RESEARCH ON THE INFLUENCE OF HEAT TREATMENT ON THE OF THE STEEL CUTTING TOOLS (PART I)

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ABSTRACT: *The positive influence of the heat treatment on the wear resistance of the tools is differentiated according to the chemical composition of steel and the type of the used heat treatment.*
In this paper it presents the results of some researches with various heat treatment for the OSC10 steel, compared with the 205Cr115 steel from that the cutting punch were made, each one realizing by 16000 punching in the same technological conditions.
The effect of heat treatment by the quantification of durability was determined by: the deformation active parts, the wear, the cutting forces, the cutting edge aspect, the deviations from geometric shape and residual tensions.

KEY WORDS: heat treatment, cutting tools, punches.

1. INTRODUCTION

1.1. The heat treatment of the punches from 205Cr115

The semi-products after forging, have ledeburitic structure, the carbides being arranged in string, into segregation, producing a strong anisotropy of mechanical properties being 30-40% lower transversal than longitudinal. Removing carbide segregation is achieved in part through a homogenization annealing. The steel is stable to heat, resistance to wear, high depth of penetration, high grinding capacity and the minimum capacity variation. These characteristics are due to the formation of carbides of type (CrFe) 7C3 which are extremely tough 1600-1800 daN/mm2.

The punch of 205Cr115 was previously been annealed for homogenize at a temperature of 840 ° C and maintained 2 hours, in a vertical electric furnace, cooling being made outdoor.

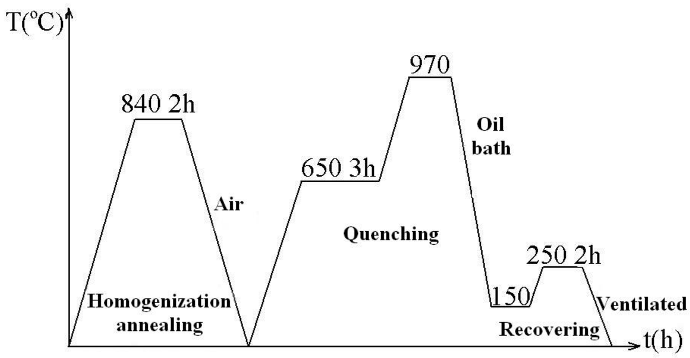

Fig.1 The heat treatment cycle of punches from 205Cr115

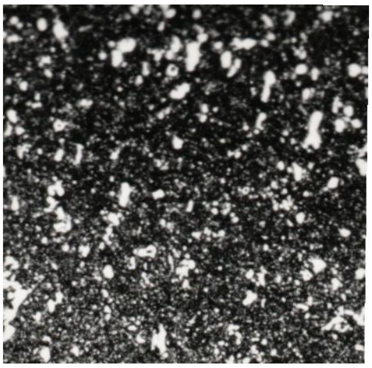

Fig.2 The structure of 205Cr115 hardened and tempered x400

The heating for the quenching (Fig. 1) was made in two steps: the first step up to 650 ° C, maintaining at this temperature for 2-3 h to ensure homogenization temperature, and in the second step the heating was performed at a slow velocity down to a temperature of 970 ° C. After austenitising the punch was taken out from the oven and cooled in an oil bath at 150-200 ° C. The returning was performed at a temperature of 250 ° C with a maintaining for 2 hours. The punch hardness was 58HRC after returning. The obtained structure after returning consists of martensite return, residual austenite and carbides (Fig. 2) magnification 400:1.

1.2. The heat treatment of the punches from 0SC10

For the punch from OSC10 firstly was achieved a stress relieving annealing at 400 ° C with the maintaining 2 h (Fig. 3), with the outdoor cooling. This was followed by quenching in two stages: 400 ° C with holding at this temperature for 15 to 20 ', followed by a final heating to 760-780 ° C in a salt bath maintaining at this temperature for 30 '.

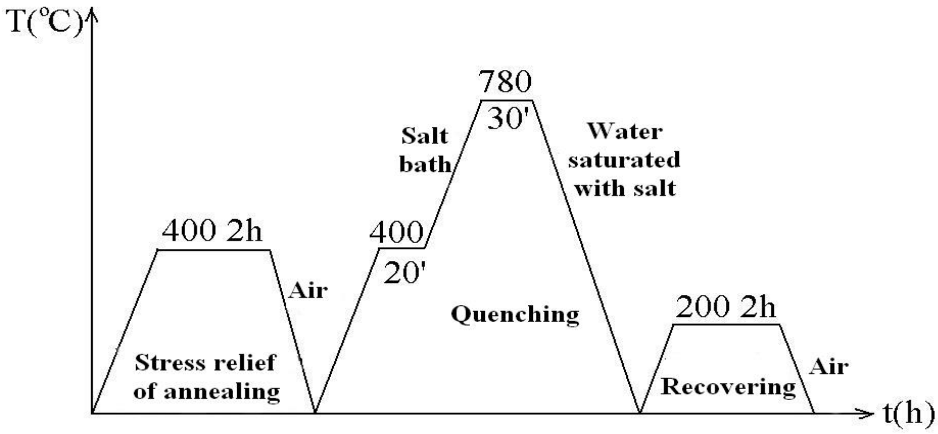

Fig.3 The heat treatment cycle of punches from OSC10

Fig.4 The structure of OSC10 hardened and tempered x200

The cooling was performed in saturated water pool (NaCl + CaCl). Following these operations was realized a hardness of 63HRC punch. Finally, a return was performed at a temperature of 200 ° C with keeping for 2 hours, the operation was carried out in a salt bath consisting of nitrogenous. The obtained hardness of the punch was 55 HRC. The obtained microstructure consists of martensite recovery, residual austenite and carbides, magnification 400:1, (Fig. 4).
implicitly the opportunity of the stipulated measures of improvement.

1.3. The heat treatment of the punches from 0SC10 by ionitriding.

The ionitriding is a modern nitriding method, in which the nitrogen is superficially incorporated by using glow discharge concentrates energy in the form of a plasma jet. Appropriate machines are used composed of a vacuum oven electrical heating, dispenser of gas, electrical system, the vacuum system to a level of 10-3 Torr.

The ionitriding was made to finished punches by rectification and heat treatment above (Figure 5).

The pieces which were treated were placed in an oven and electrically isolated from. With the help of the electrical installation was obtained the active state gas plasma discharge to constant voltage difference of 1500 volts between the furnace wall and workpieces. The pieces were connected to the negative pole and the wall of the oven to the positive pole. NH3 dissociation was possible due to voltage drop when it came to the ionization of atoms, positive ions constantly oriented towards cathode (treated piece) and the electrons to the anode (mantle oven).

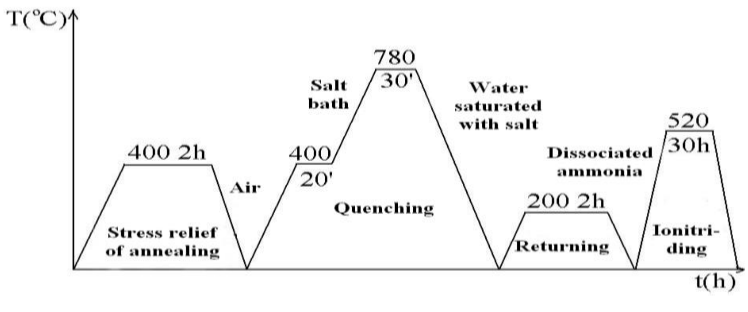

Fig.5 The heat treatment cycle of punches from OSC10 ionitriding

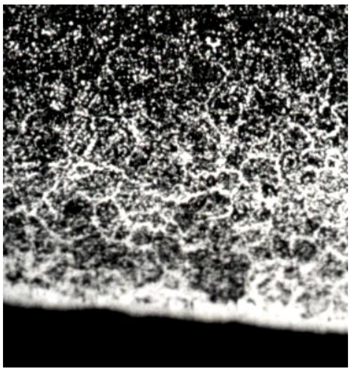

Fig.6 The structure of OSC10 ionitriding x200

The kinetic energy of the ions that fell on the surface of the pieces was converted into heat for atomic nitrogen diffusion into the interior of material from pieces. The nitrogen formed with the iron nitride FeN, which then decomposed by yielding nitrogen into stages less rich as Fe2N, Fe3N, Fe4N, which aired. The temperature at which the operation was performed to 520 ° C and the holding time was 30 hours. The cooling was carried out in a container under the gas. The nitrided layer depth (Figure 6) result was 0.2 mm, with a hardness of 640HV.

1.4. The hardening by electrical sparkles of the active edges for the punches from OSC10

The hardening by electric sparks of dies of the active elements is based on the deposit mass diffusion in the layers of edge under the influence of electric discharges and electromagnetic forces in the work area of some elements of hardening.The productivity of the charging process by electrical spark is directly proportional to density of the operating mode and inversely proportional to the surface roughness loaded.

As a result of the high temperature of the discharge, electrical spark hardening is accompanied by the formation of three layers on the surface of the workpiece, as follows:

- an outer layer consisting of deposited material, which is a very rough layer (made of austenite, martensite, carbide and nitrides), resistant to wear;

- an intermediate layer formed by alloying the base metal with the consideration;
- an inner layer formed from basic material that underwent structural changes after heating (troostito-martensitic structure characteristic of steels subjected to comeback after quenching).

The quality and productivity of electrical spark hardening depends on the frequency and amplitude of the vibration electrode that hardening is performed and the force of contact between the electrode and the workpiece. After hardening through electric spark, the wear resistance of active work surfaces increases on average by 50 ... 150%.

The disadvantages of electrical sparks process of hardening constitute their asperities and the non uniformity of the surface layer deposited, with values above the permissible limits in case of stamping dies. These disadvantages are removed by running with tools of iron and abrasive paste (40% of boron carbide, diamond, cubic boron nitride).

The main components of an electrical sparks hardening installations are:

- feeding device done in form of a portable device;
- vibrator that produces electric sparks through repeated opening and closing of the electric circuit arc of discharge.

After hardening by electrical sparks, those elements do not require any technological operations (heat treatment, rectification), which is the main advantage of this method. The punch from OSC10 of quenching used in the experiments was related to the cathode circuit. Installation worked at an electric current of 40A, voltage of 220 V and the battery capacity condensers was 500 μF. In order to deposit hard, have been used electrodes made of ferrochrome (75-80% Cr and 0.15% C). The obtained roughness after filing was 12.5μm. The duration of hardening was about 1s/mm2. The depth of the modified layer was 22μm. The hardness of the outer layer (Fig. 7) reached 755HV.

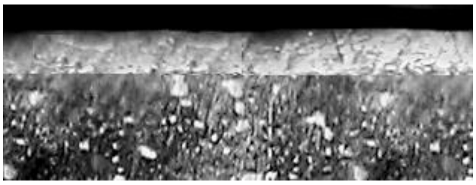

Fig.7. Hardened and tempered OSC10 covered by spark x400

1.5. The hardening by hard chrome plating (electrolytic) of active edge punches from OSC10

The submission of a chrome layer on the surface of a piece by hard chrome plating (electrolytic), is applied in order to increase the hardness and wear resistance of the surface layer of the working surfaces of the active elements of stamping or die [4].

However, the purpose of this procedure is to restore the dimensions of the active elements, worn during exploitation. The physical hard chrome is based on phenomenon of electrolysis which takes place in an electrolyte bath containing chromic acid and constitutes the primary source for the production of chromium ions. Hard chrome plating is followed by mechanical processing operation, which must be obtained original the dimensions of the covered surface. Therefore need take into account the layer thickness deposited by electrolytic plating.

For the punch of quenched OSC10 used in experiments was made in advance an electrolytic degreasing into a degreasing bath of NaOH with a concentration of 70 g / l at 20 ° C for about 5 '. Were used anodes from steel sheet and the current density was 10 A/dm2. After washing in hot water at a temperature of 70-80 ° C was performed chroming, in a chromium plating bath having the following composition: 1% Cr2O3 chromic anhydride and concentrated sulfuric acid (95-97%) (a quantity of 250 ml H2SO4 per bath volume of 350 l). The chroming operation was performed at 60 ° C and a current density of 10 A/dm2, with maintenance of 5 ', the thickness of deposited layer is more than 23μm.

Before the actual chroming was done anodic attack (reverse polarity) for 20 s at a current density of 4 A/dm2-by. The anodes from the chroming bath were of Pb being in the form of a plate of 5 mm thickness.

Finally was done washing in cold water and then in hot water (both by immersion) followed by drying in the air. The hardness of the layer of chromium (Figure 8) was 720HV.

Fig.8 Structure OSC10-chromed x 400

2. CONCLUSIONS

In order to draw a conclusion on sustainability of tools have been made several checks as follows: the analysis developed in the cutting forces, deformation analysis produced by used in sheet workpiece of punches, the appearance of the cutting edges of worn punches, the deviation from the geometrical shape of tools and the visual analysis of the parts obtained burrs.

From the studies and research carried out the tools used for cutting through stamping operations have been concluded the following:

- In the study of forces, from the force variation of graphical analysis showed that the durability of the largest of the five tools is the OSC10 punches covered by the sparks and hard chrome plated.
- After a careful analysis of the deformations produced by used punches in sheet workpiece was conclude that the small deformations exists at stamping with the punches from OSC10 chromed and covered by sparks.
- The diagrams deviations from the geometric shape were observed that both of punches and dies show traces of wear process. Minima and maxima and sharp deviation graph are explained by the fact that on the active elements edges exist pinches, traces of seizure and plastically deformed parts. Following the analysis of graphs was observed that the best behaved wear had the chrome punches and covered by sparks and the die that worked in tandem with the punch covered by sparks. The oval shape after the cutting process due to the fact that the notch is made along both the fiber and perpendicular to it, the resistance of the material is different, leading at wear more pronounced in certain portions. This differential wear is also due to gaping media mechanisms.
- Analyzing the external appearance of the cutting edges of punches worn is observed seizure traces, plastic deformation, dislocations of material, the most affected being the punch from OSC10 hardened and tempered. The less affected by wear are the punches from OSC10 hard chrome plated and covered by sparks, however were seen in these cases small scrubs of the deposited layer and dislocation of material. The dies that worked in tandem with the punches from OSC10 chrome plated and covered by sparks have the edge without deformations or dislocations of high material, which confirms that the wear of the punches chrome plated and covered by sparks is minimal compared to other punches.
- From the visual analysis of burrs was observed that the smallest burrs possess casters obtained by stamping the punch from OSC10 covered by sparks.
- This denotes that sustainability the largest of punches under study has the punch OSC10 covered by sparks and the punch from OSC10 chrome plated.
- After statistical processing of experimental research results and optimize material choice of tools both technically and economically the general conclusion can be drawn that the most suitable material to use in building tools is OSC10 covered by sparks.
- In the second part of the paper will make a quantification of the stresses and strains of these tools in the cutting process.

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