The experimental research results specific energy consumption dependence for the biodiesel production and main operational and process parameters equipment are given.
Etherification, power, specific energy intensity, rapeseed oil, biodiesel.

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PROSPECTS FOR IMPROVEMENT RESOURCE The responsible PARTS AGRICULTURAL MACHINES

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Powered promising areas increase service life of critical parts of agricultural machines.
Resource nanoparticle dispersion strengthening, carbides, nitrides, vanadium, driving wheel, roller, link tracks, tractor.

Problem. The structure of the materials used in the engineering of farming country, irrational and a hindrance to the successful resolution of the problem of raising the technical level of machines produced. For example, the proportion of high-strength steels used in total Cast and rolled steel is 6% compared to 18-20% in rural economic engineering developed countries. In the design of the machine is mainly used traditional construction materials, assortment and quality of which do not meet modern requirements. This is one reason that about 40% of agricultural machinery, manufactured, and 30% of tractors are compared with foreign counterparts high metal content, low resource idovhovichnist separate units that are particularly exposed to abrasion wear.

For example, to set cultivator working bodies of foreign firms «Lemken» in terms of a superior domestic counterparts 10 times. Compared to classic agricultural machinery use of such technology can reduce fuel consumption of lubricants by 30% and shorten the field work.

The technical provision of agriculture in Ukraine remains quite low. Recently, at the same time narrowing the volume of agricultural production declined and agricultural machinery fleet. Much of the technology that is available on farms worked by two or more legal limit.

To restore the previous level of agriculture should significantly increase the number and quality of agricultural machinery. Do this by importing impossible because imported equipment 2 - 3 times more expensive than domestic.

Therefore, the development of new ways to increase service life of critical parts of agricultural machines is an urgent problem.

Analysis of recent research. Operational properties of structural steels are determined by a combination of the values of their characteristics, such as strength, ductility, fatigue strength, hladostoykost, fracture toughness, wear resistance and several others.

The least favorable combination of these properties in carbon steel as the increased strength with increasing carbon content is accompanied by a decrease in natural plasticity, fracture toughness and other characteristics.

Formation of the desired combinations of performance properties achieved by alloying and modifying element for reducing the structural heterogeneity of steel, increasing the strength of solid solution strengthening and degree of dispersion of the metal.

By strengthening the efficiency of steel alloying elements are as follows: Ni, Si, Mn, Cr, Mo, C, N, V. The most significant and economical strengthening structural steel is achieved by doping with vanadium and nitrogen. This allocation determined by the characteristics of vanadium carbides and nitrides. If necessary thermodynamic conditions of allocation of austenite and ferrite as easily made directly from the solid solution crystal structure defects in the metal matrix. In other doping elements thermodynamic, kinetic and crystallographic conditions dispersed and uniform allocation carbide phase is less favorable.

Based on the analysis of physical and mechanical properties of structural steels of different doping can conclude that for complex formation favorable ratio high level of strength and plastic properties while minimizing alloying elements chemical composition of the steel, modes of modification and heat treatment should ensure dispersion of all elements of the structure and reduction of primary and secondary chemical and physical heterogeneity castings.

Materials in ultra condition (size order of nanometers) have specific properties that are due to the peculiarities of the structure and the large number of atoms located on the surface of nanomaterials. For example, the proportion of atoms trapped on the surface of nickel with an average size of 5 nm is 15%, while for single crystal Ni measuring 1 cm - about 10.6% [1].

Because neskompensovannosti relations atoms that surface layers of nanoscale particles broken symmetry distribution of forces acting on them. This increases the surface free energy compared with macro and mikrorazmernymi materials and, consequently, to intensify the processes of adsorption, ion exchange, etc. and atomic surface atoms make a significant contribution to the thermodynamic properties of nanoscale solids and largely determine the structural transitions and melting temperature of nanoparticles, which are often called energy-systems [1].

Specific properties of steels and alloys containing nanoscale elements of the structure, open up opportunities for new efficient materials and their use in engineering, medicine and agriculture.

So is theoretical and practical interest to develop integrated management principles doping carbon, manganese, silicon, chromium, vanadium and nitrogen regimes modification and various heat treatment to obtain nanoscale structural elements and proof of physical - mechanical properties of structural steels to Sparingly of chrome-molybdenum and hromonikelemolibdenovyh with an increase of service life.

The purpose of research. Develop new ways to increase service life of critical parts of agricultural machines.

Results. Formation of nano-objects in the solid phase probably as a result of solid solutions. Getting nanoscale objects (carbides, nitrides, intermetallic and others.) The decay of solid solutions used in the manufacture of hardened and tempered material variance and the solid alloys.

The process is heated to a high temperature alloy (usually higher than the temperature of phase transformations) to dissolve large initial phase and homogenizing solid solution obtained fixing state of rapid cooling (quenching) and separation of the solid solution dispersed secondary phases in the process of tempering or aging. A typical distribution of secondary phases (carbides, nitrides, intermetallic and others.) Is shown in Fig. 1.

One of the known examples of solid solution is the formation of Al - Cu alloys Guinier-Preston zones, thickness of 0.5-1.0 nm and a diameter of 4-10 nm, their transformation during heating and aging, a metastable phase thickness of 10 nm and a diameter of 150 nm, which further processes that use heat and exposure becomes a stable phase Al2Cu. Another typical example is the selection of solid solution alloy carbides, nitrides, and other phases yntermetallydov size of 1 nm or more.

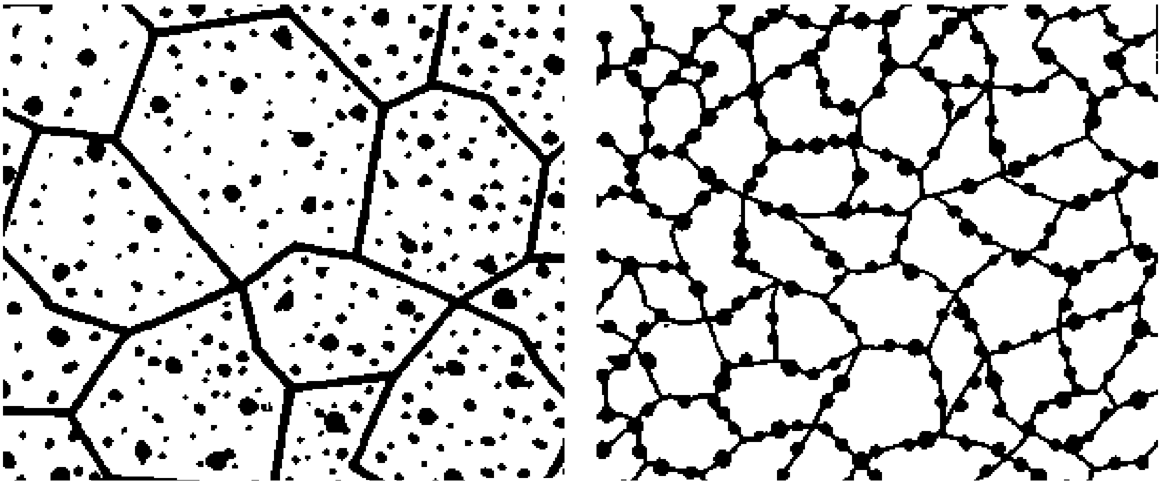

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Fig. 1. Dispersion (a) and aggregate (b) the structurevariance the solid alloys.

Heat treatment of alloys, properties are determined by the dispersion and distribution of second phase has a number of features. Heating temperature and exposure to hardening alloys are determined by the maximum dissolution of secondary phases in the matrix and minimum grain. The increase in heating temperature and exposure time for quenching leads to intensify the process of dissolution of secondary phases, while the growth of grains. Issue after quenching and aging leads to separation and coagulation of secondary phases, size and distribution of which depend strongly on the heat treatment and chemical composition of the alloy.

The process of secondary phases depends on the free energy of the system and thermokinetic parameters of phase transformations that define the sequence alloy structural conditions and patterns of nucleation of new phases and growth. Options heat treatment and chemical composition of the material have an ambiguous effect on the dispersion and distribution of secondary phases.

Temperature equilibrium various phases in the metal significantly depends not only on the absolute change in free energy of the system as the ratio of free energy change of the initial phase and the phase formed. If the free energy of the initial phase, such as ferrite doping wholly or largely unasliduyetsya during phase transformations, phase formed such austenite, the temperature shift early phase transformation during heating will be in the region of higher temperatures. If the unasliduyetsya the free energy of the beginning of the process will move into the region of lower temperatures.

A necessary condition for obtaining disperse phases is their dissolution in the high-temperature heating. Temperature equilibrium secondary phases and solid solution determined thermodynamic activity component phases and the free energy of formation in solution, which, in turn, depend on the chemical composition. For example, the equilibrium temperature of aluminum nitride, vanadium and cerium, and vanadium carbides in austenite can be calculated by the following equation:

TVN = (- 9473 + 2436 [V] +8950 [N] +932 [C] +160 [Mn] -67 [Si] +419 [Cr] +
+1610 [Al] +411 [Ce] -535 [Ni] +2659 [Mo]) / (lg [V·N] - 3,97+
+1,5 [V] +5,44 [N] +0,059 [Si] +0,128 [Cr] +0,0598 [Mn] +0,831 [Al] +
+0,196 [Ce] +0,408 [C] -0,0344 [Ni] +1,5 [Mo]); (1)

TAlN = (- + 11 794 1558 [Al] +310 [N] -73 [C] +2461 [V] +108 [Si] +325 [Mn] +
+281 [Cr] +411 [Ce]) / (lg [Al·N] -5,0 + 0,861 [Al] +1,6 [N] +
+0,118 [C] +1,5 [V] +0,18 [Si] +0,171 [Mn] +0,086 [Cr] +0,196 [Ce]; (2)

TVC = (- 9500-66 [Si] +38 [Mn] +212 [Cr] +9323 [N]) / (lg [V·C] -
-6.72 + 6.5·10-3 [Mn] +0,0524 [Cr] +0,0932 [Si] +5,79 [N]; (3)

TCeN = (-9040 + 700 [C] -271 [Si] -80 [Mn] +312 [Cr] +2461 [V]) / (lg [Ce·N] -
- 4,25 + 0,654 [C] -0,097 [Si] +0,106 [Cr] +1,5 [V] +0,067 [Mn] (4)

where - [V], [N], [C], [Mn], [Si], [Cr], [Al], [Ce], [Ni], [Mo] elements in austenite content, by weight. USD. %.

The reduced dependence in non-equilibrium conditions characterizing the temperature starting your secondary phases during cooling and completely dissolved by heating steel.

Bold secondary phases of solid solutions begins with their supercooling below the equilibrium temperature. Thermodynamic activity and diffusion mobility components that form the secondary phase is one of the main factors that determine the kinetics of the process.

It is known that the ratio of the volume of the new phase, released in time τ the equilibrium volume (ξ) Is described by AN Kolmogorov:

$$\xi = 1 - \exp\{-[(X_\beta - X_\alpha^p)/(X_\alpha^o - X_\alpha^p)]\int_0^\tau J(\tau)V(\tau - \tau_0)d\tau \text{ And} \quad (5)$$

where J (τ) - The rate of formation of secondary phases; V (τ -τ_0) - The amount of the new phase that occurred at time τ_0 at time τ; $X_\beta, X_\alpha^p, X_\alpha^o$ - Respectively, the mole fate fazoutvoryuyuchoho element in the secondary phase equilibrium in solution with secondary phase and in the initial metastable solution.

The rate of nucleation of a new phase of arbitrary shape described by the equation:

J = A·Nv (kT / h) exp [- (W + U) / RT], (6)

where A - constant, depending on the energy barrier of secondary nucleation phase (W); h - Planck's constant; Nv - fazoutvoryuyuchyh number of atoms per unit volume elements; U - diffusion activation energy (close to the activation energy of diffusion of the least mobile component); k - Boltzmann constant.

The growth rate of spherical particles (radius r), according to calculations BJ Love is described by the equation

$$dr / d\tau = [(X_{\alpha}^{o} - X_{\alpha}^{p})/(X_{\beta} - X_{\alpha}^{p})](D/r) ,(7)$$

where D - diffusion coefficient of the solute.

The reduced dependence shows that the allocation of secondary phases kinetics of the solid solution content is controlled fazoutvoryuyuchyh elements in solid solution temperature, which determines the value of the thermodynamic reaction of the stimulus, the diffusion of the components forming the secondary phase and time process.

Effect of temperature on the kinetics of the allocation of secondary phases associated not only with the absolute value of the temperature (T), but with the departure process from the equilibrium temperature of the secondary phase of solid solution (Tr).

For small values of hypothermia (ΔT = Tp - T) value of the energy barrier W is important, therefore, the factor exp (-W / RT) is close to zero, which results in spite of the high diffusion mobility of atoms fazoutvoryuyuchyh elements to an infinitesimal rate inception. With increasing values (ΔT) value of the energy barrier nucleation of a new phase decreases and if diffusion mobility of atoms is sufficiently large, the decay rate increase. In case of intensive growth activation energy (U), which exceeds the accelerating effect of reducing the value W, the decay rate after reaching the peak begins to decrease.

Given that the process of dissolution and release of secondary phases in the austenitic region occur in relatively high diffusion mobility of atoms can assume that in this case the effect of the temperature factor mainly proyavlyatymetsya in process temperature deviation from equilibrium.

The kinetics of dissolution and release of secondary phases in austenite content is determined fazoutvoryuyuchyh items deflection temperature process of phase equilibrium temperature, time and process activity components in solid solution.

For example, change the content of vanadium nitride (qVNa) by heating and nyzko- serednolehovanyh steels determined by the values of thermodynamic activity coefficient of nitrogen (fN) and vanadium (fV), the degree of deviation from the equilibrium temperature austenitizatsiyi dissolution temperature nitride phase (ΔT = TVN - T), the duration of heating (τ) And described by the following relationship:

$$qVNa = 3,63 + 5,56\cdot 10\text{-}2\tau - 4,36lg\ (fN\cdot fV) + 0,176\Delta T. \quad (8)$$

Present law allows to evaluate the effect of doping on the process of dissolution and release of vanadium nitride in the austenite steels with different parameters termochasovyh heating.

Feature selection of secondary phases during high-temperature tempering hardened iron alloys is that the process begins with the formation of disc-shaped zones isomorphic matrix elements replacement and implementation, turning them into "mixed" areas that include elements of replacement and implementation, and finally, the selection of secondary phase with the crystal lattice B1, regardless of its equilibrium, followed by a rearrangement of the equilibrium structure.

The mechanism of nucleation phase implementation iron does not depend on the type of element implementation. The collapse begins with the formation of clusters isomorphic matrix zones. The formation of clusters and karbido- nitrydoutvoryuyuchyh elements and carbon and nitrogen changes the thermodynamic relations in the alloy, which is one of the reasons for the diffusion of carbon atoms and nitrogen atoms to the places where karbido- and nitrydoutvoryuyuchyh elements with greater affinity for carbon and nitrogen than iron . Clusters of atoms are mixed and thus the free energy of the alloy decreases.

Studies show that the kinetics selection carbides and nitrides in the delivery of structural steel hardened described, respectively, diffusion mobility (DSf, DNf) and the limit of solubility ([C] pf, [N] pf) of carbon and nitrogen in ferrite and duration of the process (τ). Analytical dependences are as follows:

$$qkf = 19.3 + 0.848\cdot ln\ DSf - 3.01\cdot lg\ [C]\ pf + 4.75\cdot 10\text{-}3\tau (9)$$

$$qVNf = 57.6 + 0,356\cdot ln\ DNf - 9,17\cdot lg\ [N] + pf\ 7.79\cdot\tau (10)$$

$$dk = 294.79 + 23.776\cdot lnDcf + 0.48\cdot (LnDcf)\ 2\ (11)$$

$$dVN = 0,866 + 4,96\cdot 10\text{-}2\cdot lnDNf + 7,44\cdot 10\text{-}5\cdot (LnDNf)\ 2\ (12)$$

$$\lambda_{for} = -4.87 + 28.81\cdot lg\ [C]\ pf + 1.23\cdot lg\ [C]\ pf\cdot lnDcf + 8,62\cdot dk, (13)$$

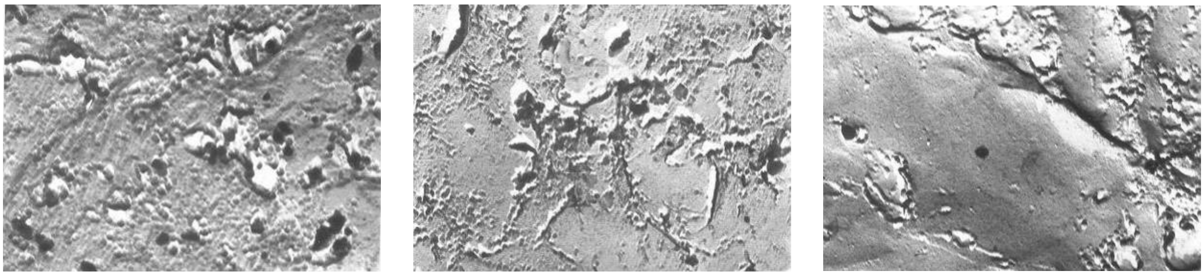
$$\lambda_{VN} = -0.963 + 1.31\cdot lg\ [N] + pf\ 3.33\cdot 10\text{-}2\cdot lg\ [N]\ pf\cdot lnDNf\ 23,47 +\cdot dVNf \quad (14)$$

where qVNf and qkf, dVN and dk,λ_{VN} andλ_{for} - Weight fraction, size and distance interlobar vanadium nitride and carbide, respectively.

The above laws provide forecasting kinetics selection nanoscale carbide phases and nitrydvanadyyevoyi in low- and serednolehovanyh structural steels and optimization of temperature and time parameters to improve them for the purpose of even distribution of nanoscale dispersed secondary phases in the matrix.

In the case of the known kinetics selection of secondary phases of solid crystalline solution focused management process possible formation of nanocrystalline materials.

Production of critical parts of agricultural machines, as a link tracks, driving wheels and rollers coming from low-alloy structural steels nanoroz-dimensional vanadium nitride particles and their use allowed reduce abrasive wear rate of 1.5 - 2 times, and lifetime pidvysyt 2-2.5 times.



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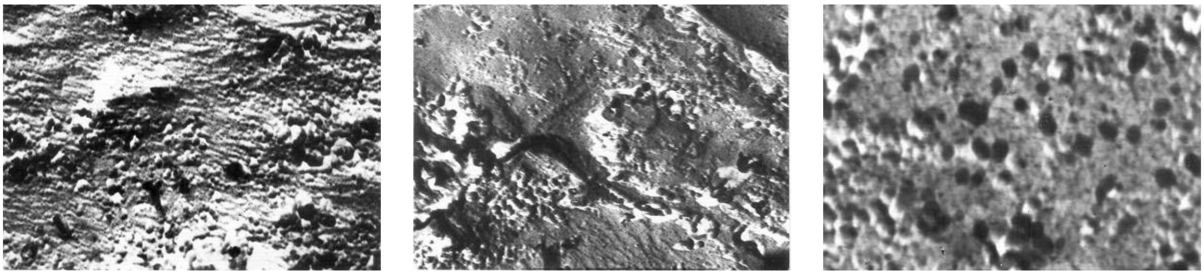

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Fig. 2. Nanosize vanadium nitrides (including black) for improved steels 20HHSAFL (a) 40HHSAFL (b) 20HH3SAFL (a) 20HHS3AFL (d) 20H3HSAFL (e) and Armco-iron (e): a, b, d, e - an increase of 27,000; E - 39000.

Conclusion. Established quantitative regularities of chemical composition on the phase parameters determining the formation of nanoscale elements of the structure and properties of structural steels. The analytical dependencies provide the possibility of computer optimization of chemical composition and heat treatment of structural steels with optimal combination of alloying, abrasive wear resistance and service life of critical parts of agricultural machines.

References

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Pryvedenы perspektyvnыe direction Increase resources work otvetstvennыh parts agricultural machines.

Resource nanoparticles, dyspersyonnoe uprochnenye, carbides, nytrydы, vanadium, veduschee wheel, roller, Zveno husenytsы, tractor.

Perspective directions of increasing the service life of responsible details of agricultural machines are.

Resource, nanoparticle, dispersion hardening, carbides, nitrides, vanadium, driving wheel, roller, track link, the tractor.