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UNDERSTANDING THE INFLUENCE OF REDUCTION MODES ON THE DEFORMATION UNEVENNESS IN A TUBE WALL

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The accuracy of geometrical dimensions and the shape of hot-deformed seamless tubes is the most important quality characteristic of this type of metal products. In this case, particular attention is paid to the dimensional accuracy of the tube wall. A deviation in the wall thickness may lead to the unevenness of mechanical properties over the tube section, as well as to the appearance of defects on the tube surface [1].

Forming a finished tube on a stretch reduction mill is one of the most important stages in the production of hot-deformed seamless tubes. A reduction mill is a mill that runs in a continuous mode and consists of three roll stands arranged in a series. As a result of successive reduction of gauges along the stands, the diameter of the rolled tube decreases; in this case, the wall thickness can increase, decrease or remain unchanged [2].

Determination of the rolling modes is one of the main tasks related to the development of reduction processes.

The aim of this research is to determine the influence of reduction speed modes on the deformation unevenness degree in the production of hot-deformed seamless steel tubes.

The process of reducing a rough tube to produce a 93.17x12.45 mm tube of steel grade TT309 (L80 type1) was examined.

A number of numerical experiments was carried out to simulate the reduction process performed in different speed modes. The characteristics of the modes are shown in Fig. 1.

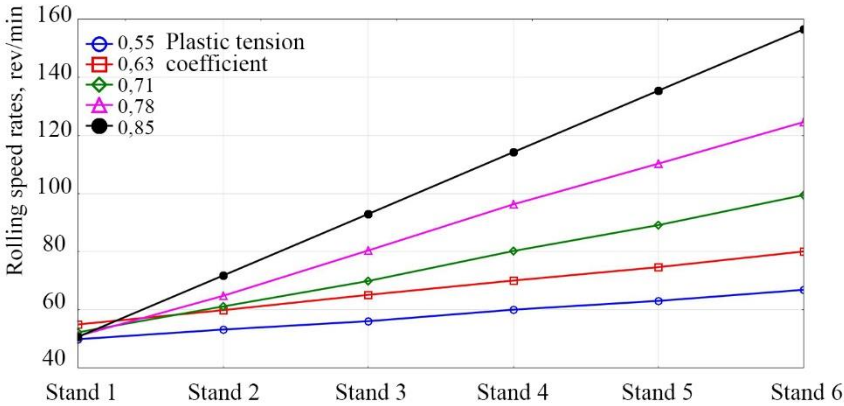

Fig. 1. Reduction Speed Modes

Using numerical simulation, the results of the stress distribution in the deformation zones of the stretch reduction mill stands were obtained (Table 1).

Table 1

Stresses in the deformation zones of the stretch reduction mill stands

	Effective stresses, MPa					
Plastic tension coefficient	Stand number					
	1	2	3	4	5	6
0.55	43.3	45.3	47.1	46.1	46.3	46.9
0.63	42.1	45.1	45.8	46.3	46.6	46.2
0.71	42.9	44.3	44.7	45.4	45.3	45.8
0.78	41.9	44.2	44.9	45.5	45.4	45.7
0.85	43.2	45.9	46.3	45.9	45.9	47.1

Having analyzed the color-coded charts of the stress state and geometric parameters of the longitudinal and cross sections of the billet in the deformation zones of the stretch reduction mill stands, the authors determined that when the plastic tension coefficient is higher than 0.8, a thinning of the tube wall takes place. When the plastic tension coefficient is below 0.6, there is an imbalance of internal stresses across the tube section, which affects the accuracy of the tube profile and contributes to the formation of nonconformity defects.

Thus, the optimal value of the plastic tension coefficient is in the range of 0.6-0.8. Sticking to the above range will contribute to a uniform stress distribution in the billet during the reduction process and thus improve the profile accuracy and the overall quality of hot-deformed seamless steel tubes.

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STRESS STATE OF DIES FOR HEXAGONAL RODS PRODUCTION

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Calibrated hexagonal rods are widely used in various industries in the manufacture of fasteners (bolts, nuts, etc.) and pipe fittings (fittings, adapters, etc.) [1-4]. The most common method of manufacturing a calibrated hexahedron is to draw through monolithic polyhedral dies, which are made in the form of a steel casing with a carbide insert pressed into it [5-7], For the manufacture of dies are used solid alloys of grades HG30, HU30, containing tungsten carbide and cobalt. The following physical and mechanical properties of alloys depend on the content of elements: compressive strength — 4600—4905 MPa; bending strength — 1400—1750 MPa; tensile strength 720—1150 MPa; modulus of elasticity 574,000-608,000 MPa; Poisson's ratio 0.21-0.23.

The design of die is the most important factor related to forming energy and deformation behavior of material. The efficiency of production of hexagonal rods largely depends on the durability of dies. The premature failure of the dies is caused due to their intensive wear and destruction due to the action of substantial radial forces from the deformable workpiece. In the process of drawing circumferential tensile stresses arise in the zones adjacent to the corners of the polyhedral hole of the die, lead to the formation and development of cracks with subsequent destruction (Fig. 1).

Figure 2 shows the distribution of the contact normal pressure N when drawing a hexagonal rod from a hexagonal billet (Fig. 2).

Quantitative and qualitative distribution of radial, circumferential, axial stresses along the length of the working channel was determined on the basis of the developed technique of computer simulation of the stressed state of polyhedral dies using the finite element method.