EFFECT OF THE WHITE LAYER ON THE WEAR RESISTANCE OF STEEL 50Kh

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The continuous white layers appearing during the mechanical working of steel (turning, milling) effectively increase its fatigue and corrosion-fatigue strength, as well as its resistance to corrosion cracking [1]. However, the effect of the white layers on the wear resistance of parts is as yet not clear. Along with the opinion that the white layers increase the wear resistance of parts [2-4], there exists the view that the carbide white layers arising, for example, with friction, lower the wear resistance of friction pairs [5, 6].

The present article gives the results of an investigation of the effect of white layers, obtained by mechanical and by mechanical-ultrasonic working, on the wear resistance of steel 50Kh (0.49% C; 0.21% Si; 0.65% Mn; 1% Cr; 0.24% Ni; 0.030% S; 0.030% P).

The tests were made with sliding friction in accordance with a ring-bearing scheme in an MI-1M machine, under limiting lubrication conditions. The lubricant was M-12V oil with the additives VNIINP-360 and PMS-200A. The friction area was 300 mm². The samples were pre-worked under a loading P=15 kg for a period of 24 h. The duration of the wear resistance tests was 1000 and 1500 h with loadings of 50 and 100 kg. The mean data from the results of three experiments were analyzed. The criterion adopted for wear of the samples was the value of the weight loss after a determined time interval. Before weighing (with an accuracy up to 10⁻⁴ g) the samples were washed with aviation gasoline and alcohol, after which they were dried at a temperature of 80°C for a period of 2 h.

Some of the sample-rings (outside diameter 28 mm) were subjected to quenching from 850°C in oil and low-temperature annealing at 180°C for a period of 2 h (the structure was martensitic, HRC = 48-52); the remainder of the sample-rings were subjected to quenching and to high-temperature annealing, as a result of which a sorbite structure was obtained (HB = 299-302). The sample-bearings were cut out in the form of segments, from bronze BR.OTsS 5-5-5 (GOST JAil-Union State Standard 1019-54) and steel KhVG (Gost 5950-63), in a quenched and low-annealed state (HRC = 62-65).

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Fig. 1. Microstructure (x 300) of steel 50 Kh with a white layer, before (a) and after (b) the wear resistance tests:
1) white layer obtained by turning on quenched and low-annealed steel; 2) white layer obtained on refined steel by mechanical-ultrasonic working.
The white layer (Fig. 1) on quenched and low-annealed sample-rings was produced by turning on a 1K62 lathe, under the conditions: cutting rate 88 m/min; feeding rate 0.07 mm/rev; cutting depth 0.15 mm. The negative leading angle of the cutting tool (T30KCh) was 45°, and the radius of curvature of the cutting edge was 1 mm. On refined (quenching from 850-860°C in oil, annealing at 550°C) sample-rings, the white layer was obtained using a mechanical-ultrasonic treatment [7], with a rate of rotation of the sample equal to 1250 rpm, a feed rate of 0.07 mm/rev, and a force of 80 kg pressing the instrument against the part. For purposes of comparison, polished sample-rings made of the same steel (without a white layer) were tested. The polishing was carried out after one pass of a wheel, type 6B, with a particle size of 60, with abundant cooling and with an allowance of 0.03 mm for polishing (rate of rotation of the polishing wheel 34 m/sec; rate of rotation of sample 5-8 m/min; longitudinal feed rate 0.01 m/min). Special attention was paid to trimming of the polishing wheel with a diamond at the proper time, to avoid burns on the working part of the ring. The purity of the surface of the polished samples corresponded to the 8th class, of the turned samples to the 7th class, and that of the samples subjected to mechanical-ultrasonic treatment to the 8th class; after the wear resistance tests of these samples, it reached V8, V8, and V9. The purity of the surface was determined in Model 201 profilographic-profilometer, made by the “Kalibr” plant.

The experiments showed that the white layer, obtained either mechanically (turning) or by mechanical-ultrasonic treatment, effectively increases the wear resistance of friction pairs. Thus, the wear of refined, as well as of quenched and low-annealed steel 50Kh, after treatment with the formation of a white layer,