__Vakuumnaya installation, the pump chamber, vacuum tank, effectiveness.__

The analysis of the existing technical solutions is shown and there are proposed a number of new technical solutions that improve the performance and reliability of the vacuum systems of milking machines.

__Vacuum system, pump, camera, vacuum balloon, effectiveness.__

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The influence of internal stresses in cemented LAYER OPERATING DATA ON STEEL

__OE Semenov, Ph.D.__

Revealed regularities of distribution of internal stresses in the surface layer of consolidated parts after carburizing and hardening, the level of contact fatigue strength of steel. Established that the extreme nature of the changes compressive internal stresses provoke stress concentrators that lead to the birth of cracks, reducing the operational properties of steel.

__Hardening, tempering, compressive stress performance properties, pitynh.__

Formulation of the problem. As a result of hardening thermochemical treatment in detail, both on the surface and in the core, formed residual stresses, the magnitude and direction of which EID-nachayutsya processes occurring cooling. Residual stresses can reduce or increase structural strength, so the analysis of the nature of their distribution in the surface layer of hardened components will enable to determine the overall performance properties cementing steels.

Analysis of recent research. Arguably, the residual stresses are desirable in cases where their direction is opposite the direction of the stress arising from the operation of products.

It is known [1, 2] that the presence of compressive stresses on the surface of parts increases fatigue strength and, conversely, the presence of tensile

stress, it reduces. In this regard, details of which are exposed during operation alternating high contact load knowingly subjected to strengthening treatment, with which you can create on the workpiece surface compressive stress [1].

The magnitude and direction of residual stresses can be influenced by changing the coefficient rozmitsnennya steel in the first period of martensitic transformation, depending on the carbon content, the amount of residual austenite and cooling conditions [2].

If we consider the residual stresses in terms of physical and mechanical properties of compressed material, then other things being equal, they will decrease with the reduction of boundary strength, coefficient of thermal expansion, with increased structural homogeneity, lower temperature recrystallization, a decrease relaxation resistance and finally decreasing differences in specific volume of structural steel components in source and consolidated states [3, 4].

Found that reduce the cooling rate in the temperature range of martensitic transformation flow greatly reduces residual stresses. Thus, the transition from quenching in water for quenching in oil, residual stresses are reduced 4-6 times, while hardening the air - 10 times, the transition from hardening in oil for tempering in hot environments - in 3-4 times [4]. However, it is not associated with the level of internal stress performance properties of the material, but are only technical characteristics such as crack and strain level.

Based on the fact that during the tempering temperature increase pre-hardened steel increases the effectiveness of reducing residual stresses, the consequence will reduce wear, which depends on the surface hardness.

The purpose of research. Set patterns of influence the size and nature of the internal stresses in the surface layer of consolidated parts after thermochemical treatment, the level of contact fatigue strength of steel.

Results. In order to determine the magnitude of internal stresses in the consolidated layer of complex-alloyed steels after thermochemical treatment applied method of measuring the deflection of the sample after the removal of specified thickness of the hardened layer. For research samples were produced, which are bars of rectangular section 10 × 14 mm (Fig. 1). Samples were reinforced chemical-thermal treatment, which included cementation 930ºS temperature for 10 hours, and tempering oil with low delivery (200ºS within 2 hours). Cementation depth was 0.9 ... 1.1 mm. To the accuracy of measurement is not influenced by the internal tension in the side faces of the samples were zishlifovani to a depth of 2 mm.

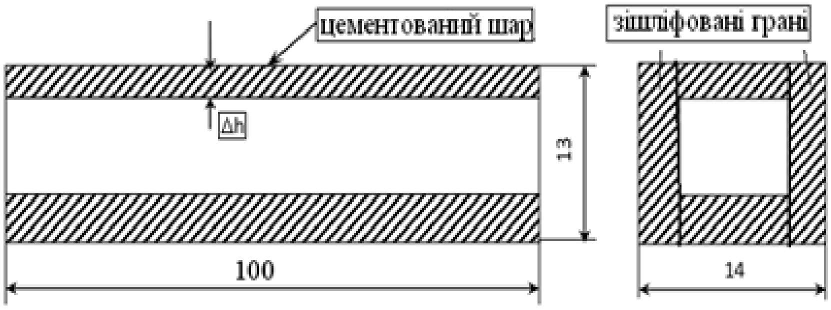

Fig. 1. Sketch a model for studies of internal stress.

The method of measuring internal stress is that in the initial state of tension on the two opposite sides of the balance each sample.

When hardened layer removed from one of the faces to a certain depth, like bends under internal pressure hardened layer opposite side.

To reduce the influence of mechanical factors on the accuracy of research when removing the hardened layer applied method of multiple etching 20% alcohol solution of nitric acid.

In deriving formulas for calculation of internal pressure came from the dependence of torque that bends the bar caused by unbalanced compressive stresses in the direction of the longitudinal axis of the bar after the removal of a certain layer of the opposite side of the sample and the mechanical properties of the material, based on this:

$$M_x = \frac{E_I \cdot I}{\rho}, \quad (1)$$

where: MX - torque; ? I - modulus of elasticity of the first kind; I - moment of inertia of the bar; ρ - radius flex pattern.

These values define the following equations:

$$M_x = \frac{N_x \cdot h}{2}; \quad (2)$$

$$I = \frac{bh^3}{12}; \quad (3)$$

$$\rho = \left(\frac{l}{2}\right)^2 + (\rho - \Delta x)^2; \quad (4)$$

where: Nx - efforts caused by compression stress in the direction of the longitudinal axis of the bar;

x - The value of deflection after removal of layers, which are defined stress;

h - The thickness of the bar after removing the layer, which determine stress;

b - The width of the bar;

l - The length of the bar;

Despite the fact that:

$$\sigma_H = \frac{N_X}{b\Delta h} \tag{5}$$

where: σn - stress in the investigated layer;

bΔh- Cross-sectional area of the removed layer;

can deduce the following relationship for determining internal stresses in reinforced layers:

$$\sigma_H = \frac{4E \cdot h^2 \cdot \Delta x}{3l^2 \cdot \Delta h} \tag{6}$$

To improve the accuracy of the proposed method was used in measuring the deflection tool microscope UIM-1 provides accurate measurements to - 10.4 mm.

The distribution of stresses in the cemented layer after thermochemical treatment was investigated by ztravlennya surface samples from one side to the nitric acid solution, followed by hand-grinding for removing oxide film. After several cycles of digestion sample thickness was measured and determined for this indicator depth ztravlenoho layer, in which the total value was determined residual internal stresses resulting from the processes that occur during hardening.

To establish a relationship of tension surface hardened layer with other parameters that were defined in the study of the processes taking place during heat treatment details, to study the magnitude of residual stresses in consolidated layer of steel were chosen with the same compositions of alloying elements and to determine prohartovuvanosti and mechanical properties [5]. The results of measurement of specimens after ztravlennya cemented layer and calculation of internal stresses in the metal layers removed, summarized in Table. 1.

The greatest stress on the surface of a steel 15HHN4, compared with her 12HNZA steel has a lower level of residual stress, due to a decrease in the degree of doping. The lowest residual stresses in the surface layer of steel 15HHN that contains the least amount of nickel. In the developed steel 15HHNBTCH we stress in the surface layer lower than in high-alloy steel 15HHN4 and are almost on a par with serial 12HNZA steel. On comparing the degree lehovanosti these steels is difficult to say, because titanium and niobium in quantities much stronger strengthen steel than nickel.

1. Distribution of internal stresses in consolidated layer.

Mark steel	Depth measurement mm	Change deflection microns	Tension σ_{in}, kPa
12HNZA	0.1	21.1	86.7
	0.3	19.4	78.4

	0.5	10.9	41.8
	0.7	4.1	16.2
	0.9	1.2	4.3
	0.1	23.8	98.2
	0.3	22.9	90.2
15HHN4	0.5	9.8	38.2
	0.7	3.9	14.9
	0.9	1.5	5.2
	0.1	9.9	46.5
	0.3	6.6	27.9
15HHN	0.5	5.5	22.7
	0.7	1.7	6.7
	0.9	1.1	3.5
	0.1	19.7	79.9
	0.3	11.0	43.7
15HHNBTCH	0.5	5.3	20.7
	0.7	1.1	4.0
	0.9	0.1	0.4
	0.1	15.3	63.2
	0.3	13.9	55.4
18XGT	0.5	3.7	14.2
	0.7	3.6	13.5
	0.9	1.1	4.0

Confirmation of these considerations may be comparing levels of residual stresses in steel and 15HHN 18XGT with lower content of alloying elements. As we see steel containing only 0.05% titanium, is 1.5 times higher levels of internal stress in the surface layer than steel of 1% nickel. However, if you compare the value of internal stresses in complex-alloyed steel, stainless steel and 15HHNBTCH three percent nickel - 12HNZA their mechanical properties [5], there are some discrepancies, ie steel with almost the same amount of internal stress have different levels of strength characteristics.

This is because the mechanical characteristics were determined by standard methods of testing on samples consolidated volume quenching and low tempering, and surface layer, which identifies internal stresses, cementation and was strengthened as a result, and different chemical composition and structure.

In addition, according to the working hypothesis, the magnitude of residual internal stresses to be associated with it microhardness structure surface modified layer. But if we compare the data with the results of the contact fatigue strength steel obtained in vitro (6), we see a discrepancy results of these studies. Anyway, when the criterion for determining stresses take their maximum value on the surface. However, contact fatigue strength, which is a defining characteristic of gears operating properties affect tension arising around the cross-section and, as shown by further research, the nature of stress changes.

This causing our work stress were determined not only on the surface but also throughout the depth of hardened layer. To study the changing nature of the absolute value of compressive residual internal stresses were built graphical dependence (Fig. 2).

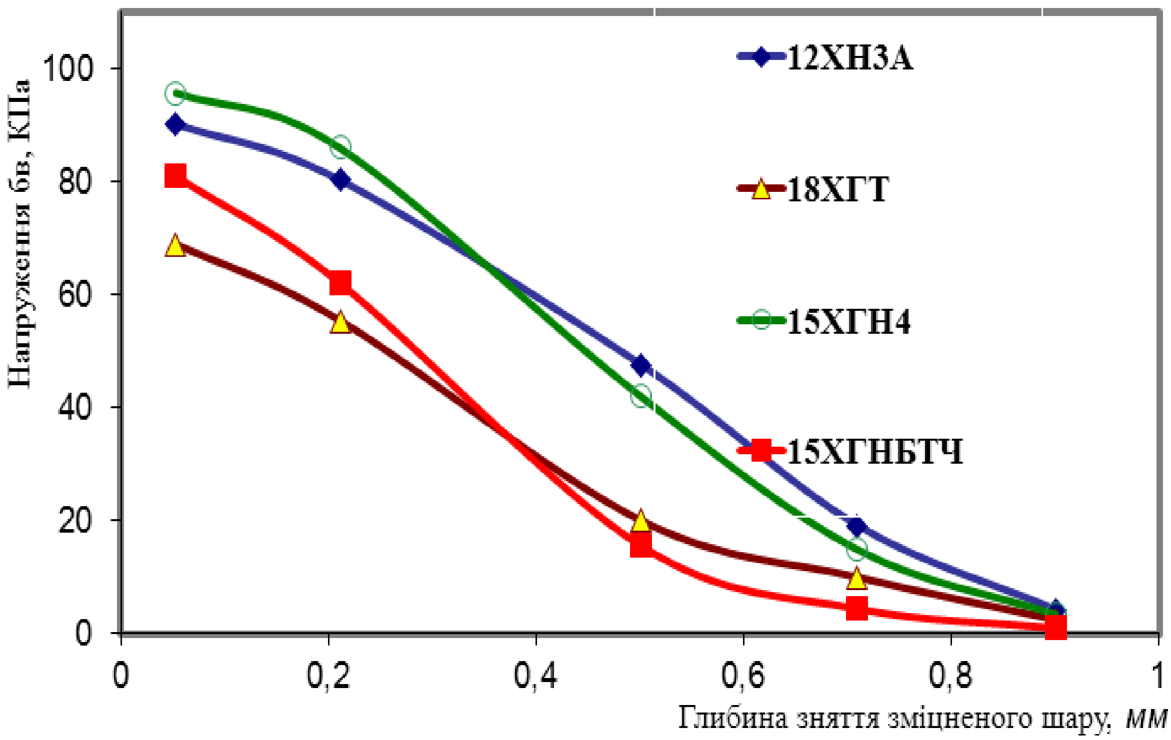

Fig. 2. The distribution of compressive residual stresses in the consolidated layer.

The nature of the curve suggests that the complex-alloy steel 15HHNBTCH has a sharp reduction of stress, as the distance from the surface, compared to the rest of the investigated compositions for cementing steel.

Computer processing of the total value of all the stress hardened layer showed that the rate in steel 12HNZA significantly higher than that of steel alloy nickel less, but with the additional introduction of alloying elements such as titanium and niobium, which form a carbide phase, resistant to high temperatures.

The results of our study microstructure (201), showed much greater dispersion 15HHNBTCH steel structural components having the highest level of contact fatigue strength compared to the rest investigated compositions for cementing steel. Analysis of the curves describing the change in residual internal stresses indicates that the steel which has a more uniform stress state nature of lowering the surface to the core (ie curve has a gentle nature, approaching the line) has the highest level of performance properties.

This is because, if the stress change is gradual in nature, without drastic changes, characterized by the lack of graphical changes, extremes in curves, the likelihood of stress concentrators in the surface layer of consolidated considerably lower. And it is the presence of hubs napruzhnen leads to nucleation and propagation of cracks that cause contact fatigue of the material surface details - pitynhu.

But recommend this characteristic to determine the performance of steel impractical for two reasons. First, the value of residual internal stresses only indirectly related to the characteristics of structural components that get in the heat treatment, and is uncontrollable parameters of the surface. Second, its definition is associated with considerable technical difficulties. At the same time, qualitative characteristics, it confirms our results in the study of the performance properties of steels with different compositions of alloying elements. Although in terms of bulk material characteristics of this setting is crucial, especially in terms of the close connection of this size with a hardness of surface hardened layers and wear resistance of materials.

Conclusion. In this paper, the dependence of the stability of steel against the formation pitynhu change the nature of internal stress obtained during the thermochemical treatment. The results show that if the level of tension in the cemented layer decreases gradually, characterized by the absence of extremes graphically on curves, the likelihood of stress concentrators in the surface layer of consolidated considerably lower.

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Vыyavlennы zakonomernosty Effect apportionment Internal tense in poverhnostnoy uprochnennoy stratum tsementatsyy parts after hardening and, in the Contact Level prochnosty steel. Established something эkstremalnыy nature Changed szhymayuschyh Internal tense provotsyruet Appearance kontsentratorov tense, kotoryya provochyruyut Origin mykrotreschyn, kotoryya snyzhaet эkspluatatsyonnыe properties of steel.

Tsementatsyya, hardening, szhymayuschye voltage, эkspluatatsyonnыe properties, pytynh.

The regularities of influence of distribution of internal pressures in surface hardened layer of parts after carburizing and hardening are derived. The level of steel contact fatigue hardness is kept during experiments. It was found that extreme changes of compressive internal pressures provokes the pressures concentrators which cause forming of microcracks and that reduces the operational performance of steel.

Carburizing, hardening, compressive stress, operational performance, pitting.