

# Research and Development of Technology for Hardening of Rollers of the Rolling Mill

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## Abstract:

In article results of a research on hardening of rollers of rolling mills which is shaping tools working in extreme conditions are considered. Bringing the result at the same time is of researches on brand 45 harden steel, particular importance, and relevance of development which consists in implementation in productions of the new materials received in the technological ways, in particular the materials providing the best combination of parameters of structure. It is shown that one of the main objectives of work was development of technology for hardening of the rollers of the rolling mill made of brand 45 steel. For the purpose of improvement of technical and utilization properties of an experimental roller of an input box of a cage of the rolling mill, it is developed the new modes of heat treatment of carbonaceous - the structural steels providing the best combination of parameters of structure, increasing their wear resistance during the work in extreme conditions.

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## INTRODUCTION

The current state of development of materials science demands a comprehensive investigation of new ways of technology and receiving absolutely new materials of purpose. It is demanded according to the current development of the industries of economy in our republic now. One of fundamental problems of science and technology of the third millennium - resource-saving. The metal economy problem also enters it [1]. For the purpose of economy of raw materials and fuel it is necessary to develop resource-saving technologies for production of metals which reserves are irreplaceable. First of all it belongs to metal-consuming products, such as,

for example, rolling rollers. Rollers are the main tool of rolling mills. "What rolling without rollers? Forging, that's all!". It is so possible to tell almost V. Vysotsky's words about a role of rollers in metal deformation processes – hot, warm and cold. Rolling rollers are the main technological tool in rolling repartition of steel works. From their reliability, wear resistance of a working surface, a reserve maintenance period of service, technical and economic indicators of work of rolling shops generally depend [1]. The quality of rolling, its operational properties in many respects depend on wear resistance, roughness and other characteristics of the roller tool. Therefore much attention is paid to

issues of increase in their wear resistance that is a relevant task. Now there are different technologies of ensuring the set parameters of a surface layer of rollers and increase in their wear resistance. One of efficient ways of increase in service life of rollers is heat treatment. Heat treatment increases their hardness and wear resistance in the conditions of abrasive wear [2]. Now there are different technologies of ensuring the set parameters of a surface layer of rollers and increase in their wear resistance. Strengthen a surface – means to increase properties of a surface: hardness, wear resistance, corrosion resistance. If it is necessary to change properties, then it means that the structure of a surface layer should change. For change of structure it is possible to use deformation, heat treatment with heating in the different ways, change of chemical composition of a surface, drawing protective layers [3].

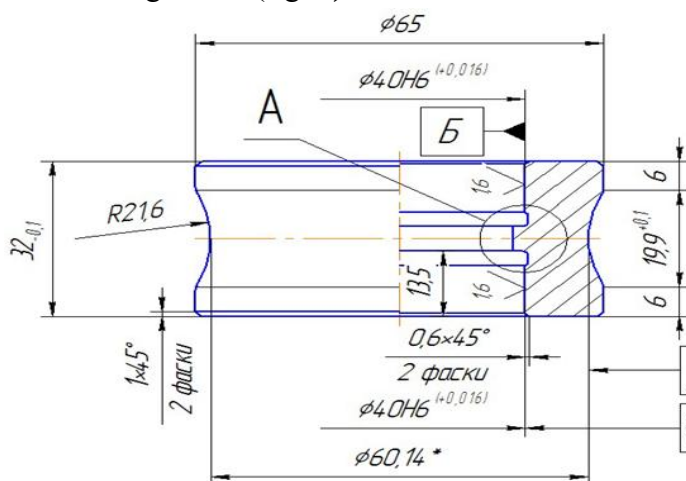
#### **In principal methods it is possible to dissect hardenings of surfaces on two basic groups:**

- 1) hardening of a product without change of chemical composition of a surface, but with change of structure. Hardening is reached by superficial tempering, superficial plastic deformation and other methods.
- 2) hardening of a product with change of chemical composition of a surface layer and its structure. Hardening is carried out by different methods of chemical heat treatment and drawing protective layers [6].

#### **OBJECTS AND METHODS OF RESEARCH**

The purpose of work is disclosure of the mechanism structuration at different options of heat treatment with the extreme mode. And also, researches to influence of structural parameters of the steel applied to production of rollers of rolling mills on wear resistance of these rollers in use [4].

Authors with assistance with JSC “Uzmetkombinat” developed working drawings of a roller of an input box of a cage №25 (fig. 1).



**Fig.1. Working drawing of a roller of an input box of a cage №25**

On a task the ordered sample of a roller (fig.1) represents a round ring-shaped product from hard-alloy material with the outer diameter of 65 mm, with an inside diameter of 48 mm. Width of a ring of 32 mm, on both edges of a roller there are sides 6 mm wide. Distance between boards of 20 mm. At this distance a roller the arc, deepened about 3 mm in depth. In the middle of an arc arc wings smoothly pass into an edge board. From outer side sides are limited to the facets 2 mm wide smoothing acute angles of a roller on a circle. Taking into account thickness of such facets thickness of the sides limiting a roller from two parties reaches 6 mm [4]. It was necessary for a solution of objectives: select an object of researches, the modes of heat treatment of samples, to set the complex of researches allow determining both structural parameters, and properties, methods of durability tests on the same objects [5-6]. The contrastive analyses of firmness of the rollers of a roll armature of a camp 300 CIII-2 made of different materials of reduction in tab. 1 which are carried out by authors.

**Table 1:Contrastive analysis of firmness of the rollers of a roll armature of a camp 300 CIII-2made from different materials**

| № p\p | Name products           | Diameter, mm | Roller form | Material                       | Resource work / amount of rental, (t) | Time of carrying out tests, years |
|-------|-------------------------|--------------|-------------|--------------------------------|---------------------------------------|-----------------------------------|
| 1     | Roller 23 cages         | 80           | rhombus     | Steel 65G                      | 320                                   | 2008.                             |
| 2     | - // -                  | 80           | oval        | Steel 20XH                     | 230                                   | 2010.                             |
| 3     | - // -                  | 80           | oval        | Hard alloy (spraying, CIII-2)  | 3250                                  | 2009.                             |
| 4     | - // -                  | 80           | rhombus     | Hard alloy(spraying, CIII-2)   | 3790                                  | 2009.                             |
| 5     | - // -                  | 80           | oval        | Cast iron                      | 500                                   | 2010.                             |
| 6     | - // -                  | 80           | oval        | BK 6                           | 24000                                 | 2011.                             |
| 7     | - // -                  | 80           | rhombus     | Steel 65Г                      | 200                                   | 2008.                             |
| 8     | - // -                  | 80           | rhombus     | Hard alloy(spraying, CIII-2)   | 3950                                  | 2009.                             |
| 9     | - // -                  | 80           | oval        | Hard alloy (spraying, CIII-2)  | 4800                                  | 2009.                             |
| 10    | - // -                  | 80           | oval        | Hard alloy( spraying, CIII-2)  | 6270                                  | 2014.                             |
| 11    | - // -                  | 80           | rhombus     | Steel 65Г                      | 150                                   | 2008.                             |
| 12    | - // -                  | 80           | rhombus     | Hard alloy(spraying, CIII-2)   | 1030                                  | 2009.                             |
| 13    | - // -                  | 80           | oval        | Hard alloy ( spraying, CIII-2) | 1300                                  | 2009.                             |
| 14    | - // -                  | 65           | oval        | Combined BK15                  | 20000                                 | 2012.                             |
| 15    | Roller of the 25th cage | 65           | oval        | IIIX15 steel                   | 180                                   | 2016.                             |
| 16    | - // -                  | 65           | oval        | system alloy Mo-TiC-Ni-W-Fe    | 8277 testing proceed                  | 2016.                             |

After contrastive analyses of firmness of rollers of a roll armature of a camp 300 CIII-2, izgotovlennyy of different by materialovavtor as objects of researches were selected, constructional carbonaceous qualitative steel brands steel 45. If to speak about characteristics of steel 45, then with confidence it is possible to tell that this alloy has high hardness and with ease reacts to high temperature conditions. This alloy of steel differs

from others in a set of special characteristics which are inherent only in this brand. It differs in application and high functionality, unique structure of chemical compounds, set of foundry and other production parameters.

As a part of brand 45 steel according to GOST there are such elements as phosphorus, arsenic, chrome, copper, nickel, silicon, manganese and other

substances. This steel has a big set of mechanical characteristics. Therefore it is capable to take out practically all climatic and temperature fluctuations. Test this type of steel at a temperature interval from 200 to 600 degrees. Technical characteristics This steel belongs to temperature to materials which difficult give in to welding, however, at the same time it has no holiday ability. This its feature often very well influences production of irregular shapes and details. Thanks to characteristics of this steel, the impact strength of products from it entirely depends on thickness of the taken leaf, and the thickest source code will have the greatest value. But, even despite this parameter, it is possible to tell

with confidence that practically any construction made of steel of this brand will sustain practically any including the most intensive influences. It became possible thanks to the applied ways of processing and also production which is developed according to GOST. Certainly, in the world did not create the materials having infinite endurance to different influences therefore this metal in this sense not an exception yet. But thanks to high properties of raw materials from which produce material it has magnificent indicators. Characteristic and foreign analogs of material 45 it is provided in table 2.

**Table 2:Characteristic of material 45**

|                          |                                                                                                                                                                                                                             |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Brand</b>             | 45                                                                                                                                                                                                                          |
| <b>Substitute</b>        | 40X, 50, 50Г2                                                                                                                                                                                                               |
| <b>Classification</b>    | Carbonaceous quality carbon steel                                                                                                                                                                                           |
| <b>Application</b>       | shaft gear wheel, cranked and camshafts, gear wheels, spindles, bandages, cylinders, cams and details another normalized, improved and subjected to surface heat treatment from which the increased durability is required. |
| <b>Foreign analogues</b> | Are known                                                                                                                                                                                                                   |

**Foreign analogues of the material 45**

| Japan    | France   | England | European Union | Italy | Spain  | China   | South Korea |
|----------|----------|---------|----------------|-------|--------|---------|-------------|
| JIS      | AFNOR    | BS      | EN             | UNI   | UNE    | GB      | KS          |
| S45C     | 1C45     | 060A47  | 1.0503         | 1C45  | C45    | 45      | SM45C       |
| S48C     | 2C45     | 080M    | 1.1191         | C43   | C45E   | 45H     | SM48C       |
| SWRCH45K | AF65     | 080M46  | 1.1192         | C45   | C45k   | ML45    |             |
| SWRCH48K | C40E     | 1449-   | 2C45           | C45E  | C48k   | SM45    |             |
|          | C45      | 50CS    | C45            | C45R  | F.114  | ZG310-  |             |
|          | C45E     | 1449-   | C45E           | C46   | F.1140 | 570     |             |
|          | C45RR    | 50HS    | C45EC          |       | F.1142 | ZGD345- |             |
|          | CC45     | 50HS    | C46            |       |        | 570     |             |
|          | XC42H1   | C45     |                |       |        |         |             |
|          | XC42H1TS | C45E    |                |       |        |         |             |
|          | XC45     |         |                |       |        |         |             |
|          | XC45H1   |         |                |       |        |         |             |
|          | XC48     |         |                |       |        |         |             |
|          | XC48H1   |         |                |       |        |         |             |

Chemical composition investigated by steel is given in table 3.

**Table 3**  
**Chemical composition in the % investigated steel 45 in accordance with GOST 1050-88**

| C          | Si          | Mn        | Ni     | S         | P        | Cr        | Cu     | As        |
|------------|-------------|-----------|--------|-----------|----------|-----------|--------|-----------|
| 0.42 - 0.5 | 0.17 - 0.37 | 0.5 - 0.8 | to 0.3 | till 0.04 | to 0.035 | till 0.25 | to 0.3 | till 0.08 |

### SCIENTIFIC RESULTS AND THEIR ANALYSIS

An opportunity and prospects use of heat treatment with extreme the mode of carbonaceous - structural steels is shown. The determined consistent patterns of creation of the most wear proof structures. It demanded researches of features of forming of parameters of structure of structural steels at high-temperature heating and tempering, intermediate issue, carrying out final heat treatment. It was established that in the course of the first high-temperature tempering in a certain interval of heating temperatures structures with the maximum level of deficiency of the crystal building form. The temperature intervals of intermediate issue for carbonaceous structural steels providing thermal stability of defects of the crystal building when carrying out final heat treatment were defined. As a result of manifestation of effects of heredity of elements of initial structure, the firmness rollers of the rolling mill in 50% was increased. For researches steel 45 from which samples were exposed to heat treatment on the following modes was selected: the first batch - tempering from heating temperatures 870, 1000, 1100, 1200 °C, the second - normalization from the same temperatures, tempering from temperature 870 °C. In all cases time the austenization makes 20-30 minutes, and issue temperatures after tempering - 200, 350, 450 and 600 °C. Heating was made in well deoxidized Salinas, NaCl BaCl<sub>2</sub>. Hold time at the specified temperatures was taken at the rate of 0.5-0.3 min. on the 1 mm of section of samples. As the sizes of samples were 25x25x10mm, hold time made

3 – 5 minutes. After tempering spent intermediate vacation at 200, 350, 450, 500, 550, 600, 650, 680 ° and 720 °C. Intermediate issue was made for the

purpose of removal of internal stresses, by stabilization (and polygonization of dislocation structure, ensuring crushing of grain of austenite when carrying out final heat treatment. The technology of process of issue of steel 45, depending on temperature, is carried out through:

- furnaces with forced air circulation;
- special bathtubs with saltpeter solution;
- special bathtubs with mineral oil;
- the bathtubs filled with the melted alkali.

The principle of issue of steel 45 consists that material is originally heated to a mark below, than critical level, and after that cool. However such mode of heat treatment has several different ways of carrying out which will differ from each other depending on the speed of cooling of preparation and temperature of its heating. The practical importance of results research is use of the developed modes of heat treatment with the extreme mode in shop ЧИП-2 JSC “Uzmetkombinat” and other metallurgical enterprises. The conducted researches allowed to determine also consistent patterns of redistribution of atoms of implementation in solid solution after double phase recrystallization and their influence on steel issue processes.

### CONCLUSION

1. The maximum deficiency of the crystal structure of carbonaceous - structural steel is reached at application of heat treatment with the extreme mode.

2. Optimum intervals of carrying out heat treatment with extreme mode steel 45.
3. The first batch - tempering from heating temperatures 870, 1000, 1100, 1200 0C, the second - normalization from the same temperatures, tempering from temperature 870 0C. In all cases time the austenization makes 20-30 minutes, and issue temperatures after tempering - 200, 350, 450 and 600 0C.
4. As a result of researches the new modes of heat treatment of a roller for implementation in production were offered.
5. There are "extreme" modes of both preliminary, and final heat treatment of steel providing increase of wear resistance at a sliding friction with lubricant to 50%.
6. The new modes of heat treatment of carbonaceous - the structural steels providing the best combination of parameters of structure are offered.

Thus, in work the new solution of a relevant scientific task – establishment of the principles of creation of the most wear proof structures carbonaceous - structural steels by heat treatment with the extreme mode is proposed.

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