INTERNATIONAL JOURNAL ON ORANGE TECHNOLOGY

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071

Volume: 5 Issue: 9 | Sep 2023

Influence of P6m5 Steel Structure on Modes of Low Temperature Nitrocementation

Begatov Jahongir Mukhammadjonovich

PhD, Associate Professor Joint Belarusian-Uzbek Interdisciplinary Institutem Applied Technical Qualifications, Tashkent, Uzbekistan

Platoshina Malika Mirkamal kizi

Senior Lecturer at the Department of Energy and Applied Sciences, Tashkent Kimyo International University, Tashkent, Uzbekistan

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Annotation: The article discusses a method of hardening tools made of high-speed steel grade P6M6 in order to obtain higher wear resistance. Research has been carried out on the effect of final tempering temperature on the hardness of steel, and research has also been carried out to determine the optimal temperature of nitrocarburization, in order to obtain high hardness values with a general reduction in tool processing time. To determine the effect of tempering temperature on the hardness of P6M5 steel, samples were prepared that were quenched from standard temperatures of 1200-1230°C and subjected to tempering from different temperatures. Studies have shown that the highest hardness values are achieved when tempering 540-560°C, and with a further increase in tempering temperature, up to a temperature of 620°C, there is no critical decrease in steel hardness. This circumstance makes it possible to carry out a single final tempering at a temperature of 600-620°C.

Keywords: wear resistance, tool, high-speed steel, hardening, hardness, nitro carburization, tempering, hardening, temperature, vanadium carbides, tungsten carbides, alloying element, heat treatment.

To obtain higher wear resistance of high-speed steel tools, the final tempering is combined with low-temperature cyanide plating, which Usually carried out in cyanide salts. To construct a more rational process for hardening tools made of P6M5 steel, we conducted research on the effect of final tempering temperature on the hardness of steel, and also conducted research to determine the optimal nitrocarburization temperature, in order to obtain high hardness values with a general reduction in tool processing time [1-2]. To determine the effect of tempering temperature on the hardness of P6M5 steel, samples were prepared that were quenched from standard temperatures of 1200-1230 °C and subjected to tempering from different temperatures. Research has shown that the highest hardness values are achieved when tempering 540-560 °C, and with a further increase in tempering temperature, up to a temperature of 620 °C, there is no critical decrease in steel hardness. This circumstance makes it possible to carry out a single final tempering at a temperature of 600-620 °C. It is known that intensive 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. In addition, increasing the nitrocarburization temperature from 540 °C to 600 – 620 °C makes it possible to intensify the nitrocarburization process. A slight decrease in hardness during tempering at 600 – 620 °C should be compensated by an increase in surface hardness due to the combination of tempering with the nitrocarburization process. which is the main alloying element, at temperatures above 600 °C. In addition, increasing the nitrocarburization temperature from 540 °C to 600 – 620 °C makes it possible to intensify the nitrocarburization process. A slight decrease in hardness during tempering at 600 – 620 °C should be compensated by an increase in surface hardness due to the combination of tempering with the nitrocarburization process. which is the main alloying element, at temperatures above 600 °C. In addition, increasing the nitrocarburization temperature from 540 °C to 600 – 620 °C makes it possible to intensify the nitrocarburization process. A slight decrease in hardness during tempering at 600 – 620 °C should be compensated by an increase in surface hardness due to the combination of tempering with the nitrocarburization process [3-5].

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To study the possibility of carrying out a combined technology with nitrocarburization, samples of P6M5 steel were prepared. Samples that have undergone standard heat treatment, including themselves were hardened at temperatures of 1200-1230 °C and tempered three times for an hour at a temperature of 550 °C, and were subjected to nitrocarburization at a temperature of 550 °C for 1 to 4 hours. Samples that were hardened at temperatures of 1200-1230 °C without tempering were subjected to a nitrocarburization process at a temperature of 620 °C for 1 to 4 hours [6-7]. The composition of the saturating medium was chosen based on the results of studies on the saturation of die steels (60% carbon black + 40% urea). As in the case of die steels, containers were prepared in which steel samples were placed with the appropriate backfill. The lids of the containers were covered with fireproof clay. The finished containers were placed in an electric oven heated to a given temperature. The depth of saturation was studied depending on temperature and holding time (Fig. 1) According to Fig. 1. you can note, that the most intensive process of nitrocarburization occurs at a saturation temperature of 620 °C. Moreover, a saturation depth of 0.1 mm is achieved at this temperature within one hour. A further saturation process at this temperature leads to a saturation depth of 0.15 after only 4 hours [8]. During tempering, high-speed steel undergoes two mutually competing processes:

1. The process of transformation of retained austenite into martensite with the simultaneous release of finely dispersed carbides of alloying elements.

2. The beginning of the tempering process of martensite obtained after quenching.

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

Studies of the influence of temperature and saturation time on the microhardness of the carbonitrated layer of P6M5 steel have shown that the surface carbonitrated layer of steel can reach microhardness values HV of 11000 MPa (Figure 3-4).

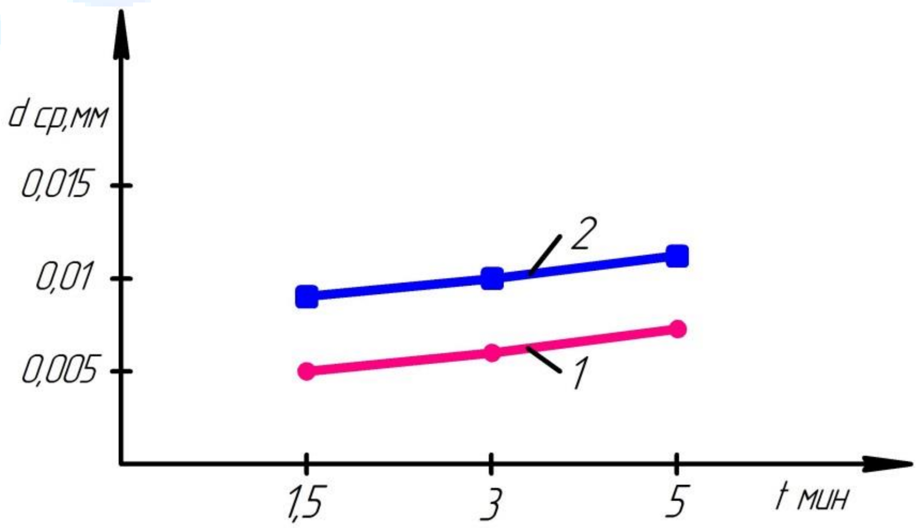

Fig.1. Influence of holding time on the depth of the diffusion layer of P6M5 steel: 1 - release 560 °C, three times, 2 - release 620°C, once

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Analyzing the data obtained, it can be noted that saturation temperatures practically give the same microhardness value. With increasing exposure time, the microhardness values increase slightly [9-10]. The decrease in microhardness with increasing saturation depth is insignificant. Thus, it can be noted that increasing the exposure time during low-temperature nitrocarburization of P6M5 steel does not give a noticeable increase in the microhardness of P6M5 steel.

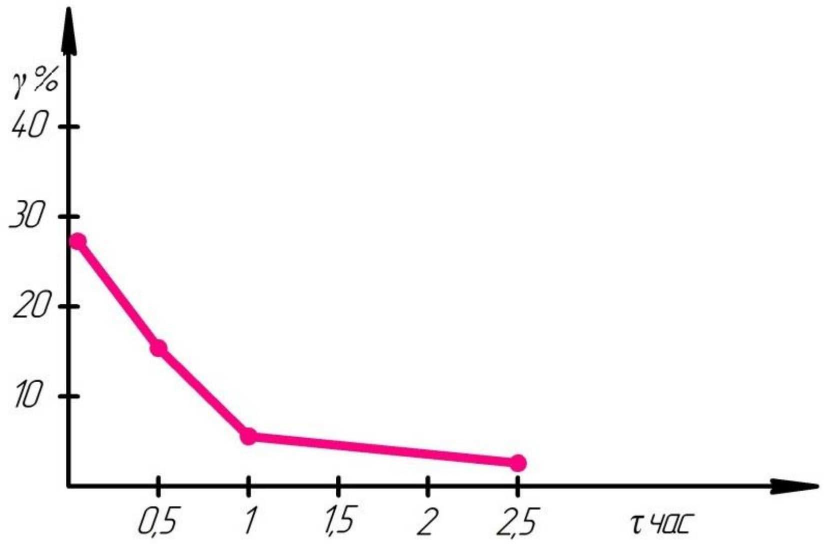

Fig.2. Effect of tempering time at 550°C on the amount of residual austenite steel P6M5, hardening from temperatures 1200-1230 °C

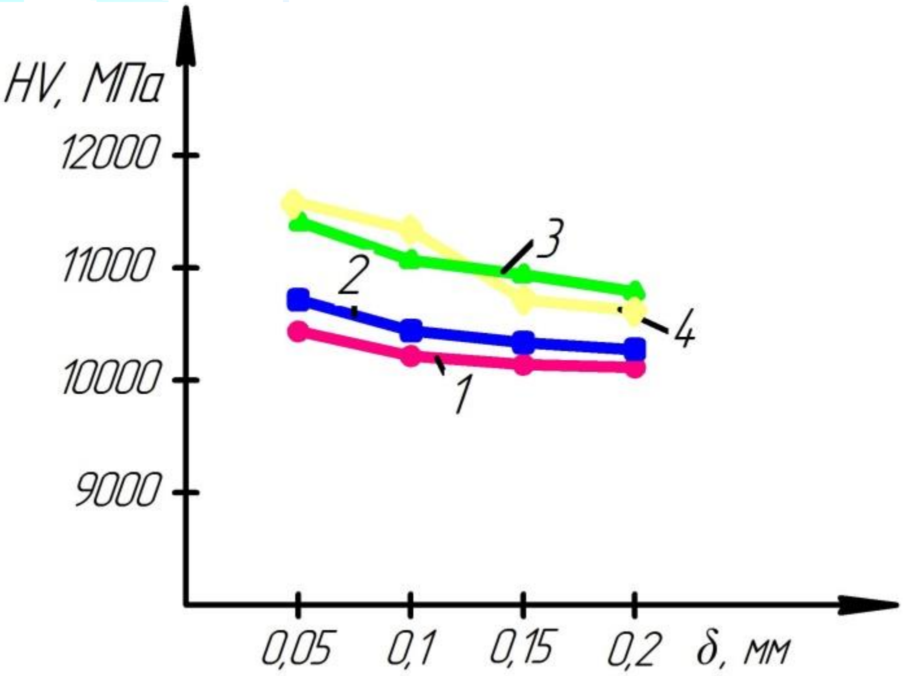

Fig.3. Change in microhardness of the cyanidated layer according to the saturation depth of P6M5 steel. Tsaturation=550 °C

Exposure time: 1 - 1 hour, 2 - 2 hours, 3 - 3 hours, 4 - 4 hours

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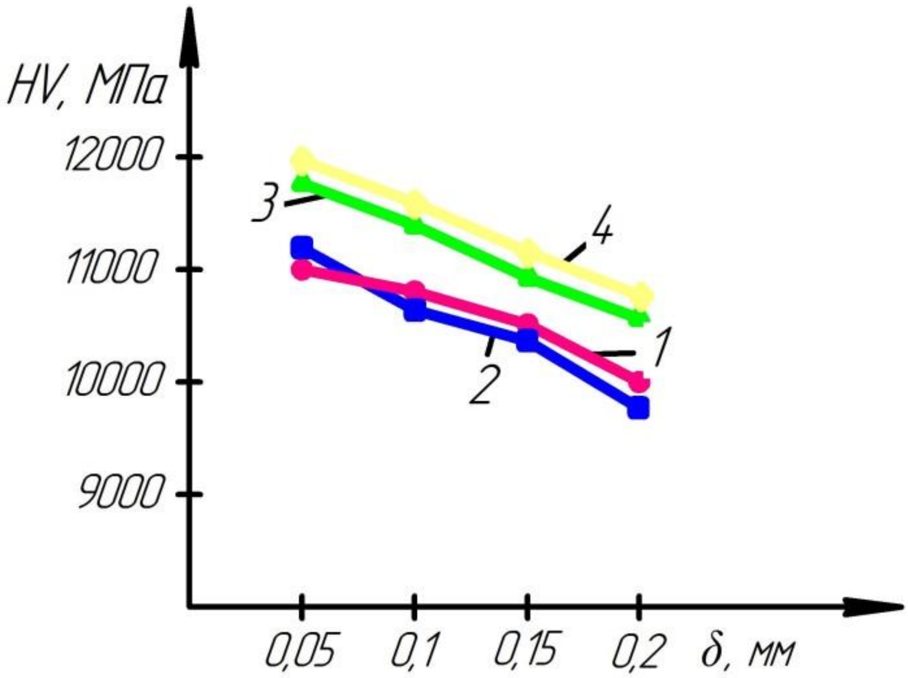

Fig.4. Change in microhardness of the cyanidated layer according to the saturation depth of P6M5 steel. Tsaturation=620 °C

Exposure time: 1 - 1 hour, 2 - 2 hours, 3 - 3 hours, 4 - 4 hours

It should be noted that the holding time during the nitrocarburization process of a tool mainly depends on the size of the tool and the size of the packaging box (container). According to the process of nitrocarburization in solid media, it lasts from 1 to 4 hours. Large tools usually take longer to process than small tools. Therefore, the exposure of instruments is prescribed in stages, with steps from 20 to 30 minutes [11-12].

In our case, the holding time was chosen from one to four hours in order to obtain data on the depth of saturation of P6M5 steel.

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