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THE INVESTIGATION OF THE INFLUENCE OF THERMOMECHANICAL TREATMENT OF THE MATERIAL OF ROTARY CUTTER BIT TOOLHOLDERS ON ITS HARDNESS

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Of great importance in the service life of a tangential cutter is the ability the cutting tool maintain working conditions as much as possible. As the practice of using tangential rotary cutters shows roadheaders, rock destruction is carried out not only cutting tool, but also the tool body itself. Overwhelming some tangential rotary cutters become unusable precisely because wear, chipping, fracture of the body, leading to exposure of the base core and breaking it out.

Figure 1. Example of worn cutters

In this regard, the best solution to this problem would be increasing the wear resistance of the cutter body.

Typical technology for the production of tangential rotary cutters

1.Manufacture of the holder using the hot method volumetric stamping at 1140÷830 °C

2. Manufacturing of a cutting tool
3. Reinforcement of the holder with an cutting tool
4. Heat treatment
5. Inspection and acceptance

Material: low-alloy steel grades 30ХГСА and 35ХГСА

After stamping, the workpiece is cooled to room temperature and subjected to mechanical processing (drilling a closed groove and turning an annular groove in the cutter shank). Then the cutting tool (core) is fastened in the groove of the head holders by soldering or pressing.

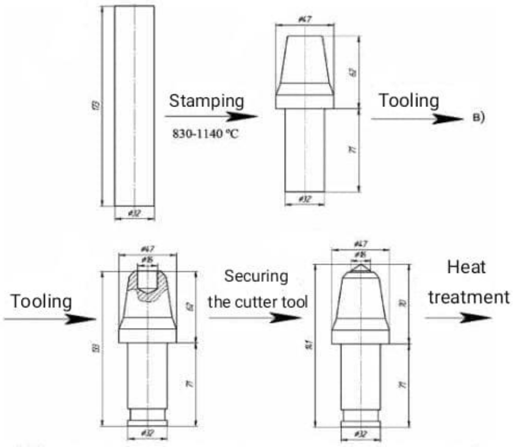

Figure 2. Method of manufacturing tangential rotary cutters

Methods for increasing the wear resistance of a rotary tangential cutter

The standard typical heat treatment technology is as follows after stamping: (Tangential cutter PC32)

1. Heating the tangential cutter body together with the core and. solder with high frequency current up to the operating soldering temperature (1070-1100 degrees)
2. Cooling in still air to room temperature
3. Grooving a groove for a carbide insert
4. Isothermal hardening in saltpeter at 300 °C
5. Cooling at room temperature
6. Low tempering in a furnace at 230 °C

After heat treatment, the steel acquires higher viscosity (about 40 J/cm^2) and an average level of hardness (up to 45 HRS)

This technological process ensures high tool resistance to impact loads, stable and long-term operation of carbide inserts

The disadvantage of this heat treatment is that the cutter body becomes insufficiently resistant to abrasive wear due to the unplanned appearance of softer sorbitol and bainite structures

Technology for increasing the resistance of cutting tools from SANDVIK INTELLECtUAL PROPERTI (5. Cutters for clearing and tunneling machines. го ко- General Specifications The conditions. GOST 51047-97. вердо- Moscow, 1998.):

The technology is focused on increasing the strength of the connection of the carbide insert in the cutter body.

The cutter is made of silicon carbide diamond composite

The body is made of martensitic steel.

The insert is secured into the housing by introducing heated metal into the annular cavity formed between the cylindrical part of the tip and the wall of the housing cavity.

As the cutter subsequently cools, the body shrinks, exerting sufficient pressure on the hardened metal to force it against the cylindrical outer surface of the tip.

The disadvantage of this method is that before hardening the cutter body forming the cavity, it is not plastically deformed, which does not allow obtaining its high surface hardness and, as a consequence, wear resistance.

The considered method of high-temperature heat treatment

(This method was put forward by Professor Bolobov V.I. of the St. Petersburg Mining University)

An important and decisive difference from standard heat treatment is the absence of a cooling stage to room temperature, as a result of which the steel acquires a martensitic structure, excluding the softer structure of sorbitol and bainite

1.Heating a cylindrical billet to the austenitization temperature (1200°C) and stamping for the tooling in its head part.

2. Cooling the chamfered workpiece to a temperature of 900°C
3. stamping on a horizontal forging machine to produce a forging
4. Quenching a forging in molten saltpeter or oil
5. Low tempering of forgings in a furnace at a temperature of 230°C
6. Mechanical processing for tooling
7. Cold pressing of cutter tool

Advantage:

It was found that the use of improved processing technology increases the wear resistance of the holder material in the core embedding zone by 1.5 times, depending on the abrasiveness of the rock being destroyed.

Influence of plastic deformations on strength characteristics

When steel is deformed during forging, the strength characteristics (hardness, tensile strength, yield strength, elastic limit) increase and the ductility and toughness of the product decrease. As the applied stress on the material increases, the amount of plastic deformation increases. But when a critical stress is reached, the material loses its ability to deform plastically and destruction occurs.

To determine the cause of such shortcomings with the existing manufacturing technology, it is necessary to consider the behavior of plastic deformations and their effecton the wear resistance of the cutter holder.

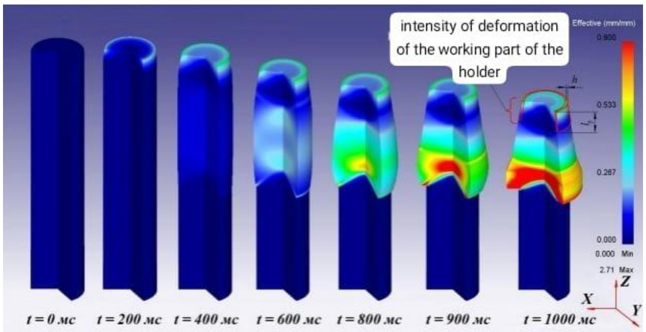

Figure 3. Results of computer modeling of plastic intensity

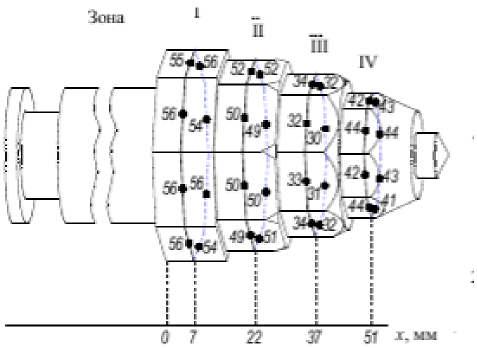

Figure 4. Hardness distribution on the surface of the finished cutter deformation experienced by various parts of the workpiece during its transformation into a holder forging

As modeling has shown (Figure 3), after stamping holders using the existing technology for manufacturing cutters, the strain intensity εi accumulated by the elements of the holder during the stamping process is noticeably differs for its individual parts: the maximum value of ε (up to 2.71) is at the junction of the tail and head parts of the holder. he minimum, close to 0, is in the end area of the head part.

For zones of greatest wear, a part of the holder with a length of lp = 15 mm, the average value of the intensity of plastic deformation εp of all i-th elements of the surface layer is 0.17

Such a slight intensity of steel deformation cannot lead to a significant increase in its hardness as a result of subsequent hardening and, as a consequence, the wear resistance of the material. This is confirmed by hardness measurements on the surface of the cutter. The minimum indicators are recorded in the area of greatest wear This uneven structure is due to uneven cooling of the cutter body due to its conical shape.

Wear test

Two tangential cutter specimens were subjected to a wear test under constant static load (P=500N) for 50 seconds. Based on the results of mass measurements before and after exposure to the rock, the loss of metal mass was determined

A sample that has undergone standard heat treatment and a sample with high heat treatment without a cooling step at room temperature:

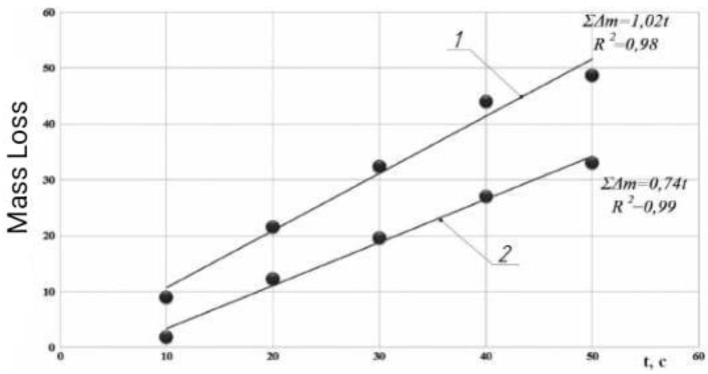

Figure 5. Dependence of sample weight loss on time for the process of abrasive wear of 30 ХГСА steel samples after Standard Heat Treatment (curve 1) and High Heat Treatment (curve2).

Based on abrasive wear on sandstone, it was found that the wear rate during HTMT (K = 0.74 mg/s) is 1.4 times higher than during standard processing (K = 1.02 mg/s), and hardness measurements showed a difference of 1.25 times.

Conclusion:

The use of improved heat treatment technology for the cutter leads to an increase in the hardness of the head part of the holder, which is explained by the presence of a martensitic hard component in the structure of its material.

It was found that the use of improved processing technology increases the wear resistance of the holder material in the core embedding zone by 1.6-2.6 times, depending on the abrasiveness of the rock being destroyed.

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