

Impact of Deformation Force by Vibration-Centrifugal Hardening on the Properties of the Surface Nanostructure of Steel 40Kh

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Abstract

This study examines the effect of deformation force on the surface layer of 40Kh steel during vibration-centrifugal hardening, which results in the formation of a nanocrystalline structure with increased microhardness and wear resistance. The deformation force, which is regulated by changing the tool's mass and eccentricity, ranges from 477.1 to 2044.5 N. Its magnitude influences the grain size, which varies from 19 to 43 nm, dislocation density, microhardness, and depth of the hardened layer. The grain sizes and the density of dislocations formed in the surface layer were determined using x-ray diffraction patterns. The initial ferrite–pearlite structure transforms into a ferritic nanostructure with simultaneous cementite dissolution under cold plastic deformation. This treatment reduces the friction coefficient of pairs, thereby lowering the temperature in the friction contact zone. At deformation forces ranging from 795.1 to 1703.7 N, the friction coefficients of the pairs in an oil medium decrease by 1.8 to 2.57 times compared with those of hardened samples. Similarly, under the same conditions, the temperature in the contact zone of the friction pairs decreases by 1.42 to 1.9 times. The structural change resulting from vibration-centrifugal hardening increases the wear resistance of friction pairs in an oil medium: the ring resistance increases by 1.72 times, and the insert resistance increases by 2.5 times compared with that of hardened samples because of the reduction in the friction coefficient of the pair and the temperature in the contact zone.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

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Ethics declarations

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.