EXPERIMENTAL RESEARCH INTO FRICTION MODIFIERS FOR THE TREAD, FLANGE AND GAUGE SURFACES OF WHEELS AND RAILS

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The tread and the flange and gauge surfaces of wheels and rails require to have different properties – relative higher friction factor on tread surfaces and lower friction factor on flange and gauge surfaces and they needs corresponding friction modifiers. Adjustment of wear rate of wheels and rails, energy losses on friction, environment contaminations by vibration, noise and friction modifiers are considered as main functions of friction modifiers. In the present paper the ecologically friendly friction modifiers for tread and flange and gauge surfaces are tested in laboratory conditions on the twin disc machine. Experimentally are established the ranges of variation of the friction factor of the friction modifiers accordingly for flanges 0.06 – 0.11 and for tread surfaces 0.12-0.4; The duration of the Single applied friction modifier was till 3000-12000 revolutions till its full removal from the interacting surfaces.

Kay words: *friction factor, third body, scuffing, wear, fatigue, pitting.*

1. Introduction

Wheels and rails are characterized by poor conditions of modification of interacting surfaces and they are subjected to direct influence of the ambient. All of it worsens working conditions of wheels and rails; they have a negative influence on the transport safety and operational expenses. In addition, the lubricants and friction modifiers, vibrations and noise are polluting the environment. Damage accumulation because of wear, fatigue and plastic deformation significantly reduces the service life of the railway wheels and rails. Therefore there are many works devoted to durability of wheels and rails and traffic safety [1-5 and references on their] and it is acknowledged that improvement of friction modifiers and interacting profiles of wheels and rails have important role in the solving of these problems.

Stability of the third body in a zone of contact of wheels and rails to relative sliding, the power and thermal loading, require of special measures to provide with their necessary properties. Friction modifiers are concentrated to its effect on decreasing the possibility of energy loss on friction, environment pollution by vibration, noise and by non ecological materials of friction modifiers, decrease of damage rate of wheels and rails and possibility of climb of wheel flange on the rail head and derailment.

2. Experimental research of friction modifiers

The new friction modifiers developed by us mainly contains ecologically friendly and inexpensive materials. For estimation of running ability of developed friction modifiers and further improvement of their properties, tests were carried out in laboratory conditions. Experimental research was performed on the twin disc machine (mod. MT1, Fig. 1) at rolling of discs with accompaniment of 20% slipping. Experimental samples represent rollers in diameter of 40 mm and width 10 and 12 mm. For estimation of properties of friction modifiers of various structures and comparison with other facilities, the lubricant of Ukrainian manufacture AZMOL, which is used for rails and wheels, and the lubricant

CIATIM-1 were tested also. The researches have shown insufficient properties of CIATIM -1 for wheels and rails.

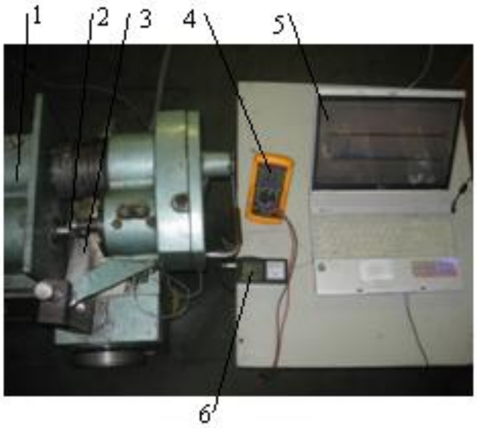
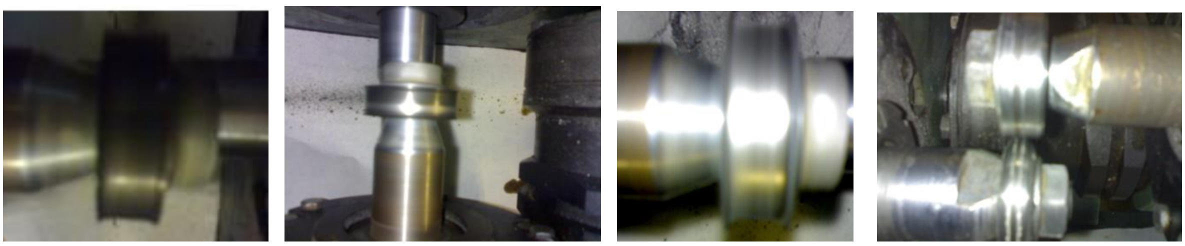


Fig. 1. Twin disk machine and measuring means:
1-twin disk machine; 2-triboelements; 3-wearing products; 4-tester;
5-personnel computer; 6-vibrometer

The friction modifier was evenly applied on the surfaces and the test was performed till the partial removal of the friction modifier and beginning of scuffing which was detected by increase of the friction moment, vibrations and noises. The tests were performed at the initial temperature of interacting surfaces 22-240C. The picture was sharply changed at destruction of the third body and scuffing occurrence: vibrations began and noise rose from 80-90 dB to 92-105 dB and the temperature in the immediate proximity from a friction track were increased to 700C - 1050C.

The tests have shown three stages of destruction of friction modifiers for wheel flange and gauge surfaces: at the first stage the friction modifier (surfaces) was darkening (Fig. 2 a), and the small reduction of friction factor was observed. At the second stage the surfaces gradually were becoming lighter (Fig. 2 b) and the friction moment thereafter of the initial small growth was down and have stabilized. While approaching the third stage, certain small impulses of a friction moment were observed which indicates on the first signs of occurrence of scuffing (Fig. 2 c) and the friction moment and their variable component was sharply increasing. The instability of the friction moment was accompanied by noise and vibrations, by the rapid removal of a friction modifier from surface and its damage was clearly visible, that is characteristic for the avalanche scuffing.



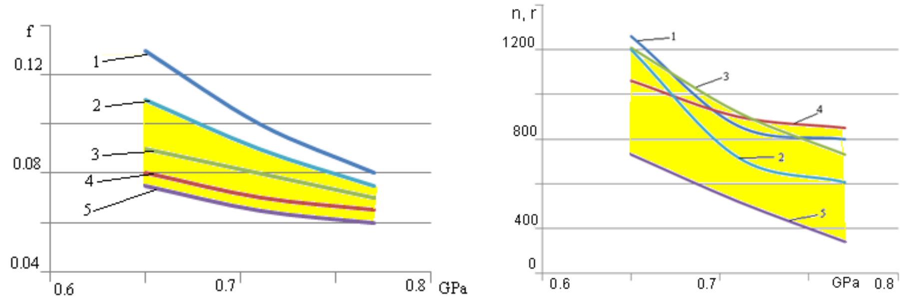
a b c d

Fig. 2. The interacting surfaces with initial line and point contact of surfaces
(a) the first stage of destruction of friction modifier (darkened surface), (b) surface with partial and total (c) removal of friction modifier and d) the initial point contact of surfaces

3. Dependence of friction factor and number of revolution on the contact stress till beginning of scuffing

It is notable, that the surface and near-surface layers are the weakest areas of solid bodies and its destruction commonly begins from them [6]. When the interacting surfaces are divided by the third body, the maximum cyclic efforts of surfaces can lead to a plastic deformation. For the heavy loaded rolling/sliding surfaces the scuffing condition is destruction of the third body and the intimate contact of juvenile interacting surfaces.

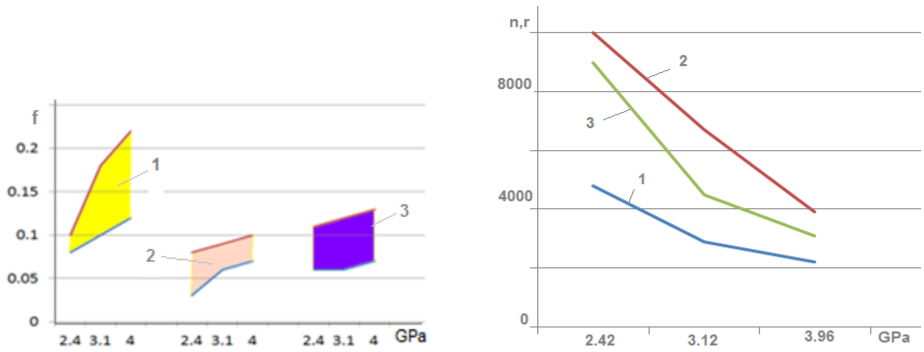
As charts show (Fig. 3) for the initial linear contact, when the contact stress is changed in range 0.65-0.77 GPa, increase of contact stress leads to decrease of friction factor (which is characteristic for solid modifiers) and number of revolution till scuffing. Dependence of friction factors on the contact stress and numbers of revolution for initial linear contact of disks is given in Fig. 3.



a **b**

Fig. 3. Dependence of friction factors on the contact stress (a) and number of revolutions (b) for initial linear contact of disks
1 – AZMOL, 2 – 5 – different compositions of developed friction modifiers

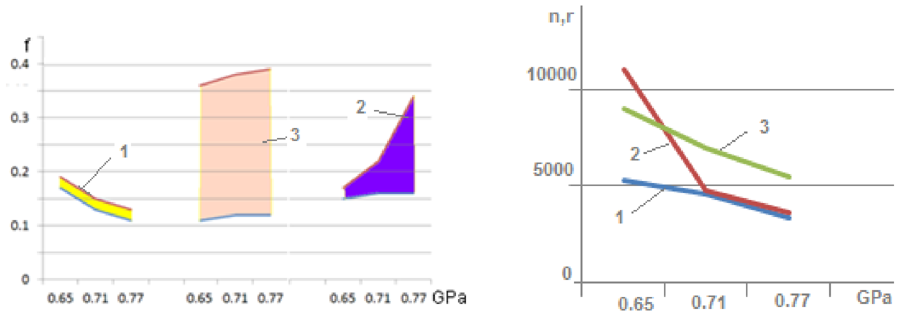
Dependence variation ranges of friction factors (a) and numbers of revolutions (b) till destruction of friction modifiers and appearance of initial attributes of scuffing on the contact stress for the initial point contact of discs is given in Fig. 4.



a **b**

Fig. 4. Dependence variation ranges of friction factors (a) and number of revolutions (b) till destruction of friction modifiers and appearance of initial attributes of scuffing on the contact stress for the initial point contact of discs;
1, 2, 3 –friction modifiers with different combinations of above mentioned components

Tests showed a high thermal resistance and adhesion properties of friction modifiers with “positive friction”. At increasing pressure the solid particles adhere and stay on interacting surfaces, especially in dents between micro asperities and under such conditions the shearing stress increases because of increasing the pressure. Dependences of stray field of friction factor on the contact stress for the developed friction modifiers for tread surfaces are shown in the Fig. 5.



a b

Fig. 5. Dependence of the stray field of the friction factors (a) and number of revolutions till irreversible removal of friction modifiers (b) on the contact stress for initial linear contact of disks for three types of friction modifiers for tread surfaces

The tests performed on the twin disc machine show that the friction factor for friction modifiers of various compositions in the case of flange surfaces changes in the range of 0.06-0.11 and for the tread surfaces – in the range of 0.12-0.4. It must be noted that the friction factor for tread surfaces were rapidly rising from the very beginning of tests, and then were stabilizing.

Conclusions

- Ecologically friendly friction modifiers are elaborated for tread and flange surfaces;
- The dominant types of various kinds of damages are revealed depending on the relative sliding for flange and gauge surfaces and tread surfaces;
- At destruction of the third body and scuffing the contact zone is a source of vibrations and noise;
- Experimentally are established the ranges of variation of the friction factor of the friction modifiers accordingly for flanges 0.06 – 0.11 and for tread surfaces 0.12-0.4;
- A friction modifier applied once was acting till 3000-12000 revolutions or till its removal from the interacting surfaces.

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