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Dnipropetrovsk, Ukraine

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(Material sciense, Constructional design)

D.Sc. in engineering, professor

National Metallurgical Academy of Ukraine

Dnipropetrovsk, Ukraine

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Size correction of fuzzy classifier rules area by dispersion value of ultrasonic measurements results in ore mineral varieties determining

Vladimir Morkun

Vice-Rector for research,
Doctor of Science, Professor,
Professor of Computer Science, Automation and Control Systems department,
Kryvyi Rih National University,
Kryvyi Rih, Ukraine

Natalia Morkun

PhD, Associate professor of Economic Cybernetics and Project Management Department,
Kryvyi Rih National University,
Kryvyi Rih, Ukraine

Nikolai Podgorodetsky

PhD, Associate professor of Labor Protection, Life Safety and Civil Protection Department,
Donbas National Academy of Civil Engineering and Architecture,
Ukraine

Abstract
An accuracy increasing method of processed ore mineral varieties determination based on subtractive clustering of its features with the correction of fuzzy rules region dimensions by the evaluation of intensity dispersion of high-frequency volume ultrasonic vibrations, which passed a fixed distance in a controlled volume of pulp is proposed.
Keywords: MINERAL VARIETIES, FUZZY CLASSIFIER, ULTRASOUND, MEASUREMENTS

To solve the problem of increasing the accuracy of fuzzy classification method of object characteristics based on subtractive clustering algorithm, it is necessary to perform the optimization of the vector, which determines the rules region dimensions for each coordinate, and if necessary, adjust it during observations [1-6]. Let's consider the procedure of setup and correction of rules region dimensions of subtractive clustering by observation results dispersion value on example of pulse parameters measurement of ultrasonic waves passed through a controlled volume of pulp. As is known, the function describing the harmonic wave, which propagates in nondispersive media is written as [5]

$$u(x,t) = A\cos(kx - \omega t), \quad (1)$$

where $k = 2\pi/\lambda$ – is the wave vector; $\omega = 2\pi/T$ – is the circular frequency; T –is the wave period.

Analysis of (1) shows that we can enter a phase function of cosine traveling wave, which propagates in the positive direction of OX axis as the argument of the wave function

$$\phi(x,t) = \omega t - kx. \quad (2)$$

To track any wave crest (max $\cos\phi(x,t)$) or for its trough (min $\cos\phi(x,t)$), with an increase in time it is necessary to proceed to increasing value of x so that the phase $\phi(x,t)$ is constant. Phase constancy condition from a mathematical point of view means that the total differential of function $\phi(x,t)$, which has the form

$$d\phi = \left(\frac{\partial\phi}{\partial t}\right)dt + \left(\frac{\partial\phi}{\partial x}\right)dx = \omega\, dt - kdx, \quad (3)$$

is equal to zero. By equating (3) to zero, we find the condition of phase constancy

$$\frac{dx}{dt} = v_f = \frac{\omega}{k}, \quad (4)$$

where v_f –is the phase velocity of the wave.

Equation (4) establishes a relationship between the phase velocity of the wave, wave frequency and wave vector. Wave propagation conditions are determined by medium properties. Thereby ω, and phase velocity are dependent on the wave vector k. A dispersing wave, which represents a superposition of traveling waves with different wave numbers, changes its form in space in process of distribution as components of different wavelengths travel at different velocities. Let's consider an ultrasonic pulse movement in a dispersive medium, by which we mean a certain sine wave, which have a finite extent in both space and time. The solution to this problem is based on the representation of the wave packet as a superposition of harmonic functions (Fourier method) [7-9]. Let's denote the intensity of an ultrasonic signal during it passing a fixed distance z in the pulp by

$$I_z = I_0 \exp\left\{-\frac{1}{V}\sum_{i=1}^{k}\sigma(r_i)z\right\}, \quad (5)$$

where $\upsilon(r_i)$ – is the ultrasound absorption cross section by particles with radius of r_i.

The dispersion of this value is given by

$$DI_z = M(I_z - < I_z >)^2 = MI_z^2 - < I_z >^2. \quad (6)$$

For a fixed number of crushed material particles in a controlled volume V [6, 10]

$$M(I_z^2) = I_0^2 \exp\left\{-nV\left(1 - \int_0^\infty e^{-\frac{2}{V}\sigma(r)z}F(r)dr\right)\right\}. \quad (7)$$

Let

$$\psi = \exp\left\{\frac{nz^2}{V}\int_0^\infty \sigma^2(r)F(r)dr\right\}. \quad (8)$$

Then

$$DI_z = I_0^2 \exp\left\{2nz\int_0^\infty \sigma(r)F(r)dr\right\}\left[\psi^2 - \psi\right]. \quad (9)$$

We will determine the relative value

$$\frac{\sqrt{DI_z}}{< I_z >} = \frac{I_0 \exp\left\{-nz\int_0^\infty \sigma(r)F(r)dr\right\}\sqrt{\psi^2 - \psi}}{I_0 \exp\left\{-nz\int_0^\infty \sigma(r)F(r)dr\right\}\sqrt{\psi}} = \sqrt{\psi - 1}. \quad (10)$$

$$\ln\frac{I_0}{< I_z >} = z\phi_s \frac{\int_0^\infty \sigma(r)F(r)dr}{\int_0^\infty 4/3\pi r^3 F(r)dr}. \quad (11)$$

$$S_D = \frac{\ln\psi}{\ln I_0/< I_z >} = \frac{z}{V}\frac{\int_\circ^\infty \sigma^2(r)F(r)dr}{\int_\circ^\infty \sigma(r)F(r)dr}. \quad (12)$$

Let's define the characteristic function

The last expression shows that the value of S_D is

defined by intensity dispersion DI_z of ultrasonic signal, which passed a fixed distance z in a controlled medium. Value of S_D is a function of the crushed ore particle size and doesn't depend on its solid phase concentration. Let the function, which is describing the traveling wave at the point $x = 0$, has a known time dependence $f(t)$

$$f(t) = u(0,t). \quad (13)$$

Let's assume that wave packet is localized in time, i.e. the envelope of the package is a function, which is quickly tending to zero at $t \to \infty$. This assumption allows us to represent the function $f(t)$ as a Fourier integral [11-15]

$$f(t) = \int_0^\infty A(\omega) e^{i\omega t} d\omega, \quad (14)$$

where

$$A(\omega) = \int_0^\infty f(t) e^{-i\omega t} dt. \quad (15)$$

Each harmonic determines its own harmonic traveling wave with wave number k, the value of which is determined by the dispersion relation

$$k = k(\omega). \quad (16)$$

Here, each traveling wave frequency component propagates with the phase velocity

$$v_f = \frac{\omega}{k(\omega)}. \quad (17)$$

The desired function $u(x,t)$, which describes the traveling wave is a superposition of these harmonic traveling waves. This means that finding of $u(x,t)$ is possible by replacement ωt on $(\omega(k)\, t - kx)$ in each harmonic component of superposition (15)

$$u(x,t) = \int_0^\infty A(\omega) e^{i(\omega t - k(\omega)x)} d\omega. \quad (18)$$

It should be noted that the calculation of the integrals in (14), (16) and (18) should be carried out at time intervals of finite length of T, i.e. perform the expansion of the function in a Fourier series, using the following expression

$$f(t) = \sum_{n=0}^{N-1} A(n) e^{i(2\pi/T)nt}, \quad (19)$$

$$A(n) = \frac{1}{T} \int_0^T f(t) e^{-i(2\pi/T)nt} dt, \quad n = 0,1,\ldots,N-1, \quad (20)$$

$$u(x,t) = \sum_{n=0}^{N} A(n) e^{i[(2\pi/T)nt - k((2\pi/T)n)x]}, \quad (21)$$

where N – is the number of function $f(x)$ values.

To speed up the computation of the coefficients $A(n)$ it is possible to use a Fast Fourier Transform (FFT). Thus, the numerical solution of the problem of wave packet motion in a medium with a dispersion relation of the form $\omega(k) = k + \alpha k^2$ is in accordance with the following algorithm:

- set the function $f(t)$, which describes the initial disturbance at $t = 0$;
- set the function $k = k(\omega)$ (at impossibility of analytical inversion of dispersion relation $\omega = \omega(k)$, one should find numerically the corresponding value of the wave number, as the root of the equation $\omega_s = \omega(k)$) for each frequency setpoint $\omega_s = 2\pi s/T, s = 1,\ldots N$;
- set boundaries of time interval on which a solution of problem is sought.
- specify the number of time grid nodes;
- calculate the values of the function $f(t)$, in time grid nodes;
- calculate the expansion coefficients of the function $f(t)$ in a Fourier series;
- calculate the values of the function $u(x,t)$ at a given time in accordance with (21).

Fig. 1 shows real and imaginary parts of the original pulse, and Fig. 2 shows the envelopes of wave packet at various points of x of measuring vessel, which were determined according to the algorithm given above. Analysis of the results shows that the wave packet is localized in the interval [18 ... 62].

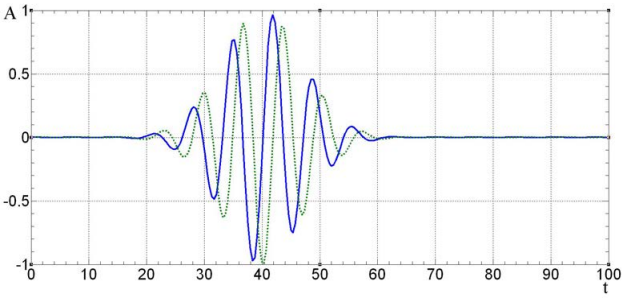

Figure 1. The imaginary and real parts of the initial ultrasound pulse

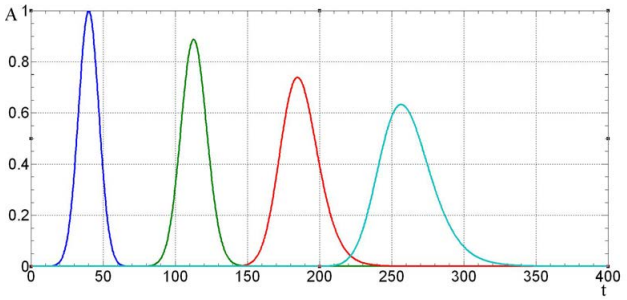

Figure 2. The envelopes of the wave packet at different time points

In the process of movement the wave packet shape is changing: there is a decrease in height of packet envelope while increasing its width (the spread of wave packet in the space caused by dispersion properties of the medium - variations of the crushed ore particle size characteristics in the pulp) [16-18].

Conclusions

The proposed method allows to identify mineral varieties of processed ore in the process initial stage with high degree of accuracy, to compare it with respective technological regulations and predefined optimum separation characteristics of classifying and processing apparatus, and thus achieves the specified parameters of beneficiation while maximizing productivity and efficiency.

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Peculiarities of carbothermic reduction of titanomagnetite ore pellets

Baboshko D. Yu.

Ph.D. in Engineering Science
Kryvyi Rih National University,
Kryvyi Rih, Ukraine

Tkach V. V.

Ph.D. in Engineering Science
Kryvyi Rih National University,
Kryvyi Rih, Ukraine

Gubin G. V.

D.Sc. in engineering
Kryvyi Rih National University,
Kryvyi Rih, Ukraine

Zima S. N.

Candidate of geological and mineralogical sciences
Kryvyi Rih National University,
Kryvyi Rih, Ukraine

Vodennikova O. S.

Ph.D. in Engineering Science
Zaporizhia State Engineering Academy
Zaporizhia, Ukraine

Abstract
The aim of this research was to study the peculiarities of structural transformations of the mineral particles in the process of carbothermic reduction of titanomagnetite ore pellets with a high mass fraction of titanium (20 % TiO_2) within the temperature range of 800-1500 °C, and also to establish technological parameters of this process.
Keywords: TITANOMAGNETITE CONCENTRATE, POLISHED SECTIONS, EDGE, CARBOTHERMIC REDUCTION, SOLID PHASE CHANGES, METALLIC IRON, TITANIUM SLAG

Ukraine possesses large reserves of complex titanium magnetite ores, which use is possible after development of new-type technology for processing of titaniferous concentrates with high content of titanium. The technology ITmk3 (Ironmaking Technology Mark Three) based on process of solidphase reduction of ferriferous pellets in rotary furnaces [1-3] is perspective for processing of high grade (> 8 % TiO_2) titanium magnetite concentrates. The technology ITmk3 is characterized by high rates of quality of the final product, law level of pollutant emissions and rather small specific capital expenditure [4-6].

Research problem statement

Previous researches of carbothermic process of titanium magnetite concentrates reduction with mass fraction of Fe_{tot} 56.5-64.5% and titanium dioxide 3.0-16.7% have shown that in case of metallization, obtaining metal ferriferous product and slag with mass fraction of TiO_2 15.4-62.5% is possible [5]. For development of technology and parameters of technological process it is necessary to study laws of textural-structural and mineralogical transformation in titanium magnetite agglomerate (pellets, briquettes).

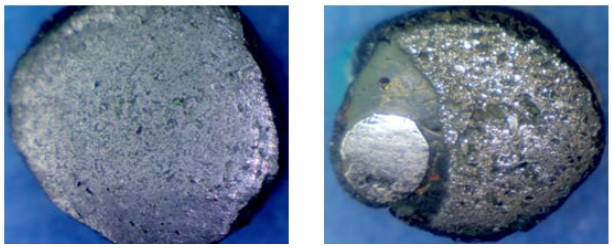
Materials and techniques of research

The object of research was pellets from titanium magnetite concentrate of apatite-ilmenite-titanium magnetite ores [7] with the following composition, mass %: 45.5 FeO; 23.0 Fe_2O_3; 22.03 TiO_2; 1.5 SiO_2; 1.2 Al_2O_3; 0.26 CaO; 3.4 MgO; 0.42 MnO; 0.516 V_2O_5; 0.04 Cr_2O_3. Taking into account recommendations [1, 2], the mass fraction of carbon and fluxing agent in furnace charge of the researched pellets with diameter of 5-10 mm was 20 and 2% respectively.

Results of researches and their discussion

Studies of textural-structural and mineralogical transformations were carried out by methods of macro- and microscopic researches.

The **macroscopic** studies of pellets polished sections have shown that pellets keep uniform structure at the initial stages of reduction (800-900 ºC). At a temperature of 1000 ºC, the coats of sponge metal of 1-1.5 mm in thickness and more emerge at the surface of pellets. At that, the core of pellets remains uniform. With increase of temperature more than 1100 ºC and holding time in cores of pellets, the spotty texture takes place. It is caused by redistribution of metal iron (Fe^o), which is accumulated in the separate microvolumes and forms light bright spots on the darker opaque background of slag zones (Figure 1a), in volume of a pellet. With growth of reduction temperature and increase in soaking time, metal iron concentrates in the form of spherical shapes from 1 to 4-5 mm in size (Figure 1b). At reduction tempe- ratures more than 1250 ºC (soaking of 20-40 min), deformation of spherical shape of pellets is observed that specifies their emolliating. Total loss of the shape takes place only at a temperature more than 1300 ºC and the soaking of 80 minutes.



a) b)

Figure 1. A texture of pellets in case of different parameters of reduction, incr. $\mathbf{5^x}$: a) reduction temperature - 1100 ºC, soaking - 20 min.; b) reduction temperature - 1300 ºC, soaking - 40 min. Bright – metal, opaque – slag

Microscopic researches of the pellets reduced at a temperature of 800 °C have shown that there are no significant phase conversions in pellets. At a temperature of 900 °C and soaking of 20-40 min, metal iron (Fe^o) in the form of discharge, which is less than 1-2 microns (Figure 2a), is formed in titanomagnetite.

At reduction temperatures of 1000-1100 ºC, the coat (outer zone) with thickness 1-3 mm and core with diameter of 5-8 mm which size does not depend on temperature and time of reduction emerge in a texture

of pellets. Intensive solid-phase changes take place only in ore grains which are less than 40 microns. Feº in the form of discharge, which is less than 1 micron in size, appears and also the separate microvolumes up to 80 microns in size containing slag are formed. Ore grains less than 20 microns in size are completely changed with formation of border discharge of Feº. In case of increase in time of reduction up to 40 minutes in the course of reduction of pellets, the similar solid-phase conversions affecting large (up to 0.8 mm) ore grains (Figure 2b) occur.

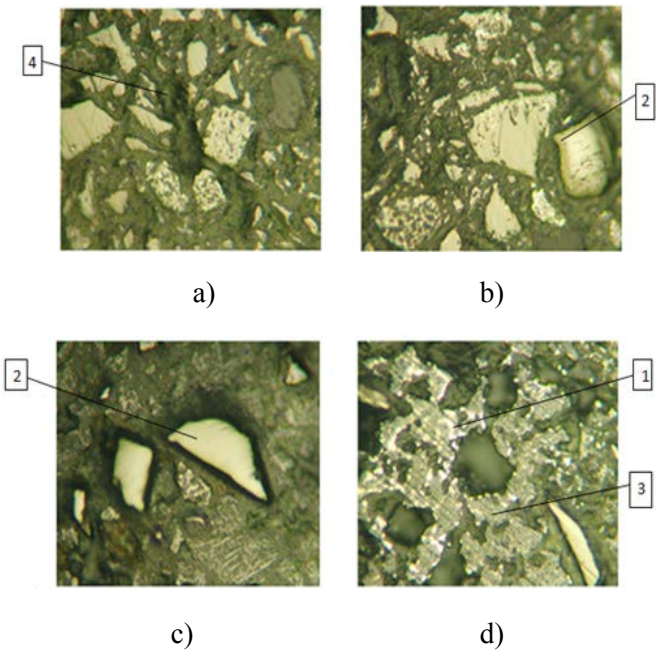


Figure 2. The structural-morphological characteristic of pellets reduced at a temperature of 900 ºC (a), 1000 ºC (b) and 1100 ºC (c, d)

The reflected light without analyzer. Incr. 175^{x}:

a) separation of metal iron in grains of titanomagnetite;

b) solid-phase conversions of grains of titanomagnetite and separation of metal iron in these grains;

c) lattice residual discharge of ilmenite denoting the structure of decay of solid solution;

d) two-phase composition of slag, isolation of Fe °.

1 – metal iron (white); 2 – titanomagnetite (light-cream); 3 – changed sections of titanium magnetite grains (dark-cream); 4 – pores (black).

In the pellets reduced at a temperature of 1100 ºC and soaking of 40 min, removing of Feº from grains of titanomagnetite takes place (Figure 2c). The amount of the slag acquiring two-phase composition increases with increase of reduction duration. Noticeable isolation of Feº is observed (Figure 2d).

Increase in reduction temperature up to 1200-1250 ºC does not provide significant changes of their composition and textural-structural characteristics.

The soaking of pellets at a temperature of 1300 ºC leads to essential changes of grains of a concentrate and again formed phases. After soaking of 20-40 min, the grains size of Feº increases up to 0.1-0.2 mm (Figure 3a, b).

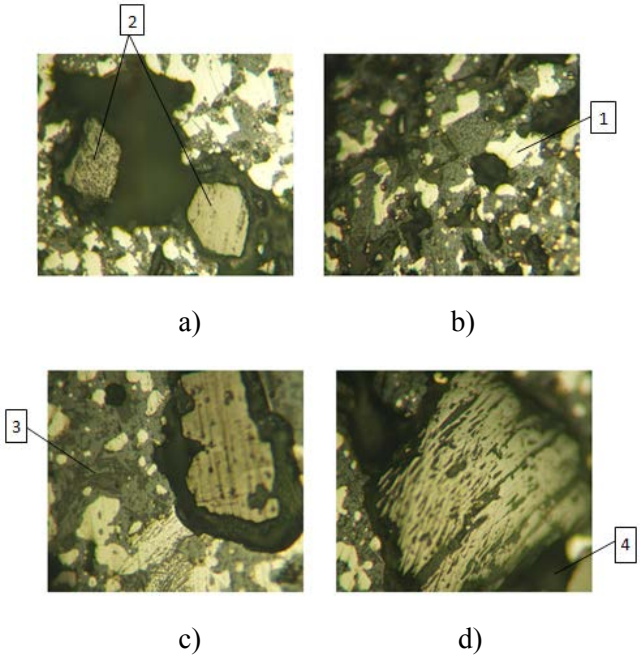


Figure 3. Change of structure and composition of pellets of titanomagnetite reduced at a temperature of 1300 ºC and soaking of 40 (a, b) and 50 (c, d) minutes

The reflected light without analyzer. Incr. 200^{x}:

a) two grains of titanomagnetite (soaking of 40 min);

b) coarse ingrained Fe° grains, two-phase slag (soaking of 40 min);

c) block structure of ore grain, coarsening of two-phase slag (soaking of 50 min);

d) grain of titanomagnetite in a solid phase (the rutile-like form of individuals in the aggregate) (soaking of 40 min).

1 – separation of metal iron (white); 2 – changed grains of titanomagnetite to a variable degree (cream of different shades to gray); 3 – slag phases (gray and dark-gray); 4 – pores (black).

Pellets still contain grains of titanomagnetite of 0.1-0.3 mm in size (Figure 3d). In pellets the slag consisting of two phases (Figure 3c, d) is formed and small-sized inclusions of Fe ° of 2-4 microns in size.

In case of long-time soaking of 50-80 min, particles of Fe° coarsen to the size of 1-2 mm (Figure 3a, b, c), some particles integrates into spherical particles with diameter up to 3-5 mm, and in structure of pellets they are distributed in the form of separate sections (fields), (Figure 4c, d).

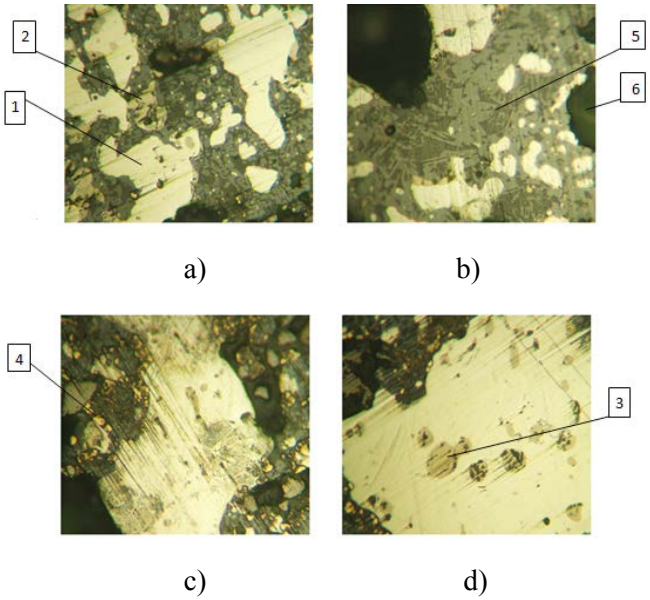


Figure 4. Change of structure and composition of pellets of titanomagnetite reduced at a temperature of 1300 ºC and soaking of 50 (a, b) and 80 (c, d) minutes

The reflected light without analyzer. Incr. 200^x:

a) coarse discharge of Fe^o and phases in slag; emergence of reddish-brown metal, (soaking of 50 min);

b) rutile-like shape of crystals in slag, Fe^o particles (soaking of 50 min);

c) separation "dirty" (with inclusions at the microlevel) metal in the white, development of "orange" grains in slag (soaking of 80 min);

d) inclusions by the increased content of titanium in Fe^o (soaking of 80 min).

1 – separation of metal iron (white), 2 – residual ore grains (gray and cream); 3 – separation of metal (reddish-brown); 4 – "orange" grains (orange); 5 – slag phases (gray and dark-gray); 6 – pores (black).

In some particles of Fe^o round inclusions of reddish-brown color with the increased content of titanium from 8 to 20% (Figure 4d) is observed. In case of soaking of 50 min, slag well crystalized and also consists of two phases (Figure 4a); in case of soaking of 80 min, slag is presented by well-structured crystals of rutile-like form (Figure 4b).

It is also should be noticed that with increase in temperature up to 1300 ºC and hold time to 80 min in reduced pellets, "orange grains" (less than 50 microns) are formed. Their distinctive feature is considerable content of iron (21-50%), titanium (14-45%), manganese (1,24-7,73%) and vanadium (1,4-2,4%).

Reduction of pellets within 5-10 minutes at a temperature of 1500 ºC leads to formation of titanic slag and particles of Fe^o in the form of reguluses from 5 to 35 mm in size (Figure 5) [8].

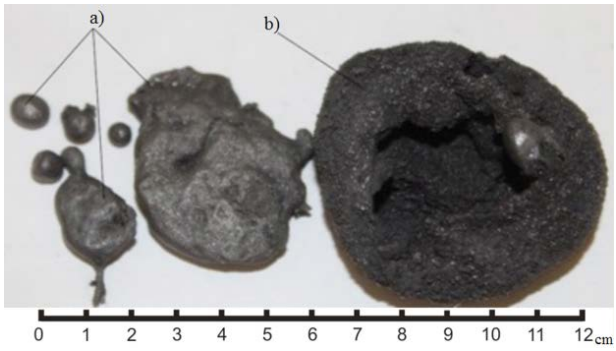


Figure 5. Pellets after reduction in case of 1500 ºC within 5 minutes: a) reguluses of metal; b) titanic slag

The batch of the pellets reduced at a temperature of 1500 ºC within 5-10 min after cooling underwent crushing. The crushed product was divided into magnetic and non-magnetic fractions in magnetic separator with magnetic field 180 mt. The X-ray fluorescent analysis of products of magnetic subdivision by instrument "EXPERT 3L" have shown that as a result of process of carbothermic reduction of titanium magnetite pellets with high mass fraction of titanium (more than 20% of TiO_2) after their crushing and division in magnetic field, obtaining the following products is possible: ferriferous with mass fraction of Fe^o 93-95% and titaniferous with mass fraction of TiO_2 at least 54%. The titaniferous product can be directed to processing for obtaining pigmental dioxide (TiO_2) or titanium sponge, and ferriferous to smelting of steel in electric furnaces.

Conclusions

The study of features of structural conversions in titanium magnetite pellets in case of carbothermic reduction have shown a basic possibility of application of ITmk3 technology for subdivision of iron and titanium from titanium magnetite grains in Fe^o in the form of reguluses and titaniferous slag. Implementation of this process requires certain temperature, temporal physical and chemical conditions in the rotary hearth furnace:

- fineness of concentrate should be at least 96-99% of class minus 50 microns;
- the maximum temperature of reduction process should be close to ilmenite melting temperature (1440-1470 °C) and with short term occupancy of titanium magnetite pellets in this temperature zone;
- the technology of restoration should include two stages: heating and preliminary soaking of titanium magnetite pellets at a temperature of 1300 °C within at least 20 min and their subsequent soaking at a temperature about 1500 °C within 5-10 min;
- reduced pellets after cooling undergo crushing and subdivision into magnetic ferriferous fraction with

mass fraction of iron of 93-95% and non-magnetic titaniferous fraction with mass fraction of TiO_2 at least 54% in a magnetic separator.

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КОНТАКТЫ

e-mail: metaljournal@gmail.com

metaljournal11@gmail.com

г. Днепропетровск

тел. +38 (056) 794-36-74

факс. +38 (056) 794-36-75

моб. +38 (050) 320 69 72

CONTACTS

e-mail: metaljournal@gmail.com

metaljournal11@gmail.com

Dnipropetrovsk

Tel.:+38 (056) 794 36 74

Fax: +38 (056) 794 36 75

Mob: +38 (050) 320 69 72

Simulation of the macrostructure influence of forging ingots on the potential capabilities of obtaining high-quality forgings

Belevitin V.A.

PhD in Engineering
Chelyabinsk State Pedagogical University,
Chelyabinsk, Russia

Smyrnov Y.N.

PhD in Engineering
Stary Oskol technological institute n.a. A.A. Ugarov (branch) National University of Science and Technology "MISiS",
Stary Oskol, Russia

Kovalenko S.Y.

Chelyabinsk State Pedagogical University,
Chelyabinsk, Russia

Suvorov A.V.

Chelyabinsk State Pedagogical University,
Chelyabinsk, Russia

Abstract
The results of range expanding potential possibilities of technological process of forgings manufacturing by using shear deformations intensification in the volume of forging ingots with a triradiate cross-section configuration which are subjected to free forging and performed by finite element modeling are presented. The influence during modeling of hypothesis of isotropy and structural heterogeneity on the transformation intensity of dendritic structure from coarse into fine-grained by using flat and combined dies was shown.
Key words: FINITE ELEMENT MODELING (FEM), SHEAR DEFORMATIONS, FORGINGS MANUFACTURING, FORGING INGOTS MACROSTRUCTURE, HYPOTHESIS OF MODELING

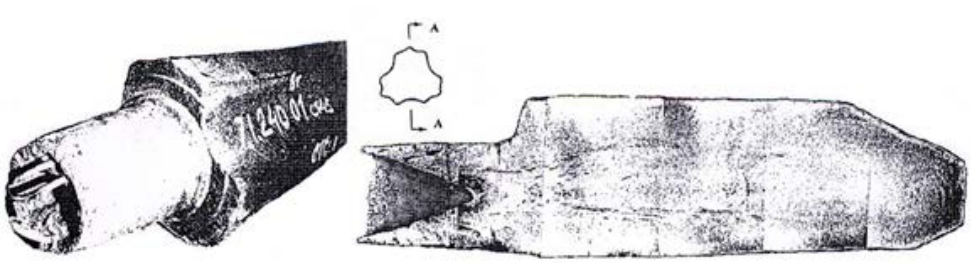
Formulation of the problem

Increasing the yield of usable metal and, consequently, the efficiency increase of production methods of finished products is one of the most important parts of the resource saving and metal capacity problem of national product. At the same time increasingly high demands are placed on the quality of the finished products.

With regard to the process of obtaining high quality forgings with a predetermined macrostructure and required distribution level of physical-mechanical properties of metal, including the part of results of the dimensions identification of allowed discontinuities when their nondestructive ultrasonic testing according to ASTM or DIN method, this problem is solved both by improving the shape of the original ingot and by the use of various technological methods which are based on such resources of physical and mechanical influence: thermal zonal factor or deformation effect of the die with working surfaces providing an intensification of shear deformation [1-3 and others].

From the standpoint of increasing working out of the axial zone of the ingot, i. e. transformation of coarse dendritic structure to a fine-grained, one of the leading roles in the mechanism of plastic deformation and closing of discontinuities (jointing, closing, cavities welding) of deformable metal [4-5] is given to shear deformations. At the same time prospective deformation effect from the intensification of shear deformations, which value is significantly less than the normal components of deformation tensor and in times more than deformation influence of latter [6]. However, implementation of the above approach requires on the one hand a detailed study on the mathematical models of possible industrial implementation of technological redistribution of forging ingots macrostructure and intensification of shear deformations, and on the other hand it requires carrying out of at least laboratory and industrial tests confirming (disprove) the results obtained from mathematical models.

As applied to the conditions of forgings production from a triradiate ingot in conditions of "Ufaley Metalware Plant", the changes in the location of "vee zones" and of liquation areas were found by sulfur prints (Fig. 1). At the same time, the question of the influence of such ingot macrostructure on the potential opportunities for obtaining the high-quality forgings by transformation of coarse dendritic structure to the fine-grained due to the intensification of shear deformations remains poorly investigated and is relevant.



a) b)

Figure 1. The triradiate ingot mass of 8 tons (a) and sulfur print in section A-A (b)

Analysis of recent researches and publications

Describing the complex set of phenomena characteristic of plastic deformation of metals and alloys the researchers in an effort to create a detailed picture of the investigated processes come to the need of building more complex mathematical models that require application of thin and efficient modern mathematical apparatus not only to determine the deformation and temperature parameters, but also to describe the structural changes and properties of the deformable metal.

The experimental data are the basis for the creation of theoretical methods of calculation of plastic deformation processes, as well as the criterion for the correctness and accuracy of analytical solutions. In fact, reliability of the results obtained by finite elements method is due to the presence of pilot and experimental data about the peculiarities of the metal plastic flow.

Potential possibilities of overcome the many difficulties, not only hinders the solution space (volumetric) problems, but also their particular cases – in two-dimensional planes of symmetry and on the side face from the status of experimental and calculated level to the experimental and analytical were established by G. A. Smirnov -Alyaev and V. M. Rosenberg [7] due to the implementation of approach for the use of experimental data processing not only in the Euler or Lagrangian, but also in the combined Euler-Lagrangian representation (CEL-view). In this case, the CEL representation of processed experimental data significantly expands the possibilities of theoretical methods for simulation of metals plastic forming and in particular the method of finite elements.

The primary starting point for FEM simulation of free forging process were the obtained from layered samples of Pb-Sb-alloy under simulation conditions using the CEL method [8] in their gradual deformation of the experimental calculated components ξ_{ij} of the strain rate tensor T_ξ, reflecting the instantaneous ("frozen") picture of the deformed state at a fixed time τ.

Further studies have shown that the location and type (configuration) of the maximum deformation rate zones (instantaneous deformations) ξ_{22} and ξ_{33} agree well with the izohrom changing diagrams obtained on samples of the epoxy resin and the lead sample with an optically sensitive coating at their elastic and plastic deformation if the izohrom fields are interpreted as strain rates fields as well as the distribution diagrams of vertical and transverse strains obtained by the measurements results of the lead samples coordinate grid applied to the symmetry planes. The differences are observed for the peripheral layers of deformable workpiece, which is due to the edge effect of the polarization-optical method. However, the results with high degree of convergence correlate with the data obtained by A. A. Milenin at FEM simulation of stretching operation in rolling-impression dies.

In connection with the foregoing, the practical use of commercial software Deform 3D (the most common specialized complex for simulating the conditions of metal plastic deformation in the deformation process) appears advisable. At the same time from the position of identifying the best conditions for working out the cast structure of forge triradiate ingot which is subjected to plastic deformation the greatest interest atracts the distribution of shear deformations ξ_{ij} (tangential component T_ξ) in its cross-section.

Work objective

Based on the finite element method we should develop the simulation technique and estimation of influence of forging ingots macrostructure with triradiate cross-section on the potential of obtaining high quality forgings due to the intensification of shear deformations.

The presentation of research results

Below are the initial results of 3D-FEM simulation of plastic deformation of forging ingots with a triradiate cross-section made in Deform 3D software package for the following conditions:

– Dies type: flat and combined (flat top, and bottom with a cutout corner 135°);

– Ingot macrostructure: isotropic and with the presence of liquation;

– Degree of percentage reduction ε: 3.7 % and 11 %.

The results of primary calculations are shown in Fig. 2 and 3. In this case, Fig. 2 (left half) shows the pattern of shear deformations isolines ξ_{23} in cross-section subjected to compression in a flat die at a value ε = 11 % of triradiate ingot with taking into account its liquation and condition of its isotropy (right half), and Fig. 3 shows the picture of tangential component isolines T_ξ in cross section for similar conditions.

Comparison of isolines values with taking into account the liquation and isotropy conditions indicates the occurring differences in subjected to plastic deformation forge triradiate ingot while maintaining their overall distribution pattern.

The maximum values according to the absolute values of the tangential deformation (instantaneous) in the cross-section of the triradiate ingot take place in the areas of contact with deforming tool – die. At the same time the highest vertical and transverse deformations are characteristic of the central deformable layer of the workpiece.

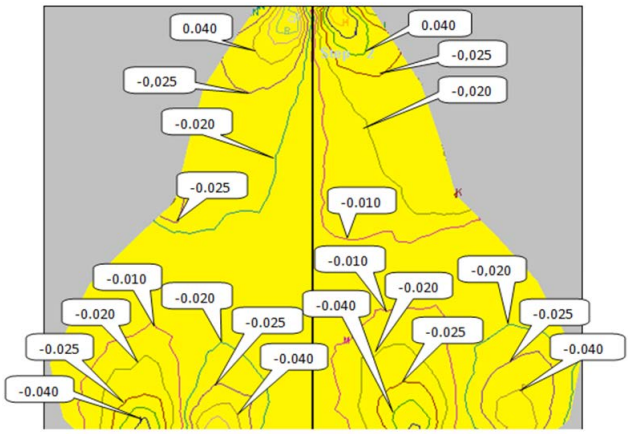


Figure 2. Isolines of shear deformations ξ_{23} in cross section models subjected to reduction ε = 3.7 %: with chemical inhomogeneity (left) and without it (right)

Taking into account that the difference, and, consequently, the square of the difference between the normal components of the strain rate tensor T_ξ are maximal in the axial zone where the shear deformations are developed the least,here values of the second invariant tensor T_ξ are expected to be relatively low, i. e. intensity of instantaneous shear deformation H, the cumulative degree of shear deformation Λ, reflecting the total effect on the working out the cast structure of forging ingot subjected to plastic deformation.

This conclusion is confirmed in further distribution of isolines values of instantaneous intensity of shear deformations H in cross section taking into account its chemical inhomogeneity. Accounting the chemical heterogeneity was carried out by varying the sizes of the elements of the finite element mesh proportional to the corresponding value of deformation stress of the workpiece deformable material.

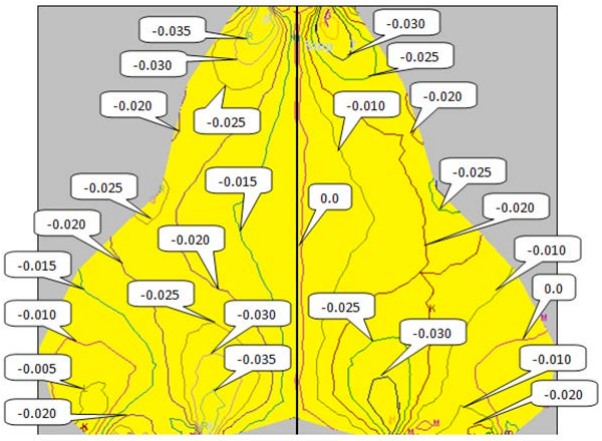


Figure 3. Isolines of tangential component T_ξ in cross section models subjected to reduction ε = 11 %: with chemical inhomogeneity (left) and without it (right)

Comparative analysis of intensity fields of instantaneous shear deformations H in cross section with taking into account its chemical inhomogeneity (Fig. 4, left) and without (in condition of its isotropy Fig. 4, right) reveals some illustrative differences in H valus, which is grater by 17.5% for the case of the ingot deformation based on the availability liquation in its volume.

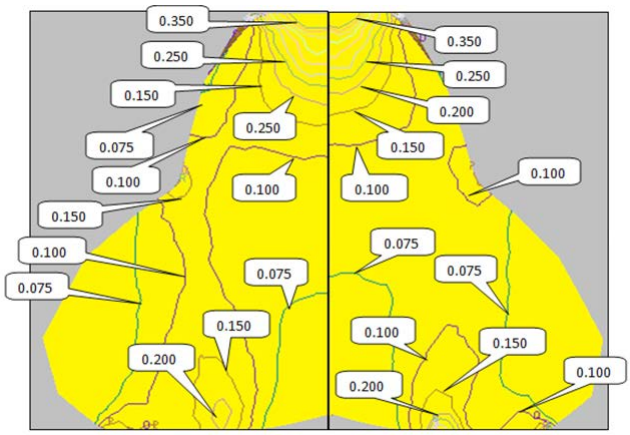


Figure 4. Intensity isolines of instantaneous shear deformations H in cross section models subjected to reduction ε = 11 %: with chemical inhomogeneity (left) and without it (right)

At the same time, the differences relate to the penetration on the greater depth in the axial zone of the deformable workpiece by the impact of deforming tool – upper flat die while expanding the occupied area of H values influence for which values liquation are specified. From the standpoint of increasing working out of axial zone this circumstance plays a positive role, especially in the case of rational technological modes of deformable workpiece turning.

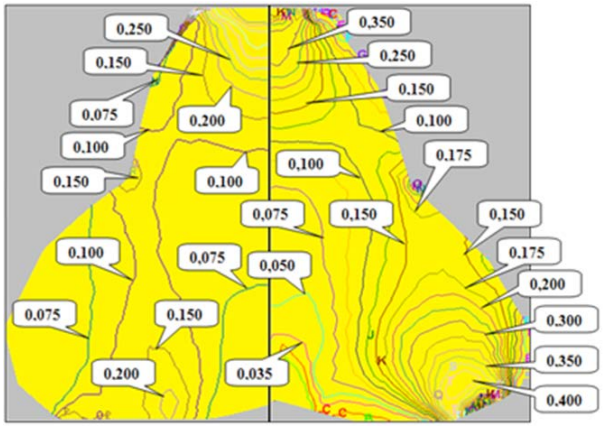


Figure 5. Intensity isolines of instantaneous shear deformations H in the cross section of models under isotropy conditions of its physical and mechanical properties, ε = 11.0 %: reduction in the flat (left) and in the combined dies (right)

Comparative analysis of isolines fields with inten-

sity shear deformation H in cross section under condition of isotropy of its physical and mechanical properties using reduction(ε = 11%) with flat dies (Fig. 5, left) and with combined dies (upper die is flat and bottom die is rolling-impression) (Fig. 5, right) reveals some differences in the values of magnitude H mainly within the area of the bottom rolling-impression die with a cutout corner of 135° (Fig. 5, right bottom) in the direction of their increasing by at least 2 times, while in the upper flat die action area has practically similar pattern of the isolines fields with identical values of magnitude H.

Comparative analysis of the intensity fields of instantaneous shear deformations H in the cross section of the triradiate ingot by using combined dies (upper die is flat, and the bottom – rolling-impression) with taking into account chemical inhomogeneity and as a result, anisotropy of the deformation resistance in its cross section (Fig. 6, left) and without it (under condition of its isotropy, Fig. 6, right) reveals certain differences in values of the magnitude H, relating mainly axial zone and to a considerably lesser extent of areas adjacent to the zones of contact with the dies. From the standpoint of increasing the axial zone working out , i.e. the transformation of coarse dendritic structure in the fine-grained, this fact plays a positive role as a result of the significant role of shear deformation in the actual mechanism of plastic deformation and closing of discontinuities (jointing, discontinuities welding) of the deformable metal [4-5].

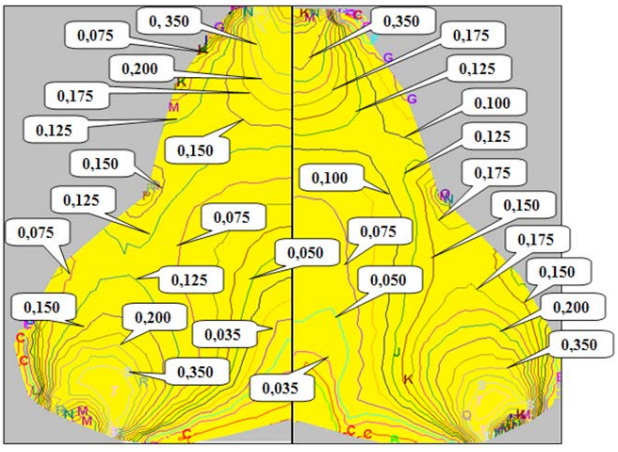


Figure 6. Intensity isolines of instantaneous shear deformations H in cross-section of models subjected to reduction ε = 11.0 % in combined dies: taking into account the chemical inhomogeneity (left) and without it (right)

The presented in Fig. 5 and Fig. 6 results allow us to expand the range of forging technological processes of difficult-to-form and low-plasticity steels and ensure minimal anisotropy of mechanical properties at low forging ratio in the case of application, in particular, rational modes of deformable workpieces turnings. This success in solving the problems of effective resource saving (energy and material capacity of forgings) is largely determined by the potential and conditions for the practical implementation of human capital of professionals of industrial production metallurgical and engineering sectors, scientists and researchers from research and development, technology and design-engineering organizations.

Conclusion

Availability of obtained in layered samples from Pb-Sb-alloy simulation conditions using the combined Euler-Lagrangian method of pilot and experimental data about the characteristics of plastic flow of the metal allowed us to develop on the basis of the finite elements method the simulation methodology of the macrostructure impact of forging ingots on the potential opportunities for obtaining the high-quality forgings by transformation of coarse dendritic structure to the fine-grained due to the intensification of shear deformations. For the first time for the free forging case of forging ingots with triradiate cross section by 3 D-FEM simulation method we obtained the fields of isoline "instantaneous" shear deformations ξ_{ij} strain rate tensor T_{ξ} ("instantaneous" tangential deformations) and the intensity of instantaneous shear deformations H for applications of flat and combined dies taking into account isotropy as well as the presence of chemical inhomogeneity of forging ingots macrostructure. The possibility of expanding the range of forging technological processes of difficult-to-form and low-plasticity steels with ensurence of minimal anisotropy of mechanical properties at low forging ratio in the case of application, in particular, rational modes of deformable workpieces turnings was predicted.

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The introduction of a unified national approach to classification procedure of wastes to hazardous

Tymofii Zhukovskyi

Cand. Sc., Head of Laboratory of
Scientific research institution "Ukrainian scientific research institute of ecological problems"
Kharkiv, Ukraine

Olena Pshenichnova

Cand. Sc., Researcher of
Scientific research institution "Ukrainian scientific research institute of ecological problems"
Kharkiv, Ukraine

Leonid Pisnya

Cand. Sc., Leading Researcher of
Scientific research institution "Ukrainian scientific research institute of ecological problems"
Kharkiv, Ukraine

Olena Tkachova

Head of the Sector of
Scientific research institution "Ukrainian scientific research institute of ecological problems"
Kharkiv, Ukraine

Valerii Kartsev

Researcher of
Scientific research institution "Ukrainian scientific research institute of ecological problems"
Kharkiv, Ukraine

Abstract
The research results of the main sources of law of the European Union and Ukraine in the field of waste were presented in the article. The comparative analysis of wastes classification procedure to hazardous in the European legislation and in the existing environmental legislation of Ukraine was carried out. A unified national approach to the classification procedure of each particular type of wastes to hazardous harmonized with the requirements of European legislation for wastes was presented.
Key words: IMPLEMENTATION, LEGISLATION, UKRAINE, THE EUROPEAN UNION, METODOLOGY, HAZARDOUS WASTES

Introduction

One of priority directions in the environmental field has been and remains a waste management issues. The problem of reducing the negative impact of wastes on the environment is becoming increasingly important with the growth of scientific and technological progress and the rate of consumption.

There is a developed system of legal regulation of wastes management in Ukraine. But the Ukrainian legislation in the sphere of wastes is significantly different from the corresponding international and European legislation on a fundamental approach to wastes management, as well as on identification, classification and allocation of wastes to hazardous [1].

On September 16, 2014 Ukraine ratified the "Agreement on Association between Ukraine on one hand, and the European Union, the European Atomic Energy Community and their Member States on the other hand." According to Article 290 of Chapter 13 of the Agreement the Parties guarantee that their legislation will provide high levels of environmental and labor protection and will make efforts for further improvement of this legislation [2]. Ukraine Association with the European Union is impossible without the implementation of EU legislation, so the Cabinet of Ministers of Ukraine by its order dated 15 April 2015 No 371 adopted the developed by Ministry of Ecology and Natural Resources of Ukraine plans to implement the acts of the EU legislation in the sphere of environment.

Results of the study of European legislation for wastes

Legal regulation of wastes management is part of the European Union (EU) environmental law. European environmental law and European sources of law in respect to wastes are in the process of constant development and improvement.

European Waste Catalogue (Decision 94/3 / EWG) is a classification system on wastes, which is subjected to periodic review and update, if necessary [3].

Since 2008 Framework Directive of the EU is the European Parliament Directive and Council 2008/98 / EU of 19 November 2008 «On waste and repealing of certain directives" [4]. The Directive sets out the basic requirements for the identification and management of waste in the EU and Member States:

1. Hazardous wastes must be labeled in accordance with international standards and European Union standards.

2. The EU Commission has the right to establish criteria for determining wastes as hazardous.

3. The classification of wastes to hazardous should be based on European Union legislation on chemical substances and chemical preparations.

4. When determining waste as hazardous the limit values (established limits) should be considered, which are operated by legislation in the case of defining chemicals to hazardous.

Since 01.01.2002 till 01.06.2015 the waste classification and the attributing waste to hazardous has been carried out according to the Commission Decision dated 3 May 2000 (2000/532 / EC) [5]. The wastes are classified as hazardous under the condition that their physical properties and/or the concentration of hazardous substances (in wt., %) is such that the wastes have one or more characteristics set out in Annex III

to Directive 91/689 / EEC.

With coming into operation of the Framework Directive 2008/98 / EC in 12.12.2008 the attributing of waste to hazardous is based on of Annex III to Directive 2008/98 / EC, which lists the properties of wastes that cause their dangerous nature [5].

In order to account the scientific achievements and technological progress in the field of chemicals, the esurience of uniform determination mechanism of wastes to hazardous and its classification in all the Member States of the EU Commission 18 December 2014 has adopted Regulation (EU) No 1357/2014 about replacing Annex III to Directive 2008/98 / EC on wastes [6].

In this judgment assessment of hazardous wastes is based on the use of the criteria of Regulation (EC) No 1272/2008 (CLP Regulation) and takes into account the classification data of chemical substances and their preparations according to international GHS standards [7].

The main differences between the European and Ukrainian legislation concerning the classification of wastes

Ukrainian legislation on wastes is significantly different from the corresponding international and European legislation. The European legislation (in accordance with Decision 2000/532 / EC) defines the hazardous properties of waste firstly, and on their basis – assignment to the safe or to hazardous which in the List of wastes marked with (*).Whereas according to Article 34 of the Law of Ukraine "On Wastes" all hazardous wastes according to their harmful effects on the environment and on human life and health are divided into 4 classes [8].

The classification of wastes according to the 4 hazard classes was carried out on the basis of SSanRN 2.2.7.029-99 State sanitary rules and norms "Hygienic requirements for industrial waste management and determination of their class of danger to human health." However, based on the decision of the Decisions of the State Service of Ukraine for Regulatory Policy and Entrepreneurship Development from 15.07.2014 No 33 SSanRN 2.2.7.029-99 become invalid [9].

Ministry of Ecology of Ukraine by its order dated 16.10.2000 No 165 approved the List of hazardous properties of wastes [10]. However, the approved list does not fully correspond to the List of hazardous properties of waste used in the legislation of the European Union for the identification of wastes as hazardous. The List does not take into account the following dangerous properties: irritant; toxic to specific organ (STOT) / inhalation toxicity; acutely toxic; carcinogenic; acrid; toxic for reproduction; mutagenic; sensitizing.

Thus, at the present time in national law in contrast to the European there are no method of identification of hazardous properties of wastes, criteria and waste attributing mechanism to hazardous or safe.

The objective of the study, statement of the problem

In order to implement the EU directives in the field of waste management including hazardous wastes the unified approach to procedure of wastes attributing to hazardous was introduced.

To achieve this objective it was necessary to solve the following problems:

1) to analyze the current EU legislation on wastes;

2) to analyze the existing normative-legal acts of Ukraine to determine the waste degree of hazard;

3) to study the European techniques of wastes classification as hazardous;

4) to develop a unified approach to the procedure for attributing each type of waste to hazardous, which would receive the status of national and became mandatory for use in each region of Ukraine.

Research Materials

The regulations documents of the European Union, the European Directives, Ukraine legislation on waste have been used for study.

The results of research

In order to implement the directives of the European Union in the field of waste management and for the Ministry of Ecology and Natural Resources of Ukraine members of the research institution "Ukrainian Research Institute of Environmental Problems" was developed unified national approach to the attri- buting procedure for each specific type of wastes to hazardous, harmonized with the requirements of European legislation on waste.

The first step on referring the wastes to hazardous is establishing qualitative and quantitative composition of the wastes and determining their physical properties. The concentrations of the ingredients in the wastes are defined in weight percentage or mg of chemical that contains in the waste, per kg of the total weight of waste, when it concerns to POPs (Persistent Organic Pollutants).

Hazardous wastes properties are divided into 15 categories (HR1-HR15), which take into account the physical-chemical and biological properties of the wastes:

- HP 1 "Explosive";
- HP 2 "Oxidizing";
- HP 3 "Flammable":
- HP 4 "Irritant - cause skin irritation and eye damage";
- HP 5 "Toxic for specific organ (STOT) / Toxic

by inhalation";
- HP 6 "Acute toxicity";
- HP 7 "Carcinogenic";
- HP 8 "Corrosive";
- HP 9 "Infecting";
- HP 10 "Toxic for reproduction";
- HP 11 "Mutagen";
- HP 12 "Liberate very toxic gases";
- HP 13 "Sensitizing";
- HP 14 "Ecotoxic";
- HP 15 "Wastes with hazardous properties listed above, which do not appear in the initial state."

Hazardous properties of chemical substances included in the composition of the wastes may be determined by Regulation (EC) No 1272/2008, or by tests in accordance with Regulation (EC) of 30 May 2008 No 440/2008, which establishes the test methods in accordance with the Regulation of the European Parliament and Council Regulation (EC) No 1907/2006 on the registration, evaluation, authorization and restriction of chemical substances and preparations (REACH), or other internationally recognized methods of testing based on testing against animals and humans in accordance with article 7 of Regulation (EC) No 1272/2008.

International chemical name of the chemical substance, EC number, CAS number, hazard class and category code, hazard code, the additional danger code are given in the tables of Annex VI «Harmonized classification and labeling for certain hazardous substances" of Regulation (EC) No 1272/2008 of 16 December 2008 on classification, labeling and packaging of substances and mixtures.

Hazardous properties HP4, NR6 and NR8 are evaluated on the basis of threshold values for individual substances. I t is not included in the evaluation process if the substance is present in the wastes in a concentration below the threshold value. If hazardous wastes properties are measured according to concentration or test, the wastes must be investigated.

Wastes containing polychlorinated dibenso-p-dioxins and dibenzofurans, and / or their concentrations exceed the limits specified in the Annex IV to Regulation (EC) of 29.04.2004 No 850/2004 on persistent organic pollutants and amending to Directive 79/117 / EEC should be identified as hazardous.

Pure metal alloys, which are not contaminated by hazardous substances are considered safe wastes. Wastes of the metal alloys, which are classified as hazardous in the List of wastes marked with (*).

Step by step way of classifying wastes to safe or hazardous is shown in the figure 1.

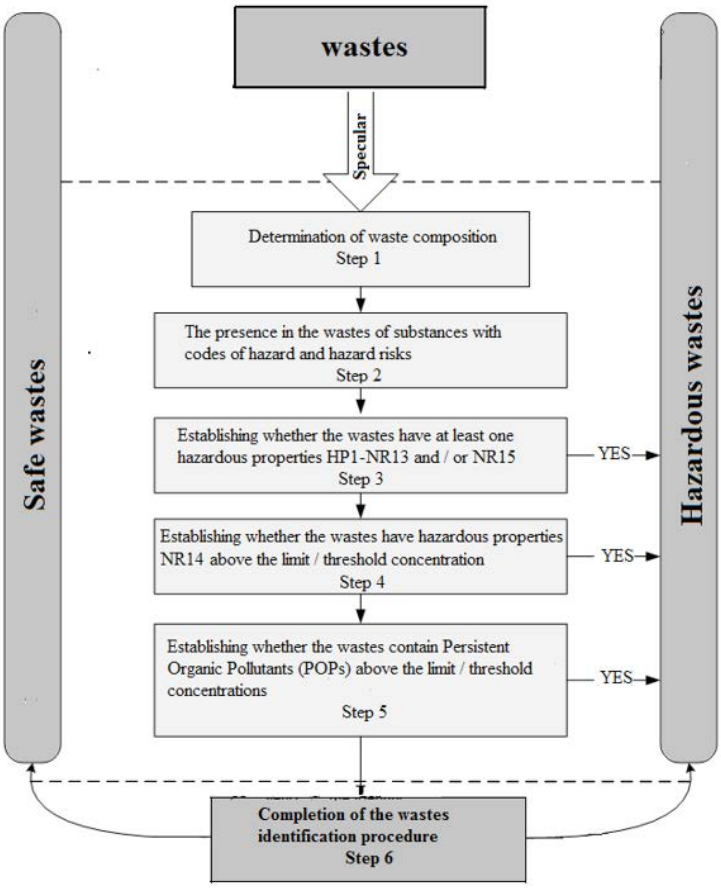

Figure 1. Algorithm of wastes classification to safe or hazardous

Step one: the waste quality and quantity should be studied to define the chemicals concentrations that are part of the waste.

Step two: Tables 3.1 and 3.2 of Annex VI «Harmonized classification and labeling for certain hazardous substances" of Regulation (EC) No 1272/2008 establish the chemicals presence in the waste with codes of danger and risk of danger.

Step three: whether the waste has one or more hazardous properties HP1-NR13 and / or NR15 should be established. If the waste has at least one of the above mentioned hazardous properties, they are defined as hazardous. It is important to establish all the hazardous properties, which are contained in the waste. Therefore, if the wastes do not have any of the hazardous properties HP1-NR13 and / or NR15, or contain at least one or more of them further evaluation by step four is carried out.

Step Four: whether the wastes have hazardous properties of NR14 should be established. If the wastes have hazardous properties NR14 they are classified as hazardous. In the case when the wastes do not have such hazardous properties further evaluation is carried out by step five.

Step five: whether the wastes contain POPs above the limit / threshold concentrations should be established. The List of Persistent Organic Pollutants that is a subject to the provisions on waste management and their thresholds values. It is given in the Annex and IV of Regulation (EC) No 850/2004 of the European Parliament and of the Council of 29.04.2004. If wastes contain POPs in concentrations exceeding the thresholds, the wastes are classified as hazardous.

Step Six: if it is found that the wastes have one or more hazardous properties HP1-NR15, and / or containing POPs exceeding the established thresholds, the wastes are classified as hazardous.

In the case when the wastes do not have any of the hazardous properties and do not contain POPs above set thresholds values, the wastes are considered as safe.

Conclusion

The study showed that:

1. The principles and ways of waste classification in the European legislation and environmental legislation of Ukraine are significantly different.

2. At present, there are no criteria for classification wastes to hazardous in Ukrainian legislation. The EU legislation on waste is developed List of wastes, which identifies wastes that are classified as hazardous and safe.

3. European legislation clearly defined the principles and criteria for classification wastes as hazardous.

Hazard assessment of wastes should be based on the use of the criteria of Regulation (EC) No 1272/2008 (CLP Regulation) and take into account the classification data of chemical substances and their preparations according to the international GHS standards.

4. In accordance with European legislation, the hazardous properties of wastes are divided into 15 categories (HR1-HR15), which take into account physical-chemical and biological properties of the wastes. The criteria are established by categories according to which the assessment of wastes is carried out.

5. Hazardous properties HP4, HR6 and HR8 are assessed on the basis of threshold values for individual substances. If the substance is present in the wastes with concentration below the threshold value, it is not included in the evaluation process.

As a result of the study:

- A unified national approach to the procedure of classifying of each specific type of wastes as hazardous, harmonized with the requirements of the European Waste Legislation was developed;

- The methods of wastes classification to the dangerous for the 15 categories of hazardous properties were worked out.

Using the developed techniques allows obtaining internationally comparable data for the monitoring of environmental programs, as well as high-quality, harmonized data on the creation and management of the hazardous waste.

Using the developed techniques will create a standard basis at European level of the national waste management, development and implementation of the activities of environmentally safe management with hazardous wastes.

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Innovative stagnation of industrial enterprises of Russia: state and perspectives of development vector

Pavel Gurianov

Candidate of economic sciences
National University of the mineral resource "Mining University",
Saint-Petersburg, Russia
E-mail: pavelgurianov19@gmail.com

Abstract
Intention of Russian government to implement breakthrough to economy of hi-tech product cannot be put into practice without study of position of enterprises concerning their current readiness for introduction of innovations. Upgrading can serve as pulse for implementation of the advanced production lines and for creation of own products and processes.
Key words: STOCK CAPITAL, INVESTMENTS, INNOVATIONS, MINERAL AND RAW COMPLEX, UPGRADING, INDUSTRY, STAGNATION, EXPORT, ECOLOGICAL SAFETY, ECONOMIC GROWTH

The market economy of Russia goes through process of transition from raw orientation to post-industrial one, from ineffective sale of hydrocarbons and other resources to knowledge-based and service economy. The characteristic "lost decade" is often announced by authoritative economists during stagnation and recession: it is important to analyze a present raw policy. [5]

The purpose of implemented reforms is assumed to avoid this dependence and deeper integration into global market space. Raw orientation of Russia affects significantly the economic development of country; huge oil and gas reserves do not stimulate production of labor-intensive products because the state is not interested in development of other branches due to having one but extremely profitable. The subject is studied in large number of papers connected by common subject of "resource curse".

It is obvious that in the world with permanently growing competition those industrial enterprises, which keep pace with scientific and technical progress, high technologies, namely, introduce innovations systemically in production, stand a good chance of development and extension of position in the market. [9] In numerous foreign researches, it was proved that from 20 to 60% of GDP growth of the developed countries took place due to innovations and results were carried into labor productivity[10, 14, 15]. For fund raising, the industrial enterprises can use both Russian and foreign stock market. [11]

Nominal wages in industry vary depending on labor productivity. The average monthly salary in mining in August, 2015 was 62 493 rub., for comparing in processing industry - 31 306 rub., and in production and distribution of the electric power, gas and water - 36 226 rub. Certainly, in Russian industry, working conditions are quite rough; according to researches, 33.3% of all workers labor under conditions which are not correspond to health standards of modern working conditions.

Important task of Russian and world industrial politics is ecological safety of the planet. For this pur-

pose, in due time we have entered the Kyoto Protocol and participated actively the conference on climate in Paris in December, 2015. [12]

Data on investments into basic stock of Russian industry are provided in Table 1. The mining industry is in the lead more often. Taking into account that the number of the enterprises are several times less than in processing one, more advantageous situation becomes more obvious.

Table 1. Investments into basic stock, bill. rub.

Branch	2007	2008	2009	2010	2011	2013	2014
Mining	929,8	1173,7	1111,8	1264,0	1534,3	2004,0	2172,1
Processing productions	986,4	1317,8	1135,7	1207,6	1418,7	1945,3	2019,0
Production and distribution of electric power, gas and water	465,7	617,0	684,1	818,8	1016,5	1187,6	1173,8

Source: Russian Federation Federal State Statistics Service

Data on cost effectiveness of the sold goods and services of the enterprises in the Russian industry are provided in Table 2. The highest rates are in mining industry while the worst rates in recent years are in processing industry and in production and distribution of electric power, gas and water in 2013. Under conditions of deterioration in world state of business, the expectations of the Russian economy can be placed only to the mining enterprises.

Table 2. Cost effectiveness of the sold goods, production (operations, services), %

Branch	2005	2007	2008	2009	2010	2011	2013
Mining	35,6	30,5	25,4	28,8	31,9	31,4	22,1
Processing productions	15,3	18,3	17,1	13,4	14,8	13,2	8,8
Production and distribution of electric power, gas and water	5,3	5,2	4,9	6,8	7,1	6,4	4,4

Source: Russian Federation Federal State Statistics Service

In Table 3, the data on Return on Total Assets can be seen. The highest return is in mining industry.

Table 3. Return on Total Assets, %

Branch	2005	2007	2008	2009	2010	2011	2013
Mining	12,9	11,4	10,5	8,8	11,6	14,2	11,3
Processing productions	11,9	14,8	8,6	6,1	8,2	8,4	4,5
Production and distribution of electric power, gas and water	2,7	3,5	2,3	2,2	4,6	1,1	0,7

Source: Russian Federation Federal State Statistics Service

Wear of fixed assets is provided in Table 4. Unlike the previous tables, outsider is mining industry, at that since 2005 the situation almost has not been changed. Some economists expect that improvement of investment environment will lead to growth of direct foreign investments, that growth of highly qualified labor power from abroad will be observed, it will be simpler for domestic enterprises to obtain additional capital, effective management systems, machinery and technology from the world market of innovations. Actually, the Russian enterprises do not use the considerable potential of American, European and Asian financial markets. [4] It is necessary to make additional joint efforts by both the state and private sector in this direction.

Table 4. Level of wear of fixed assets (at the end of year), %

Branch	2005	2007	2008	2009	2010	2012	2013
Mining	51,7	50,0	45,6	45,9	51,1	51,2	53,2
Processing productions	44,1	41,7	41,0	41,1	46,1	46,8	46,8
Production and distribution of electric power, gas and water	48,6	45,5	40,1	41,7	51,1	47,8	47,6

Source: Russian Federation Federal State Statistics Service

Failures in dynamics of scientific and technical development of Russian industry in the last decade of the last century do not respond to new challenges of the existing model of economic development of the countries aimed at innovative breakthrough; consequently, rise of the quantitative and qualitative disproportions takes place. Similar tendencies are observed in national economic system in general, as well as in mining industry.

In 2011, only 280 industrial enterprises of the country included research-and-development and design-and-engineering subdivisions. Only 6,8% of mining enterprises implemented innovative activity. This is very law level, this index is higher even in processing industry, namely, 11,6%. Only 9,4% of all the industrial enterprises of Russia implement innovative activities in the field of technologies (in 2000 - 10,6%). As a comparison, in the developed countries industry these values absolutely differ: in Germany - 69,7%, in Canada - 65,0%, in Great Britain - 43,7%, and even in economy of Spain experiencing hard time - 37,0%. [6] It can be stated that Russian industry is in innovative stagnatory trap except military-industrial complex.

Specific weight of the enterprises implementing organizational innovations in reference year was only 5,0% (2000 - 22,1%) of total number of industrial production enterprises. During the period under consideration, in the large industrial enterprises the sharp lowering of indices is observed, while in small industrial enterprises the reverse tendencies are observed; in 2000, the index of innovative activity was 1,3%, in present time it is 4,9%. This is extremely modest; and consequently, in scientific community the hypothesis that the Russian economy is unreceptive to innovations emerges. Let us notice that so far it is only a hypothesis, but the number of its supporters is growing. [7]

Investments in low-technology branches are oriented to the "process technological innovations" by 80% providing enhancement of technological process. These innovations almost do not affect the growth of product quality (raw materials and results of its primary processing), they affect only its prime cost or growth of production volume; due to new technologies and methods of production they reduce resource intensity, product yield from the mass of raw materials, energy capacity, production volume (production and processing) and other technological indices. Reduction of prime cost determines profit markup saving the raw materials price at the level necessary for achievement of export attraction; and growth of productivity provides growth of gross output of produced and processed raw materials. [2]

Dependence of mining enterprises on an environment makes the enterprises work under the conditions of uncertainty; necessary application of innovative development should rely on consideration of mining industry risks connected to reliability of geological exploration. [8] We consider that the large industrial enterprises should cooperate with the small and medium ones more closely. [13]

Guarantee of successful activity of both economy in general and any enterprise is the most productive use of the available innovative potential (all available material and knowledge assets), by implementation of the innovative processes determining steady dynamics of enterprise development. For example, metallurgical complex providing the country with metal and the main constructional materials historically takes the leading place in economy. The metallurgy share in GDP is about 5%, in industrial production - over 17%, in export - about 14%. The branch uses about 30% of the electric power, 25% of natural gas, up to 10% of oil and oil products from the common industrial level, its share in railways freight traffic is about 20%. However, there is rather low level of product diversification of all main subindustries of ferrous and nonferrous metallurgy, that is generally one of system weaknesses of the Soviet metallurgy; therefore, now the foreign trade balance in metallurgy generally corresponds to determination of raw model: domestic metal-producers export production of low processing, namely workpieces, ferroalloys, scrap, ingots and pigs of non-ferrous metals while metal-customers import qualitative products with neces-

sary characteristics. [2]

Although process of updating of fixed productive assets is going on, according to experts its rates are absolutely insufficient. Wear of fixed assets of Russian industry at the end of 2014 is more than 50% that affect production. To solve this problem is rather difficult, as updating of the equipment requires big expenditure and temporary reduction of amounts of profit, and not each owner is ready for such long-term investment. Reality of domestic entrepreneurship is desire of "fast" money that, in fact, is hangover of the 90th years when the stage of primary accumulation of the outlet was considered as norm. Thus, long-term projects with low rate of return are not popular today.

Problem is also general technological backwardness of production; in 2012, more than 16% of steel were produced in obsolete open-hearth furnaces, about 30% of steel workpieces were produced by means of Soviet rolling aggregates and this situation almost does not change for the better.

In fact, today competitiveness of domestic steel products reposes on cheap raw materials, available energy resources and low costs for labor power. Certainly, this is too unreliable benefit which can be lost at any time; for example, if the market is entered by producers from the countries with much cheaper labor power (Southern Asia, Africa, Brazil, etc.).

Certainly, there is also a problem with structure of production. The share of production of steel high-added value products is only 7%, the rest is low- and intermediate-added value ones. In other words, today we export bars and workpieces which in other countries subsequently turn into products with high additional cost.

The metallurgy belongs to those industries of economy where process innovations predominate. That is such innovative technologies which provide first of all decrease in material costs in production and product competitiveness. So all the measures, namely legislative, fiscal, tariff, organizational and managerial, production and technological, etc. should be directed, first of all, to decrease in resource intensity of production and technological base and improvement of quality of final products.

Moreover, Russian metallurgists invest huge money in upgrading, that is in technology of energy saving, utilization of secondary sources of heat and labor efficiency improvement. At the present moment, benefit from investments is not big. There is even a contradiction between innovation and stability. A number of researchers consider that for solving of such contradictions, it is necessary to perform innovative breakthrough in the short-term or medium-term periods, and to carry out radical (fundamental) ones in the long-term period depending on enterprise lifecycle and products. [3]

There are a lot of factors affecting costs of the metallurgical enterprises in whatever part of the world they are. Generally, it is a combination of two factors: cost of resources and coefficient of their use. By the cost of resources, Russia has an advantage of western economies.

The last two years, the price of iron ore and coal in Russia is scarcely different from world. If our gas prices reach world level, steel production in Russia will be significantly more expensive than foreign one. For example, after recent increase in gas price in Ukraine, cost value of steel production is higher than in Italy or France.

The labor productivity in America and Europe is several times higher than in Russia. It almost levels wages differential. In a year this benefit will sputter out if our enterprises do not introduce technology for significant increase of labor productivity. But anyway, the low cost of labor compensation will not be benefit any more in the term of the next five years.

According to a number of experts, innovations directed to increase in volumes of production but not to increase in processing or new types of processing as such, will appear after a while when new technologies will become ordinary. There will appear new crises of product quality, share in the market will decrease, and therefore, new capital investments in innovation will become necessary. Considering that at this moment the situation in the enterprise is critical, it will be complex challenge to make a raise of means for an innovating. [2]

Innovations are condition for enterprises viability. In the Russian Federation, exogenous demand for innovations exists in respect of small number of innovations due to state orders and foreign investors. Endogenous demand for innovations is extremely small in comparison with exogenous one. Under conditions of extreme deficit of own current assets, high cost of loan resources, "disinvestment" and non-payments demand for innovations in Russia became highly-elastic by price remaining inelastic by income of buyers of innovations [1]. The majority of mining enterprises of country have reached a limit of technical and economic growth on the basis of technology of the 3rd and 4th technological modes. Without development of basic innovations and also innovations of the 5th and 6th technological modes, it is impossible to increase the offer of product innovations and to raise competitiveness of industrial enterprises of country.

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e-mail: metaljournal@gmail.com

metaljournal11@gmail.com

г. Днепропетровск

тел. +38 (056) 794-36-74

факс. +38 (056) 794-36-75

моб. +38 (050) 320 69 72

CONTACTS

e-mail: metaljournal@gmail.com

metaljournal11@gmail.com

Dnipropetrovsk

Tel.:+38 (056) 794 36 74

Fax: +38 (056) 794 36 75

Mob: +38 (050) 320 69 72

Attitude to the future professional activity of students-metallurgists

Marina Suriakova

Candidate of Psychological Sciences,
Associate professor
Department of Engineering Pedagogics
National Metallurgical Academy of Ukraine
Dnipro, Ukraine

Abstract
The article presents the research results of attitude of future professionals to the career. The attitude is a factor of regulation of professional work of the specialist and determines its effectiveness.
Key words: PROFESSIONAL CAREER, EMOTIONAL ATTITUDE, CAREER EXPECTATIONS, PROFESSIONAL REGULATION

During professional formation of experts at the stage of their training as a result of theoretical preparation and certain practical experience, subjective ideas of specialty are formed, subjective value of profession is defined, the relation to professional work is developed.

At the end of the fourth year of study the students of metallurgical professions have already some qualifications on the iron and steel enterprise during the work experience internship. Therefore, it is possible to assume certain level of determinacy of future engineer-metallurgist in regard to their profession and working practice in whole, which is connected with modelling of specialist's professional way, regulation of professional behavior and making decision for place of work.

The leading role of expert's attitude to the professional activity is highlighted by the following researches of professional work: E.F. Zeyer, D.M. Zavalishina, O.N. Ivanov, E.A. Klimov, A. Karpov, M.S. Pryazhnikov, A.K. Markov, L.M. Mitin, N.V. Kuzmin, S.P. Bocharova, B.F. Lomov, G.S. Kostyuk,

T.V. Kudryavtsev, V.A. Tolochek, A.R. Fonareva, V.D. Shadrikov etc.

Generally, the attitude to people and activity is defined as subjective aspect of showing reality, the result of cooperation of person with environment. [5; 291].

Analyzing the identification facilities of person with profession D.M. Zavalishina accentuates: "The important condition of career longevity of person is positive emotional attitude to the work". [1; 200].

The system of person's attitudes is at the influence of external events of life and therefore it is defined by some movability. B.F. Lomov remarks the importance of timely transformations in the system of person's subjective attitude due to change of objective status of individual in society and if it does not happen, then "the difficulties may emerge in taking new social function and there may appear conflicts with surrounding persons or inner tension". [2]

V.N. Myasyschev providing the essence of the concept «attitude» noted that at the heart of all attitudes of a person is his work relations. Scientist considered that the formation of positive labor orientations, labor skills and knowledge are the objects of educative work. The object of social labor nurturing consists in synthesis of wish and duty of work in combination with necessity and freedom of labor [3].

Set out conditions prove the necessity of study of attitude to professional activities of future experts, which determined the aim of our investigation.

298 students of metallurgical HEI of full-time and part-time education at the age of 20-32, which study in different metallurgical specialities related on grounds of community generalized structure of activities on speciality 0904 Metallurgy of education and qualification level «bachelor degree».

The method of color metaphor of I.L. Solomin [4] focused on signification of emotional attitude of a person to a wide range of events which are connected, principally, with different kinds of labor and professional activity.

The method provides the list of items requiring study and eight colored cards, which are proposed to researcher. It is necessary to pick up such color for each notion, that according to researcher's mind suits it perfectly. After assumption of color to each notion there is adjustment of colors on the degree of attractiveness - from the most attractive to unpleasant.

The analysis of results is based on principles:

- The concepts marked with the most attractive color are characterized by the most positive attitude to it; the most unpleasant colors indicate concepts which are characterized by the person's negative attitude to it.

- The complex of concepts marked with one color are characterized by similarity of emotional attitude to them; they are associatively combined in person's mind.

According to the problems solution of this investigation the list of 39 concepts, which conditionally grouped together by category is formed:

1. Values and wants - earnings, money; safety, stability, guarantees, confidence; communication, love, trust; freedom, acknowledgment, career, power, superiority; success, creativeness, knowledge, responsibilities, duty.

2. Activity and types of activity - labor, work, study, profession, business, education, administration, science, art, sport, computer.

3. People, myself - I, people, family.

4. Events and steps of life journey - my past, my future; failure.

5. Emotional sufferings - boredom, confidence, faith, doubt.

The conceptions are selected in the list include

Notions that were selected into the list include the main activities of the person in the period of emerging adulthood, values and needs that are typical for solution of certain age tasks (achievement of identity, establishment of kinship and professional self-determination).

Methodology of color metaphoric expressions was applied in student groups.

During interpretation of the results obtained the following was considered. Motivational sphere of person covers phenomena of wants, motives, tendencies, interests, values, mindset, positions. It is closely connected with the system of emotional attitude of the person towards various aspects of reality: to other people, to oneself, to the activity. In the structure of relations one of the most significant is the relation to the future, to oneself, to different types of activities. Special value in this research has identification of the relation to activities which characterizes availability, force and content of motives to activity and content of the experiences arising in relation to it. In general attitude to the activity is reflected through the notions "labor", "work", "study", "profession", "career", "business", "responsibilities", "duty". To all the suggested notions we may assign certain color (according to the mind of test person), and then his place in the arranged according to the degree of attractiveness is defined.

In case when the notions are associated with colors, which are located on the 1st, 2nd and 3rd places, it is possible to determine positive attitude to this notions.

Concepts located on the last places in such range (6, 7, 8) reveal negative attitude to them. Thereafter location of notions in the middle of the range (5,6) is possible to define as neutral attitude to them.

Some research tasks are made with the help of analysis of emotional attitude of students-metallurgists to the suggested notions.

The place of concept color in the arranged by degree of attractiveness range reflects the value of this concept in the value system (needs, motives, addictions, interests, etc.), degree of its importance in this stage of human life. At the beginning of range the most attractive concepts that are more significant for test students, with positive emotional tinge are located; the last places of the range are taken by concepts that are irrelevant, unattractive, unpleasant for the examinee. Thus there revealed the most also least important concepts determining corresponding emotional relation of examinees.

Middle group values of place of location of notion in the range of attractiveness reveal in general the extent of attractiveness of this notion for the test students. Analysis of values according to place of location in the range allows to distribute the notions according to the level of attractiveness and certain emotional attitude to them: high, middle, low level of attractiveness. The lower the average value of location of notion is, the more attractive it is (located in the beginning of the range) and vice versa.

Arranging the data according to their rank in the range of middle group values of places of notions allows to define the groups of notions with different level of attractiveness, which is presented in table 1.

Table 1. Groups of notions with high, medium and low level of attractiveness (n=282)

Groups of notions		
High level of attractiveness	**Medium level of attractiveness**	**Low level of attractiveness**
I	Profession	Guarantees
Future	Creativeness	Past
Success	Independence	Management
Family	Money	Science
Love	Business	Work
Freedom	Sport	Computer
Confidence	Knowledge	Power
Earnings	People	Responsibilities
Communication	Stability	Labor
Trust	Education	Duty
Career	Safety	Doubt
Acknowledgment	Preference	melancholy
Art	Study	Failure

Table 1 reflects grouping of notions with their quantitative meaning that allows to distribute them according to the level of attractiveness. Content analysis of each group of concepts helps to realize connections within the group, reveal differences of each group of notions and also to match content characteristics of group notions and peculiarities of attitude to them of test students.

The group of notions with high level of attractiveness contains the notions that are the most important for test students. Attitude to oneself and own future is characterized by high level of self-acceptance, positive expectations and confidence in successful development of further events. Events that are expected in future are connected with such values as personal success, acknowledgment, career, confidence, freedom; in the area of human relations they are connected with values of communication, love, trust, family, an important place among physical needs is taken by earnings; art is defined among occupation and type of activities.

Notions that are connected with professional activity (e.g., notions “labor”, “work”, “study”, “profession”, “career”, “business”, “responsibilities”, “duty”), did not enter the group with high level of attractiveness.

The group of notions with middle level of attractiveness, reflecting middle level of interest in them, is represented by such concepts as safety, stability, independence, priority; need in self-actualization contain the notions creativeness”, “knowledge”; material needs are represented by the notion “money”; among

the types of activity there defined profession, business, education, sport; medium positive attitude to the people reflects the notion "people".

One can see that the notions "profession", "study", "education", "business" correlate with the notions that have positive tinge (e.g. "safety", "stability", "independence"), which reflects positive attitude to this notions.

Group with low level of attractiveness contains the notions with small importance for test students or even categories with undesired notions. Among such small values are "power", "guarantees" (that is probably shows their lack among test people), among the smallest values are "responsibilities", "duty". Among the notions reflecting types of activity there are "labor", "work", "management", "science", "computer", which may be perceived as unimportant, not significant or unpleasant. These notions are associated with failures, boredom, doubt and person's past.

In such a way content analysis of the group of notions according to the level of their attractiveness reveals certain level of attitude to the notions, which are connected with professional activity ("labor", "work", "study", "profession", "career", "business") and allows to make preliminary conclusion concerning peculiarities of attitude to professional activity.

The notion "career" exists in the presentation of test students separately from other notions and has positive emotional coloring, which provides positive attitude to the notion. Notions "profession", "study", "education", "business", "knowledge" are considered to be significant in the person's life but not the most important, not connected with the notion "career". The notions "labor", "work", "responsibilities", "duty" are indicated with less importance.

Results of investigation of emotional attitude to the wide range of events connected with different types of professional activity of a person, through the revealing of attractiveness of notions connected with professional activity indicate significant differences in the system of these notions, nonconformity to the real correlation of these notions between each other, absence of seeing of accurate connections between notions, oddness of related concepts, which make career expectations.

In order to reveal key feature that combines investigated notions into one group and also hierarchy of correlations of features, cluster analysis was used. Analysis of notions of marked groups allows to determine their content characteristics and reveal general feature. Notions that entered different groups (clusters) are shown in table 2.

Table 2 reflects almost symmetric distribution of notions that entered the groups: group 1 contains 12 notions, group 2 – 14 notions, group 3 – 13 notions. Such quantitative representation of groups allows to compare their content between each other and with content of group of notions as well, distributed according to parameter of attractiveness.

Table 2. Groups of notions connected with various activities according to the results of cluster analysis A

Group 1		**Group 2**		**Group 3**	
No	**Notion**	No	**Notion**	No	**Notion**
m5	Guarantees	m31	Education	m21	Art
m4	Safety	m27	Study	m19	Creativeness
m26	Business	m25	Science	m35	Trust
m18	Management	m28	Computer	m23	Preference
m14	Power	m24	Duty	m10	Acknowledgment
m13	Stability	m17	Responsibilities	m30	Past
m11	Career	m33	Sport	m38	People
m7	Confidence	m29	Profession	m39	I
m22	Freedom	m16	Knowledge	m37	Future
m12	Independence	m20	Labor	m32	Family
m6	Earnings	m15	Work	m8	Communication
m3	Money	m36	Melancholy	m9	Love
		m34	Doubt	m1	Success
		m2	Failure		

Notions, which are combined in the group 1 reflect safety needs (“guaranties”, “safety”, “ stability”, “confidence”), values and needs connected with self-actualization (“freedom”, “independence”, “career”, “power”), material needs (“earnings”, “money”), certain types of activities and occupation (“business”, “management”). Analysis of notions of the group 1 reveals their content-related similarity with the group with middle level of attractiveness (according to the indicator of location of concepts among attractive ones), notions of which reflect moderate level of interest in them. In general analysis of notions content in the group 1 allows to define common feature that combines the notions with each other and to denote it as “Self-actualization”.

Group 2 combines the notions that reflect type of activities and person’s occupation (“education”, “study”, “science”, “computer”, “sport”, “profession”, “labor”, “work”), negative emotional sufferings and states (“melancholy”, “doubt”, “failure”), concepts, connected with self-actualization (“duty”, “responsibilities”), which have negative connotation as well, and notion “knowledge” with positive tone. Analysis of concepts of group 2 proves similarity of the content of concepts of group with low level of attractiveness (according to the indicator of location of concepts among attractive ones) which contains the notion of insignificant degree of importance or undesirable concepts among examinees. “Activity” can be the general feature, which unites concepts of group 2 between each other and the generalizing name for concepts of the group.

Cluster analysis reveals the connection between Group 1 and 2. Such indicator correlates with the results of content-related analysis, which reveals their connection. This is reflected in the names of theses groups – “self-actualization” and “activity”.

Group 3 includes the notions, which reflect communication needs and values (“trust”, “communication”, “love”), self-actualization needs (“preference”, “acknowledgment ”, “success”), activities, which are not connected with labor and professional experience (“creativeness ”, “art”), people (“I”, “people”, “family”), stages of life journey (“past”, “future”). Conceptually , the notions entered group 3, are similar to group of concepts with high level of aattractiveness (according to criterion of location of concepts among attractive ones) which contains concept of the importance for examinees. The main feature, which combines the notions among each other and reflects the general sense of group of concepts, can be the concept «Private life».

In general the results of cluster analysis show the difference in attitude of the people on test to certain life-sustaining activity: there is middle-attractive estimation of events, which are connected with confirmation in the society; disapproving evaluation of events, which are connected with professional activity; active-positive evaluation of private life events.

The character of attitude to the professional career was investigated through the groups notions, with which the notion of “ professional life ” may correlate: through the notions “labor”, “work”, “study”, “profession”, “career”, “business”, “responsibilities”, “duty”. According to the results of analysis none of the notions entered the group of notions with positive attitude; most of notions related to professional activity have negative meaning for the person, they are separated from the personality.

So the research results of attitude to the wide range of events connected with different types of activity with the help of revealing of their attractiveness rate, indicate significant difference in emotional attitude to certain notions. The difference in affective evaluation is the same as some differences in the system of notions, mismatches with real ratio of these notions, absence of perspective of firm connections between notions, oddness of related notions, which form the notions “professional activity”, “professional life”.

The results of analysis of attitude to professional life are investigated through the notions “labor”, “work”, “study”, “profession”, “career”, “business”, “responsibilities”, “duty”, and show that none of the notions entered the group of notions with positive attitude; most of notions related to professional activity have negative meaning for the person, they are separated from the personality.

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Creation and implementation of massive open online course on discipline “Web-design and presentation of intellectual activity results” on the subject “Creation of Web Pages”

Iryna Bulhakova

Senior lecturer
Department of electronics and computer technologies of management systems,
Educational and Scientific Professional Pedagogical Institute
Ukrainian Engineering and Pedagogical Academy,
Artemovsk, Ukraine
E-mail: pokataeva2@yandex.ru

Abstract
Relevant problems of development and introduction of materials for remote learning are considered in the paper. They are presented in the form of video course on discipline “Web design and presentation of intellectual activity results” on the subject “Creation of Web Pages”. The intensification, computerization and optimization of educational process of higher educational institutions are considered.
Key words: VIDEO COURSE, ELECTRONIC EDUCATIONAL AND METHODICAL SUPPORT, WEB DESIGN, SOFTWARE

Statement of problem in general view and its connection with important scientific and practical tasks

Today, there are a lot of platforms for development of MOOC (massive open online courses). These platforms create the special companies - educational content providers specializing in delivery of such services (Coursera, Udacity and edX). In turn, adapted platform allows user to develop each separate MOOC as a unique product.

As in the modern information society an important role is played by information, access to which is provided by means of global Internet, the specification was selected (development and introduction of massive open online course on discipline “Web design and presentation of intellectual activity results” on the subject “Creation of Web Pages”).

The analysis of the last researches and publications, where the solution of this problem is found and upon which the author is based

The subject of remote learning was considered by the following authors: Okolesov O.P., Polat E.S., Pydkasystyi P.Y., Tyshchenko O.B., Petrov A.E. and Briton Bob Gomersall. The following researchers develop and use the videos in teaching: Dmytriiev V.I., Khamydullyna Ye.D., Hodli A.S. Researchers who use information technologies including video: Holieva L.A. Practical use of videos and their development are studied by the following authors: Horbatiuk V.F., Henseruk H.N.

Separation of unresolved earlier parts of general problem to which this article is devoted

In course of studying of literature on area of research, it was revealed that in domestic practice, the

directions of educational videos are poorly developed and studied, theoretical background prevails, and practical development affects outdated technologies. On this basis, it is possible to draw a conclusion that implementation of educational set of video records within a discipline is relevant and perspective for training of future teachers.

The formulation of paper objective (statement of problem)

Tasks are the following: to research re- levance of implementation of the developed course video, to find out the efficiency and determine optimum forms of integration of video records, to reveal features of their use in educational process and how it influences improving of the organization of students self-directed learning, educational motivation, efficiency of digestion of training material in case of study of disciplines of computer profile, which object of study is Web design.

Presentation of the main material of research with full grounding for the obtained scientific results

Information and information technologies with greater and greater speed penetrate into all spheres of human life and lay down demands of the high level to training of students in higher education institution. For meeting of these requirements it is necessary to acquire the whole set of processes connected to representation of intellectual activity results by means of Web-technologies. And therefore, creation the Internet content and performance of other operations connected to calculations or programming, that is connected to work with computer, are the disciplines representing the most perspective directions of training of specialists of different profiles. The discipline "Web design and presentation of intellectual activity results" is important for beginning of professional way of bachelors in the direction of preparation 6.010104.06 "Professional education. Computer technologies", formation of idea of Web-technology and its basic principles. The knowledge of HTML is important for basic representation of materials on Web-technology, but they have not been any more that reference point in the world as it had been before. The insufficient number of classroom hours for study of discipline "Web design and presentation of intellectual activity results" and a large number of hours selected for independent study of this discipline cause a number of difficulties with study of training material. One of improving ways of material learning is use of video courses for the most difficult and basic parts of material with purpose of organization of independent study of students.

In course of development of the video record, a lot of attention is paid to integration of video sequence and audio maintenance with structure and training material. Materials of general nature and record of practical use of skills were used.

After determination of training material, which will be used, it is necessary to come up with components of development of the general concept:

- in general modern stylistics video genre will be easier to acquire information, than with a set of separate concepts;
- innovative component should be as simple as possible, for easier perception of information by pupils;
- software environment of development, that is execution of this type of operation, requires different programs which perform the specific task;
- such visual elements, as color component, suites, genre and unique methods of video series creation.

The genre animation design was selected by style which reflects the modern esthetics of video-design. Use of this genre will be expedient for several reasons:

- esthetic attractiveness of the modern style of video-graphics is the most harmonic for end customer (student or person who improves knowledge);
- its application will increase the interest to the product, and improve concentration on study;
- pedagogical and psychological methods should be considered when creating of video course. The main objective of material is to impart knowledge to the student for their learning.

This style uses a row of instructional techniques and rules of creation of video series, animation, structure. These features also depend on a software environment. Usage of After Effects is the leading program for creation of videos in the Windows operating system. For execution of work, software environment Adobe is predominantly used. And for editing of separate elements the program Pinnacle Studio 16 was used. It is rather easy to understand and has a range of opportunities for execution of this work. Such programs as Photoshop, After Effects, perform a row of tasks, and at the same time have deep program integration.

The first stage is design of general videos stylistics, which will be unique and recognizable. The use of prepared template videos, into which it is necessary to insert the text and images, is desirable only in case of already prepared general concept of disciplines. For example, availability of corporate design of educational institution could use this method for creation of the general style of all educational subjects. The style will be applied for printed materials,

as well as for electronic educational production that is conductive for distribution of recognition and increase of awareness. In case of its absence, the style will be invented from scratch.

According to color theories, the harmonic color gamma is selected. The service colorscheme.ru is an auxiliary tool for search of the appropriate colors. This service is used as a free web service. It has two main components. After selection of colors, every color is represented to the RGB model for their further copying. The next component of web service is library of color shades. Each color tone is divided into groups for convenience of usage. The models HEX and RGB of every color are seen. The main color palette from 3 "warm" and 2 "cold" colors was selected for complex of training video records on discipline "Web design and presentation of intellectual activity results" on the subject "Creation of Web Pages". Black and white are used as complementary neutral colors.

In design, not second role is played by font suite. For this operation two fonts were used: a_LCDNova-Obl and Times New Roman.

Design of a concept, which will be further used in video format, was executed in the program Adobe Photoshop 6. It allows achievement of the following results:

- the concept can be changed in sizes without quality loss;
- fast and flexible changing of component elements;
- the work can be exported to other software for further editing;
- integration into the main program of video-design Adobe After effects.

As creation of a prototype is separate branch of development of design, it has the row of techniques and tools. For possibility of flexible change of elements, the vector graphics are used.

Set of tools allows creation of unique product, which is limited only to the imagination of developer. Vector objects contain the necessary elements as filling of figure surface with color, and its hatchings. In course of edges creation dash-dot lines are also used for simulation of graphic effects.

At the second stage, introductory video which will be repeated at the beginning of training video records, is created. According to the current trends of design, the logo of prototype discipline was repeated with its full animation. The course part of introductory video contained animation with name, animated icon play, original shift between scenes. This shift separates logical scenes of training.

On the basis of lecture material, the whole video was divided into scenes by a number of separate subthemes of training. Not all the material was used for creation of video. As basic provisions of lecture are sounded and duplicated by the text, all training material will increase video record duration too much that will reduce attention of students. The student will acquire the remaining text with lecture material in course of distant work from methodical material. Everything that requires dynamic illustrative accompaniment for the best understanding is introduced in the video record. Duration of each scene varies depending on material, but lasts about 1 minute. This time is optimum for concentration of student attention.

Duration of scenes depends on audio maintenance. For this purpose, it is necessary to plan the scenario, in which the selected text comes after sound. For sound recording, the specialized microphone with noise reduction system (SVEN MK-490) was used, and the software Adobe Audition was used for processing and conversion of sound. The system multitrack record allows recording at the different levels of audio flow. The sound recording can include excess noise and shortcomings. For this purpose, there are means allowing partial improvement of sound by reducing of excess outside sounds. This is one of the main methods in Audition - Noise reduction.

Distinguished features of style of animation design are dynamics of graphic elements, laconicism of information provision, flexibility of elements, and fast rate of video effects and shifts. However, for the training video record, it is necessary to pay not less attention to content, that is to find the best combination of training material with graphic stylistics. Videos in this style can be created for enough long time. For creation of product lasting several minutes, it can be spent about several weeks. Therefore, for optimum time of each lesson creation, it is necessary to develop template elements of design in the context of company stylistics.

List of template scenes:

- a row of charts elements, certain style of lines and auxiliary elements (arrows, the beginning and the end of operation) are developed for diagrams. Without overloading of colors, the three-colored diagram is used: dark-red for the text and shaped lines of charts, black for color of lines and arrows, green for specifying of the beginning and the end of content.
- Beginning of subject. After shift, the name and number of lesson goes as separate slide. Scenes with sub-themes of lecture material go as additional screens.

- Code scenes. In the developed style, the main body of code appears together with lateral face behind which additional elements of design can be displayed; these elements can indicate importance of present situation to what special attention should be paid. In code scenes, there is also common text where the thesis accompanies a sound row of the speaker.

- Text scenes. These scenes are minimized because the main text is in a sound row which accompanies dynamic elements of design, code, and selected text.

- Scenes with visual additional elements. Such scenes without text by means of various means of design visually present the text, process, and model.

Sample scenes will help to vary training material more flexibly. If it is necessary, the modularity will allow interchanging of the position of material, changing of outdated one and correcting of errors. In Adobe After Effects, these scenes are part of composition. First of all, the project is created, then the main composition in which time duration parameters, sizes of a video series, picture frequency in a second, background color are set, is created. The basic composition can be used as the main scene of the first lesson. The basic composition will consist of compositions of separate sub-themes of lesson, and also of such compositions as transitions of scenes. All these scenes of one lesson will be combined in one folder as all created compositions to be in the joint project. Absence of the organization can worsen orientation in the available materials. In After effects, there are two main panels for the organization of the available materials: project and line of time (English Timeline). Further, they are used in Timeline where are arranged in a definite way as it is demanded by technological process of creation of these or those scenes.

Layers of the form can be used in animation and transformed by means of additional effects, changes of their main properties, addition of masks. Feature of a body are the following: constant shape, which can be changed only by means of additional masks, and also the fact that they are created and stored in the Project panel that makes it possible to use dynamically them for future replacement by other images. The form is more intended for creation of complex objects and their coherence. At the same time, it is possible to add parameters as filling of objects; it gives a number of additional opportunities for creativity. The possibility of creation of mask exists as in a body, and in shape, however, only the body has a possibility of automatic creation of mask in the area of the whole object.

Thus, it is always possible to add a mask of form of the main or any figure to rectangular area of a body. There is an opportunity to export prepared prototype of work with Photoshop, however, the vector After Effect elements have technological features; therefore, all the elements will be redrawn again. The introductory part consists from five-color transition, the name of course and subject of lesson. A role of strips will be performed by forms which will be cut off by Linear Wipe and animated by means of effects. This effect is included into group of effects Transitions and is intended to create border with a certain angle which will hide part of the image.

The effect will be used further for animation of appearance of some elements, text and code. Dynamics of the movement of this line will create the necessary animation. The basis of all animation in After Effects consists in use of Keyframes.

During animation creating, need of application of the same effects to various layers very often emergences. For this purpose, the auxiliary object (null object) is used. It is enough to connect any layer with null object having used an option opposite to the layer. The quantity of layers which can be connected to one null object is limited. Further use of keyframe for null object will be displayed on all layers connected to it.

After all the thematic parts are ready, it is high time to connect them by means of the program Pinnacle studio 16. Prepared projects can be exported to a set of formats including video for web, DVD, Blu-ray, video HD, etc. Many various effects and transitions are built in the program. The sound in the Dolby Digital 5.1 format is maintained. According to the planned scenario, it is necessary to arrange video and audio material. Each unit should correspond each other. Additional attention is required by voice of the speaker when editing. After its record and processing by Adobe Audition, it conforms to all technical requirements. But in order to avoid sharp transitions, it is necessary to use function of audio volume setting of audio track. After editing is complete, we select video output option. Further, we select item of setting where there is a possibility of optimization of parameters of video output.

Further approbation of complex of video records in educational process of discipline “Web design and presentation of intellectual activity results” on the subject “Creation of Web Pages” for the purpose of improvement and determination of optimum forms of integration of video of courses into educational process of disciplines has been carried out; object of study is web design and language of html of the document.

Developed videos are used as evident illustrative

material for increase of understanding of the theory, and for process of learning and memorizing of material by the student.

In order to check a research hypothesis which consists in the fact that success and level of understanding of training material of discipline will be increased in case of integration of video course into it; practical implementation of course to educational process has been carried out.

The video course has been shown when studying the following material on the subject "Creation of Web Pages": creation of the Web page; work with hypertext references; placement of drawing in the Web page; addresses and conditions of the Web page on the Internet; addition of graphics in HTHL code; Web graphics bases.

Approbation of videos was carried out on the basis of Educational and scientific professional pedago- gical institute of Ukrainian Engineering and Pedago- gical Academy at department of electronics and computer technologies of control systems of students of full-time education group ADET - K11 within classes in disciplines "Web design and presentation of intellectual activity results" in classroom lessons and organization of independent work of students in system of remote learning. Results of training of students of group ADET - K11 in the form of total points have been compared to results of the previous group. According to comparison, the coefficient of quality has grown by 12,5% that demonstrates improvement of group study in general.

Conclusions of this study and prospect of further researches in this direction

Interpretation of results of experiment has allowed drawing of conclusions on efficiency and effectiveness of use of video course on lecture and independent trainings.

Systematic use of the developed pedagogical software product in classes gives the chance to note the following supervisions:

- increase of interest in material due to emphasis of the video to more complex features of HTML marking, its visual representation;

- modern video series of animation design applies associative skills of students, stimulates students to ask more questions;

- than time is spent with lecture material at independent training;

- use of the video record requires from the lecturer more use of means of ICT on lecture classes;

- possibility of loading of video in MOOC platforms avoids necessity to use intermediate transmission media of material from the lecturer to students, and need to save this information in data storage item.

As a result of approbation of educational complex of the video record, it is possible to draw a conclusion that its introduction in process of training is expedient, and affect positively the results of training.

During further work, deep study of successful foreign models of training materials, expansion of a complex of video records on discipline "Web design and presentation of intellectual activity results" is planned, and also application of experience obtained in case of development and introduction of video course into educational process of other disciplines of Teaching and Research Institute of Professional Education of the Ukrainian Engineering and Pedagogical Academy.

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A new design of non-automatic weighing calibration device for weight-free verification of large-load platform railroad scales

Boryak K. F.

Dr. Hab. (Engineering)
Odessa State Academy of Technical Regulation and Quality,
Odessa, Ukraine

Abstract
The article puts forward to supplement the verification standard weight measuring instruments with a new auxiliary verifier – 'Non-automatic Weighing Calibration Device with maximum weighing range of 60 tons (VNKU-60)' in which hydraulic jacks and ballast weight for applying the load forces on the load carrier are used. Version 1 of the design of VNKU-60 had limitations related to use of only one type of rail car — a 'gandola car' as a ballast weight, into the body of which the construction of the very device was arranged. In this connection version 2 of the VNKU-60 device design has been elaborated, which has turned out universal one, as for its use any types of rail cars fit that are available during verification. In spite of the difference, the author recommends both versions of the VNKU-60 device design for introduction instead of weight-verification cars for weight-free verification for large-load platform railroad scales.
Keywords: NON-AUTOMATIC WEIGHING CALIBRATION DEVICE, LOAD CARRIER, WEIGHT-TRANSMITTING DEVICE, RAILROAD SCALES, WEIGHT-FREE VERIFICATION, CALIBRATION OF LARGE-LOAD SCALES, STANDARD WEIGHT MEASURING INSTRUMENTS

Large-load platform scales are the most common means of instrumentation when performing commercial transportation by railroad. Technical and metrological characteristics of the scales shall meet the requirements [1; 2]. Verifying (calibrating) the scales shall be performed in accordance with the requirements [3]. According to these requirements the basic method of verifying large-load stationary platform railroad scales is directly loading the scale platform with M_1 class standard weights 2 tons in mass [4]. The total mass of the weights which is required under verification must be multiple of the largest weighing capacity range (LWCR) of loading. The weights to the scale platform are delivered by a weight-verification car. In the course of verifying it is necessary to perform the multiple loading of the scale platform that requires moving the large masses of weights.

Applied problem for solution of which the research was directed

The problem is lack of weight-verification cars (WWC) most of which were made in Soviet times and are obsolete. Owing to this, the deadlines of inter-verification period are broken, that results in temporary suspension of operating the weighing equipment and production timeouts. It leads to great losses that industry enterprises bear in case of waiting their turn.

Thus, for a significant reduction in operating costs and time for performing the verification of large-load scales, devising a new method of weight-free verification and relevant standard instrument that is intended for designs of platform railroad scales available in operating to avoid additional financial costs for their

modernization is pressing and economically expedient.

Analyzing recent achievements

A well-known Russian technique of weight-free verification for large-load platform railroad scales [5] in which loading the scale platform not with weights or ballast masses but with various loading mechanisms measuring load forces by means of the standard sensors embedded in the device is proposed, and the results are compared with readouts of the duty sensors of the load carrier.

Many patents were issued to various designs of the loading device. As a variant, loading the scale platform by means of hydraulic cylinders is proposed. In this direction, a number of well-known industrial companies have fulfilled a modernization of the design of platform scales, which includes a special frame binding and strengthening of the foundation, which allows of making a rest for the loading device installed onto the scale platform. In some designs a rope that is attached to the foundation is run through the hole at the very scale platform. The winch that is placed on top of the scale platform pulls the rope creating tension force. In other designs of the scales making the placement of the force-measuring sensor of the standard device under the scale platform is proposed, which is far from always possible.

Thus, the above discussed Russian technique of weight-free verification has certain disadvantages. In creating a load force onto the load carrier, a counteracting force is appeared, which leads to a need for significant strengthening of the scales foundation or a considerable complexity of the very metal structure. These structural complexities led to the fact that the total cost of new platform scales has significantly increased, and applying the well-known method of weight-free verification for the existing scales has become absolutely impossible. However, the complexity of the scales design which must withstand a counteracting force to the loading device of several tens of tons, which is appeared according to Newton's third law, led to the fact that the Russian method of weight-free verification has become widely used neither in Russia nor in Ukraine. In substantiated cases it can be used for diagnosing the technical state or adjusting the individual components of a weighting terminal. But at present, applying the Russian technique under verification of platform railroad scales is unacceptable. The reason of this consists in the fact that a verification officer has not the proper design of the loading device that would create load forces onto the scale platform, which would be adequate to real operating conditions. These circumstances have delayed the wide application of the weight-free verification technique in practice.

A new auxiliary verifier that is called 'Non-automatic Weighing Calibration Device with maximum weighing range of 60 tons (VNKU-60)' is put forward to introduce into verification standard weight measuring instruments, which shall replace the weight-verification car outfitted with weights [6] in the course of using the railroad platform scales.

Version 1 of the VNKU-60 design was elaborated for using one rail car of the 'gondola car' type as a ballast weight [7]. In addition to limitations in usage of one type rail car only for verification — 'gondola car' as a ballast weight, version 1 of the VNKU-60 design had other shortcomings:

1. The presence of danger zone when performing the assembly work, which is due to the location of the constituent elements of instrument design in the space between the body of gondola car and railroad rails of load carrier.

2. The existing design limitations on increasing the maximum load force on the vertical struts and truss rod of gondola car body.

The aim of the research is the elaboration of a new design version of the non-automatic weighing calibration device and corresponding technique of weight-free verification for large-load platform railroad scales for it.

The subject of the research is the ways of creating load forces onto the load carrier, which would be adequate to real operating conditions.

Describing the basic material

A new scheme (Fig. 1) and a method (Fig. 2) of loading the load carrier for weight-free verification of scales using VNKU-60 have been worked out.

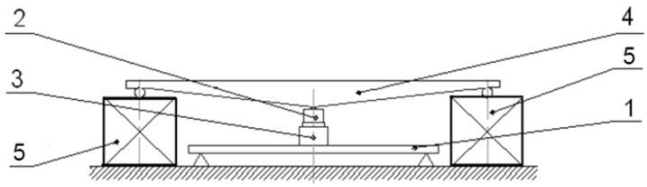


Figure 1. Scheme of loading the load carrier using two ballast weights, where: 1 = load carrier; 2 = weight-measuring sensors; 3 = hydraulic jack; 4 = weight-transmitting device; 5 = ballast weight.

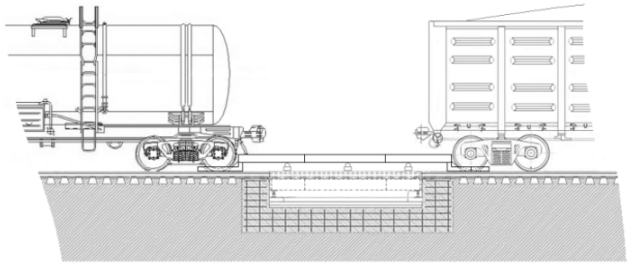
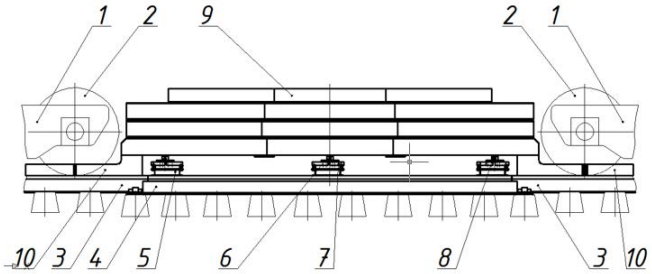
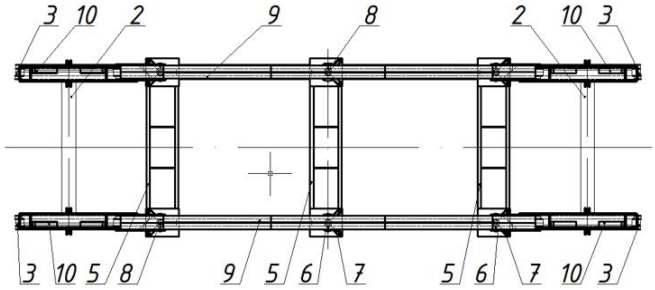


Figure 2. Layout scheme of ballast weight when loading the load carrier

The new version of the VNKU-60 device for weight-free verification of platform scales [8] includes the ballast weight that is formed with two railroad cars 1 of any type, which are loaded with cargo of random type according to laid-down rule (Fig. 3).



a)



b)

Figure 3. New version of VNKU-60: side view (a); top view (b), where: 1 = railroad cars; 2 = wheelsets of cars; 3 = railroad rails; 4 = load carrier; 5 = weight-transmitting devices; 6 = weight-measuring devices; 7 = strain-gage sensors; 8 = loading devices (hydraulic jacks); 9 = load-receiving devices; 10 = clamps for wheels

Wheelsets 2 of the cars are located on rails 3 of the approaching lines beyond of load carrier 4, and on the site of rails located on the load carrier 4 three weight-transmitting devices 5 are installed, which are located in parallel to each other and perpendicularly to the rails of load carrier 4. At each weight-transmitting device 5 two weight-measuring devices 6 located over rails 3 of the loading carrier are installed. Each of weight-measuring devices 6 contains a set of three standard strain-gage sensors 7. On top of weight-measuring devices 6 loading devices 8 (e.g. hydraulic jacks) are installed, which are connected in parallel with a source of pressure. Above and loading devices 8 (hydraulic jacks) along rails 3 of load carrier 4, load-receiving devices 9 are located horizontally, which are made in the shape of a set of beams with connecting elements. Both ends of each load-receiving device 9 content clamps 10 in the shape of forks for rigid attachment of the wheels of abutting wheelsets 2 of railroad cars 1. The sets of beams of load-receiving device 9 and clamps 10 can be made demountable that will assure their use without applying lifting machines.

The proposed device for weight-free verification of platform scales shall be used in the following way (Fig. 3). At the site of rails 3 that pass through load carrier 4 weight-transmitting devices 5 are installed, which are located in parallel to each other and perpendicularly to the rails 3 of load carrier 4. At weight-transmitting devices 5 weight-measuring devices 6 with standard strain-gage sensors 7 are installed. Over weight-measuring devices 6 loading devices 8 (hydraulic jacks) are installed, which are connected with pipes in parallel to the pressure source that ensures their simultaneous action. After that onto loading devices 8 along rails 3 of load carrier 4 load-receiving devices 9 made in the shape of a set of beams with connection element are horizontally put on. Then by rails 3 of the approach lines both rail cars 1 are brought from opposite sides to load carrier 4 and stopped them at a distance that their wheelsets 2 should be located outside of load carrier 4. Then by means of clamps 10 of load-receiving devices 9 on both sides first wheels of wheelsets 2 are grappled and rigidly fixed at rails 3 of the approach lines from subsequent moving of cars 1. After that pressure in the hydraulic circuit of loading devices 8 is gradually changed, as a result of which the load force changes that is transmitted from loading devices 8 through weight-transmitting device 5 to load carrier 4 and at the same time to weight-measuring device 6 with standard strain-gage sensors 7. The load force is initially raised up to the maximum weighing level and then is diminished up to the minimum weighing level according to rules that are specified in the datasheet for load carrier by manufacturer.

The number of such cycles of loading when verifying load carriers is set according to the current state standard of Ukraine [1]. Thereafter the related results of measuring the load forces obtained from the weighing devices of two types — reference and working ones are analyzed, then measurement error is calculated which is compared with rated one. On the basis of the comparison a conclusion on the suitability of scales for further use is drawn. If the design of platform scales consists of two or more load carriers, then the procedure shall be performed in turn and separately for each of them.

The VNKU-60 device has the following technical characteristics:

Largest weighing limit, LWL, kg	60,000
Smallest weighing limit, SWL, kg	400
Bound of absolute error of replication and weight measurement, kg	±31.5 (for sensors C_3)

	±23.6 (for sensors C_4)
	±18.9 (for sensors A_5M)
Climatic version	according to GOST 15150-69
Load module UHL3, °C	–20…+ 40
Control system UHL1, °C	–40…+50
External communication interface versions	RS232, RS485, CAN
Weighing cycle time, s	20
Voltage, V, Hz	220, 50 ± 20 % ± 15 %
Power consumption, no more than, W	53
Operating temperature range, °C	–20…+ 40
Overall dimensions (LxBxH), mm	6584x1910x950
Total weight, no more than, kg	1750
Maximum weight of single structural member, no more than, kg	70

The total quantity of the sensors installed in version 2 of VNKU-60 is half as many as that for version 1 and amounts to 18 units. A power bridge of three ZEMIC H8C beam strain-gage sensors with accuracy class: C_3, C_4 or A_5M with rated load of 5,000 kg is used for measuring tensile forces in the stretch/pinch mode. According to i. 1.2 of DSTU OIML R 60:2010 and recommendation [10; 11] the error of all 18 strain-gage sensors shall be considered in the aggregate if the operating characteristics of these sensors are referred to the envelope of introduced errors. Hence it follows that the bound of introduced error of the VNKU-60 device according to a sensor class is:

$$\Delta = \frac{5000\ \text{kg}}{3000} \cdot 1{,}05 \cdot 18 \approx \pm 31{,}5\ \text{kg},$$

$$\Delta = \frac{5000\ \text{kg}}{4000} \cdot 1{,}05 \cdot 18 \approx \pm 23{,}6\ \text{kg},$$

$$\Delta = \frac{5000\ \text{kg}}{5000} \cdot 1{,}05 \cdot 18 \approx \pm 18{,}9\ \text{kg},$$

therefore according to the requirements of i.3.5 and i.3.7 [1], VNKU-60 can be used as an auxiliary verifier for verifying the platform railroad scales with calibrating interval of e=50 kg only during the operation with the bound of introduced error less than ±2e=100 kg.

To verify the very VNKU-60 device, 30 standard weights of M_1 class are used. In this case the bound of introduced error is:

$$\Delta = 0{,}1\ \text{kg} \cdot 30 = \pm 3\ \text{kg},$$

that fully meets the requirements of i.3.7.2 [1].

Conclusions

The new design version of the VNKU-60 auxiliary verifier meets the requirements of Ukrainian technical regulations [9] which were developed on the basis of Directive 2009/23/EU on non-automatic weighing instruments and also the requirements of i.3.7 for verification standard devices [1] in the part of i.3.7.2 that concerns auxiliary verifiers. Existence of two different design versions of the VNKU-60 auxiliary verifier increases profitability of their wide application in practice of weight-free verification or calibration of large-load platform railroad scales in Ukraine. And in the absence of additional costs for a modernization of car complexes and mobility of the elaborated VNKU-60 device make it very attractive for application in weight-free verification in comparison with weight-verification cars.

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Analysis of intersectoral technological linkages on mettalurgy innovative development

Omelyanenko V.A.

Head of Technology Transfer Organization Group
of Center of Scientific Technical and Economic Information,
Sumy State University
Sumy, Ukraine

Abstract
The article deals with theoretic bases of intersectoral technology linkages in metallurgy and methodic bases to determine its potential with reference to technological package conception. Methodic of intersectoral technology transfer effects identification is suggested.
Keywords: INTERSECTORAL LINKAGES, TECHNOLOGY TRANSFER, INNOVATION, TECHNOLOGY, METALLURGY

1. Introduction

In metallurgical industry development in global crisis production costs are in primary foreground. New technologies that increase efficiency and reduce costs in sector enterprises is one of the key factors of competitiveness of industry and economy in general, as mining and metallurgical complex occupies an important place in GDP structure, and metal acts as the material base of production apparatus. Domestic demand for the metal is characterized by reducing the supply of specialized metal-working industries, primarily in mechanical engineering and production of construction materials.

The relevance of this study is caused by the fact that after years of unstable situation of metallurgical industry is entering a new qualitative level of development, caused by cross-sectoral technology transfer. Modern metallurgy includes a wide range of manufacturing operations of producing metals and alloys. For estimates place of metallurgy in economy and influence on development of related industries we propose to use intersectoral analysis. The idea about

relative value of inter-branch technologies transfer as a source of the industrial technological development can be received after having determined ratio between two effects (Kholmeckiy, 2006):

1) growth of total productivity in all economy sectors through intersectoral technology diffusion;

2) growth of total productivity in linked sectors.

Numerous researches show tendency of technological multiplier values increase practically in all OECD countries. It is preconditioned with complications of the consumed industrial production in technological plan and with more increasing sectoral specialization and growth of industrial equipment, components and materials intersectoral trade volumes.

Informational technologies can radically change modern economic realities. For example, principle of recourses superfluity mostly appears through opportunities to copy information infinitely. It allows to maximize economic effects on society and economic system. When we talk about growth of information share in producing goods, we suppose that information about product, which is necessary for its production, has basic value. International studies show close connection between ICT and economic development of traditional industries. Wide use of high-speed communication and Internet technologies is promoter for ICT projects development, and also provides great multiplicative effect for various sectors in national economy, quickens and enlarges technological progress and finally provides GDP growth either in separate regions, or in the country on the whole. One has also to mention, that developing countries with more developed telecommunication infrastructure are able to attract many outsourcing companies and foreign investments.

It was estimated that in 2010 corporations spending on R&D began to recover quickly and metallurgical industry is also included in this trend (\EU Industrial R&D Investment Scoreboard. 2010).

Intersectoral innovations have either local origin, i.e. they are investigated by the enterprise independently, or they can have inter-regional and international sources. New research in EU found out that local and national clusters suit to innovations. Researchers Rune Andres and Rodriguez Posera analyzed experience in Norway companies and found that "global pipelines", considered to be sustainable interrelations between actor – member of cluster and external actor) in practice determine bigger success of company than local relations. This conclusion is contrary to that one, which was expected after ten years of investment policy in innovative clusters development at the national level (Hwang, V. and Horowitt, G.).

For example, the USA leadership in production of packing consumer goods and long-term use goods contributed into the success of advertisement creation and marketing. Japanese positions in production of electronics became result of the fact that Japanese success in semi-products branches was oriented to production of memory cells and integral schemes, used in production of various electronic goods (Porter, 1993).

2. Intersectoral technology linkages

Modern metallurgical production is a complex industry the most important features of which are multidisciplinary and cyclicality of processes, presence a lot of processes types, high resource and capital intensive and high impact on environment. Perspectives of intersectoral interconnections first of all deal with ability for further metallurgy technologies improvement. Potential of intersectoral linkages must be observed based on fact that any technological process has to be examined as a part of more complicated process and as a set of less complicated technological processes. Every of these processes is able both to form unique competitive advantages and grade advantages of its processes.

Today together with specialization and differentiation of sectoral productions, cooperation and integration processes are developed, which lead to formation of sustainable producing relations between sectors and create intersectoral complexes. Practically every science-intensive sector can be observed as intersectoral complex, which is integrative structure, characterized by interaction of various sectors and their elements, various stages of production and goods distribution.

One of reasons of innovation clusters appearing is formation of technological relations between producers in value chain and ability to form competitive advantages through clusters in interconnected economy areas. One competitive sector can lead to creation of another one in process to strengthen partnership relations through cluster mechanism. This sector may often be the most exacting purchaser of goods and service from sectors, on which it depends on. Its existing in country becomes important factor, determining competitiveness of sectors-suppliers.

Competitive technology sector develops all connected with it sectors, through more strict requirements for production and technological support through innovation exchange (fig. 1). New technologies of production supplier stimulates introduction of new goods on firm-purchaser.

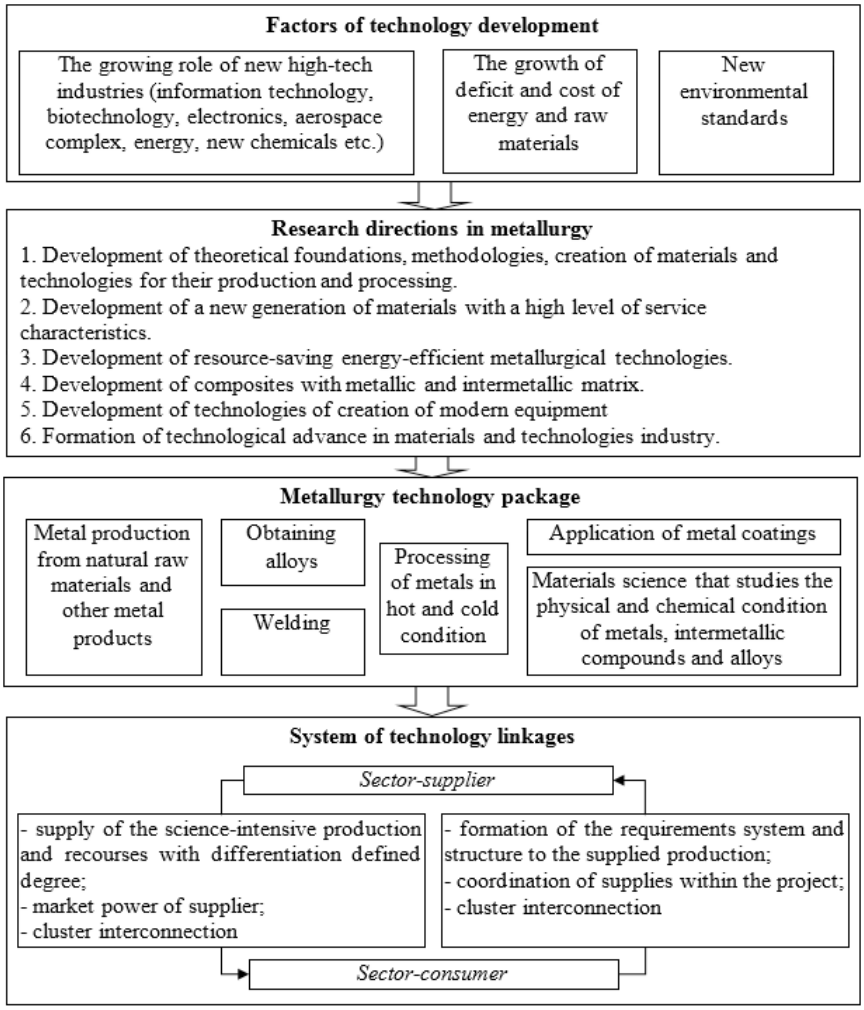

Figure 1. Technology linkages system factors in metallurgy

Nowadays green technologies are important tools to develop many sectors, state in which directly impacts the economic security and comfort in ecosystem. Metallurgical sector cross other constantly, that's why it allows to consider green technologies as intersectoral development tool. Recycled materials are not only essential component of metallurgy resource base, but also causes significant changes in technological structure and its intersectoral linkages.

2. Methodic of intersectoral technology transfer effects identification

Various sectors, which are developed owing to uneven development of enterprises separate groups, face with difficulties in introduction of intersectoral innovations (Schlafman, 2013).

Intersectoral technology linkages of metallurgy can be analyzed through:

- direct influence on achieving of industry main goals;
- inter-sectoral linkages in supply and using of products;
- feedbacks between the industry-consumer and industry-supplier.

However technological connection in metallurgical process can also take place in reverse order, because uncompetitive sector may blow up other sectors, connected with it, when it is consumer (Tretiak, 2008).

New technologies can be distributed both at horizontal (sectoral and inter- sectoral transfer) and vertical level (transfer between large and small business). Distribution and sectoral level is caused by competition between analogical companies, and inter-sectoral innovations diffusion is connected with decreasing of various barriers and sectoral reviewing. At the vertical level innovations are moved through technologies transfer by two contrary directions: from small venture companies to large producers and from last ones to small business, which uses innovative technologies.

Many investigations show the innovative traps or technologies break in intersectoral interaction. Technologies purchase requires more expenses, than buying of separate machines and equipment. Purchasing

of technologies (technological package), needs definite level of personal powers, where new technology can be successfully integrated, and out-of-date po-wers cause narrow places in production and in its inter-branch interactions (Balatsky, 2003).

Technologies market is described with less capacity than market of machine and equipment. Separate machines and equipment purchase is better coordinated with active technologies and adapted to productive requirements. As a result branch stage-by-stage may transfer to state, which will allow to purchase complex technologies. In these branches innovations are provided by the proper industrial policy, oriented to stimulate and support new equipment purchase.

External factors (competition, level of sectoral concentration, mass and norm of income, another peculiarities of sectoral markets) lead to paradoxical situation in funds reproduction, which is closely connected with investments and innovations. The average age of funds in those branches which must produce more productive equipment for final consumption branches, is higher, than in branches, which produce final consumption items and mining branches.

Technological trap in two directions: not low-technology branches can absorb new technologies, but medium-tech branches do, which have to provide technological progress in them, have old-fashioned powers.

Intersectoral technologies of additional value are supposed to be an important aspect. One of innovative development aspects can be ecological constituent improving in production, which is important for metallurgy.

4. Conclusion

The scenario of innovative development of metallurgical industry is characterized by the development of domestic demand for products with high added value, which in turn will contribute to the development of new technologies and manufacturing high-tech products. Selection of innovative policy priority directions in industrial sectors has to provide achievement of definite level in inter-sectoral efficiency.

Currently the main objective of metallurgical industry it to make industry high-tech, a dynamic, efficient and competitive. The processes of global and domestic economy are reflected in change of indicators of metallurgy and quantitative characteristics of its cross-sectoral linkages.

Parallel convergence development will accelerate development of list scientific and technological areas with strong economy impact. Special interest is presented by probable qualitative changes of the economic system, influenced by technologies, because in long-term perspective economy development, particularly average labor efficiency is determined by technologies development in most. It includes firstly technologies of production and labor tools use, producing and business-processes.

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The method of determining static microhardness of metals and their alloys by Kotrechko

Oleksiy Kotrechko

PhD in Technical Sciences, associate professor
National University of Life and Environmental Sciences of Ukraine,
Kyiv, Ukraine
E-mail: oleksiykotrechko@gmail.com

Abstract
The developed method of determination of static microhardness of metals and their alloys with use of the indenter of new construction in the form of tetrahedral pyramid with angles between edges $\alpha = 90^0$. It provides change from elastic to plastic deformations in case of smaller values of hardening in the course of tests. The metals microhardness index obtained in case of researches with the suggested method is more accurate in comparison with existing standard ones by Knoop and Vickers. Its application can be recommended to plant and engineering departments of machine-building industry in case of researches of mechanical properties of metals. Novelty of method of static microhardness determination of metals and their alloys is confirmed with patents of Ukraine.
Key words: METAL, STATIC MICROHARDNESS, INDENTER, TETRAHEDRAL PYRAMID, ANGLE BETWEEN PYRAMID EDGES $\alpha = 90^0$

1. **State-of-the-art**

Microhardness of surface layers of metal products after chemical heat treatment, laser and plasma cladding, metallizing, hardening, etc. is connected to their wear resistance, fatigue resistance, and also reliability and longevity of operation of finished products. Therefore, for the purpose of comparative evaluation of specific strengthening types of processing of metals and their alloys, development of new methods of determination of accurate values of microhardness is reasonable.

2. Analysis of the known methods of determina-

tion of static microhardness of metals and their alloys

Methods of determination of metals static microhardness by Knoop and Vickers are known. The first suggested and the most widespread method of determination of microhardness by Knoop [1] was developed by National Bureau of Standards (USA) in 1939. According to this method, during researches rhombic-pyramidal indenter with angles between edges $172^{\circ}30'$ and $\frac{h}{d}=\frac{1}{30}$ is used. Disadvantage of Knoop method is that the ratio of depth of indent (h) to the length of big diagonal (d) is approximately $\frac{h}{d}=\frac{1}{30}$; therefore, in most cases indents are not always symmetric and errors are possible in case of their measurement. The existing standard method of determination of metals microhardness by Vickers [2] assumes regular tetrahedral pyramid with an angle between opposite edges in case of vertex $\alpha=136^{\circ}$ to be used during researches. It is known that impressions of the indenter in metal is followed by its hardening [3]. At the same time, resistance to indenter penetration into sample is constant and depends on its geometry, and the obtained values of hardness exceed actual ones. Therefore, development of new construction of the indenter, which provides transition from elastic to plastic deformations in case of smaller values of hardening, is necessary.

3. Method of determination of static microhardness of metals and their alloys.

For determination of static hardness of metals construction of the indenter [4] in the form of the regular tetrahedral pyramid with vertex angle $\alpha=90^{0}$ is developed and suggested (Figure 1).

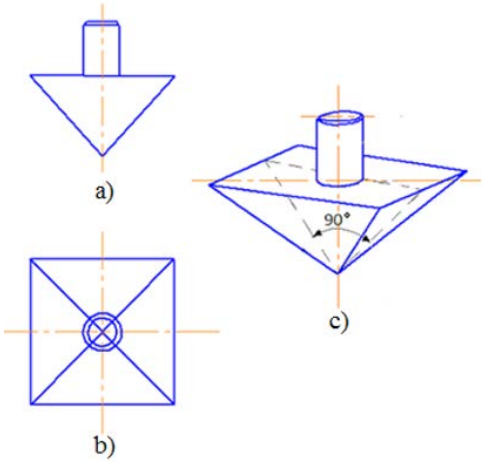

Figure 1. Design of indenter: a) and b) - frontal and horizontal projections respectively; c) - general view

The method of calculation of static microhardness of metals [5] is based on measurement of arithmetic mean values of two diagonals (d_1 and d_2) of indent 1 of pyramid 2 in the researched product 3, obtained after impression of pyramid into a sample (Figure 2).

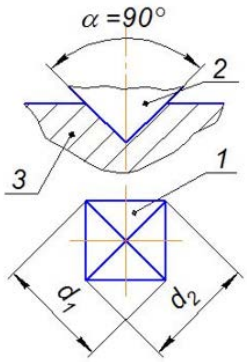

Figure 2. Diagram of measurement of pyramid indent

Value of static microhardness ($HK\mu$) is determined by ratio of loading (P) to the area of indent (F) of a pyramid:

$$HK_{\mu}=\frac{P}{F}, \quad kH/mm^2$$

The area of obtained indent is calculated by formula:

$$F==\frac{d^2}{2sin\frac{\alpha}{2}}=\frac{d^2}{1,4142}, \quad mm^2$$

where d - arithmetic mean value of lengths of two diagonals of indent of pyramid, mm; α – angle between opposite edges at pyramid vertex; $\alpha=90^{0}$.

Consequently, static microhardness will be equal to:

$$HK_{\mu}=1,4142\frac{P}{d^2}, \quad kH/mm^2$$

Conclusions

The use of suggested design of indenter reduces value of hardening during its impression into metal; therefore, values of static microhardness obtained by method of Kotrechko are more accurate than standard ones by Knoop and Vickers. For the purpose of development of the optimum sizes and geometry of finished products and support of their reliability and longevity, application of the developed method of determination of static microhardness of metals during researches of mechanical properties of metals is reasonable; and it can be recommended to plant and engineering departments of machine-building industry in case of researches of mechanical properties of metal products.

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Formation of soil pollution area by oil when there is break of airtightness of main pipeline

Volodymyr Grudz

Professor, D.Sc. in engineering
Head of «Construction and repair of gas and oil pipelines and storages» department
Ivano-Frankivsk National Technical University of Oil and Gas,
Ivano-Frankivsk, Ukraine
E-mail: srgg@nung.edu.ua,

Andriy Zhdek

Associate master mechanic,
Branch «Main Oil Pipelines «Druzhba» JSC «Ukrtransnafta»,
Lviv, Ukraine
E-mail: azhdek@druzhba.lviv.ua,

Vasyl Bolonnuy

Ph.D. in Engineering Science
Associate in training activity
State Higher Educational Institution "Drohobych oil and gas college"
Drohobych, Ukraine
E-mail: vasil_b@bk.ru

Abstract
The process of oil filtering in the porous medium (soil) which is caused by sources of transported product in case of break of airtightness of long operated underground oil pipeline is researched in the article. Analysis of reasons of accident rate of oil pipelines is carried out and the nature of end-to-end defects of pipe body is considered. Modelling of formation of area of pollution of the soil by oil for creation of the field of filtering rate in the porous medium as the function of space coordinates and time is carried out.
Mathematical model based on the law of linear filtering in the form of Darci, continuity equation in two-dimensional form, where the leakage from the pipeline is modelled by function of Dirac source is developed. The results obtained allow to create non-stationary distribution of filtering rate in the soil, on the base of which, the conclusion about formation of area of environmental pollution by oil leakages is drawn.
Key words: EMERGENCY LOSSES, THROUGH FAULT, LEAKAGE FLOW, FILTERING RATE, SOIL POLLUTION AREA

Terms of oil pipelines operation in Ukraine are considerable and make from 15 to 52 years. One of the most serious problems of operation of such oil pipelines is their accident risk - unforeseen refusal of linear part that is followed by catastrophic influence on environment. At untimely and low-quality scheduled preventive maintenance of linear part of long operated oil pipelines, the risk of emergencies with depressurization of pipeline and oil spills increases significantly [1, 2, 3].

Authors fulfilled considerable scientific analysis of emergency situation connected with depressurization of the linear part of main pipelines of Ukraine and some other countries.

Great ecological disaster connected with accident at the oil pipeline of JSC "Komineft" happened in August, 1994 in Usinsk region of the Komi Republic, the Russian Federation. As a result of appearance of holes on the pipeline, there happened large-scale oil leakage. According to various data, losses made from 102 thousands to 576 thousands barrels of crude oil. There is no exact data on the area of polluted surface, but the numbers vary from 69 to 115 hectares.

On March 15, 2008 at 17:00 in Brodivsky district of the Lviv region (Ukraine) near the village of Yablunivka at Kilometer 649 of main oil pipeline "Odessa - Brody" with diameter of 1020 mm one of inspectors has found oil leakage - within the protected zone. Approximately one ton of raw materials was lost, the area of contamination was 50t sq.m.

On October 14, 2008 near the city of Budapest (Hungary) there was a break of oil pipeline "Druzhba" of the Hungarian oil and gas company MOL in the area connecting Hungary with Slovakia. As a result of this incident, there happened leakage of several hundred cubic meters of oil. The pipe was broken through as a result of territorial works, which were carried out by contractor in the private territory near the oil pipeline without coordination with Hungarian oil and gas company.

The gap on the main oil pipeline "Perm — Almetyevsk" in Perm Krai, Russian Federation happened on February 17, 2009 near the village of Klyuchiki. According to preliminary data, in result of failure of oil pipeline, about 10 tons of oil poured out [7].

On September 13, 2011 in three kilometers from the city of Petropavl, North Kazakhstan Region (Kazakhstan) on the Kilometer 1056 of the Taymis — Omsk — Novosibirsk oil pipeline (TON-2) of the North Kazakhstan oil pipeline management office of East branch of JSC "KazTransOil" during territorial

works on laying of fiber optic communication line in the protected zone, there happened a failure of the oil pipeline with a diameter of 720 millimeters. Accident caused the oil spill approximately on the area of 1000 square meters and volume - 200 cubic meters.

On July 19, 2012 at 10 a.m. during examination of oil pipeline "Druzhba" between villages Russkoe and Chopovtsy of Mukachevo district of Zakarpattia region (Ukraine), the workers of oil pipeline revealed the leak of oil into the soil reclamation canal. As it turned out, the oil leak is a result of break of rubber hose of high pressure, which was illegally fitted in the oil pipeline. Amount of the poured oil - up to 500 liters.

On August 14, 2012 at about 6 o'clock in the evening near the village of Krivets of Bogorodchansky district of Ivano-Frankivsk region (Ukraine) as a result of depressurization of underground oil pipeline with diameter of 159 mm which belongs to NGDU "Nadvirnaneftegaz" of JSC "Ukrnafta" there was a leak of about 4 m^3 of oil onto the ground surface with further transfer to local water body. In result of investigation it was established that accident had happened because of corrosion damage of the pipeline.

Accident at the main oil pipeline "Unecha - Mozyr" of the republican unitary enterprise "Gomeltransneft Druzhba" of "Belneftekhim" concern has happened on November 4, 2012 at about 11 a.m. in the village of Igovka of Dobrushsky district of Gomel region (Belarus). In result of drop scattering of oil by the wind, pollution of ground surface at the area of 70 × 200 meters took place. The area of oil spill has covered about 100 sq.m.

50 tons of oil have spread as a result of the failure of "Nizhny Novgorod— Yaroslavl" oil pipeline, which happened on December 20, 2012 near the village of Zhovtnevoe, Vyaznikivsky district, Vladimirskiy region (Russian Federation). The khor that passes through the village was flooded with oil.

On May 21, 2014 Zakarpattia section of the branch "Main oil pipelines "Druzhba" of JSC "Ukrtransnafta" revealed pollution of the soil by oil on the outskirts of Kaydanovo village of Mukachevsky district of Zakarpattia region (Ukraine). In result of accident about 42 m^2 of soil was polluted by oil.

On December 26, 2014 on the territory of the Rakoshino village of Mukachevsky district, Zakarpattia region (Ukraine) locals revealed slick oil spot. After arrival of emergency response group, there were revealed two more spots 50 and 5 m^2 in area. Oil leak happened due to violation of tightness of the linear part of main oil pipeline "Druzhba".

One of the largest accidents of 2014 happened on December 5 on the "Ashkelon — Eilat" oil pipeline in the south of Israel. 21.9 thousand barrels of oil poured out into the Arabah desert from faulted out pipe. Ecologists marked that it was the largest accident in memory of Israel. Investigation showed that oil leak turned out to be the consequence of imprudence during repair works, when the pipeline was damaged.

Because of damage of "Druzhba" oil pipeline that occurred on April 27, 2015 near the agrotown Bobovichi of the Gomel region (Belarus), oil supply to Europe was temporary stopped. Incident happened in the territory of oil pumping station "Gomel" as a result of break of airtightness of technological oil pipeline "Unecha — Mozyr" with diameter of 530 mm and working pressure of 4.5 MPa and a depth 1,7 m which is under supervision of JSC "Gomeltransneft Druzhba" of concern "Belneftekhim". The area of oil spill was 0,06 hectares. The amount of leak is unknown.

On June 23, 2015 suburb of Nefteiugansk, Khanty-Mansi Autonomous District of the Russian Federation was flooded by oil pipeline after the accident in the area of Ust-Balykskyi deposits of subsidiary JSC "Rosneft". Diameter of damaged oil pipeline is about 40 cm. The volume of the spilled oil is unknown.

Breakdown of the oil main pipeline of Buguruslanskyi region of oil control of JSC "Transneft — Privolga" happened on December 15, 2015 in six kilometers from the village Ponykla of Buguruslanskyi district of the Orenburg region (Russian Federation). The area of oil spill was 500 sq.m., amount of the spilled oil is unknown.

On January 25, 2016 break of the pipeline Peruvian state company Petroperu caused spillage of 3.0 thousand barrels of oil and pollution of two rivers in the northwest of the country. According to preliminary data, two breaks took place and the landslide became the reason of one of them.

On April 25, 2016 in the Mediterranean Sea at coast of Genoa (Italy), big oil spill was formed. The reason of it was accident happened on April 18, 2016 in the pipeline of the Ligurian company Iplom. At first, oil rushed into one of the local rivers, and in several days a spot of 2 kilometres in length and about 500 meters in width emerged in the waters between the cities of Genoa, Savona and Imperia. Amount of the spilled oil is unknown.

Having analysed emergency situations on the linear part of oil main pipelines, it is possible to select five basic reasons leading to depressurization (Figure 1):

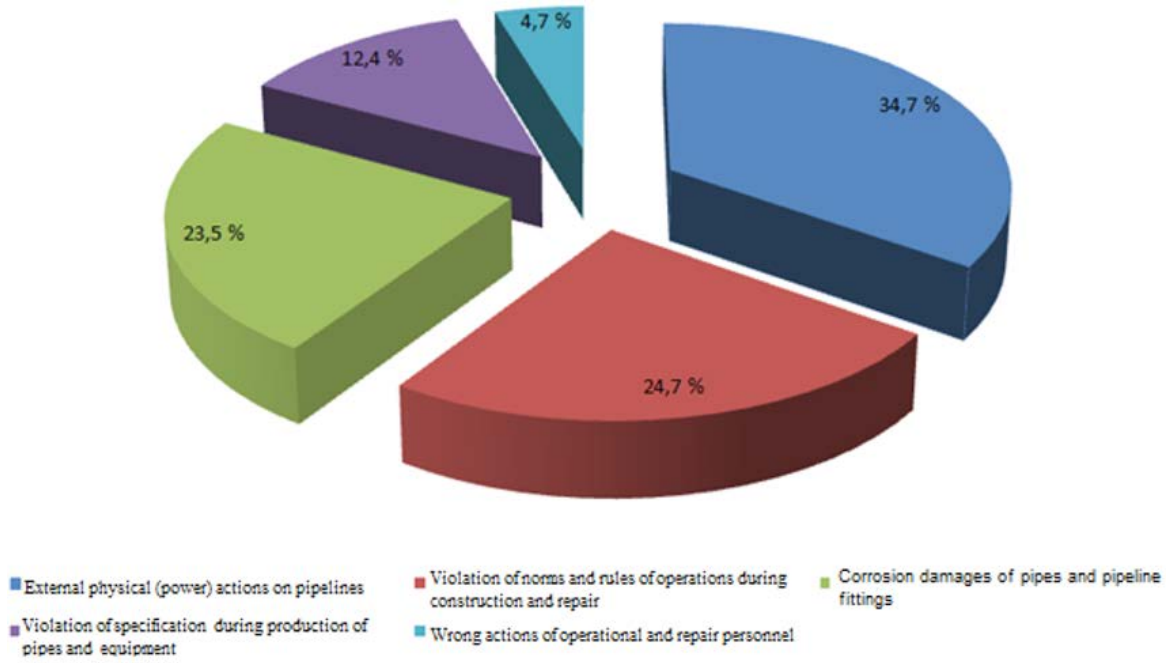

Figure 1. Origins of emergency situations connected with depressurization of linear part of main pipelines

- external physical (power) influences on pipelines, including criminal inserts which have led to leakages – 34.7%;
- violation of norms and rules of works during construction and repair, deviations from design decisions – 24.7%;
- corrosion damages of pipes, locking and control valves - 23,5%
- violation of specifications at production of pipes and equipment - 12,4%;
- wrong actions of operating and maintenance staff - 4,7%.

Let us consider the character of defects of pipeline body during emergency oil spills. These are through faults of various forms and sizes that can be both in base metal and in welded seams of pipes – fig.2.

a) b)

c) d)

e)

Figure 2. Characteristic defects of pipe body leading to emergency losses of transported environments

The greatest damage is caused by accidents on pipelines where breaks took place in base metal of pipes or in zone of welded joints. The basic factor determining the extent of damage in case of failures of oil main pipelines is the amount of the spilled oil and the area of the polluted territory.

Today, especially important scientific task is prediction of nature of formation of pollution area of the soil by oil from the pipeline. A series of papers [4, 5, 6] are devoted to the problem of formation of areas of pollution. In these papers, physical phenomenon (physical sense) of process is considered, results of physical modelling and their analysis are provided, methodical bases of the acceptable risk are developed. However, necessary attention was not provided to the problem of formation of pollution areas. Therefore, process modelling of formation of pollution area, that is creation of field of speeds of filtering in the porous medium as functions of spatial coordinates and time, is the relevant task.

Authors have obtained the equation allowing prediction of change of pressure in the porous medium in time due to growth of the filtration resistance caused by spillage of oil from the pipeline

$$P(x,y,t)=\frac{æqa}{2\pi F}\int_0^\infty \frac{\sin\lambda y_0 \sin\lambda y}{\lambda}\left\{\left[\sigma(x-x_0)-1\right]\left[e^{-\lambda(x_0-x)}erfc\left(\frac{x_0-x}{2\sqrt{æt}}-\lambda\sqrt{æt}\right)-\right.\right.$$
$$-e^{\lambda(x_0-x)}erfc\left(\frac{x_0-x}{2\sqrt{æt}}+\lambda\sqrt{æt}\right)\Big]-\sigma(x-x_0)\left[e^{-\lambda(x-x_0)}erfc\left(\frac{x-x_0}{2\sqrt{æt}}-\lambda\sqrt{æt}\right)-\right. \quad (1)$$
$$\left.\left.-e^{\lambda(x-x_0)}erfc\left(\frac{x-x_0}{2\sqrt{æt}}+\lambda\sqrt{æt}\right)\right]\right\}d\lambda.$$

For establishment of nature of formation of pollution area of the soil by oil from the pipeline, it is necessary to determine consistent pattern of speed change of filtering in time [4, 5]. The superposition principle of movements, according to which the velocity vector of filtering of product in the soil is presented in the form of the vector sum of its projections to coordinate axes, is used for this purpose

$$\overline{w}=\overline{w}_x+\overline{w}_y. \quad (2)$$

Values of projections of velocity vector of filtration are defined basing on the Darcy's law using the dependence (1)

$$w_y(x,y,t)=-\frac{k}{\eta}\frac{\partial P(x,y,t)}{\partial y}=\frac{q}{2\pi F}\int_0^\infty \sin\lambda y_0\cos\lambda y\left\{\left[\sigma(x-x_0)-1\right]\left[e^{-\lambda(x_0-x)}erfc\left(\frac{x_0-x}{2\sqrt{æt}}-\lambda\sqrt{æt}\right)-\right.\right.$$
$$-e^{\lambda(x_0-x)}erfc\left(\frac{x_0-x}{2\sqrt{æt}}+\lambda\sqrt{æt}\right)\Big]-\sigma(x-x_0)\left[e^{-\lambda(x-x_0)}erfc\left(\frac{x-x_0}{2\sqrt{æt}}-\lambda\sqrt{æt}\right)-\right. \quad (3)$$
$$\left.\left.-e^{\lambda(x-x_0)}erfc\left(\frac{x-x_0}{2\sqrt{æt}}+\lambda\sqrt{æt}\right)\right]\right\}d\lambda;$$

$$w_x(x,y,t) = -\frac{k}{\eta}\frac{\partial P(x,y,t)}{\partial x} = \frac{q}{2\pi F}\int_0^{\infty}\frac{2}{\sqrt{\pi æt}}\sin\lambda y_0 \sin\lambda y\{\left[\sigma(x-x_0)-1\right][e^{-\lambda(x_0-x)}erfc\left(\frac{x_0-x}{2\sqrt{æt}}-\lambda\sqrt{æt}\right)+$$
$$+\exp[-\lambda(x_0-x)-\left(\frac{x_0-x}{2\sqrt{æt}}-\lambda\sqrt{æt}\right)^2]+e^{\lambda(x_0-x)}erfc\left(\frac{x_0-x}{2\sqrt{æt}}+\lambda\sqrt{æt}\right)-$$
$$-\exp[\lambda(x_0-x\ -\left(\frac{x-x_0}{2\sqrt{æt}}+\lambda\sqrt{æt}\right)^2]]-\sigma(x-x_0)[e^{-\lambda(x-x_0)}erfc\left(\frac{x-x_0}{2\sqrt{æt}}-\lambda\sqrt{æt}\right)+ \quad (4)$$
$$+\exp[-\lambda(x-x_0)-\left(\frac{x-x_0}{2\sqrt{æt}}-\lambda\sqrt{æt}\right)^2]+e^{\lambda(x_0-x)}erfc\left(\frac{x-x_0}{2\sqrt{æt}}+\lambda\sqrt{æt}\right)-$$
$$-\exp[\lambda(x-x_0)-\left(\frac{x-x_0}{2\sqrt{æt}}+\lambda\sqrt{æt}\right)^2]]\}d\pi.$$

Dependences (3) and (4) allow to calculate value of projections of velocity vector of filtration in each point of the plane and time. For creation of formation of pollution area, entire process breaks into discrete periods Δt, on the beginning of each of which according to (3) and (4) projections of velocity vector of filtration are defined. Based on projections of velocity vector the vector itself is being built. Growth of pollution area in the direction of each velocity vector of filtration for the specified period is defined by product $w\Delta t$.

According to this algorithm calculations are carried out and graphs reflecting the nature of formation of pollution area of the soil by leak from the oil pipeline are built and shown in figure 3.

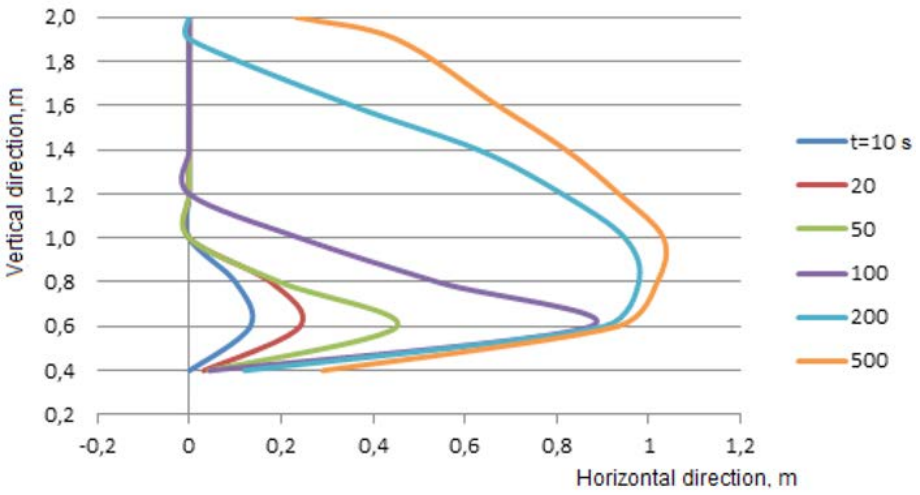

Figure 3. Nature of formation of pollution area of the soil by leak from the oil pipeline

The analysis of obtained graphic dependences shows that non-stationary process of formation of pollution area by leak from the oil pipeline can be divided into three phases respectively. The first phase starts with the moment of leak and is characterized by distribution of liquid in the vertical direction and downwards due to action of gravitational forces, at the same time pressure filtrational counteraction gradually grows till the moment when the size of filtrational resistance becomes equal to the size of gravitation force. From this point the second phase, which is characterized by distribution of liquid in the horizontal direction starts, at the same time filtrational resistance continues growing that causes a liquid filtation in the vertical direction up and is the beginning of the third phase of non-stationary filtration, which comes to the end by liquid achievement of soil surface.

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КОНТАКТЫ

e-mail: metaljournal@gmail.com

metaljournal11@gmail.com

г. Днепропетровск

тел. +38 (056) 794-36-74

факс. +38 (056) 794-36-75

моб. +38 (050) 320 69 72

CONTACTS

e-mail: metaljournal@gmail.com

metaljournal11@gmail.com

Dnipropetrovsk

Tel.:+38 (056) 794 36 74

Fax: +38 (056) 794 36 75

Mob: +38 (050) 320 69 72

The dolerites of Tindouf Basin, particulary the Naga region

Souad Bentaalla-Kaced

Postgraduate student,
Ecole Nationale Polytechnique,
Alger, Algérie
E-mail :souad.bentaalla@gmail.com

Karima Deramchi

Assistant Professor,
Ecole Nationale Polytechnique, Alger, Algérie
E-mail :karimaderamchi@yahoo.fr

Tahar Aifa

Professor,
Université de Rennes 1,
Rennes, France
E-mail : tahar.aifa@univ-rennes1.fr

Abdelaziz Boutrid

Assistant Professor,
Université Badji Mokhtar,
Annaba, Algérie
E-mail :aboutrid@yahoo.fr

Berdoudi Said

Assistant Professor,
Ecole Nationale Polytechnique,
Alger, Algérie
E-mail :berdoudisaid@yahoo.fr

Samira Boutria

Postgraduate student,
Ecole Nationale Polytechnique,
Alger, Algérie
E-mail :samiraboutria@yahoo.fr

Abstract
The purpose of this work is the dolerite of Tindouf Basin and particularly the Naga area where few wells drilled have registered gas flow from the dolerite banks and the enclosing levels of the host rock.
By summarizing all the geological data brought by the polls that have recognized these intrusive rocks, we will try in this article to debate about this kind of reservoir which can prove to be in the future a new play.
Keywords: DOLERITE, RESERVOIR, HYDROCARBON, WELL

Introduction

Generally, the igneous rocks have always been considered by the Oil Companies as non-objective, despite some fortuitous discoveries directly or indirectly related to these rocks. We also knew for years that the presence of oil and gas is proven in these non-sedimentary rocks that may act as traps after magma cooling and solidification, giving numerous hydrocarbon fields.

The Tindouf Basin

The Tindouf basin is oriented ENE-WSW (Fig. 2) [3], along 800 km (including 540 km in Algeria), it's an asymmetrical basin with a southern slope with a gentle up dip towards Eglabs and narrowband northern flank, very sloped and pleated, it is bordered on the east by the Ougarta chains and Reganne depression, north by the Anti-Atlas and west by El Ayoun basin [1], [2] and [3].

The depot center of Tindouf basin is relatively close to the north flank where the sediment thickness is around 8000 m, while it is around 1500 m (average) to the south. The sedimentary cover is composed mainly of Paleozoic formations, Cambrian to Carboniferous [3] and a thin layer of tertiary is covering almost the entirely surface of the basin.

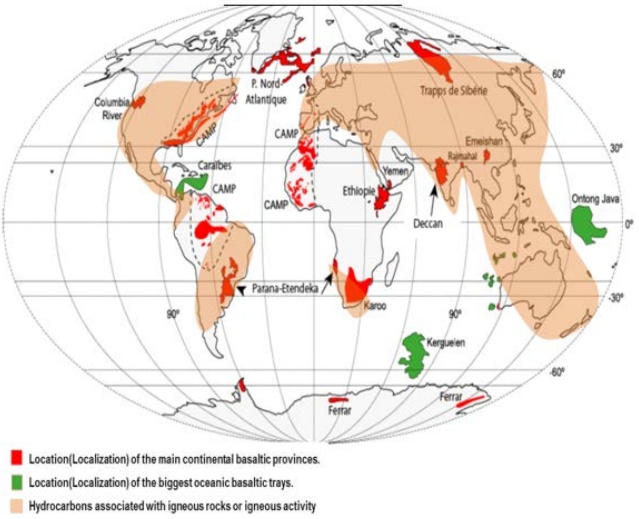

Figure 1. Map showing the geographical distribution of main Continental Flood basalts and oceanic basaltic trays ([4], Modified)

The dolerite in the Tindouf Basin

The Paleozoic series of Tindouf basin have experienced dolerite intrusions affecting the Cambrian formations and particularly the upper Devonian (Famennian) (Figure 3). they are set up in the surrounding rock as sills and dykes and are linked to global tectonic characterizing the West African Craton in response to the opening dated Jurassic of the Central Atlantic [1], [2] and [3].

A few meters of metamorphic contact affecting the Paleozoic host rocks proving the intrusive nature of these dolerites, is described by different studies. According to the well results, the magmatism seems to be less pronounced in the southern part of Tindouf basin but it is more prolific in the northern part of the basin where it is reported an intense tectonic activity.

Two major features as structural axis are related in Tindouf basin, the first one trending W-E, (Anti Atlas direction), has been reasonably explored by seismic & drilling & some gas & oil shows are reported.

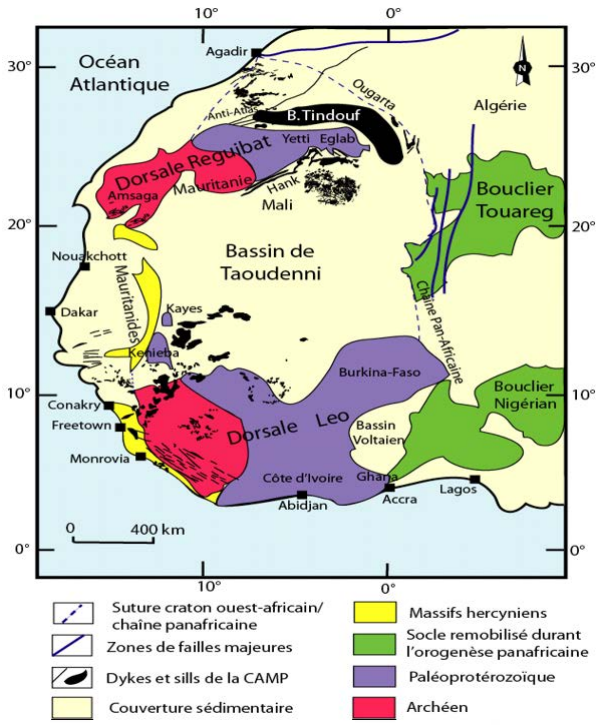

Figure 2. West Africa Simplified geological map showing the distribution of magmatic formations of the of Central Atlantic area [5]

The second one is located in the south, where drilling, despite absence of traps, revealed also many gas & oil shows. In the central part, another axis oriented NW-SE (Ougarta direction), is described, it was explored by two stratigraphic wells TIN-1 and TIN-2.

A gas coming was recorded from the TIN-1 Upper Devonian (Strunian) sandstones; these sandstones are-associated with a thick bench of dolerite (about 67 m). A second bench of dolerite was also identified just above the Strunian-Tournaisian limit (Figure 4) [7].

This gas coming was questionable & according to the TIN-1 survey completion report done in 1962, the geologists have tried to find a relationship between the sandstone strata & the dolerite wall rock. None coming of gas, such as found in TIN-1, was recorded during the drilling of the TIN-2 in 2012; these two holes are 40 km distant from each other.

The description of the TIN-1 sandstone (and dolerite bench) where was recorded gas coming, reported the presence of fractures which improving the gas flow. So it was decided to study all dolerite benches encountered by TIN-1 & TIN-2 wells [7]. For both TIN-1 & TIN-2 wells, two groups of dolerite are recognized in the Strunian and the Famennian. A gas shows were also recorded (master log of TIN-2) during penetrating of the Famennian dolerites benches (Figure 4).

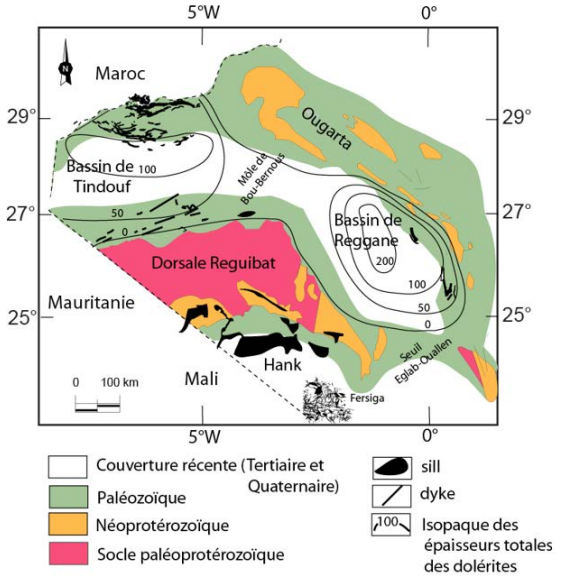

Figure 3. Map isopachs total thicknesses of dolerite subsurface basins of Tindouf and Reggane [1].

When drilling TIN-2 well, they encountered the same dolerite bench occurring at the same level of Famennian of TIN-1; and an unmeasured gas flow was recorded after test achievement [7].

Comparison with intrusion doleritic REG-1 and REG-2 (Basin de Reggane)

The neighbor pericratonic basin Reggane has also experienced an intense activity intrusive affecting the Paleozoic series of Upper Devonian and Carboniferous (Figure 2).

Two wells REG-1 & REG-2 drilled respectively in 1979 and 1980 in the extreme North-West part of the Reganne basin in the vicinity of Bou Bernous saddle are encountered the dolerites [8].

During a test conducted in REG-2, 1500 m^3 of dry

gas was recorded from the Famennian affected by 114 m of this diabase intrusion [8].

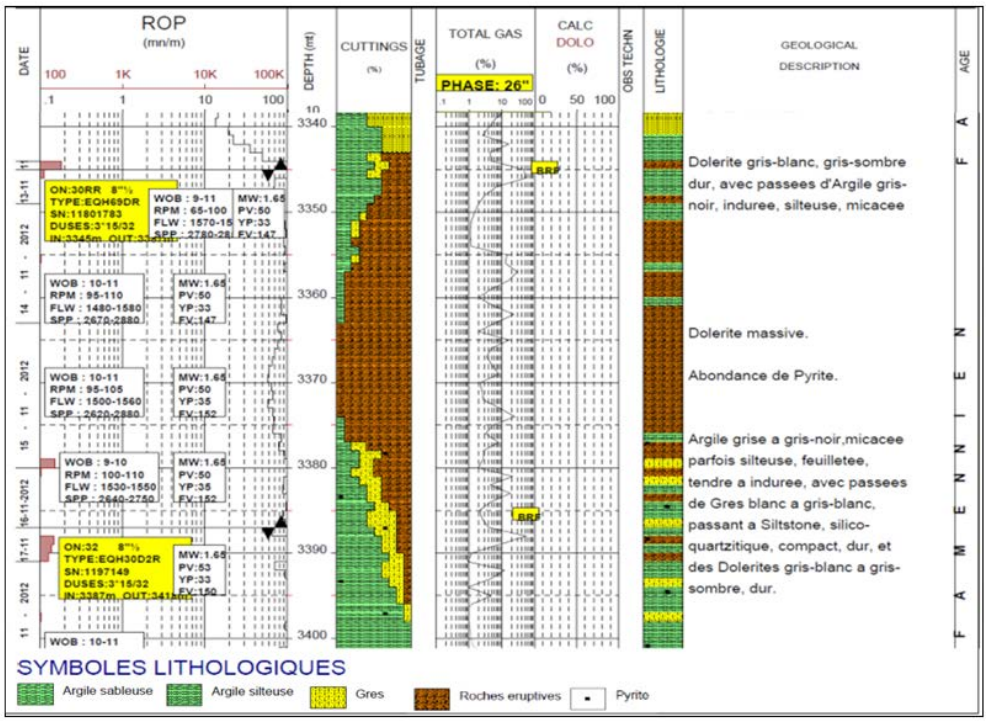

Figure 4. Masterlog -TIN-2 / Dolerite in Famenian @ [3340-3400 m]. (At the Dolerites bench, two (02) peaks of gas when the circulation of the bottom (BRF) of the plug which is rated at the log of total gas)

Comparison with deposit forms by reservoirs granitic of offshore Vietnamese (Cuu Long basin)

The geological setting of these dolerites can be compared and correlated to the granitic reservoirs in the Cuu Long basin of Vietnamese offshore.

This basin is tertiary rift formed in the early Oligocene & located in offshore southern Vietnam [6].

The Miocene inversion has intensified the fracturing of the granite basement where several reservoirs were identified and all give good oil flow after hydraulic fracturing. The porosity is less than 5% and the permeability ranges from 0 md à1000 md, the average depth of the top of these fractured granite reservoirs is from 2500 m to 4000 m.

The source rock of the Mesozoic granitic reservoirs is formed by excellent argillaceous bedrocks.

The reserves of oil are ranging from 100 to 400 mmb with good rates from 2000 to 4000 BBL [6].

The life cycle of this basin is considered as challenge; it's generally ranging from 1 to 13 years and depends on several factors (the importance of fractures, the hydrocarbon column, the reserves in place and the production rate).

The Tertiary clastic reservoirs were the initial exploration objective in this basin, while the granitic reservoir was investigated coincidentally and became after the discoveries, the main target in this area.

The case study of the Cuu Long basin confirms that the magma reservoirs, contrary to the general believe, can be a very good reservoir for gas or/& liquid hydrocarbons [6].

However to evaluate the potential of these reservoirs, the resistivity logs must be analyzed. The resistivity of igneous rocks is generally very high, but in case of presence of fractures and hydrocarbons, the drop in the resistivity is recorded. Furthermore the solidified magma could be more subject to fracture.

It is recommended to look for such reservoirs with such potential: (i) define the area of maximum of fractures and (ii) find the presence of a good source rock adjacent to reservoir.

Recall that these two conditions can be met in South-West Algeria basins Tindouf and Reggane (Chabou, 2001).

Conclusions and recommendations

In this report we have attempted to provide an answer about the behavior of igneous rock and particularly the dolerite as hydrocarbon reservoirs in the NAGA area of Tindouf Basin.

Three paragraphs were discussed: (i) A summary of the results of TIN-1 and TIN-2 wells of Tindouf basin. (ii) A comparison with the neighboring basin of Reggane where the Paleozoic series has logged an intrusive activity affecting mainly the Paleozoic Upper Devonian and Carboniferous. (iii)A case study and a summary for hydrocarbon prone, worldwide,

associated with igneous rocks.

Indeed, the magmatic rocks are spreading throughout the world, but a few are considered as hydrocarbons bearing rocks.

Generally, only shows & very low flow rates are recorded from these kinds of reservoirs. Furthermore, it's well known that the igneous rocks form the best reservoir when they have been exposed on the surface and have undergone any tectonic event that led to the creation of fractures and while remaining in contact with mature source rocks.

Dolerites observed in Tindouf and Reggane basins showed an unmeasured gas flow (TIN-1 / Tindouf) and gas shows or low flow rates (REG-1 / Reggane: 1500 m^3 / Gas Day) [8]. The phenomenon associated with the dolerite is: (i) Magma absorbing layer containing the bedrock. (ii) The host rock and magma became one body. (iii) The gas contained in the source rock form gas bubbles, filling the pores with gas & generating a vesicular porosity.

As soon as the bedrock magma mixing is carried out and after cooling, often fractures appear in these igneous rocks.

In our case, compaction can force the hydrocarbons within the Famennian source rock to move in new formed reservoir.

As a case study the Cuu Long offshore basin, located in Vietnam, shows that the magma reservoirs, contrary to the popular believe, can be a very good reservoir for gas or/& liquid hydrocarbons. To evaluate the potential of these kinds of reservoirs, we learn also from this study it is necessary to analyze the resistivity logs. Indeed, the resistivity of igneous rocks stay high, but in the presence of fractures and hydrocarbons, the drop in the resistivity is logged.

After cooling the solidified magma became subject to fractures, it is recommended to search for such potential reservoirs to find the maximum of fractures and the good source rock communicating with these reservoirs. Recall, these two conditions could be met in the Southwest Algerian basins Tindouf and Reggane. Around Naga area (Tindouf Basin), the resistivity data of the Strunian and Famennian was analyzed. No resistivity drop is reported. However it should be noted that the Naga region has been the site of intense fracturing. As recommendations, we suggest exploring the North of Naga; it remains an interesting area, structurally faulted. To rule on the existence of oil potential in these igneous rocks, it would be appropriate to take a pilot wells in the area. This would allow for an assessment of the dolerite reservoirs in contact with the source rock using the appropriate logs i.e.: imaging of the resistivity (fractures characterization & fractures orientation), the neutron-capture spectroscopy (measure mineral composition) and the magnetic resonance log (fluid characterization). Following, if the existence of hydrocarbons is confirmed, consider if needed a hydraulic fracturing program.

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Efficiency of use of collecting agents for increase of extraction values by copper, gold and silver flotation from complex slags of copper-smelting production

Irina Shadrunova

Head of mountain ecology department,
Doctor of Engineering Sciences, professor,
Institute of Comprehensive Exploitation of Mineral Resources,
Russian Academy of Sciences
Moscow, Russian Federation
E-mail: shadrunova_@mail.ru

Margarita Sabanova

Head of the research laboratory,
Sibay branch of JSC "Uchalinskiy GOK",
Sibay, Republic of Bashkortostan,
Russian Federation
E-mail: m_sabanova@mail.ru

Natalia Orekhova

Associate Professor of Mineral Processing Department,
Doctor of Engineering Sciences, associate professor,
Nosov Magnitogorsk State Technical University,
Magnitogorsk, Russian Federation,
E-mail: n_orehova@mail.ru

Olga Gorlova

Associate Professor of Mineral Processing Department,
Candidate of Engineering Sciences, associate professor,
Nosov Magnitogorsk State Technical University,
Magnitogorsk, Russian Federation
E-mail: gorlova_o_e@mail.ru

Tatiana Chekushina

Leading researcher of Mountain Ecology Department
(Russian University of people's friendship, Moscow, Russian Federation),
Associate Professor of oil-field geology, mining, oil and gas business;
Candidate of Engineering Sciences, associate professor,
Institute of Comprehensive Exploitation of Mineral Resources,
Russian Academy of Sciences,
Moscow, Russian Federation
E-mail: council-ras@bk.ru

Abstract
The article presents the results of the study of the possibility of using additional collecting agents of BTF series (dialkyldithiophosphates) to increase the extraction of copper, gold, silver from difficult copper smelting slag. The characteristic of used reagent modifications is given. The results of open and closed laboratory flotation experiments are presented; the influence of the pH pulp on extraction of metals is traced. The reasons of increase of copper extraction when applying BTF are analyzed, the optimal ratio of primary and secondary collector is determined.
Keywords: INDUSTRIAL RAW MATERIALS, COPPER, COPPER SLAG FLOTATION, PYRITE, RECYCLE WATER, THE PH OF THE PROCESS, COLLECTING AGENTS, DIALKYLDITHIOPHOSPHATES, EXTRACTION INCREASE

Introduction

Non-ferrous metal industry is the largest producer of waste the main volume of which falls on the slag accumulating over the years in areas of processing enterprises. However, formed slag is a valuable mineral raw material and can be used in the national economy. The Urals region is the main part of the "Copper Belt" of Russia.

Difficult copper smelting slags are characterized by [1] prevalence in the structure of splice of copper sulfide, iron oxide, iron sulfide size of less than 0.044 mm. They are involved in the processing under the conditions of a systematic underutilizing of enrichment plants processing copper and copper-zinc ores especially in the southern Urals. The size of inclusions of the copper-containing mineral phases in the sulfide splices is 1-3 microns. A characteristic feature is the inclusion of an aggregate copper sulfide inside the splice.

Technology used in the flotation is a universal method of enrichment of raw materials of natural (mineral resources) and man-made (mining and metallurgical waste) origin containing non-ferrous metals. It provides the most complete and least expensive extraction of copper from easy specimen slag in copper-smelting production [2]. However, extraction of copper by flotation from difficult slag does not exceed 60% [2], and sometimes even losses of cop -

per with flotation tailings prevail over the extraction of copper in concentrate. The acute issue is extraction of gold and silver, which are carried as an asset (in operation) of the metallurgical enterprise especially from converter slag. Thus, the problem of increasing the extraction of copper, gold, silver despite the continuously ongoing researches in this area continues to be relevant.

A promising solution to these problems is the use of dialkyldithiophosphates. BTF grade reagents containing substances of this chemical class are selected for studies, because of their availability and a number of specific features of the flotation action proven to be effective additional collectors in flotation with xanthogenate in the copper-zinc [3] and copper-pyrite [4] ores increasing the extraction of precious metals. BTF reagents are highly resistant, highly soluble in water and easy to handle.

Converter and dump slags of one of the Southern Urals enterprise are studied and referred by our proposed typification to fayalite-magnetite-pyrite type. The content of the sulfide phase in average is 7%, 0.5% are presented by bornite, and the rest - by pyrite. Copper is located in metal alloys, α_{avCu} varies from 1.40% to 85.08% therein. In addition, metallic copper buckshots of different size are present in slags with α_{Cu} up to 98%. The copper occurs as an impurity in pyrite and pyrrhotite (to 3.23%), in oxide phases (magnetite, ferrite), in fayalite and sodium aluminosilicate. The main copper phases are chalcocite-bornite solid solution (α_{avCu} – 73.15%), bornite (α_{cpCu} – 56.09%), sulfide Fe-Cu solid solution (α_{avCu} – 54.91%), sulfide Fe-Cu-Zn solid solution (α_{avCu} – 16.83%).

The studies of slag flotation showed that the area of effective extraction of copper is pH = 5.0 – 7.5, and maximum values have been obtained at pH = 5.5. That is, the flotation proceeds in the range of pH critical for a stable state of the main collector – potassium butyl xanthate o(PBX). This necessitates the use of an additional collector sustainable to more acidic environment. From BTF reagents for experiments following modifications: BTF 163 BTF 1614, BTF 1624 BTF-1522, BTF 1541 BTF-1552 have been selected. The products are produced according to TU 2452-001-51848149-00 under the brand name "Flotoreagent BTF." The whole technological process is developed and approved by CJSC "Mechanobr Orgsintez-reagent", St. Petersburg under the guidance of V. I. Riaboy Doctor of Engineering Sciences, Professor. The characteristic of reagents is shown in Table 1. The table is based on materials [3,4].

Experiment

Flotation experiments were carried out according to used earlier schemes of copper-containing slag processing at the concentration plant Sibai branch of OJSC "UGOK", using recycled water on the equipment of research laboratory. The permanent experimental conditions include: weight of copper slag Q = 700g; grinding fineness – 98.5% of the class -0,044mm; % solid pulp for flotation – 28%, content of free CaO in the recycled water 450-480g/m^3; time of roughing flotation – 20 min. BTF series reagent are supplied into the process as an additional collector consecutively after potassium butyl xanthate (PBX).

Table 1. Characteristics of BTF reagents

Grade of BRF reagent	Type of flotated ores	Foa-ming	Selectivity	Action
163	Cu- Zn , Cu- Ni, Cu- Mo, Cu- FeS, Au- containing, polymet.	remarkable	Relatively high selectivity of action	Provides an increase in the extraction of non-ferrous, rare and precious metals from sulphide ores
1614				
1624				
1522	Cu- Zn , Cu- Ni, Cu- Mo, polymetallic	Mo-derate	Belongs to a type of enough selective collectors	According to the collective capacity exceeds flotoreagent BTF-1541. Increases extraction of Au, Ag and platinoids. Increases extraction both thin and large classes of sulfide minerals. Helps to improve the flotation of oxidized forms of sulfide minerals
1552				

1541	Cu- Zn , Cu-Ni, polymetallic	weak	Selective when separation of pyrite and when separation of sulfide minerals of non-ferrous, rare and precious metals	Provides a high quality of copper and zinc concentrates in the flotation of copper-zinc ores maintaining or increasing the extraction of copper and zinc

Variable conditions of the experiments:

- pH of the medium in grinding and in floatation, which was achieved by supplying to the process of actual highly alkaline recycled water with (pH) = 11 and recycle water conditioned to pH = 7, process water at pH = 7.

- expenditure of the collector, consumption of the frothing reagent, the consumption ratio of potassium butyl xanthate (BPX) and the BTF consumption.

The flotation scheme includes the following: copper "head", recleaning of the copper head, roughing flotation, recleaner flotation to final tailings. Supplying of the collector (a combination of collectors) is carried in each operation fractionally.

Results and discussion

During the experiment when the flotation of converter and dump slags of the same enterprise the identical extraction dependences of copper and precious metals to the flotation regimes were obtained. The paper presents the results obtained in the flotation of copper converter slag in the open cycle (Table 2-6).

Table 2 shows that the maximum extraction of copper in concentrate was 84.05% and the minimum losses with final copper tailings – 15.95% achieved at pH 6.5- 6.8 in grinding and pH 5.5-6 in flotation on one and the same consumption of BPX. Reducing of process pH increases the product yield from the "head". Flotation rate and overall yield increase at constant quality of the concentrate. But at the same time flotation at pH=7 on a "clean" process water is not active.

Table 2. Flotation results of difficult converter slag at different values of pH process

No op	Denomination	Yield ,%	β^{Cu}, %	ε^{Cu}, %	Conditions
1	Cu «head»	2.97	22.43	33.07	$pH_{grinding}$=11.0-11.5 $pH_{flotation}$= 12.0-12.5 BPX Collector 400g/t
	g Cu concent.	8.31	9.08	37.47	
	Foam contr.	2.23	3.05	3.38	
	∑g Cu concent	**13.51**	**11.02**	**73.92**	
	Final tail.	86.49	0.61	26.08	
	Initial slag	100	2.01	100	
2	Cu «head»	3.85	24.75	47.31	$pH_{grinding}$ = 9.0-9.3 $pH_{flotation}$ = 8.0-8.5 BPX Collector 400g/t
	g Cu concent	9.71	6.38	30.75	
	Foam contr.	3.41	1.78	3.01	
	∑g Cu concent	**16.97**	**9.62**	**81.07**	
	Final tail	83.03	0.46	18.93	
	Initial slag	100	2,01	100	
3	Cu «head»	4.20	23.12	48.2	$pH_{grinding}$ = 6.5 -6.8 $pH_{flotation}$ = 5.5- 6.0 **BPX Collector 400g/t**
	g Cu concent	10.10	6.4	32.08	
	Foam contr.	3.30	2.3	3.77	
	∑g Cu concent	**17.6**	**9.62**	**84.05**	
	Final tail	82.4	0.39	15.95	
	Initial slag	100	2.01	100	

4	Cu «head»	1.74	19.65	16.97	Process water pH 7.0 BPX Collector 400g/t
	g Cu concent	7.01	12.01	41.79	
	Foam contr.	3.59	4.35	7.75	
	∑g Cu concent	**12.34**	**10.86**	**66.52**	
	Final tail	87.66	0.77	33.48	
	Initial slag	100	2,01	100	

Analysis of the results (Figure 1) of comparative series of flotation experiments using the additional collector BTF on the actual recycled water at a pH in grinding of 11.0-11.5 and pH in flotation of 12.0-12.5 has revealed that the supply to the flotation process of any additional modification of the studied reagents can significantly reduce the total consumption of the collector. This increases the yield of product from "head" and the yield of the total concentrate.

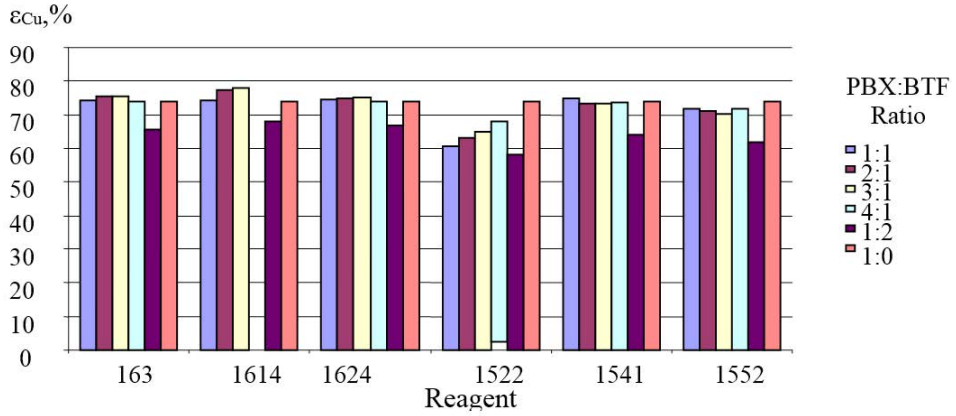

Figure 1. Extraction of copper in concentrate at different ratios of main and additional collectors

The best indicators of flotation obtained using BTF 163 and BTF 1614. The optimum ratio of potassium butyl xanthate (PBX) and BTF was 3: 1. In this case the copper extraction of 77.85% was obtained by using a combination of PBX + BTF1614 when the overall consumption of 300 g/t, i. e. the total collector consumption reduced by 100 g/t (Table 3).

Table 3. Results of copper converter slag flotation while reducing the total consumption of collectors

No op	Product	Yield,%	β^{Cu}, %	ε^{Cu}, %	Conditions
5	∑g Cu concent	**13.95**	**10.9**	**75.61**	$pH_{grinding}$=11,0-11,5 $pH_{flotation}$= 12,0-12,5 Collector PBX+BTF 163 ∑300 g/t
	Final tail	86.05	0.57	24.39	
	Initial slag	100.0	2.01	100	
6	∑ g Cu concent	**14.53**	**10.75**	**77.85**	$pH_{grinding}$=11,0-11,5 $pH_{flotation}$= 12,0-12,5 Collector PBX+BTF 1614 ∑300 g/t
	Final tail	85.47	0.52	22.15	
	Initial slag	100	2.01	100	

The results of flotation experiments using the maintenance mode of specified pH value in grinding and in flotation, with supply of established optimal combination of collectors (PBX: BTF1614 = 3: 1), with changing the total consumption of reagents are given in Table 4.

Table 4 shows that reducing the process pH to 6.8-5.5 has allowed to obtain an increase in the copper extraction by 6.68% with loss in the quality of copper concentrate by 1.48% and desired total consumption of collector decreases by 50% to 200 g / t.

Table 4. Results of copper converter slag flotation with decreasing pH process and combinations of collectors

No op	Denomination	Yield,%	β^{Cu}, %	ε^{Cu}, %	Conditions
8	**∑g Cu concent**	**18.3**	**9.27**	**84.53**	$pH_{grinding}$ = 6.5-6.8 $pH_{flotation}$ = 5.5-6.0 Collector PBX+BTF 1614 ∑200 g/t
	Final tail	81.7	0.38	15.47	
	Initial slag	100	2.01	100	

The study of distribution of the total iron, sulfur sulfide, gold and silver between the concentrate and final tailings when different modes of flotation have shown that growth of extraction of copper, gold, silver, and decrease of losses with final tailings corresponds to the growth of iron and sulfur extraction to the concentrate (Table 5). Consequently, the copper extraction increase is associated with the growth in the extraction in the splices concentrate of copper containing phases with iron sulfide.

Table 5. Results of extraction of copper, sulfur, iron in the concentrate when various modes of flotation

No op	Denomination	Yield, %	β^{Cu}, %	β^{S}, %	β^{Fe}, %	ε^{Cu}, %	ε^{S}, %	ε^{Fe}, %	Conditions
1	**∑g Cu concent**	**13.51**	**11.02**	**5.04**	**40.25**	**73.92**	**35.67**	**12.74**	pH_{grin}=11.0-11.5 pH_{flot}= 12.0-12.5 PBX 400g/t
	Final tail	86.49	0.61	1.42	43.05	26.08	60.86	87.26	
	Initial slag	100	2.02	1.91	42.67	100	100	100	
2	**∑g Cu concent**	**16.97**	**9.62**	**6.53**	**40.67**	**81.07**	**58.16**	**16.17**	pH_{grin} = 9.0-9.3 pH_{flot} = 8.0-8.5 PBX 400 g/t
	Final tail	83.03	0,46	0.76	43.08	18.93	41.84	83.83	
	Initial slag	100	2.01	1.91	42.67	100	100	100	
3	**∑g Cu concent**	**17.6**	**9.62**	**7.00**	**42.2**	**84.05**	**67.8**	**17.88**	pH_{grin} = 6.5 -6.8 pH_{flot} = 5.5- 6.0 PBX 400 g/t
	Final tail	82.4	0.39	0.7	41.4	15.95	32.2	82.12	
	Initial slag	100	2.01	1.82	41.54	100	100	100	
6	**∑g Cu con-cent**	**14.53**	**10.75**	**5.89**	**39.65**	**77.85**	**45.48**	**13.52**	pH_{grin}=11.0-11.5 pH_{flot}= 12.0-12.5 PBX +BTF 1614 300g/t
	Final tail	85.47	0.52	1.1	43.1	22.15	54.52	86.48	
	Initial slag	100	2.01	1.88	42.59	100	100	100	
7	**∑g Cu con-cent**	**17.3**	**9.75**	**6.88**	**40.54**	**83.6**	**64.27**	**16.86**	pH_{grin} = 9.0-9.3 pH_{flot} = 8.0-8.5 PBX +BTF 1614 250g/t
	Final tail	82.7	0.4	0.8	41.8	16.4	35.73	83.14	
	Initial slag	100	2.02	1.85	41.58	100	100	100	
8	**∑g Cu con-cent**	**18.3**	**9.27**	**7.03**	**41.12**	**84.53**	**68.92**	**18.2**	$pH_{grinding}$ = 6.5-6.8 $pH_{flotation}$ = 5.5-6.0 PBX +BTF 1614 200 g/t
	Final tail	81.7	0.38	0.71	41.5	15.47	31.08	81.8	
	Initial slag	100	2.01	1.87	41.44	100	100	100	

Table 6. The results of the closed experiments using PBX and combinations of PBX with BTF 1614

No op	Denomination	Yield, %	β^{Cu}, %	β^{Au}, g/t	β^{Ag}, g/t	ε^{Cu}, %	ε^{Au}, %	ε^{Ag}, %	Conditions
9	**∑g Cu concent**	**14.17**	**10.55**	**1.43**	**46.4**	**73.97**	**48.57**	**62.99**	pH_{grin}=11.0-11.5 pH_{flot}= 12.0-12.5 PBX 400 g/t
	Final tail	85.83	0.61	0.25	4.0	26.03	51.43	37.01	
	Initial slag	100	2.01	0.42	11.5	100.0	100.0	100.0	

10	**∑g Cu concent**	**19.14**	**9.02**	**1.15**	**40.2**	**84.22**	**54.18**	**72.38**	pH_{grin} = 6.5 -6.8 pH_{flot} = 5.5-6.0 PBX 400 g/t
	Final tail	80.86	0.40	0.23	3.45	15.78	45.82	27.62	
	Initial slag	100	2.05	0.41	10.10	100.0	100.0	100.0	
11	**∑g Cu concent**	**15.3**	**9.93**	**1.32**	**44.8**	**79.02**	**48.82**	**64.11**	pH_{grin}=11.0-11.5 pH_{flot}= 12.0-12.5 PBX:BTF 3:1 300 g/t
	Final tail	84.7	0.48	0.25	4.53	18.04	51.18	35.89	
	Initial slag	100	1.92	0.41	10.69	100.0	100.0	100.0	
12	**∑g Cu concent**	**18.01**	**9.65**	**1.38**	**42.9**	**85.13**	**60.25**	**72.92**	pH_{grin} = 6.5 -6.8 pH_{flot} = 5.5-6.0 PBX:BTF 3:1 200 g/t
	Final tail	81.99	0.37	0.2	3.53	14.86	39.75	27.08	
	Initial slag	100	2.04	0.41	10.59	100.0	100.0	100.0	

Analysis of concentrates and flotation tailings on gold and silver content in various reagent modes showed that when decreasing the process pH and supply of collectors combination the increase in gold and silver extraction in concentrate was observed (Table 6).

Conclusion

The combination of potassium butyl xanthate as the main reagent of collectors and BTF series reagent as an additional in the flotation process of copper smelting slag production in recycle water of the mining and processing enterprise allows increasing the extraction of copper, gold and silver in concentrate when decreasing twice the total consumption of collector compared to the traditionally used reagent mode using only potassium butyl xanthate.

In the alkaline medium (pH> 11), the increase in the extraction of copper in concentrate with the expected decrease in quality of the concentrate was obtained using reagents BTF: 1541,163, 1624, 1614.

The best results were obtained using BTF1614 reagent in combination with potassium butyl xanthate at the ratio: PBX:BTF = 3: 1. In an alkaline medium (pH greater than 11) the increase when extraction to the concentrate was as follows: copper – 5.05% , gold – 0.25%, silver – 1.12%. The copper content in the final tailings was reduced from 0.61% to 0.48%. At the optimum pH of flotation process (pH less than 7 to 6.8-5.5) the increase in the extraction of copper in the concentrate amounted to 11.16 % as a result of the active flotation of copper sulfide splices with pyrite. The increase in extraction of gold and silver in the concentrate were 11.68% and 9.93% respectively. The copper content in the final tailings at the same time reduced to 0.37%.

The work was supported by the Ministry of Education of the Russian Federation (Agreement No 14.604.21.0128), a unique identifier of the project RFMEFI60414X0128

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Simulation of rock massif tension at ore underground mining

Vladimir Golik

ScD, Professor,
North Caucasus mining metallurgical Institute (State Technical University)
Russia

Vitaly Komashchenko

ScD, Professor,
The Peoples' Friendship University of Russia

Vladimir Morkun

Vice-Rector for research, ScD, Professor,
Professor of Computer Science, Automation and Control Systems Department,
Kryvyi Rih National University,
Kryvyi Rih, Ukraine

Olga Burdzieva

Candidate of Geographical Sciences,
Geophysical Institute of Vladikavkaz Scientific Center of RAS,
Russia

Abstract
In the article the stresses in the elements of geomechanical system were determined. Methodology of research organization, massif management options and massif state control parameters optimization are described. Rock massif tension at ore underground mining is simulated.
Keywords: ROCK MASSIF, TENSION, ORE, UNDERGROUND MINING

In roach deposits developing a combination of induced geomechanical processes with natural processes violates the geodynamic equilibrium in upper crustal and activates the catastrophic events [1-5]. Stability of ore-containing massifs is determined by the level of stresses on the contour of stope ores, which is governed by voids filling with hardening mixtures after the evidence of this option effectiveness, for example, the method of photoelasticity [6-8]. The most complex is the mining of heavy ore deposits by combined opencast and underground methods. The criterion of combination effectiveness is the prevention of critical stresses [9-13]. Technique for organization of research includes the selection of the optically active materials; development of a device for patterns loading at different angles of force vector inclination based on the lateral thrust; results photoregistration devices [14-17]. Models were made from the optically active polyurethane with fringe value of 7,6 MPa for conditions: laying depth of mine working from the surface is 350m, the volumetric weight of overlying rocks is 3,0 t/m ^{3}. The stability of a given contour point is described by the condition

$$\sigma_1 - \sigma_2 \geq \sin\delta(\sigma_1 + \sigma_2) + \sigma_{rs} + (1 - \sin\delta), \quad (1)$$

where σ_1, σ_2- are the stresses in contour point; δ -is the angle of internal friction, 30^0; σ_{rs} – is the rock strength.

In-situ stress:

$$G_H = \gamma H \frac{G_M}{\sigma_{in}} \quad (2)$$

where γ – is the ore and host rocks density, t/m^3; H– is the stratification depth of the point from the surface, m; σ_{in} – is the stress in the model; G_M – is the stress in the model, MPa; G_H – is the in-situ stress, MPa.

For determining of stresses in the model the following expression is used:

$$\sigma_M = \sigma^{1.0} \cdot n, \quad (3)$$

where $\sigma^{1.0}$ = 0,1 kgf/cm^2 per one band; *n* – is the band number in point of interest of model.

Stresses in the model and in-situ are determined from the expression

$$G_H = \gamma H \frac{G_M}{k}$$

where *k*– is the similarity coefficient.

Condition of massif was investigated under conditions:

- horizontal stress 0,5; 1,0; 1,5;
- the force vector inclination angle to the vertical axis α = 0 for each value of horizontal stress;
- large fill modulus E = 0,1 MPa, host rock modulus – 1,4 MPa;
- options with cameras large fill and without it.

The options of massif control are characterized by stresses values, which are measured in cameras, interchamber pillars and on the vertical section of the camera.

For a coefficient of horizontal stress λ = 0,5 the maximum stresses in arch keystone zones and camera walls are equal to 7,6×7,5 = 57 MPa, and in arch pillar apex to 7,6 x 2 = 15MPa. The maximum compression stresses in interchamber pillar are 7,6×6,5=49 MPa.

For a coefficient of horizontal stress λ = 1,0 the stresses in arch keystone zones, camera walls and in arch pillar apex are equal to 7,6×6,5 = 49 MPa. In pillar the maximum stresses are reduced to 7,6×5,5 = 42 MPa.

For a coefficient of horizontal stress λ = 1,5 the stresses in arch keystone zones and camera walls are equal to 7,6 x 6,5 = 49 MPa, and in arch pillar apex to 7,6×8,5 = 64 MPa in contrast to 15 for coefficient of horizontal stress λ = 0,5.

The stresses in arch pillar was:

− for a coefficient of horizontal stress
λ = 0,5 7,6×5,5 = 41 MPa;
− for a coefficient of horizontal stress
λ = 1,0 7,6×13,5 = 102 MPa;
− for a coefficient of horizontal stress
λ = 1,5 7,6×18,5 = 140 MPa.

The maximum stress at the camera contours and keystones of arch pillar are developed with a coefficient of horizontal stress of 1,5 (Table 1).

Table 1. The stresses in the elements of geomechanical system, MPa

Thrust coefficient	Open mined-out area	Filled with hardening mixture
Arch pillar of block		
0,5	3	2
1,0	7	5
1,5	13	9
Left arch keystone		

0,5	5	6
1,0	4	5
1,5	3	4
Right arch keystone		
0,5	5	5
1,0	5,5	6,5
1,5	6	8

Optimization of the massif state control parameters is often a decisive factor in ensuring the efficiency of deposits development [1, 5, 7, 18].

Conclusions

The level of technogenic stresses is determined by simulation on low molecular materials with results photodetection. The most stress have an arch pillar of cameras. Large fill of cameras reduces the stress level up to 2 times. In options without large fills in interchamber pillars the stress concentration is close to critical.

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Complex approach to implementation of filling emulsion explosives Ukrainit in underground conditions

Ihor Kovalenko

Ph.D., Assoc. Professor
Ukrainian State Unversity of Chemical Technology,
Dnipro, Ukraine
E-mail: il-kovalenko@mail.com

Nikolay Stupnik

D.Sc., Prof.,
Kryvyi Rih National University,
Kryvyi Rih, Ukraine
E-mail: knu@alba.dp.ua

Mikhail Korolenko

PrJSC "Zaporiz'kyi Zalizorudnyi Kombinat",
Zaporozhie, Ukraine
E-mail: info@zgrk.com.ua

Valeriy Nebogin

Co.Ltd "NTT Tehnotron",
Zhovti Vody, Ukraine
E-mail: info@technotron.com.ua

Dmitriy Kiyaschenko

Co.Ltd "Ukrvzryvtehnologiya",
Kharkov, Ukraine
E-mail: kiyashenko@yandex.ua

Abstract
Filling emulsion explosives are safe alternative to trotyl-containing materials. The paper objective is creation and implementation of complex approach to introduction of filling emulsion explosives with high explosion and technological parameters in underground mines of Ukraine. Compositions and technologies of production of filling emulsion explosives Ukrainit-PP-2 with controlled parameters of dispersion, viscosity, gas generation speed are developed. The small-size and self-propelled mixing and charging machinery for holes charging in drifting faces and blind drifts is developed and implemented. The advanced technology of formation and reliable holding of charges of emulsion explosives in vertical wells with a diameter more than 89 mm is tested. The self-propelled and block-modular mixing and charging machinery is developed for charging of drill ring of well from the mouth of face. The diagram of logistics and technical means of transportation of components of emulsion explosives from a surface in mine to the area of consumption is developed. The complex approach allows increasing efficiency and safety of explosive works in underground conditions and abandoning application of trotyl-containing explosives.
Key words: FILLING EMULSION EXPLOSIVES, TECHNOLOGY OF CHARGING, MIXING AND CHARGING MACHINERY, TRANSPORTATION

Relevancy

Emulsion explosives (EE) are safe alternative to trotyl-containing substances which are widely used when mining in underground conditions [1, 2].

However, introduction of emulsion explosives in case of underground ore extraction in Ukraine is significantly complicated. It is due to lack of domestic mixing and charging machinery and technology of formation blasthole and borehole charges in Ukraine, and also absence of technology of reliable holding of charge in upward and steeply inclined boreholes of big diameter (more than 89 mm) in world practice.

The paper objective is creation and implementation of complex approach to implementation of filling

emulsion explosives with high level of detonation and technological parameters in underground mines of Ukraine.

Achievement of objective assumes solution of the following interdependent tasks:

1. creation of emulsion explosives compounding, technology of their obtaining and sensitizing;
2. development of domestic mixing and charging machinery for holes charging and drill ring of wells;
3. creation of technology of formation and holding of charge in upward and steeply inclined boreholes of any diameter;
4. development and implementation of logistics of transportation of emulsion matrix of explosives from a surface.

At that, the complex of solution should consider all mining-and-geological and technological features of ore underground extraction in Ukraine.

The first step of introduction of filling emulsion explosives in underground conditions was the use of proven experience of emulsion explosives «Ukrainit-PP-2B» application in open mining operations of Ukraine [3]

- principally new method of sensitizing is use of water solution of inorganic peroxides as the gas-generating component (GGC), but not toxic nitrite sodium;
- possibility of "cold" gas generation and alkalescent nature of emulsion that provides the sufficient safety level of application in the sulphide-bearing rocks;
- absence of toxic products of explosion due to balance of composition and nearly 100% of completeness of all chemical reactions of decomposition of emulsion explosives. Formation of particles of calcium oxide and water vapors, which connect and settle possible polluting emissions, that is especially relevant for underground conditions;
- high speed of detonation (at least 5000 m/s) that provides intensive destruction of rocks of any level of hardness with high-quality crushing.

According to results of Ukraine first tests of filling EE in underground conditions in 2009 (holes charging in drifting faces of PJSC "Zaporizhzhia Iron Ore Plant"), the complex of research works on adaptation of EE composition Ukrainit to application conditions was initiated. Thus, the technology of driving operations assumes detonation of holes in 15-20 min after their charging. It required to increase the speed of gas generation of "cold" emulsion Ukrainit. The task was solved owing to introduction of the catalytic agent–hydrochloric acid to composition of the gas-generating component (Pat 82960 UA). It allowed not only increasing of gas generation speed to the required values, but also of EE detonation parameters. The hydrogen chloride in the system leads to formation at the initial moment of explosion of chloride nitrosonium (NO_2Cl), which accelerates thermal expansion of ammonium nitrate [4-5] and emulsions on its basis.

The main problem of charging of drill ring of well is holding of filling emulsion explosives in upward and steeply inclined boreholes. Experience of the leading foreign companies [6-8] including "ORICA" has shown that it is almost impossible to create and hold charge of emulsion explosives in wells with a diameter over 89 mm. At that in Ukraine, in the faces unsuitable for self-propelled technique, drilling is carried out by NKR machines (diameter of wells is up to 105 mm).

The solution of this problem is impossible without significant increase of viscosity of emulsion matrix of explosives. It required to change approach to technology of emulsifying. The device of static emulsifying which differs significantly from known one (Pat 69553 UA) was developed for obtaining high-viscosity emulsions. The device combines several controlled stages of emulsifying. Its application allowed obtaining emulsion compositions of specified viscosity and dispersibility that provided high power/weight ratio of emulsion in combination with scientifically based approach to selection of fuel phase [9].

Characteristics of filling EE Ukrainit-PP-2 for underground application are presented in Table 1. They are based on emulsions of two types: low-viscosity (type 1) and high-viscosity (type 2).

Table 1. Characteristics of filling emulsion explosives Ukrainit-PP-2

Characteristic	Value	
	type 1	type 2
Density at a temperature (20±10)^{0}C in 1 hour after sampling, kg/m3	1050 – 1400	
The gas generation level at a temperature (20±10)^{0}C in 30 min., %, minimum	15	10

Fullness of detonation of charge in polymeric enclosure with a diameter of 50 mm from ammonite charge No 6ZhV weighing 100 g	FULL	
Oxygen balance, % (calc.)	– 0,18… -2,15	
Warmth of explosion, kJ/kg (calc.)	3000-3100	3100-3200
Volume of explosion gases, l/kg (calc.)	760-840	760-840
Critical diameter of open charge, mm	30-35	35-40
Detonation speed in a steel shell with a diameter of 50 mm (at the density of 1250 kg/m^3), m/s	5100-5400	5100-5300
The minimum initiating pulse, the equivalent to ammonite No 6ZhV, g	30 – 40	
The relative working capacity in trotyl equivalent	0,75-0,80	
Toxic gases of explosion expressed in terms of CO, l/kg	up to 15	up to 14
Unit volume electrical resistance, Ohm·m, minimum	760	
Critical density at a temperature of (20±10) ^{0}C, kg/m^3	1440	1415
Water resistance of emulsion matrix during 24 hours, kg/sq.m, minimum	0,5	

The developed filling EE Ukrainit-PP-2 for mechanical charging of blasthole and borehole charges possess high rates of safety, namely, form the minimum quantity of toxic gases of explosion, which are not sensitive to blast, friction and heating; that is exothermal expansion does not begin up to the temperature of 175^{0}C.

The task of development of small-size and self-propelled mixing and charging machinery for formation of blasthole charges was solved in the schematic diagram of dosing pump of original construction. Experts of "NTO Tekhnotron" (Zhovti Vody) have developed design of piston dosing pumps of "single" (Figure 1) and "double" action with hydraulic control and rigid mechanical linkage of the main pump of emulsion and dosing pump of gas-generating component supply with possibility of its smooth control (Patent 19784 UA). Such devices provide introduction of the gas-generating component (GGC) directly to emulsion at the output from the pump with high-quality mixing of components.

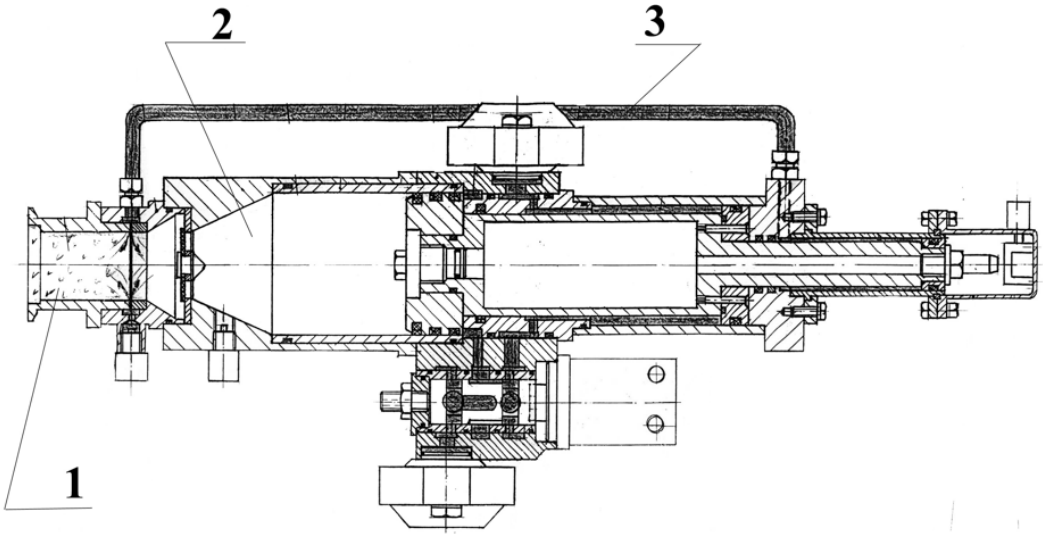

Figure 1. Dosing pump of "single" action 1 – output of ready-made emulsion explosives; 2 – supply of emulsion; 3 – supply of the gas-generating component

On the basis of dosing pumps of double action, experts of "NTO Tekhnotron", "Ukrvzryvtekhnologiya" and "ZZhRK" have developed and produced the first domestic samples of portable mixing and charging machinery of models SZS-1, ZEP-15 (Patent 62192 UA) of two modifications of ZEP-10 (Patent 67340 UA). This samples provide high-quality automatic dispensing and mixing of components with driven feed of obtained initial explosives in holes.

These chargers have successfully undergone comprehensive industrial tests under various gidro-, mining-and-geological conditions in mines: "Prohodcheskaya" and "Ekspluatatsionnaya" (JSC "Zaporizhzhia iron ore plant", Dniprorudne), "Nova" (LLC "VostokRuda" Zhovti Vody), PJSC "Kryvy Rih Iron Ore Plant", "Evraz Sukha Balka" (Kryvyi Rih), uranium mining plant SE "VostGOK" ("Smolinska" and "Ingul" mines).

Further progress of experimental development directed to implementation of underground filling EE of Ukrainit allowed developing and implementation of self-propelled mixing and charging machine of model ZEVS-1 (Patent 82519). Charger of model ZEVS-1 has two-stage system of cleaning of waste gases, system of automatic fire suppression of running diesel, unit for chucks transportation and means of initiation in a basic configuration.

When maintenance of small sizes, two mixing and charging circuits are specified in design of self-propelled holes charger ZEVS-1. Circuits consist of two two-component dosing pumps of double action of original design ND-30. The implemented principle of well-balanced dosing allowed excluding of expensive proportional hydraulics and programmable electronics.

Unlike foreign analogs, in ZEVS-1 chargers, functioning of dosing pumps is provided not only by running diesel engine, but also by additionally set low-power engine. Such design solution provides reduction of expenditure of diesel fuel and emissions of waste gases that is extremely important for operations in blind drifts. The self-propelled charger ZEVS-1 is completely independent and does not require connection to mine pneumatic and electric circuits. Due to rather low cost, simplicity of service and small overall dimensions, self-propelled charger ZEVS-1 provides effective conduction of blasting operations in framings with section of 9-15 sq. m. and charging of 2-3 drifts per change. ZEVS-1 is successfully applied under conditions of PJSC "Zaporizhzhia iron ore plant".

The main characteristics of domestic mixing and charging technique for formation of blasthole charges with filling EE Ukrainit-PP-2 are presented in Table 2.

Table 2. Mixing and charging machinery for charging of holes with filling emulsion explosives Ukrainit PP-2

Parameters	Model of mixing and charging machinery			
	SZS-1	ZEP-15	ZEP-10	ZEVS-1
Type of charger	portable			self-propelled
Productivity, kg/min.	20,0-80,0	10,0-15,0	10,0-15,0	30,0x2=60,0
Emulsion container volume, l	7,0-150,0	15,0	20,0	360,0
GGC container volume, l	up to 5,0	1,4	2,0	up to 10,0
Drive	Electrohydraulic / pneumatichydraulic	Water / pneumo	Pneumo	diesel-hydraulic
Dimensions, mm	1100x1000x 1200	800x700x600	500x990x 850	4500x1900x2300
Mass, kg	from 300,0	up to 40,0	from 37,0	3400,0

One of problems of EE charge formation in the upward wells is insufficiently fast gas generation of high-viscosity emulsions. For this problem solution, the process diagram of charge machines of the leading foreign companies surely includes the additional delivery line of special catalytic agent of decomposition of GGC. It complicates the process diagram and requires additional vessel and pumping equipment.

The task of increase of gas generation speed of viscous composition of EE Ukrainit-PP-2 was successfully solved by means of original construction nozzle which operation was studied in the special mixing and charging stand. This nozzle provides uniform mixing of emulsion and gas-generating additives with

increase in dispersibility and viscosity of finite emulsion explosive. The result is achieved due to the big shear loads emerging at the output from injector nozzle. It allowed to implement charging of drill ring of any diameter from mine face. Nozzle design provides arrangement of primed blasting cartridge on it for support of inverse initiation of explosive charge.

The conducted complex of design and experimental, research and development operations allowed developing the process flow diagram of mixing and charging machine for charging of drill ring of well in underground conditions. Against order of PJSC "Zaporizhzhia iron ore plant" according to the technical design specification developed by domestic experts of companies «Explominetech» (Germany) and "Ruda" (Poland), the mixing and charging machine RTCh-23 was designed and produced.

At the present time, RTCh-23 is successfully applied under conditions of «Ekspluatatsionnaya» mine (PJSC "Zaporizhzhia iron ore plant") including charging of the upward wells with diameter of 105 mm that has no analogs in world practice. According to results of explosion, high quality of crushing, absence of "boulders" and "overhang", small time of face airing are fixed.

For loading of emulsion explosive Ukrainit-PP-2 of drill ring of well in the drawing drifts, the technique, which provides use of low-viscous emulsion and locking devices of original design (TU 22.2-36373037-004:2014), was developed. Locking devices are equipped with the discharge chamber of supply of EE with ball-type valve and container where the insulating polymeric hole is located (in corrugated state). The container is provided with tube of compressed air supply for unrolling of insulating polymeric hole and its overturning along the well height.

In the course of charging, emulsion explosive, which is produced by means of the constructed mobile block and modular installation of UBM-1 model, moves via valves in well after installation of locking device at estimated distance from the mouth of well and unrolling of insulating hole. Application of developed technique allows mechanized charging of drill ring of well of any diameter from the mouth of face with low-viscous emulsion. Experience of application under conditions of «Ekspluatatsionnaya» mine (PJSC "Zaporizhzhia iron ore plant") has shown that the developed technique is most effective in case of high water inflow and significant destruction of walls of well. Technical characteristics of UBM-1 and RTCh-23 are given in Table 3.

Table 3. Technical characteristics of mixing and charging equipment for charging of drill ring of wells with filling emulsion explosive Ukrainit-PP-2

Parameter	Block and modular installation UBM-1	Mixing and charging machine RTCh-23
Diameter of charged wells, mm	89, 102, 105	
Supplementary equipment for upward wells	locking devices	Special tamping plug or brush
The horizons on which loading of blocks is possible	travelling, subfloor	subfloor
Productivity, kg/min.	50-80 (viscosity of up to 50 000 cP)	to 80 (viscosity of up to 180 000 cP)
Charging productivity (output per shift / monthly), t	up to 7,0 / up to 50,0	over 8,0 / up to 110,0
Engine power, kW	up to 4,0	up to 112,0
Emulsion / GGC container volume, l	200,0 / 10,0 (refillable containers)	3000,0 / 50,0
Maximum dimensions LxWxH, mm	750x450x500 o oil-pumping station 800x650x500 – pumping unit, 960x840x1100 – emulsion container	9550x2000x2300
Mass, kg	60,0 + 90,0 + 65,0 = 215,0	21 100,0

Logistics is important aspect of problem of complex implementation of filling EE at underground operations. In parallel with development of mixing and charging equipment, schemes and technical means of delivery of EE components Ukrainit to the place of consumption were developed.

In 2009, the car-supplier VDEK-3 was developed for delivery of emulsion composition to the mine by rail transport. The car is used in mines of the main horizons equipped with a rail track of 750 mm. Charing of VDEK-3 is performed in superficial warehouse of explosives from suppliers of emulsion. Delivery of emulsion Ukrainit by the car-supplier from surface in mine is performed in cage, and then by mine electric locomotive in the rail workings in underground warehouses or distributing chambers. After carrying out tests and improvements, for the moment, 13 cars VDEK-3 are produced and put into operation in PJSC "Zaporizhzhia iron ore plant". In mine, the emulsion is unloaded from cars by means of the screw pump BN for mining workings in polytainers with volume of 30 l and is delivered in driving faces by self-propelled transport. In case of preparation of mass explosions in RTCh-23 and UBN-1, reservoir for emulsion composition of volume of 3 m^3 for direct delivery to places of charging is provided.

The cassette KEK-3m has been developed and produced for in-mine delivery of EE components on trackless workings. The cassette provides delivery of emulsion composition in mine to workplaces RTCh-23 and UBN-1 or accumulative containers of emulsion. Delivery of KEK-3m is carried out with use of self-propelled machine "Multimec 6600" of NORMET company. The cassette KEK-3m consists of the following parts: platform, containers for emulsion and gas-generating additives, hose chain, screw transporting pump, gauging rod, hydraulic stand. Technical characteristics of technical means of delivery of emulsion Ukrainit from a surface in mines are given in Table 4.

Table 4. Technical characteristics of technical means of delivery of emulsion explosives components Ukrainit-PP-2

Characteristic	Delivery car VDEK-3	Cassette KEK-3m
Transportation type in mines	rail	self-propelled machine
Supplied components	emulsion	emulsion / gas-generating additives
The mass of transported emulsion, kg	4 000	
Volume of containers in sections for GGC, l	-	21*2 = 42
Pump productivity, m^3/hour	-	to 10
Total weight with load, kg	no more than 6000	no more than 8000
Overall dimensions, mm	length on buffers – 3950 width – 1350 height from a head of rail – 1600	3600x1500x1300

Implementation of integrated approach to introduction of safe filling EE Ukrainit-PP-2 allowed creation of domestic mixing and charging technique, technical means of delivery and advanced technologies of holes charging and drift ring of wells of any diameter. The complex approach allows increasing efficiency and safety of explosive works in underground conditions and abandoning application of trotyl-containing of explosives.

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КОНТАКТЫ

e-mail: metaljournal@gmail.com

metaljournal11@gmail.com

г. Днепропетровск

тел. +38 (056) 794-36-74

факс. +38 (056) 794-36-75

моб. +38 (050) 320 69 72

CONTACTS

e-mail: metaljournal@gmail.com

metaljournal11@gmail.com

Dnipropetrovsk

Tel.:+38 (056) 794 36 74

Fax: +38 (056) 794 36 75

Mob: +38 (050) 320 69 72

Editorial department

The journal is registered by Ministry of Justice of Ukraine. Registration Certificate No. 15475-4047P of July 13, 2009.

Publisher: "Ukrmetallurginform" STA", Ltd

e-mail: metaljournal@gmail.com

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e-mail: metaljournal@gmail.com

metaljournal11@gmail.com

г. Днепропетровск

тел. +38 (056) 794-36-74

факс. +38 (056) 794-36-75

моб. +38 (050) 320 69 72

CONTACTS

e-mail: metaljournal@gmail.com

metaljournal11@gmail.com

Dnipropetrovsk

Tel.:+38 (056) 794 36 74

Fax: +38 (056) 794 36 75

Mob: +38 (050) 320 69 72