WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL

ISSN: 2776-0979 Volume 2, Issue 4, April, 2021

INFLUENCE OF LOW-TEMPERATURE NITROCEMENTATION MODES ON THE STRUCTURE AND PROPERTIES OF R6M5 STEEL

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Abstract

This article presents the result of studies of the influence of modes of low-temperature nitrocarburizing on the structure and properties of steel R6M5. Shown the possibility of carrying out a combined technology with nitrocarburizing.

Keywords: nitrocarburizing, cyanidation, austenite, martensite, hardening, dislocation.

Introduction

To obtain a higher wear resistance of high-speed steel tools, the last tempering is combined with low-temperature cyanidation, which is usually carried out in cyanide salts. To build a more rational process of hardening a tool made of R6M5 steel, we researched the effect of the final tempering temperature on the hardness of steel and also researched to determine the optimal temperature of nitrocarburizing to obtain high hardness values with a general reduction in tool processing time.

To determine the effect of the tempering temperature on the hardness of steel R6M5, samples were prepared that were quenched from standard temperatures of 1200-1230 °C and subjected to tempering at various temperatures. Studies have shown that the highest values of hardness are achieved during tempering at 540-560 °C, and with a further increase in the tempering temperature, up to 620 °C, there is no critical decrease in steel hardness. This circumstance makes it possible to carry out a one-time final vacation at a temperature of 600-620°C. It is known that the intense release of vanadium carbides occurs at a tempering temperature of 560°C, and the release of tungsten carbides, which is the main alloying element, at temperatures above 600°C. Also, an increase in the temperature of nitrocarburizing from 540 to 600°C - 620°C makes it possible to intensify the process of nitrocarburizing. A slight decrease in hardness during tempering 600°C - 620°C should be compensated for by an increase in surface hardness due to the combination of tempering with the nitrocarburizing process. which is the main alloying element at temperatures above 600°C. Besides, an increase in the temperature of nitrocarburizing from 540 to 600°C - 620°C makes it possible to intensify the process of nitrocarburizing. A slight decrease in hardness during tempering 600°C - 620°C should be compensated for by an increase in surface hardness due to the combination of tempering with the nitrocarburizing process. which is the main alloying element at temperatures above 600°C. Also, an increase in the temperature of nitrocarburizing from 540 to 600°C - 620°C makes it possible to intensify the process of nitrocarburizing. A slight decrease in hardness during tempering 600°C - 620°C should be compensated for by an increase in surface hardness due to the combination of tempering with the nitrocarburizing process.

Experiment and Result

To investigate the possibility of carrying out a combined technology withSamplesofsteel R6M5 were prepared by nitrocarburizing. Samples that underwent standard heat treatment, including quenching from 1200-1230 °C and three-hour tempering gat 550 °C, were subjected to nitrocarburizing at 550 °C for 1 to 4 hours. Specimens quenched from 1200-1230 °C without tempering were subjected to nitrocarburizing at a temperature of 620 °C for 1 to 4 hours. The composition of the saturating medium was selected based on the results of studies on the saturation of die steels (60% soot + 40% carbamide). As in the case of die steels, containers were prepared in which steel samples were placed with appropriate backfill.

The lids of the containers were covered with refractory clay. The finished containers were placed in an electric furnace preheated to a predetermined temperature. The saturation depth was investigated depending on the temperature and holding time (Fig. 1) According to Fig. 1. It can be noted that the nitrocarburizing process takes place most intensively at a saturation temperature of 620 °C. Moreover, the saturation depth of 0.1 mm is achieved at this temperature within one hour. The further saturation process at this temperature leads to a saturation depth of 0.15 only after 4 hours. During tempering, high-speed steel has two mutually competing processes:

1. The process of transformation of retained austenite into martensite with simultaneous precipitation of finely dispersed carbides of alloying elements.
2. The beginning of the tempering process of martensite was obtained after quenching.

The first process gives an increase in the hardness and heat resistance of steel, the second is a partial drop in the hardness of martensite obtained in the hardening process. It is known that when hardened steel is heated to temperatures of 550-600°C and a certain exposure at this temperature, special carbides are precipitated. This increases the martensitic point, which leads to the transformation of retained austenite into martensite, respectively, to an increase in the hardness of the steel. Usually, after the first tempering, the retained austenite decreases from 25 to 10% (Fig. 2.)

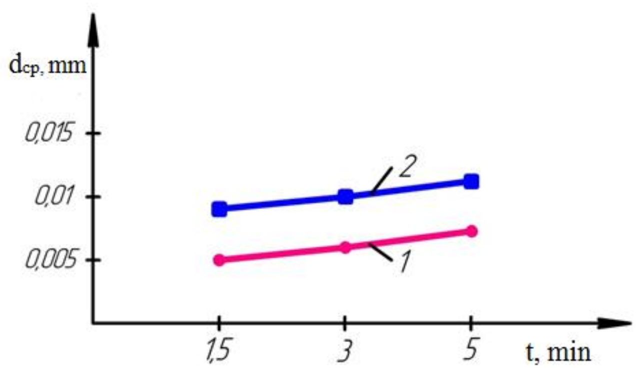

Fig. 1. Influence of holding time on the depth of the diffusion layer of steel R6M5:
1 - vacation 560 ° C, three times, 2 - vacation 620 ° C, single

Studies of the effect of temperature and saturation time on the microhardness of the carbonitrided layer of steel R6M5 showed that the surface carbonitrided layer of steel can reach values of microhardness HV 11000 MPa (Figure 3-4).

Analyzing the data obtained, it can be noted that saturation temperatures practically give one value of microhardness. With an increase in the holding time, the microhardness values slightly increase. The drop in microhardness with increasing saturation depth is insignificant. Thus, it can be noted that an increase in the holding time during low-temperature nitrocarburizing of R6M5 steel does not give a noticeable increase in the microhardness of R6M5 steel.

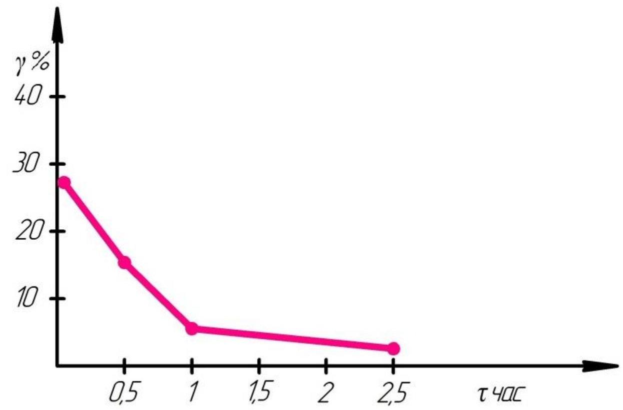

Fig. 2. The influence of the tempering time 550 °C on the amount of residual austenite steel R6M5, hardened from 1200-1230 °C

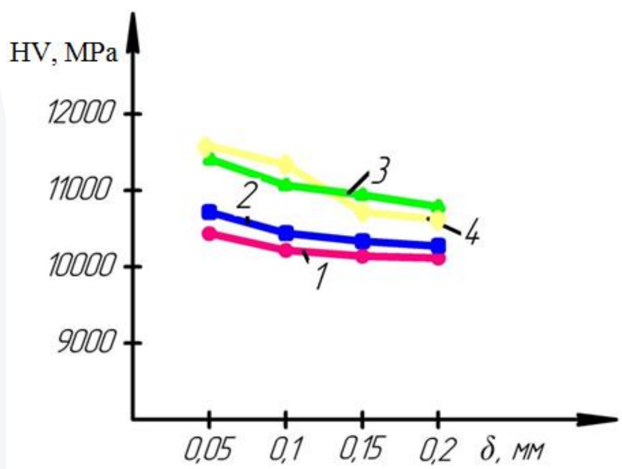

Fig. 3. Change in the microhardness of the cyanide layer according to the saturation depth of steel R6M5. T sat = 550 °C
Exposure time: 1 - 1 hour, 2 - 2 hours, 3 - 3 hours, 4 - 4 hours

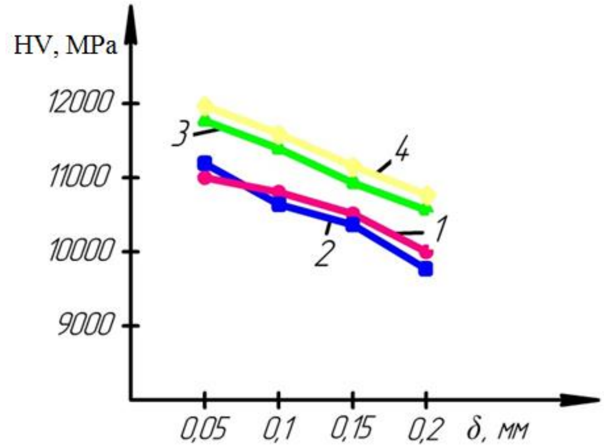

Fig. 4. Change in the microhardness of the cyanide layer according to the saturation depth of steel R6M5. T sat = 620 °C Exposure time: 1 - 1 hour, 2 - 2 hours, 3 - 3 hours, 4 - 4 hours

CONCLUSION

It should be noted that the holding time during the nitrocarburizing process of the tool mainly depends on the size of the tool and the size of the packing box (container). The process of nitrocarburizing in solid media lasts from 1 to 4 hours. Large tools usually take longer to process than small tools. Therefore, the exposure of the instruments is prescribed in steps, with steps from 20 to 30 minutes. In our case, the holding time was chosen from one to four hours to obtain data on the saturation depth of R6M5 steel.

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