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FORMATION OF STRUCTURE AND MECHANICAL PROPERTIES OF STEEL FOR BOLTS 38XA

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A quite important link in development of environmentally friendly and resource-saving hardware production technologies is a structured approach to the preparation of graded rolled metal products that enables functional management of properties by means of changing the degree of particles dispersion, the number and morphology of phase components.

Today, the most widely-spread thermal operation of making rolled products of medium carbon and alloy steels preceding the stage of cold massive forming is batch or bell annealing to granular pearlite. The annealing time is up to 36 hours or more. But even following such long thermal exposure the structure of metal products may have some spots with traces of lamellar pearlite and sometimes feature non-uniform distribution of properties along the roll length [1].

The number of automotive industry hardware products is subject to exclusive standards for surface defects such as the depth of surface defects, decarburized layer presence and surface finish.

The existing technologies of heavy-duty hardware treatment prior to cold massive forming imply the exposure of hot-rolled steel to plastic deformation and removal of major surface defects by means of the expensive grinding operation [2].

Intolerable high mechanical characteristics $\sigma_{0.2}$ and $\sigma_в$ result from heavy cold work hardening in the process of drawing and cutter grinding as well as an unsatisfactory microstructure which is inadmissible for cold massive forming of an automotive engine group bolts. Typically, surface defects (collar marks, silvers, decarburized layer etc.) of rolled products are removed by means of surface grinding. The surface grinding of rolled metal products, in addition to cold work hardening, results in other surface defects such as hardening of a surface layer accompanied with cracks in that layer (the hardened layer depth is within 0.15-0.3 mm). There may rough spiral cuts and cracks occur on the surface of rolled metal products. Improper alignment for grinding may result in a non-uniform peripheral stripping of calibrated rolled products with an inadmissibly excessive (above 0.1 mm) decarburized layer remaining on the surface. This technology of processing rolled products chips over 5.5% of metal. The most primal calculation expressed in monetary terms shows that grinding 1 ton of rolled metal products results in min. 55 kg of chipped metal per ton or the loss of 1650 roubles.

Prior to cold massive forming of hardware the produced rolled products must meet the requirements of GOST 10702-78 High-Grade Structural Cold-Pressing and Heading Carbon and Alloy Steel: $\sigma_{в}$ ≥600.0 MPa; hardness HB < 207; decarburized layer thickness < 0.05 mm; surface finish class should conform to group E GOST 14955-77, i.e. there are particular marks acceptable if their depth does not exceed the half of the limit diameter deviation; $\sigma_{0.2}$ is not specified in GOST 10702-78.

In the absolute majority of cases, calibrated rolled steel products, grade 38XA, produced using actual technology feature $\sigma_{в}$ above 700 MPa ($\sigma_{в\ =}$ 75 MPa) and inacceptable values of $\sigma_{0.2}$ > 640 MPa ($\sigma_{0.2}$ = 660 MPa) where the difference of $\sigma_{0.2}$ and $\sigma_{в}$ on examination reaches 10-12 MPa. About 50% of checked rolled metal products feature hardness above the permissible value specified in GOST 10702-78, HB > 207. In most of the cases, the contraction ratio (Ψ) is less than 55%, i.e. below the permissible value. A portion of rolled metal products (≈ 20%) features the decarburized layer thickness above 0.05 mm which exceeds the permissible value. The surface finish class of over 50% of calibrated of rolled metal products does not conform to GOST 14955-77. By microstructure only the half of rolled metal products conforms to the regulatory and technical documentation requirements after annealing to granular pearlite because of non-uniform heating of metal charge in the furnace cavity.

In order to avoid the abovementioned defects it is suggested to produce calibrated rolled 38XA grade steel products of the ready diameter of 9.65 mm from the initial hot-rolled steel diameter of 14.0 mm using the following flow diagram:

- HFC (high-frequency current) annealing of hot-rolled products at the temperature of 760-780°C;

- etching rolled metal products to complete removal of scale;

- drawing rolled metal products from d = 14.0 mm to d = 12.5 mm (reduction rate is 20.0%);

- HFC annealing of rolled metal products at the temperature of 760-780°C;

- etching rolled metal products to complete removal of scale;

- drawing rolled metal products from d = 12.5 mm to d = 11.0 mm (reduction rate is 22.0%);

- HFC annealing of rolled metal products at the temperature of 760-780°C;

- etching rolled metal products to complete removal of scale;

- drawing rolled metal products from d = 11.0 mm to d = 9.65 mm (reduction rate is 23%);

- HFC annealing of rolled metal products at the temperature of 760-780°C;

- etching rolled metal products to complete removal of scale;

- calibrating through a die, d = 9.65 mm (within the elastic deformation).

Calibrated rolled 38XA steel products produced using the suggested technology unlike those produced by actual technology feature much lower plastic resistance, higher plasticity and lower hardness. These metal products have no decarburized layer.

The resulting rolled metal products are considered suitable for cold massive forming.

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