced by 1.9 times; the working hours for servicing the friction unit are reduced too.

It has been decided to apply the grease grade "NATOL-P-1" in the bearing units of the complex PQF instead of the grease grade "Mobilux EP2", which is confirmed by an act of industrial tests. Currently, the grease grade "NATOL-P-1" is implemented at JSC "Tagmet".

So far, in the roller bearing block of the coil conveyor of the mill PS-150-1 on "Arcelor Mitall", it was used the grease grade "Mobilgrease XHP 222" with the frequency of replenishment of 1 time every 2 weeks, at 50 g per bearing. Without an additional pumping, the grease loses its properties and "cokes" in 1-1.5 months of operation.

The factory committee drew up an act that on the 17th of February 2010 (during maintenance), the rolling bearings of the roller bearing block № 11 of the first section of the right coil conveyor of the mill PS-150-1 was cleaned and washed with kerosene from grease grade "Mobilgrease XHP 222" and the lubrication was done with "NATOL-P-1", in the amount of 300 g.

On the 4th of April 2010 (70 days of operation), the visual inspection of the state bearing block have shown that this grease grade preserved its mechanical properties, bearing bad working condition. The traces of "coking" grease were not found, the visual separation of the base oil and thickener was not observed. The bearing unit was filled with the grease (the grease did not slip from the bearing). Extraneous sounds in the bearing were not observed. A refueling lubrication of "NATOL-P-1" was not required.

On the basis of a result of the control survey, the Committee concluded that the grease grade has maintained its properties for more than two months of operation, i.e. it has a high mechanical stability and long-term lubricating properties and it preserves the bearing performance.

It had been decided to continue the operation of the bearing block without replenishment of grease.

3. CONCLUSION

The new grease grade "NATOL-P-1" can successfully take the place of the grease of known firms in the high-loaded friction units in the sheet metal equipment. Its anti-wear properties were determined by an improved roller friction test machine SMC-2. The grease grade "NATOL-P-1" was successfully tested on the industrial metallurgical enterprises of Ukraine and Russia.

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