The analysis of Russian and foreign works allows to make conclusion that intellectual educational systems (IES) as new educational technologies are able to provide the new experience of education for future information security specialists in consideration of raised requirements for their training level all over the world. The specificity of IES consist in educational process modeling using dynamically developing knowledge base and automatic selection of efficient strategy and personal individual education trajectory, automated registration and analysis of new information entering in the database. In addition, intellectual educational systems allow to resolve the local problems of self-education of students and control the level of their professional skills. These systems can manage the student's education, resolving problems that they will meet in their further professional activity and controlling unassisted student's work.

Thus, the main task of present-day professor consist in the choosing of optimal and valid organization forms of education and using such a innovation techniques and methods in the educational process, that will provide efficient mastering of professionally significant knowledge, skills, acquirements necessary for future specialist at any professional activity. Using of intellectual educational system as the methodical guide of unassisted student's training doesn't just provide efficient mastering of professionally significant knowledge, skills, acquirements necessary for future specialist at any professional activity, but transform the professor's mission into the mission of organizer of student's educational activity, possessing the efficient tool that allow to achieve nice results in education's quality.

APPLICATION OF COMPLEX METHODS TO SOFTWARE PRODUCT PROTECTION FOR ILLEGAL COPYING

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The problem of illegal usage of software products cropped up in 80 of XX century simultaneously with the appearance of personal computers, due to some specific features of this type of computers. It has happened as a result of hardware standardization and mass distribution of personal computers without any software.

Software-technical method is the most efficient method used nowadays. At the stage of development a program includes a fragment of code that checks conditions of the program usage and blocks it's execution in case of inconformity to the determinate terms of agreement.

Nowadays there are several types of software-technical protection, but each of them has its own disadvantages. For example one serial number could be used on some computers.

There're sufficient reasons for using a combination of several methods to achieve the most efficient software product protection. One of the most secure combinations is consolidation of cryptographic protection of executable code and external hardware acting as electronic key and external computation module that execute necessary computations for the software. Given method doesn't run the danger of such software attacks as disassembling, debugging and analysis of the memory dumps by reason of the protection of executable code by resistant cryptographic algorithms. Electronic key fulfills just computational functions therefore interception of passing information between the computer and the electronic key won't give desirable result for an intruder.

MATHEMATICAL MODELING OF THE PROCESS OF WATER - SOLUBLE SALTS WITHDRAWAL FROM PIGMENT ORGANIC SUSPENSION BY DECANTATION

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The main qualitative attribute of pigments and coloring agents is dyeing concentration that depends on many factors, the main of which is presence of water-soluble salts in the finished products paste, generating at the process of synthesis. Water-soluble additive withdrawal is one of the effective way to increase the qualitative attribute of pigment.

Among the diversity of methods of water-soluble salts withdrawal from sediment the following can be pointed out: repulping, washing by filters, decantation.

Decantation is the easy and gentle cleaning method towards the pigment crystal structure, implying the process of hard and liquid phase's separation by means of sedimentation

Aiming to define the quantity of cleaning cycles necessary for archiving the desired concentration of water-soluble salts in pigment paste the mathematical model of the process of water -soluble salts withdrawal from organic pigment suspension was developed.

When developing the mathematical model the following assumptions are taken into consideration: the mass of water-soluble salts is less than mass of water and hard particles; during the sequence period (mixing together with sedimentation) the gradient of

water-soluble salts concentration in volume of suspension is considered as negligible; the character of dependence linking the equilibrium concentrations of water-soluble salts in paste and liquor is linear; the volume of paste in all cycles of washing is constant; pigment is a ball-type particle with radius r_0.

Suspensions and sediments of pigments and colorants show electrokinetic potential that influences the process of water-soluble salts withdrawal [1–3]. Fine particles of hard phase (pigment) of some micron size bear electrical charge in relation to surrounding aqueous dispersion medium that appears as a result of preferential absorption of ions of a definite sign, sur-

face ionization or due to absorption at the surface of polar molecules [2,4]. The system of spatial-split charges appeared at the phase border line (pigment-liquor (polar liquor)) represents a double electric layer [3,4]. Complex – a pigment particle in the dispersion phase with the double electric layer surrounding it represents micelle. Aggregate inside micelle represents a hard phase (pigment particle), pigment with potentialdefining ions, composed by ions of chlorine Cl^-, represents a micelle core. Core together with the absorption layer form a particle, that surrounded by the diffuse layer. The micelle composition can be represented the following way:

$$\{[(\text{Pigment})_n m Cl^-]_x Na^+\}(m-x)Na^+$$

where n – number of potentialdefining molecules, m-number of potentialdefining ions of chlorine, x – number of sodium ions.

The amount of water-soluble salts on the surface of micelle core is sum of quantity of water-soluble salts counterions in the micelle absorption and diffuse layers:

$$v = v_{ad} + v_{dif} \tag{1}$$

where v – quantity of water-soluble salts on the surface of a micelle core, kmol; v_{dif} – quantity of water-soluble salts in the micelle diffuse layer, kmol;

v_{ad} – quantity of water-soluble salts in the micelle absorption layer, kmol.

At diffuse layer the quantity of water-soluble salts counterions on the surface of a micelle particle in integral form:

$$v_{dif} = 4\pi \int_{r_1}^{r_3} C \cdot r^2 \cdot dr \tag{2}$$

where C – concentration of counterions in a diffuse area, kmol/m^3; r – the interval from the surface of a pigment particle, m; r_1 – the border of the absorption layer, m; r_3 – the border of the diffuse layer, m.

At the absorption layer the quantity of water-soluble salts counterions on the surface of a micelle core with allowance for maximum possible quantity of counterions:

$$v_{ad} = \frac{4\pi r_0^2}{S_{mol}} \cdot \frac{1}{1 + \dfrac{1}{C_l} \cdot e^{\Delta\mu + z \cdot F \cdot \frac{\varphi_0}{2}\left(1 + e^{-\frac{\delta}{\lambda}}\right)}} \tag{3}$$

where r_0 – radius of micelle core, m; S_{mol} – space occupied by one counterion, m^2; $\Delta\mu$ – the change of substance chemical potential at transfer from liquor to absorption layer, J/mol; φ -the difference of potential in the given point and in the liquid volume (at the

«endless» moving from the surface) J/C; λ – the thickness of the diffuse layer; m; δ – the thickness of the absorption layer; m; F – Faraday constant, C; z – ions charge.

Let's bring into equation (1) equations (2-3):

$$\nu = 4\pi \cdot C_l \cdot \int_{r_0}^{r_0+\lambda} e^{-\frac{F \cdot z \cdot \varphi}{R \cdot T}} \cdot r^2 \cdot dr + \frac{4\pi r_0^2}{S_{mol}} \cdot \frac{1}{1 + \frac{1}{C_l} \cdot e^{\frac{\Delta\mu + z \cdot F \cdot \varphi_0 \cdot \left(1 + e^{\frac{\delta}{\lambda}}\right)}{2}}} \qquad (4)$$

where R – gas constant J/(mol C) ; T – absolute temperature, C.

The material balance of quantity of water-soluble salts for sedimentation and decantation processes appeared as a result of summing the quantity of water-soluble salts in hard material (pigment) and in liquor will have the following form:

$$\nu_s = \nu_{pigment} + \nu_l = N_{p.p.} \cdot \nu_{p.p.} + C_l^0 \cdot V_p \cdot \left(1 - \upsilon_{pigment}\right) \qquad (5)$$

ν_s – total quantity of the water-soluble salts in pigment suspension, kmol; ν_l – quantity of the water-soluble salts in liquor, kmol; $\nu_{pigment}$ – quantity of the water-soluble salts in the total pigment volume, kmol; $\nu_{p.p.}$ – quantity of the water-soluble salts on the surface of one pigment particle, kmol; V_p – volume of paste, m³; $N_{p.p.}$ – number of pigment particles, p/m³; $\upsilon_{pigment}$ – pigment volume fraction in paste.

The paste layer obtained after decantation is brought to the volume of the initial suspension by adding water as a solvent, as a result the volume of water placed to the paste will be $(V - V_p)$ m³.

The quantity of water-soluble salts is not changed, the volume of paste is constant, the volume of water in liquor has grown up to $(V - V_p)$.

Therefore, the material balance of the process of paste dilution by a solvent (water) can be represented the following way:

$$V_p = (1 - \upsilon_{pigment}) \cdot V_l + (V - V_l) = V - \upsilon_{pigment} \cdot V_l \qquad (6)$$

where V – volume of the initial suspension, m³; V_l – volume of liquor, m³.

The concentration of water-soluble salts in a solvent (water) becomes equal to C_l^1 while the quantity of substance of these salts doesn't change.

The concentration of water -soluble salts in a solvent (water) C_l^1 is found out using integral way (method of successive approximation).

1-st approximation is based on the approximate dilution of liquor only.

First integral step. Let's find the concentration of salt in liquor C_l^1 at the first dilution taking into consideration the concentration of salt in the initial liquor C_l^0 and volume of the initial suspension V m³ and paste V_p m³.

$$C_l^1 = C_l^0 \cdot \frac{V_p}{V} \qquad (7)$$

where $C_l^i = C_p$ – mole concentration of water-soluble salts in a solvent, kmol/m³.

Let's calculate the quantity of water-soluble salts on the surface of pigment

$$\nu_{pigment} = N_{p.p.} \cdot \nu_{p.p.} \qquad (8)$$

where the quantity of one particle $v_{p.p.}$ is defined according to the equation (4)

Second integral step. Let's find the concentration of salts in liquor C_l^1 at the first dilution taking into consideration the quantity of water-soluble salts in a pigment suspension and on the pigment surface during the first dilution:

$$C_l^1 = \frac{v_s - v_{pigment}}{V_l} = \frac{v_s - N_{p.p.} \cdot v_{p.p.}}{V - \upsilon_{pigmenta} \cdot V_p} \qquad (9)$$

The process of successive approximation for the equations (7)–(9) is held up to the moment when the difference between the iterations for C_l^1 calculating by equation (7) and C_l^1 – calculating by equation (9) will exceed the desired number.

The concentration of water-soluble salts in liquor and at the pigment surface doesn't change, the volume of liquor changes due to decantation influencing the total quantity of salts, as a result the material balance of the process of suspension sedimentation and dispersion phase (liquor) decantation can be represented the following way:

$$v_s = v_{pigment} + v_l = N_{p.p.} \cdot v_{p.p.} + C_l^1 \cdot V_p \cdot (-\upsilon_{pigment}) \qquad (10)$$

These findings are used for the next process of dilution. The calculation is repeated until the moment the concentration will take the value less or equal to the desired.

The procedure offered allows to calculate the technological parameters of the process of water- soluble salts withdrawal from azopigment suspension by method of decantation and sedimentation.

References

1. Malinovskaya T.A. Suspension Separation in the Organic Synthesis Industry / T.A. Malinovskay. - M.: Chemistry, 1972. - 320 p.

2. Lukomskiy U.Y., Gamburg, U.D. Phusic-chemical Fundamentals of Electrochemistry: textbook/ U.Y. Lukomskiy, U.D. Gamburg. - M.: ID Intellect, 2008. – 424 p.

3. Damaskin B.B., Petriy O.A. Introduction to Electro-chemical Kinetics / B.B. Damaskin, O.A. Petriy, 2nd edition. - M.: Higher School, 1983. - 400 p.

4. Zakharchenko V.N. Colloid Chemistry: textbook for universities / V.N. Zaharchenko. - M.: Higher School, 1989. - 238 p.