ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

Vol. 5, Issue 9 , September 2018

Increase of Abrasive Wear Resistance of Steels by Thermal Processing

D.M. Berdiyev, , A.A. Yusupov, M.A.Umarova

Cand. Tech. Sciences, Tashkent State Technical University, Uzbekistan
Cand. Tech. Sciences, Tashkent State Technical University, Uzbekistan
Cand. Tech. Sciences, Tashkent State Technical University, Uzbekistan

ABSTRACT: The application of heat treatment for the purpose of increasing abrasive wear resistance is considered for the example of samples of steels St3Ghs, 35, 45, 65G and U8 in comparison with the standard sample of technical iron. It is proposed to preliminarily normalize with extreme temperature 1100 °C before the final thermal treatment of carbonaceous and low-alloyed steels.

KEYWORDS: abrasive wear resistance, heat treatment, hardness, carbon, high-carbon and low-alloy steels, dislocation density, loose abrasive particles, preliminary structure preparation, solid-solution hardening of martensite.

I.INTRODUCTION

One of the most destructive is abrasive wear. In the conditions of abrasive action of soil and dust, all tillage machines operate, the parts of the working bodies (WB) of which are made of medium- and high-carbon steels such as 40G, 65G, 70G, L53, L65, etc., thermally treated for high hardness. Even in this case, the correct choice of material and method of hardening is not guaranteed [1]. The situation is exacerbated in the repair industry, when, due to a lack of necessary steels, their replacement with other steels gives unpredictable results in terms of wear resistance of the product.

This paper, an attempt is made to solve two problems:

to increase the abrasive wear resistance of steels for parts of WB tillage machines by thermal treatment with the introduction of pre-treatment operations;

to establish empirical dependences of wear resistance of steels on parameters of their structure.

II.OBJECT AND METHODS OF RESEARCH

Samples from medium- and high-carbon steels 45, 65G and U8 were studied and for comparison samples from steels 35, St3Ghs and technical iron. Technical iron was used as a reference material, and steel St3Ghs as steel, which can be hardened for martensitic with a minimum carbon content (0.28% C) [2]. In this case, the preliminary treatment consisted of normalizing from heating temperatures from A_{c3} (or A_{c1}) + (30 ÷ 50) °C to 1200 °C. The final heat treatment included quenching with the temperatures of heating usually adopted for each steel grade and tempering at 200, 350, 450 and 600 °C.

The structure parameters were determined by light microscopy, electron microscopy and x-ray diffraction analysis. In particular, the state of a thin structure was estimated by the dislocation density determined from the physical width of the x-ray line of interference (220) [3].

III. RESULTS OF THE RESEARCH

Laboratory wear tests were carried out during sliding friction against loose quartz abrasive particles in the PV-7 installation [4], as in previous studies the authors established the similarity of the wear-resistance series, i.e. preservation of quantitative ratios of relative wear resistance during testing at the PV-7 installation and field testing of the coulter of the cotton seed opener [5].

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 9 , September 2018

The results of the studies showed that with an increase in temperature during normalization, austenite grain growth is observed, but the state of the fine structure varies according to the extreme dependence. The maximum dislocation density in the α phase is observed if the heating temperature during normalization was 1100 °C (fig. 1). In previous studies it was found that at a heating temperature of about 1100 °C, the dissolution of refractory impurity phases in austenite begins. These are mainly oxygen and nitrogen-containing phases, for the beginning of dissolution, which is characterized by the chemical micro in homogeneity of the solid solution. In this case, with a *γ-α* transformation, the dislocation density increases. Heating to 1200 °C during normalization promotes homogenization of austenite, and upon cooling after *γ-α* transformation, the dislocation density decreases [2,5].

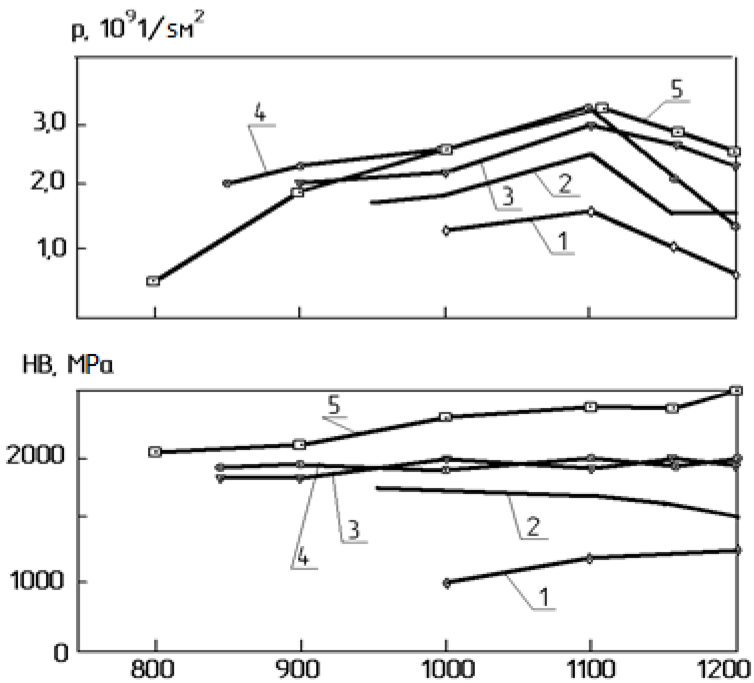

Fig. 1. Influence of the temperature T of normalization on the density p (a) of dislocations and the hardness of HB (b) of technical iron (1) and carbon steels St3Ghs (2), 35 (3), 45 (4) and V8 (5)

After the final heat treatment, austenitic grain is crushed, approximately the same for each grade of steel; however, the dislocation density remains different. Inheritance of the elements of the original submicro construction takes place, since the position of the extremum of dislocation density is conserved (fig. 2). This strongly affects the abrasive wear resistance in sliding friction against loose abrasive particles (fig. 3). If the preliminary normalization was carried out at a temperature of 1100 °C, then the wear reduction was quite large - from 20 to 50% for steels in a low-released state. The wear value also changes after final tempering at 350, 450 and 600 °C. Hardening without tempering can additionally increase the wear resistance of steels [6]. In our experiments, some of the St3Ghs samples were not subjected to tempering after the final quenching, and some of the samples were quenched from different temperatures and also without tempering. From fig. 3 it can be seen that the wear of steel St3Ghs after quenching without tempering noticeably decreased (up to 40%).Thus, preliminary preparation of the structure by carrying out normalization from the extreme temperature of heating after the final heat treatment provides an increase in abrasive wear resistance up to 50%. Tempering on extreme conditions without release in addition increases wear resistance.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 9 , September 2018

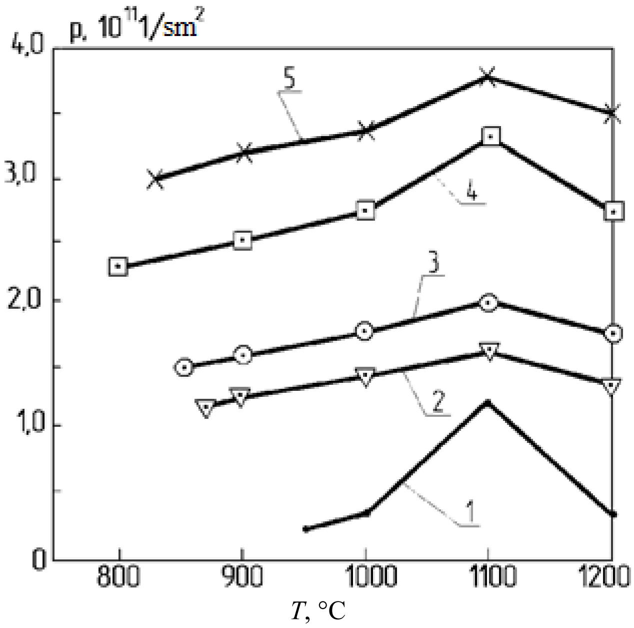

Fig. 2. Effect of pre-normalization temperature T on the density of ρ dislocations after repeated quenching from the heating temperature of A_{c3} + (30 ÷ 50) °C (St3Ghs, 35, 45, 65G) and A_{c1} + (30-50) °C (U8 steel) and tempering at 200 °C; steel: St3Ghs (1), 35 (2), 45 (3), 65G (4) and V8 (5)

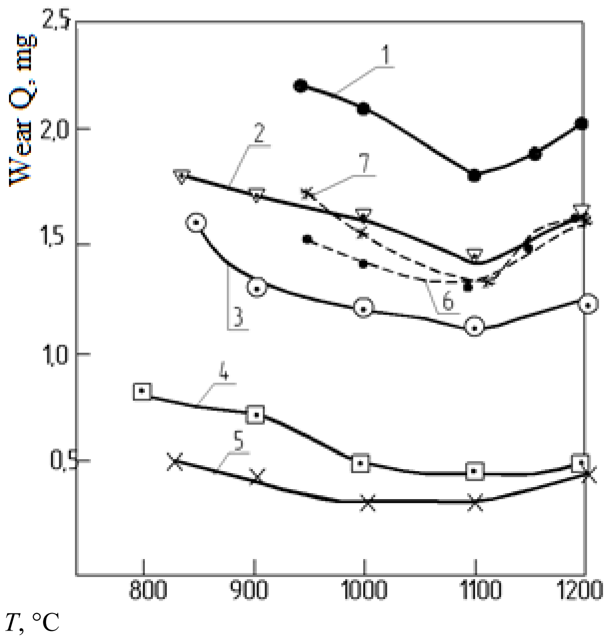

Fig. 3. Effect of prenormalization temperature Ton wear Q after repeated quenching and tempering at 200 °C for steels St3Ghs (1), 35 (2), 45 (3), U8 (4), 65G (5) and steel St3Ghs without tempering (6 and 7, where 7 is the direct quenching from the indicated temperatures)

A reasoned choice of the steel grade and ways of its hardening are possible if data are available on the effect of the structural parameters of steels on their wear resistance.

Analysis of the results of the experiments showed that after quenching and tempering at 200, 350, 450 and 600 °C, there is a linear relationship between the amount of wear and density:$Q = f\sqrt{\rho}$For each grade of steel and each tempering temperature, the wear of hardened and low-released steels can be determined by the formula [7]:

$$Q = Q_{0St3Ghs} - \alpha\Delta\sqrt{\rho} - a\cdot(\Delta C)^{V}$$

where $Q_{0St3Ghs}$ - wear of steel with a tempered martensite structure with a minimum (0.28%) carbon content; $\Delta\sqrt{\rho}$- the difference between the square roots of the dislocation densities of the investigated steel and steel St3Ghs after quenching from 950 ° C of low tempering; ΔC - the difference in the content of carbon in the steel under study and in steel St3Ghs; a, b - coefficients and exponent.

Tempered steels after tempering at a temperature of 350 °C and above have the structures of a ferrite-cementite mixture and a step between the dependences $Q = f\sqrt{\rho}$are determined only by the influence of the number and dimensions of cementite particles. Therefore, to determine the wear, you can use the formula:

$$Q = Q_{0Fe} - \alpha\Delta\sqrt{\rho} - K\lambda^{-1}$$

whereQ_{0Fe}- wear of annealed technical iron (standard); - Dislocation density; λ - the average distance between the cementite particles in the tempered steel; α , K - variable coefficients that depend on the tempering temperature.

IV.CONCLUSION

Heat treatment of the pre-prepared structure, consisting in the normalization of carbonaceous and low-alloy steels from an extreme temperature of 1100 °C, reheating to the accepted for each grade of quenching, quenching and tempering steel, provides an increase of 20-50% sliding friction against loose abrasive particles.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 9 , September 2018

An empirical relationship has been established between the wear resistance of steels and the parameters of their structure.

REFERENCES

1. Tkachev V.N. Wear and increase the durability of parts of agricultural machines. M.:MechanicalEngineering. 1971. 264 p.

2. Berdiyev D.M., Mukhamedov A.A. The choice of steels and the technology of their thermal hardening with the help of a computer program // Engineering and Technology, Moscow. 2009. No 1. Pp. 24-26.

3.Crystallography, X-ray diffraction and electron microscopy/S.Umansky, Yu.A. Skakov, A.N.Ivanov, L.N.Rastorguev. M.:Metallurgy, 1982. 632 p.

4. Tenenbaum M.M. Resistance to abrasive wear. M.:Mechanicalengineering, 1976. 267 p.

5. Mukhamedov A.A., Tilabov B.K. Increase of wear resistance of parts with hard-alloy coatings by thermal treatment // Izvestiya VUZ. Ferrousmetallurgy. 2013. No 12. Pp. 35-37.

6. Structure and wear resistance of steel U8, laser-treated / L.G.Korshunov, A.V. Makarov, V.M.Schastlivtsev and ot. // Physics of metals and metallurgy. 1988. Vol. 66. Issue. 5. Pp.948-957.

7. Berdiyev D.M. Increase of abrasive wear resistance of steels by thermal processing with preliminary preparation of structure // Bulletin of mechanical engineering. Moscow. 2018. No 9. Pp. 57-59.