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• EARTH SCIENCES

L. Anichshenko

THE PROBLEMS OF THE INDUSTRIAL WASTE WATER DISPOSAL INTO CARBONATE RESERVOIRS OF THE PRE-CASPIAN DEPRESSION

The greatest threat to the natural environment is an industrial waste water, which is able to be filtered and migrate, it penetrates deeply into the underground hydrosphere and spreads polluting substances over considerable distances.

Cleaning technology is not developed yet for severely toxic and industrial waste water that is difficult to decontaminate neither abroad no in our country, they are increasingly should be buried underground lately.

The territory of pre-Caspian basin is conducive to search for deep carbonate aquifers-collectors for the disposal of industrial waste water. The most promising place for the disposal of industrial waste water is the water zone of the First the Carbonate Column [1].

Experimental works take place at Zhanazhol and Alibekmola oil deposits to pump industrial waste water into the water zone of the First the Carbonate Column.

Industrial waste water is a technological solution, resulted after oil purification from hydrogen sulphide and ethyl-, and metilmerkaptanov the Setup for crude oil demercaptanization.

The main physical-chemical indicators of industrial waste water are: pH value =12,3. The density of industrial waste water is 10200mg/dm^3. The dissolved carbon dioxide and oxygen are missing. The concentration of hydrogen sulphide is 0,640 mg/dm^3. The amount of dissolved substances (solids, TDS) are 11022 mg/dm^3. The content of suspended solids (colloidal particles, TSS) is 106 mg/dm^3, The content of calcium and magnesium accordingly is 40,0 и 24,0 mg/dm^3. The content of chlorides is 266 mg/dm^3. The content of sulfates is 365 mg/dm^3. The content of hydrocarbons is 366 mg/dm^3. The content of carbonates is 9780 mg/dm^3. The content of phenols is 0,0189 mg/dm^3. The content of petroleum products is 34,8 mg/dm^3. The content of common iron is 2,13 mg/dm^3. The content of heavy metals (Cd, Pb, Cu, Zn) accordingly is 0,0052 mg/dm^3; 0,0482 mg/dm^3; 0,0188 mg/dm^3 and 0,0198 mg/dm^3.

The industrial waste water corresponds to the standards of governing document 39-01-041-81 "Methodology of predictive determining quality standards of wastewater for waterflood into oil zone of the new oil fields" [2], where, in particular, the content of pumpable sludge solids up to 15-50 mg/dm^3 and petroleum products up to 15-50 mg/dm^3.

According to the accumulated experience industrial waste water to be buried usually contains dissolved mineral salts, organic substances, particles and bacteria.

The chemical reactions occur while pumping the industrial waste water into the aquifer, which brings sedimentation, heat, gas, etc. Together with the growth of the bacteria it can cause colmatage of porous absorbing part of the borehole and lowering capacity. To prevent such occurrence assessment of compatibility is requred of industrial waste water from underground waters and water rocks, and special preparation of the industrial waste water for pumping if nessessary.

Assessment of the compatibility of the industrial waste water and the formation water complies with the industry standard 39-228-89 [3]. It compares the coefficient of permeability of rock samples measured before and after the interaction of injected water with reservoir water and rocks (considering also the process of precipitation of insoluble salts and sludge swelling clay particles of rock fracturing-collector).

The experiments are carried out at the formation temperature and current pressure difference. The coefficient of permeability of before and after the interaction of injected water with reservoir water and breed is defined by the Darcy formula:

$$\text{Cperm} = \frac{0 \cdot 1 \cdot Q \cdot \mu \cdot L}{t \cdot F \cdot \Delta P},$$

where:

Q – the volume of water passed through the layer, cm^3;

t – time of water filtration, sec;

μ - viscosity of water, mPa·sec;

L – the length of the seam, cm;

F – the cross-sectional area of a reservoir, cm^2;

ΔP – the average pressure difference, MPa.

Set the increment coefficient of permeability (ΔCperm) models of rock formation element due to the interaction of the injected water with reservoir water and breed:

ΔCperm = Cperm - C□perm

Where:

Cperm - the coefficient of permeability of the reservoir until the water injected with interaction of water and rock in-place, mcm^2;

C□perm - the coefficient of permeability of the reservoir after the interaction of water with the formation of the injected water and breed, mcm^2.

Then calculate the absolute accuracy of determining permeability coefficient (ECperm). Downloaded water deemed compatible with reservoir water and rock if:

ΔCperm ≤ ECperm

and, conversely, incompatible if:

ΔCperm > ECperm.

Examination of the compatibility of the water consists of the mixing the original types of waters in different ratios, storing them within a certain period of time and the weighting of the appeared sediment.

To determine the compatibility the filtered water was taken from the observation wells ##55, 132, 123, 405. Mixing was performed in volumetric ratio of 100: 0, 90: 10, 80: 20, 70: 30, 60: 40, 50: 50, 60: 40, 70: 30, 20: 80, 10: 90 and 0: 100 with filtered water from the line of pumping. Then samples were shaken during 4 hours, filtered through filter "Blue Ribbon" which was brought to constant weight, the sediment was dried at 110°C.

As a result of the above mentioned works due to chemical incompatibility of waters the sediment was formed. Maximum value is due to low rate of dilution of the formation water with pumping water (Figure 1).

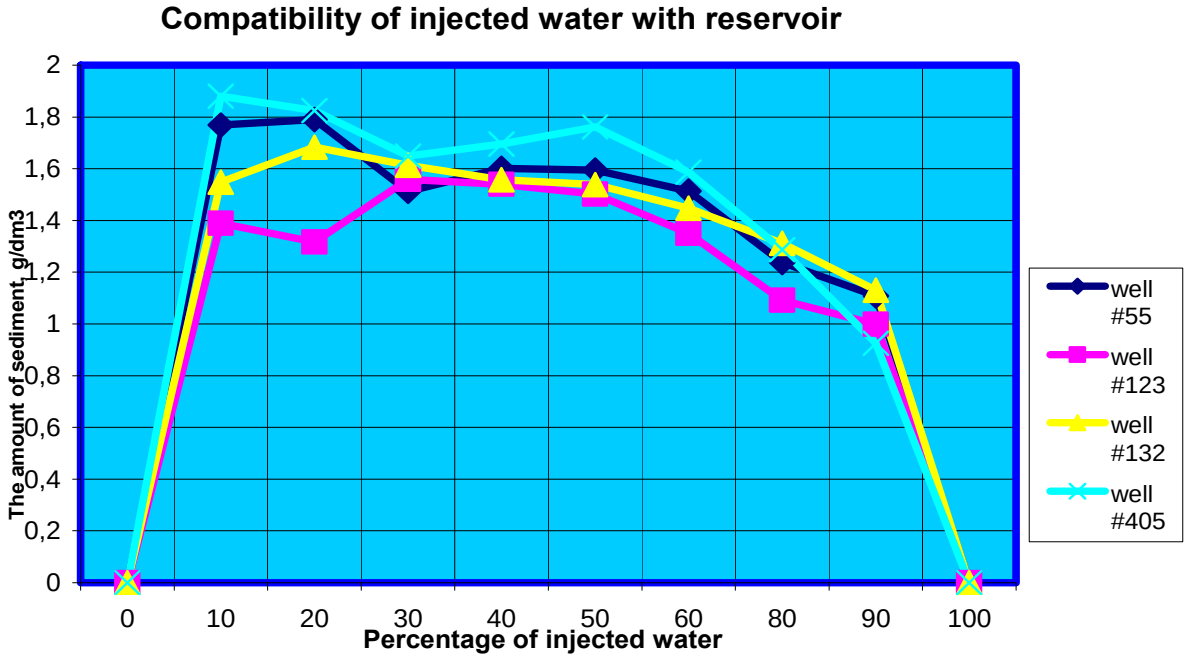

Fig.1

The research results are presented in the Table 1.

Table 1. **Compatibility of reservoir and injected water**

The water content of the wells	The water content of the line download	Compatibility of the waters			
		the amount of sediment, g/dm^3			
		well #132	well #55	well #123	well #405
100	0	0	0	0	0
90	10	1,5479	1,7684	1,3889	1,8806
80	20	1,6835	1,7899	1,3165	1,8245
70	30	1,6129	1,5124	1,5583	1,6494
60	40	1,5581	1,6013	1,5397	1,6957
50	50	1,5389	1,5948	1,5012	1,7613
40	60	1,4476	1,5132	1,3499	1,5866
20	80	1,3122	1,2377	1,0912	1,2874
10	90	1,1310	1,1082	0,9984	0,9248
0	100	0	0	0	0
Maximum values		1,6835	1,7899	1,5583	1,8806

In order to obtain information about condition of groundwater manufacturing monitoring is held through sampling of the observation wells and absorption wells.

Sampling and analysis are carried out in accordance with the normative-methodical manuals (State standard 17.1.3.06-82 [4], State standard 17.1.3.12-86 [5], etc) applicable on the territory of the Republic of Kazakhstan. That provides maximum retention of salt and water gas composition, guarantees the exclusion of the randomness of the selected sample. The volume of water required for the definition of substances, is selected depending on the method of analysis.

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3. The industry standard 39-228-89 «Water for waterflooding oil reservoirs. Quality requirements»

4. State standard 17.1.3.06-82

5. State standard 17.1.3.12-86

Резюме

Батыс Қазақстанда өмір және қоршаған орта қауіпсіздігін қамтамасыз ету мақсатында өндірістік ағынды суларды Алибекмола, Жаңажол кенорындарындағыдай карбонатты тұзүсті түзілімдеріне айдау тәжірибесі қолданылған.

Резюме

В Западном Казахстане в целях безопасности жизнедеятельности и защиты окружающей среды имеется опыт закачки промышленных сточных вод в карбонатные подсолевые отложения таких месторождений, как Алибекмола, Жанажол.

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DYNAMIC (PHYSICAL AND MECHANICAL) CHARACTERISTICS FINDING OF THE KAPSHAGAI HYDRO POWER PLANT (HPP) LAIR DAM IN DIFFERENT BURIED LEVELS

Kapchagai HPP, located 70 km north of Almaty for the territory of Almaty region, is one especially important object, which plays an important role in providing the Republic of Kazakhstan with electricity. On the other hand Kapchagai HPP is located in seismic hazard region and represents a serious potential threat to dense populated country sides Ili and Balkhash regions of Almaty region, crucified annex to the north of it. Therefore, stable operation of the object at a strong earthquake is critical, both for the stability of the economy, and for the preservation of human life.

Modern seismic activity area surrounding the Kapchagai HPP was studied based on observations of a network of stationary seismic station since 1951. In the area bounded by the coordinates 43 ° 20'-44 ° 20 'N and 76 ° 30'-77 ° 30 'E. for the observation period from 1951. Recorded 237 earthquakes, including the most powerful - Bakanasskoe 25 September 1979. With K = 14 and 23 August 1960. With K=13. Up to 1969. Recorded two earthquakes with K = 11 (in 1955 and 1956) and five earthquakes with K = 10. May 1, 2011 on the shore of Kapchagai water storage basin earthquake with K = 13.

Program of work, the organization length is optimal (at least two years) seismic and seismic observations to track the activation of local seismogenic structures, refine the projected seismic effects on objects Kapchagai, as well as studies of the dependence of the seismic regime of exploitation Kapchagai [1-6]. In addition, provides a large amount of seismic surveys to determine the parameters of dynamic dams and outcrop (shear modulus, Poisson's ratio) needed for calculations of seismic stability of waterfront facilities.

Kapchagai HPP consists of:

• riverbed and den dams built of alluvial and aeolian sands;

• rocky outcrop, in which body to tunnel conduits;

• the power house and other auxiliary facilities.

Comprehensive studies have been carried out:

• assessment of seismic hazard in the region;

• geophysical field investigations;

• having a technical state of the structure using geophysical methods, mapping diving underwater structures, determining the strength characteristics of the material structures;

• cash-parametric analysis;

• Model tests of the dam.

Large body of seismic to identify changes the rate of passage of longitudinal seismic waves at different levels in the depth of the body of the dam to determine the dynamic parameters of the dams (shear modulus (***E***), Poisson's ratio (***μ***)), necessary for the subsequent calculations. Seismic surveys were carried out on the profile of seismic inversion method for stationary and mobile source point fluctuations. Seismic vibrations excited by the shock method (rapid lowering bucket tractors "Belarus") in increments of 2 m from the experimental work directly determined wave velocities V_p. S-wave velocity V_s determined from archival and published sources.

Changes in P-wave velocities V_p with depth, calculated refragiravian-refraction are shown in Figure 1. They differentiate significant for different soils.

a) b)

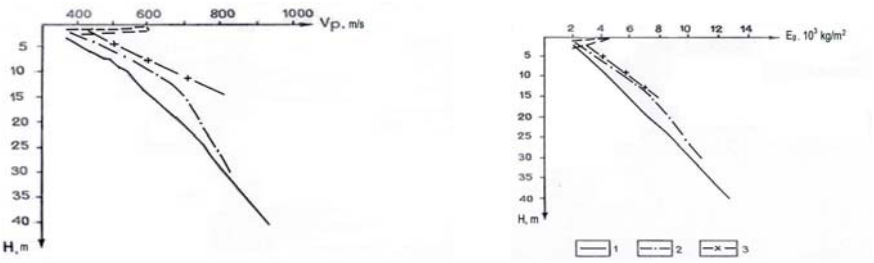

Fig. 1. Graph of the depth of the dam: a) wave velocities, and b) the dynamic modulus of elasticity (1 - sandy-loamy soil grussy (comb);2 - grussy sandy soil (berm);3 - rock mass (blowing hard prism)).

Dynamic parameters μ *(Poisson's ratio)* and E_g *(Dynamic elastic modulus)* is given by:

a) $\mu = \dfrac{1 - 2\dfrac{V_S^2}{V_p^2}}{2(1 - \dfrac{V_S^2}{V_p^2})}$; b) $E_g = pV_p^2\left[\dfrac{(1+\mu)\cdot(1-2\mu)}{(1-\mu)}\right]$

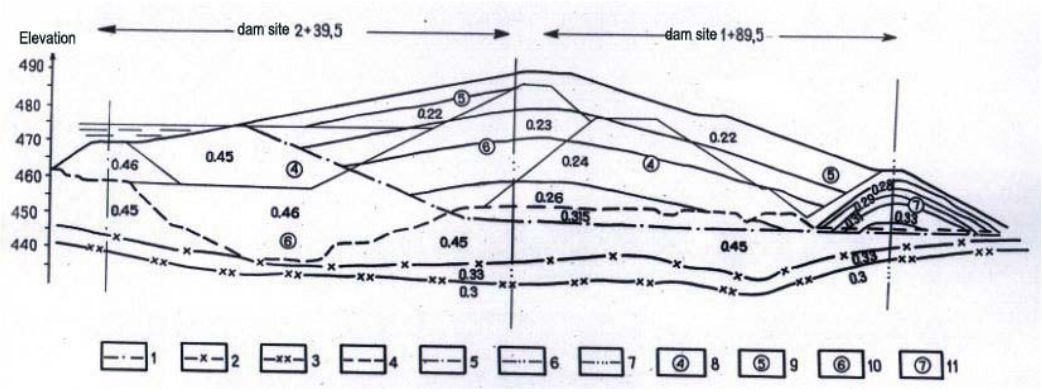

Fig. 2. Distribution of values of $\mathbf{V_p}$ in the body of the dam's Lair. $V_p = 0.45$; $V_p = 0.22$; etc.
1 - depression curve 2 - the bedrock surface, 3 - surface undisturbed rock, 4 - the dam, 5 - axis riding hard prisms, 6 - axis of the dam, 7 - axis downstream hard prisms, 8 – lumber -gravelly soil, 9 - Aeolian sand, 10 - sandy loam and sandy soil, 11 - rock

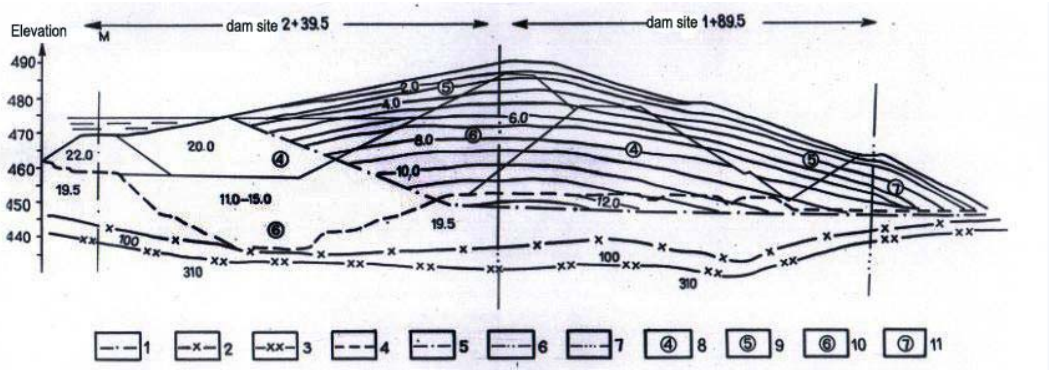

Fig.3. Distribution of values of **μ** in the body of the dam's Lair. μ = 2.0; μ =15.0; etc.

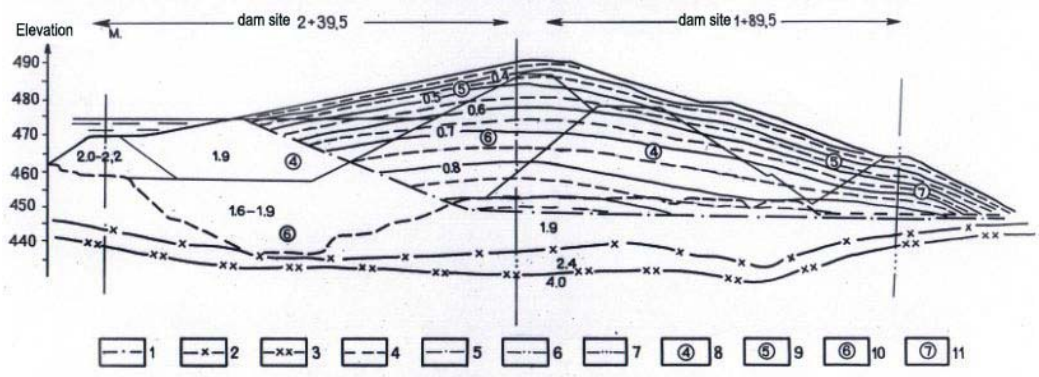

Fig. 4. The distribution of values in the body $\mathbf{E_g}$, 10^3kg/m^2 Lair dam. E_g=1.9; E_g=0.7; etc.

Figures 2-4 are the final data on the distribution of the parameters V_p, μ, E_g river bed in the body and den Dam, which are then used to calculate seismic structures.

Such work has been done for the riverbed hydroelectric dam.

CONCLUSIONS

Based on the processing and analysis of materials on recent tectonics and seismic engineering materials revealed that in an area of hydropower facilities Kapchagai forecast strong ground shaking is less than 8 points on the MSK-64 scale.

For the calculation of seismic objects waterfront Kapchagai HPP experimental distribution of Vp in the dam body and on this basis calculated the values μ and Eg. In calculating the river bed and den dams were considered the experimental data. The calculation was carried out for different levels of water content - NEC (retaining regulatory levels) according to standard procedure and the method of wave theory.

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Резюме

Қапшағай СЭС ғимараттары мен имараттарына қатысты жасалған күрделі ғылыми зерттеу жұмыстардың негізінде, сай бөгеті имаратының нақты динамикалық (физика-механикалық) сипаттамалары зерттеліп анықталды.

Резюме

В результате проведенного объемного научного исследования зданий и сооружений Капчагайской ГЭС, были исследованы и определены точные динамические (физико-механические) характеристики логовой плотины.

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METHODS OF ANALYSIS OF ACCIDENTS AT PRODUCTION

Industrial accidents should be considered as a signal on unsatisfactory condition of preventive measures of traumatism on this or other vessel, or industrial place. Investigation materials and accidents report data allow to judge about the condition of labor safety and becomes a basis for development and implementation measures on activation of accident prevention.

Research and analysis of industrial traumatism is made based on investigation material, and also using monographic, statistic, topographic and economical methods.

The most precise and exhaustive presentation about reasons of accidents occurrence gives monographic method of analysis. Monographic method is used for research of technological process, machinery, and other types of equipment; organization of working places, condition of air environment, lightning and other types of industrial condition on vessel, upload and unload platforms, vessel repair platforms, means of personal protection and its implementation.

The target of this method is: reveal of main circumstances, subjective and objective reasons of separate dangerous situation, specific accident or research of conditions of technological operation implementation. The method allows establishing reasons labor protection requirements breach in specific industrial condition.

The principle of monographic analysis is the definition of circumstances, unfavorable factors and other indexes, characterizing industrial condition or dangerous situation in its different stages. It is carried out on the basis of work place inspection results, and also learning of labor organization, technical documentation and other sources of information.

After clarification of all circumstances, accompanying dangerous situation origin and abnormally high level of industrial damages, reoccurs consequence of events and assesses the level of unfavorable factor occurrence, e.g. builds logical model of reason connections.

Statistic method represents totality of methods based on targeted acquisition, accumulation and processing of information on cases of industrial traumatism and professional deceases with further calculation of statistic indexes. The target of this method is more exhaustive learning of characteristic reasons of industrial traumatism and professional deceases, revealing of sources of danger and harm and development of preventive measures system.

The main sources of statistic information are taken from companies' report data and materials of investigation. It is well known that primary statistic data are separate facts reflecting only some sides of work conditions. In order to get conclusions on primary and repeating accidents and professional deceases on the basis of available information and consequently to have basis for development of effective measures for prevention, statistic analysis is used.

Usually for analysis of traumatic cases the dynamic method comparison of traumatic cases quantities of one economical sphere with other, and in sphere organization is compared with another, in organization departments, places and separate technological processes of the same period are compared. Such comparison of statistic data allows establishing spheres of economy, organization, department and processes with more unfavorable condition safety measures.

Statistic method of analysis has essential meaning for operational work on traumatism reduction. It gives a possibility to reveal unfavorable equipment, processes, work places, organizations and economic spheres from safety measures point of view.

Statistic analysis of traumatism must be used widely not only by safety techniques services but by all productive services of organization, head committees and ministries.

Topographic method of learning of traumatism is in learning of reasons of accidents according to places it happened. The principle of the method is not the repeat but its topography although not in same condition of their origin.

The meaning of topographic analysis method is in following. On a plan of department where conditionally all equipment and working places are marked, systematically all accidents are registered. The place, where the accident is happened is photo shoot, which makes easy investigation of accident reasons.

Accumulation of conditional marks about accidents on separate places (aggregates, equipment etc) will show where exactly and for which period (month, quarter, half year, and year) traumatism cases increased.

The weak side of this method is: it doesn't reveal potential danger, and applicable only in those cases when material on traumatism quantitatively essentially big. It is widely applied in auto inspection.

The main advantage of topographic analysis method is in its visual. It gives the opportunity to establish a place where accidents happen more often, however do not reveal circumstances and reasons of traumatism.

On the basis of topographic analysis departments of safety precautions must inspect with heads of departments and trade union committee's condition of safety precaution on unfavorable places, make deep analysis of traumatism reasons. All these will serve as initial data for development of specific organizational and technical works on accident prevention.

Topographic method of analysis is suitable for department administration and also departments of safety precautions. For this it is not obligatory to conduct such analysis every day. It is enough to apply it in unfavorable places and productions.

Economic method is in definition of economic damage from traumatism to clarify economic cost effectiveness for development of labor protection implementation. However this method does not allow revealing reasons of traumatism and it is considered as additional.

Material loss (consequences) caused to society due to disablement of employee in connection with trauma are made up of following costs and losses:

C1 – payment to a victim according to disability certificate

C2 - pension rate, defined to a victim in connection with trauma

C3 – the same for close relatives of a victim in connection with trauma

C4 – payment of benefits on temporary transfer of employees to another work due to trauma

C5 – compensation of loss to employees due to partial disability

C6 – cost of organizations for professional preparation of workers accepted instead of gone ones due to trauma

C7 – other losses, which mainly are not taken into account, although they can be essential.

$$M_l = C1 + C2 + C3 + C4 + C5 + C6 + C7 \quad (1)$$

Consolidated calculation of general material losses resulting from before mentioned formula is defined from dependence:

$$M_l = Д_В \cdot З \cdot j \quad (2)$$

where Дв – losses of working time of victims with ability loss for one or more working days, whose temporary disability of finished in reporting period (for inspected period of time);

З – average daytime salary of one worker;

J – Coefficient which considers all elements of material costs (payments according to disability certificates, pension etc) in respect to salary (j=1,5,2,0).

Usage of any method does not exclude a possibility of application of other methods of analysis of industrial traumatism.

More full and objective results are given by complex methods combining several of abovementioned methods.

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Резюме

В статье рассматриваются основные методы анализа несчастных случаев и производственных травм. Материалы расследований и отчетные данные о несчастных случаях позволяют судить о состоянии безопасности труда и служат основанием для разработки и осуществлении мероприятий по активизации профилактической работы по предупреждению травматизма.

Summary

The article reviews the main methods of analysis of accidents and injuries. Investigation materials and accidents report data allow to judge about the condition of labor safety and becomes a basis for development and implementation measures on activation of accident prevention.

Research and analysis of industrial traumatism is made based on investigation material, and also using monographic, statistic, topographic and economical methods.

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MATHEMATICAL MODEL OF THE TWO – IMPELLENT ASYNCHRONOUS ELECTRIC DRIVE

Increasing production requirements to quality of industry processes, needs of introduction high technologies, cause a steady tendency of introduction in various branches of industrial and agricultural production with variable speed drive, including an alternating current (AC) multiengine drive.

Release of an AC variable speed drive grows annually, and makes 82-87 % from total amount of realized electric drives. Use of variable speed drives in a combination to systems of technological automatic equipment allows more flexibly, smoothly, dynamic, and the main thing also, is energetically to influence production more economically, to provide considerable decrease in power consumption.

The essence of modelling consists in replacement of real system, the machine or their separate elements by model which simulates all parameters, processes and characteristics of real system [1].

At mathematical modelling the model and the original are various by the physical nature, but can be described by the identical equations in a form. The mathematical model of controlled object is understood as equation system in the form of the algebraic or differential equations, inequalities, logic conditions, operators etc. reflecting essence the phenomenon, proceeding in object. The most important property of mathematical model is its pithiness, i.e. ability to reflect the most essential parties of studied object.

The mathematical model of the two-impellent asynchronous electric drive with synchronous rotation powered by frequency converters is presented by system of the differential equations:

$$
\begin{cases}
\dfrac{d\Delta\omega_1}{dt} = \dfrac{1}{\beta_1 T_{m1}} M_1 - \dfrac{1}{\beta_1 T_{m1}} M_{C1}; \\
\dfrac{dM_1}{dt} = \dfrac{\beta_1}{T_{e1}} \Delta\omega_{01} - \dfrac{\beta_1}{T_{e1}} \Delta\omega_1 - \dfrac{1}{T_{e1}} M_1; \\
\dfrac{d\Delta\omega_{01}}{dt} = \dfrac{k_{pch1}}{T_{pch1}} \Delta u_{rs1} - \dfrac{1}{T_{pch1}} \Delta\omega_{01}; \\
\dfrac{d\Delta u_{PC1}}{dt} = \dfrac{k_{rs1} k_{ors}}{\beta_2 T_{m2}} (\Delta M_2 - \Delta M_{C2}) - \dfrac{k_{rs1}(k_{ors} + k_{os1})}{\beta_2 T_{m2}} (\Delta M_1 - \Delta M_{C1}) \\
\qquad + \dfrac{\Delta u_{3.C.}}{T_{rs1}} - \left(\dfrac{k_{ors} + k_{os1}}{T_{rs1}} \right) \Delta\omega_1 + \dfrac{k_{ors}}{T_{rs1}} \Delta\omega_2; \\
\dfrac{d\Delta\omega_2}{dt} = \dfrac{1}{\beta_2 T_{m2}} M_2 - \dfrac{1}{\beta_2 T_{m2}} M_{C2}; \\
\dfrac{dM_2}{dt} = \dfrac{\beta_2}{T_{e2}} \Delta\omega_{02} - \dfrac{\beta_2}{T_{e2}} \Delta\omega_2 - \dfrac{1}{T_{e2}} M_2; \\
\dfrac{d\Delta\omega_{02}}{dt} = \dfrac{k_{pch2}}{T_{pch2}} \Delta u_{rs2} - \dfrac{1}{T_{pch2}} \Delta\omega_{02}; \\
\dfrac{d\Delta u_{PC2}}{dt} = \dfrac{k_{rs2} k_{ors}}{\beta_1 T_{m1}} (\Delta M_1 - \Delta M_{C1}) - \dfrac{k_{rs2}(k_{ors} + k_{os2})}{\beta_2 T_{m2}} (\Delta M_2 - \Delta M_{C2}) + \\
\qquad + \dfrac{\Delta u_{3.C.}}{T_{rs2}} - \left(\dfrac{k_{ors} + k_{os2}}{T_{rs2}} \right) \Delta\omega_2 + \dfrac{k_{ors}}{T_{rs2}} \Delta\omega_1,
\end{cases}
\tag{1}
$$

For synchronization of electric motors' angular rates is entered derivative feedback controlling a mismatch of speeds with coefficient k_{ors}.

The block sheme of the two-impellent asynchronous electric drive is shown in figure 1.

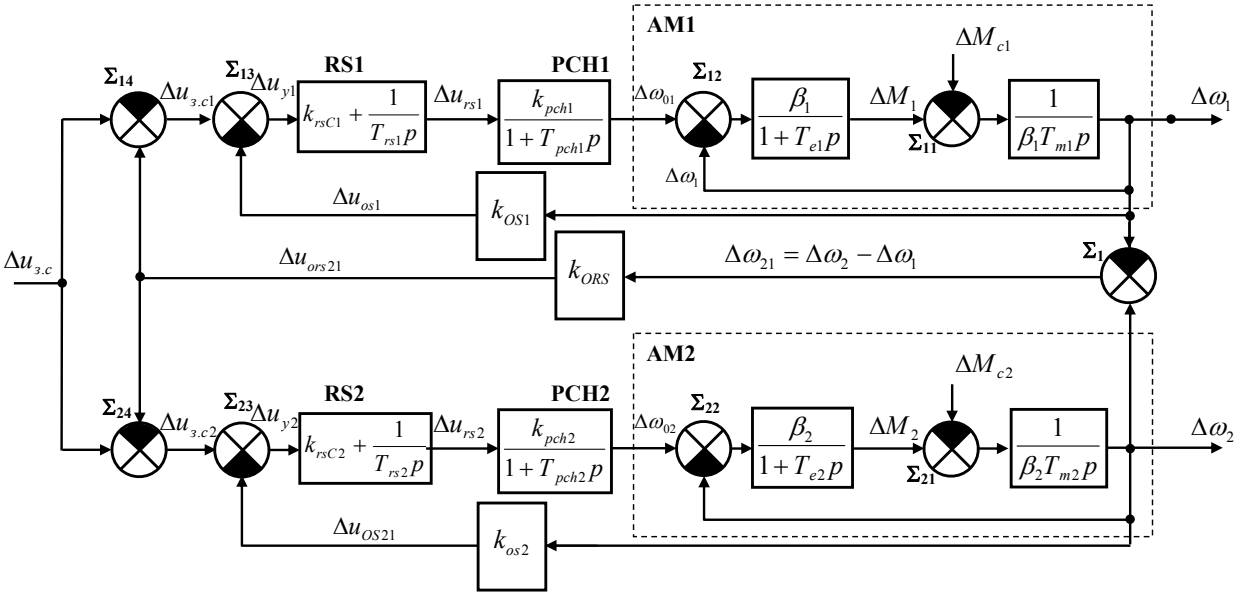

Figure 1. The block sheme of the two-implement electric drive powered by frequency converters

The two-impellent asynchronous electric drive powered by frequency converters consists of two asynchronous squirrel cage motors, two frequency converters and two regulators of speeds. Each asynchronous motor powered by frequency converters has own derivative feedback with coefficients k_{os1}, k_{os2}. For ensuring synchronous rotation of motors is entered additory derivative feedback for controlling a mismatch of speed (k_{ors}). Speeds of the first($\Delta\omega_1$) and second ($\Delta\omega_2$) motors are compared in the summation unit Σ_1. The output signal $\Delta u_{ors21} = k_{ors}\Delta\omega_{21}$ from the summation unit moves:

- in the device Σ_{14} where the given signal (Δu_{ors21}) is compared to a setting signal of control ($\Delta u_{з.c}$), then the setting signal of control ($\Delta u_{з.c1}$) is given on the first asynchronous motor powered by frequency converter of the two-implement electric drive;

- in the device Σ_{24} where the given signal (Δu_{ors21}) is compared to a setting signal of control ($\Delta u_{з.c}$), then the setting signal of control ($\Delta u_{з.c2}$) is given on the second asynchronous motor powered by frequency converter of the two-implement electric drive.

The stability of the two-implement electric drive with concrete parameters of asynchronous squirrel cage motor (type 4АНК315М4У3, power of motor 7,5 kW) [2] was searched by program MatLab [3]. The system's matrix with coefficients has a form:

$$A=\begin{vmatrix}
0 & 1/\beta_1 T_{m1} & 0 & 0 & 0 & 0 & 0 & 0 \\
-\beta_1/T_{e1} & -1/T_{e1} & \beta_1/T_{e1} & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & -1/T_{pch} & K_{pch1}/T_{pch1} & 0 & 0 & 0 & 0 \\
-\dfrac{k_{ors}+k_{os1}}{T_{rs1}} & -\dfrac{k_{rs1}(k_{ors}+k_{os1})}{\beta_1 T_{m1}} & 0 & 0 & \dfrac{k_{ors}}{T_{rs1}} & \dfrac{k_{rs1}k_{ors}}{\beta_2 T_{m2}} & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1/\beta_2 T_{m2} & 0 & 0 \\
0 & 0 & 0 & 0 & -\beta_2/T_{e2} & -1/T_{e2} & \beta_2/T_{e2} & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & -1/T_{pch2} & K_{pch2}/T_{pch2} \\
\dfrac{k_{ors}}{T_{rs2}} & \dfrac{k_{rs2}k_{ors}}{\beta_1 T_{m1}} & 0 & 0 & -\dfrac{k_{ors}+k_{os2}}{T_{rs2}} & -\dfrac{k_{rs2}(k_{ors}+k_{os2})}{\beta_2 T_{m2}} & 0 & 0
\end{vmatrix}$$

For convenience to do sums on Matlab the variables of system (1) is designated

$$\begin{aligned}
&\Delta\omega_1 = x(1); \quad \Delta M_{э1} = x(2); \quad \Delta\omega_{01} = x(3); \quad \Delta u_{PC1} = x(4); \\
&\Delta\omega_2 = x(5); \quad \Delta M_{э2} = x(6); \quad \Delta\omega_{02} = x(7); \quad \Delta u_{PC1} = x(8).
\end{aligned} \tag{3}$$

Calculation of the two-impellent asynchronous electric drive's stability with synchronous rotation, considering the above-stated matrix, is shown in figure 2

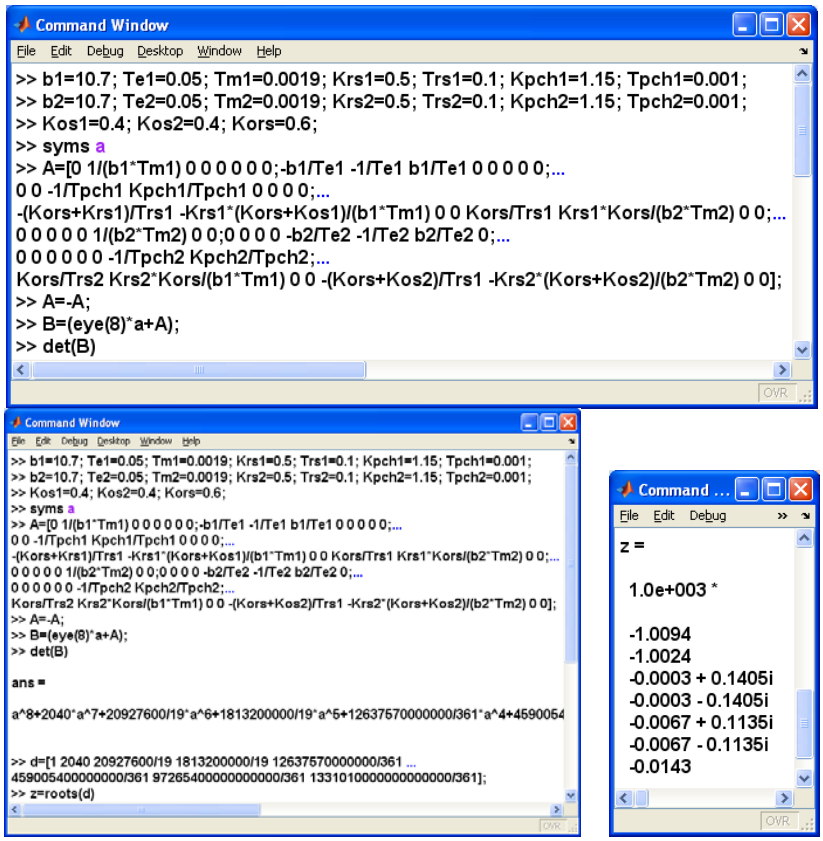

Figure 2. Program and results of the stability's calculation on Matlab

Apparently by results of the calculation, the valid components of matrix's roots are negative. It shows that at the chosen coefficients of derivative feedbacks k_{os1}, k_{os2} and coefficient of derivative feedback controlling a mismatch of speeds k_{ors}, and at the calculated parameters, the system of the two implement asynchronous electric drive powered by frequency converters is steady.

On the received system of the differential equations (1) in a software package of Matlab was made modeling of the two-impellent asynchronous electric drive powered by frequency converters. In the figure 3 is shown the program of transients analyses of the two-impellent electric drive at various static loadings.

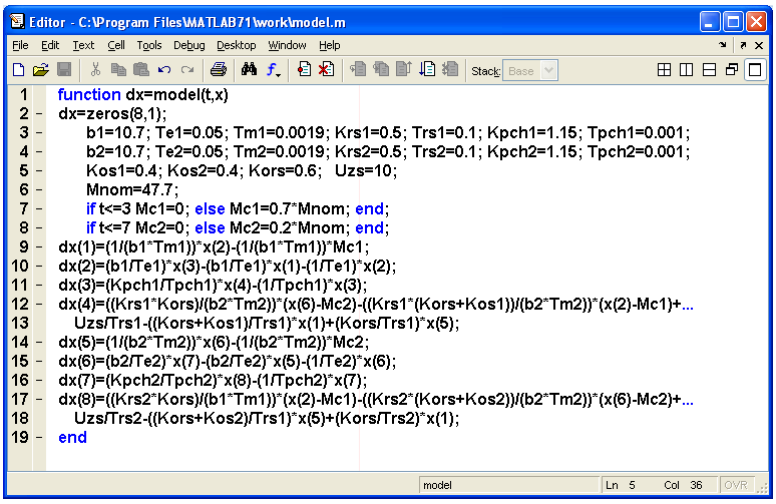

Figure 3. Transients analyses of the two-impellent at various static loadings.

For calculation of the differential equations in MatLab was used the solver “ode15s”. The solver “ode15s” is a multistep method of a variable order (from the 1st to the 5th, by default 5), using formulas of numerical differentiation.

In figure 4 are shown oscillograms of transient – response curves of the two impellent asynchronous electric drive powered by frequency converters at various loadings, according to the program of calculation in figure 2.

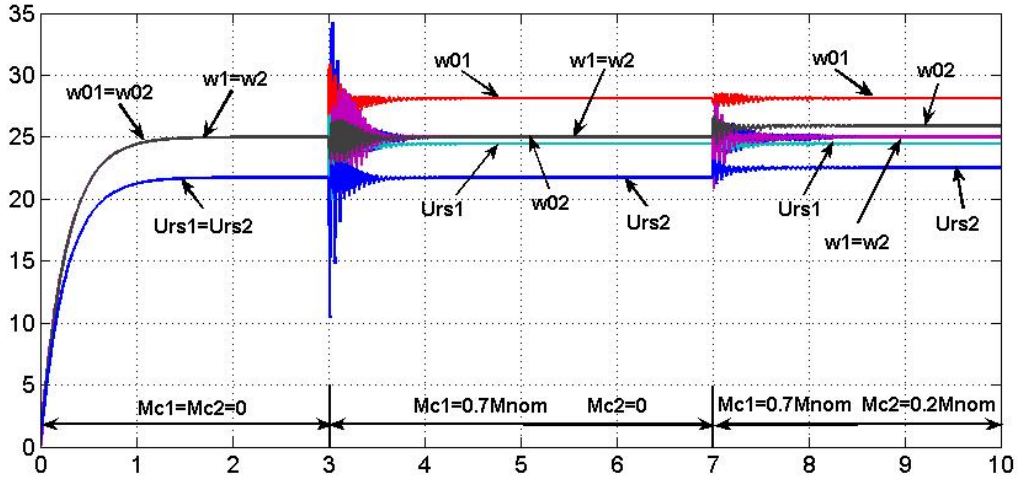

Figure 4. Oscillograms of transient – response curves of the two impellent asynchronous electric drive powered by frequency converters at various loadings.

Apparently from the received transients, at various values of static loadings on motors shafts, the system of the two-impellent asynchronous electric drive powered by frequency converters keeps synchronous rotation of electric motors with identical angular rates. At start-up of electric motors without loadings, according to figure, signals from exits of frequency converters (PCH1, 2), regulators of speeds RS1,2 are equal ($\Delta\omega_{01} = \Delta\omega_{02}$ and $\Delta u_{rs1} = \Delta u_{rs2}$), consequently speeds of motors also will be equal. At throwing on of a static load on a shaft of the first motor with value at the moment of time 3seconds, speeds of the first, second motors are leveled at the expense of giving raised signal from an exit of a regulator of speed RS1, respectively from an exit of the frequency converter PCH1 to AM1, with that providing synchronous rotation of electric motors of the two-impellent electric drive. At the moment of time 7 seconds occurs throwing on loadings on a shaft of the second motor $\Delta M_{c2} = 0.2M_{nom}$ (thus $\Delta M_{c1} = 0.7M_{nom}$ doesn't change). Apparently from figure, signals from RS2 and PCH2 raise, thereby is provided synchronous rotation of electric motors, and signals from RS1 and PCH1 remain invariable.

The result of experiments shows that the received system of the two-impellent asynchronous electric drive powered by frequency converters at various static loadings, supports synchronous rotation of electric motors.

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Резюме

Алынған өтпелі үрдістер осциллограммасына сәйкес, қозғалтқыш біліктеріндегі әртүрлі статикалық жүктемелер кезінде, жиілік түрлендіргіштері бар екіқозғалтқышты асинхронды электржетегі жүйесі қозғалтқыштардың бірдей бұрыштық жылдамдықпен синхронды айналуын қамтамасыз етеді. Суретте көрсетілгендей, қозғалтқыштарды жүктемесіз іске қосу кезінде ПЧ1-2 жиілік түрлендіргіштерінің, РС1-2 жылдамдық реттегіштерінің шығысындағы сигналдар тең ($\Delta\omega_{01} = \Delta\omega_{02}$ және $\Delta u_{PC1} = \Delta u_{PC2}$), сәйкесінше қозғалтқыштардың жылдамдықтары да бірдей болады $\Delta\omega_1 = \Delta\omega_2$. Бірінші қозғалтқыштың білігіне статикалық

жүктеме t=3с (бұл кезде $\Delta M_{c2} = 0$) уақыт моментінде $\Delta M_{c1} = 0.7M_{ном}$ мәнімен түскен кезде бірінші және екінші қозғалтқыштардың жылдамдықтары РС1 жылдамдық реттегішінің, сәйкесінше ПЧ1 жиілік реттегішінің АД1 асинхронды қозғалтқышына шығысынан жоғарылатылған сигналдың есебінен теңестіріледі, соның нәтижесінде екіқозғалтқышты электржетегі қозғалтқыштарының синхронды айналуы қамтамасыз етіледі. t=7с уақыт моментінде екінші қозғалтқыштың білігінде жүктеменің $\Delta M_{c2} = 0.2M_{ном}$ мәнімен түсуі орын алады (бұл кезде $\Delta M_{c1} = 0.7M_{пот}$ өзгеріссіз қалады). Бұл кезде, графиктен көрініп тұрғандай, РС2 және ПЧ2 шығысындағы сигналдар жоғарылап, қозғалтқыштардың синхронды айналуын қамтамасыз етеді, ал РС1 және ПЧ1 шығысындағы сигналдар өзгермейді. Берілген тәжірибелердің нәтижесі көрсеткендей, алынған жиілік түрлендіргіштері бар екіқозғалтқышты асинхронды электржетек жүйесі әртүрлі статикалық жүктемелер кезінде синхронды айналуды қамтамасыз етеді.

Резюме

Согласно полученной осциллограмме переходных процессов, при различных статических нагрузках на валу электродвигателей система двухдвигательного асинхронного электропривода с преобразователями частоты поддерживает синхронное вращение электродвигателей с одинаковыми угловыми скоростями. Во время пуска электродвигателей без нагрузок на валу, в соответствии с рисунком, сигналы с выходов преобразователей частоты ПЧ1-2, регуляторов скоростей РС1-2 равны ($\Delta\omega_{01} = \Delta\omega_{02}$ и $\Delta u_{PC1} = \Delta u_{PC2}$), соответственно скорости двигателей также будут равными $\Delta\omega_1 = \Delta\omega_2$. При набросе статической нагрузки на вал первого двигателя со значением $\Delta M_{c1} = 0.7M_{ном}$ в момент времени t=3с (при этом $\Delta M_{c2} = 0$), скорости первого и второго двигателей выравниваются за счет подачи повышенного сигнала с выхода регулятора скорости РС1, соответственно и с выхода преобразователя частоты ПЧ1 на АД1, тем самым обеспечивая синхронное вращение электродвигателей двухдвигательного электропривода. В момент времени t=7с происходит наброс нагрузки на валу второго двигателя $\Delta M_{c2} = 0.2M_{ном}$ (при этом $\Delta M_{c1} = 0.7M_{пот}$ не изменяется). При этом, как видно из графиков рисунка, сигналы с РС2 и ПЧ2 повышаются, тем самым обеспечивая синхронное вращение электродвигателей, а сигналы с РС1 и ПЧ1 остаются неизменными. Конечный результат данных экспериментов показывает, что полученная система двухдвигательного асинхронного электропривода с преобразователями частоты при различных статических нагрузках поддерживает синхронное вращение электродвигателей.

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UDC 620.22

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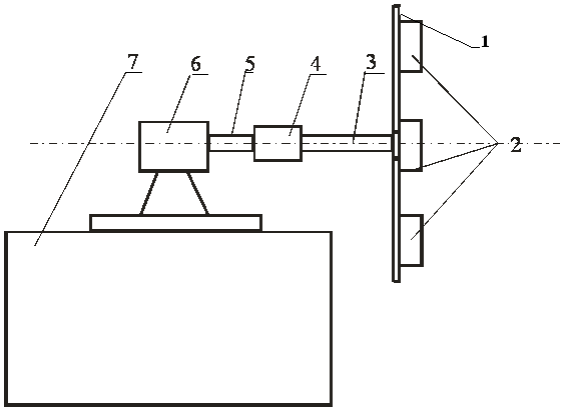
TECHNIQUE OF RESEARCHES VLIYANIKH OF MECHANICAL IMPACTS ON FORMATION OF STRUCTURE OF CONSTRUCTIONAL MATERIALS IN THE COURSE OF CRYSTALLIZATION

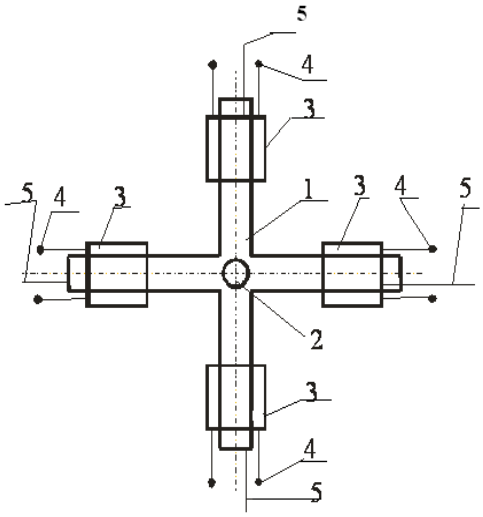
For research of possible influence of forces on formation of structure and mechanical properties of aluminum alloy AD31 in the course of crystallization the experimental installation which scheme is provided on drawing 1 was designed.

It consists of a centrifuge (1) on which blades 4 containers (2) are fixed. The shaft (3) through a variator of speeds (4) transfers rotations of a target shaft (5) electric motors (6) fixed on the basis of (7), a centrifuge (1). The variator of speeds allows бесступенчато to regulate speed of rotation of blades.

On drawing 2 more detailed scheme of a centrifuge is provided. It has four lobes crosspiece (1) with a landing opening (2).



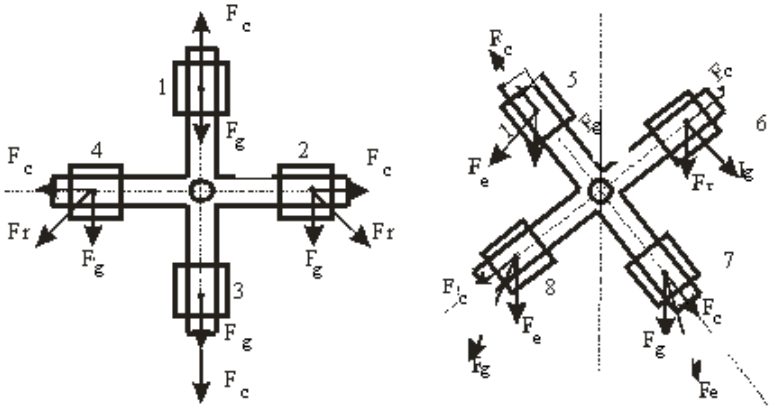
Drawing 1. Installation scheme



Drawing 2. Centrifuge scheme

For research of influence of gravitation and temperature at crystallization of an alloy of each blade the container (3) which represents the ceramic case with the spiral reeled up on it from нихрома and contacts (4) for connection of a regulator of temperatures is fixed. In the ceramic cylinder the ampoule with an aluminum alloy is located. Measurement of temperature is conducted by thermocouples 5.

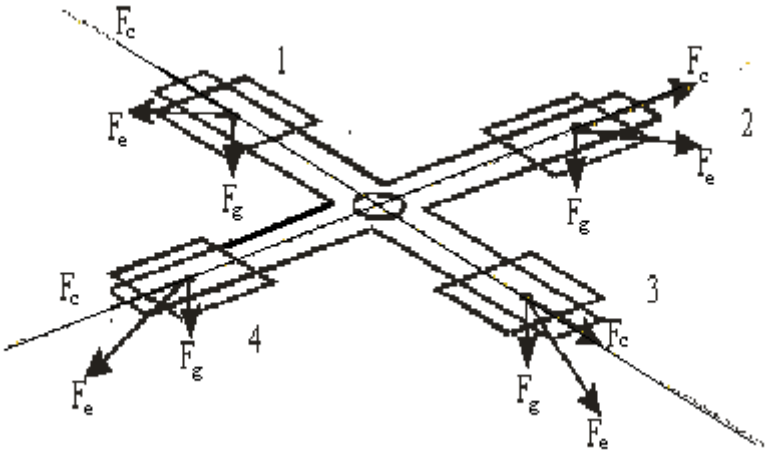
Before the beginning of test it is carried out it is sharp identical on weight with accuracy of ± 5 mg of preparations from an aluminum alloy which then are located in a special ampoule. Through contacts (4) moves necessary for melting and an overheat расплава tension on electroheating elements. Control of temperature is carried out the hromel-aluminum thermocouples (5). After heating to necessary temperature contacts (4) were disconnected from a current source, and the thermocouple from the measuring device, the electric motor (6) and crystallization of an alloy turned on proceeded under the influence of a variable (gradually decreasing) temperature and the variable resultant force operating on расплав. It is explained by the scheme of action of forces given on drawing 3.



Drawing 3. Scheme of forces

Thus, 3 schemes given on drawing give evident idea of change equally effective on absolute size and the direction. Tests with use of a centrifuge allow to carry out researches of influence of variable forces and temperatures on formation of structure and mechanical properties. Specific conditions of crystallization of an alloy affect heredity of a constructional material that is reflected in its physicomechanical properties.

Along with tests at rotation on a centrifuge in the vertical plane, similar tests at centrifuge rotation in the horizontal plane were carried out. Such experiences allowed to reveal distinctions in the hereditary features formed at a variable and constant loading. For the best perception is higher than the told we will consider the scheme of the forces operating on a studied material at rotation in the horizontal plane. The scheme is shown in drawing 4.



Drawing 4. The scheme of forces at centrifuge rotation in the horizontal plane

From drawing follows that at any position of blades of a centrifuge gravity of F_g, centrifugal force of F_c and equally effective F_e lie in one vertical plane passing through its axial line. At invariable speed of rotation of blades of a centrifuge the size and the direction of equally effective force remain constants. The gravitational component can't change in the course of test. A variable can be only centrifugal force which in turn depends on linear speed and is connected with centrifugal acceleration by the equation

$$a_c = V^2/r \qquad (1)$$

Thus, for the purpose of identification of influence of thermomechanical factors on structure and properties of aluminum alloy AD31 it is obviously possible to carry out tests under three conditions:
- crystallization and alloy cooling in normal conditions without mechanical influence;
- crystallization and alloy cooling in the conditions of constant loading (centrifuge rotation in the horizontal plane with constant speed);
- crystallization and alloy cooling at a variable in the direction and size to loading (centrifuge rotation in the vertical plane with constant speed). Let's notice that in all three cases experiences were carried out at identical speed of cooling. It was provided with that crystallization and cooling were carried out in the same containers. At carrying out tests in normal conditions the centrifuge wasn't actuated and crystallization with the subsequent cooling proceeded without influence of mechanical loading.

Samples were investigated after three various conditions of crystallization about what it is told above. But in all three cases of cooling melt it was conducted in identical containers. After crystallization of casting were exposed to aging within ~150 hours. Heat treatment – homogenization was the subsequent operation. Casting heated up in the muffle furnace to temperature 450 ^oC and after the 8th sentry of endurance were cooled with the furnace. Then from casting samples for mechanical tests prepared.

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Резюме

АД31 алюминий қорытпасын балқыту, кристаллдандыру және суыту гравитацияның механикалық қасиеттерге және құрылымға мүмкін әсерін зерттеу мақсатымен құрастырылған центрифуганың білекшелерінде бекітілген арнайы контейнерлерде жүргізуге мүмкіндік беретін ерекше тәсіл сыналып, қолданылды.

Резюме

Опробована и использована оригинальная методика, позволяющая проводить плавление, кристаллизацию и охлаждение сплава в специальных контейнерах, закрепленных на лопастях центрифуги, которая дает возможность исследовать возможное интегральное воздействия гравитации и центробежной силы на формирование структуры и механических свойств алюминиевого сплава АД31.

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UDC 378:001.895

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DEVELOPMENT OF ELECTRONIC EDUCATIONAL RESOURCES FOR IT- SPECIALTIES AT DISTANCE EDUCATIONAL TECHNOLOGY

Due to dynamically changing situation on a modern labour-market the considerable part of workers has a need for obtaining new professional skills, knowledge and abilities, and one of the most demanded directions is specialties connected with computer technologies. In the government education development program of the Republic of Kazakhstan for 2011-2020[1] electronic education is positioned as one of ten priority directions of education development. The education organization, assuming introduction of distance educational technology (DET), faces need of the solution of the following problems [2]:

- development or acquisition of information system DET;
- creation of an electronic resource of educational and methodical materials;
- education, involved in the DET;
- material support.

Development of a full-fledged electronic educational resource (the electronic textbook) is one of the fundamental problems of distance technology of education. According to working curricula of TARSU 66 disciplines are consolidated to computer systems department. (taking into account training languages of 132 disciplines). In this regard, there was a task before the faculty to complete all educational and methodical material in the form of the electronic educational course (EEC) on all disciplines. The main requirements to electronic resources are stated in GOST 7.83-2001 "Electronic edition" [2,3]. Considering that at an initial stage of introduction of DET it was necessary to develop electronic textbooks in a large number on considerable number of disciplines in short terms, the program of the automated process of receiving an electronic educational course "CONTENT" corresponding above to specified GOST 7.83-2001 was developed by the sector of educational and methodical materials of CDE. CONTENT represents the program cover supporting the international standards of information products of educational appointment for automated designing of electronic manuals from available materials on structure set by the user. CONTENT is figured on users who

have no time or opportunity to master all knowledge of the web master profession and is intended for fast creation of the electronic manuals using the web interface. Possibility of filling the modules by supervising blocks, allows to create the interactive electronic training, supervising and combined manuals. CONTENT allows to create quickly electronic courses on the basis of available sample interfaces and not less quickly to change appearance of the created manual.

In the presence of initial materials creation process of the electronic module by means of CONTENT happens in three stages:

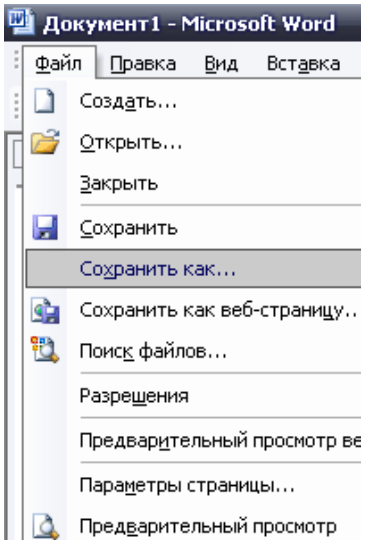
1) project creation
2) material addition
3) textbook assembly.

All that is required at creation of an electronic training course - a source text of the textbook in the text editor (MS Word), transformed further in the HTML file [3]. Thus, preparation of a material requires only knowledge of the MS Word editor. Besides, you can use already available material created in any other program which is possible for transforming to a HTML format available means.

Figure 1

At first it is necessary to define future site on a disk of the created manual. To load into the program a ready material in a format (.doc Word) step by step do the following actions:

Figure 2



1) Let's open already ready syllabus in the format ".doc", ".doc" is a typical extension of files of the “MS WORD” software product.

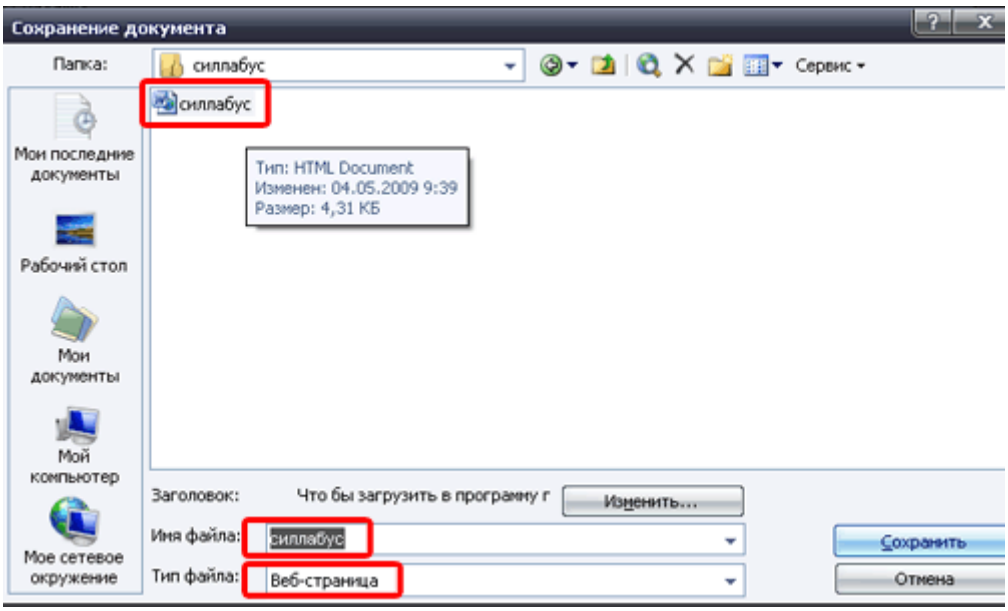
2) On the menu panel that is at the top of a window we click with the left button of a mouse the word "File".

3) The context menu of the program will open. In the menu we select the "Save as …" item as shown in figure 1.

4) Further after we selected the "Save as …" item the dialog box of saving of the file will open, an example in figure 2.

In a dialog box as in figure 2 we specify a way to our CONTENT, namely that material which we want to load in our case it will be "syllabus”. Then we set "File type" "Web page". I accent: that "The file name" has to correspond to the name of the file already attached in the program, in this case it has to be "syllabus". And pressing the "Save" button will be final action in entering the material to CONTENT.

Figure 3



All files of the textbook will be placed in earlier chosen place on a disk. On the pages of an electronic training course created with use of CONTENT, it is possible to place any kind of information (audio, video, graphics, animation and others), supported by modern Internet. For preparation of illustrations you can use any graphic editor, and for preparation of multimedia files you can use any program intended for this purpose, both specialized and regular which is included in the delivery package of Windows.

CONTENT allows to carry out import/export of manuals in the international format of information products for educational purpose of IMS Content Packaging. The CONTENT 2.1 version supports some elements of the description standard of DublinCore information products. CONTENT is the independent component entering into a complex of software for support and realization of distance learning, including also program cover STSN. STSN represents a universal network program cover for the organization of educational process and creation of educational and methodical modules with use of network technologies.

For today due to the offered program and efforts of the faculty 93% of disciplines are provided with electronic resources. Educational cases are prepared and exposed in the Internet by the beginning of an academic year. Training materials are available only for students, who received login and the password in the Center of Distance Education [4]. Within creation of the information system (IS) of distance educational technologies the automated control system of education "Tamos University Suite" is successfully introduced by the center which includes also information system the DET.

The automated control system for education "Tamos University Suite" (ASUO TUS) carries out all functions of office registrar for providing management of the educational process based on credit technology in HIGHER EDUCATION INSTITUTIONS of the Republic of Kazakhstan.

Table 1. **Electronic educational courses of "Computer Systems" department**

"Computer Systems" department				
№	Specialties	Students contingent	Quantity of disciplines by curriculum	Percentage indicators ЭУК
1	5В060200 - Informatics	65	36	93%
2	5В070300 - Information systems	174	38	95%
3	5В070400 - Computer facilities and software	88	37	92%
Total:		327	111	**93%**

Additionally integrated system of distance education WebPROFESSOR allows to train students, using a uniform database of system, and as the communication environment the Internet/the Intranet. This system provides all cycle of formation of High school education.

On introductory studies work seminars with ACST TUS are hold for students. Employees of CDE give out to each student individual login (user name) and the password for formation of the mailbox on the search server. E-mail address of CDE – http://cde.tarsu.kz/. On this e-mail address students send messages and results of the independent work for the current and intermediate control of knowledge.

The teacher carries out consultation distantly, through a forum and/or a chat, or at the request of students for internal consultation on the set subject of a course to EUK. The intermediate assessment of students' knowledge is carried out by teachers with ACST TUS use, both distantly through the Internet, and contactly in a tutorial class. Intermediate control of knowledge by the course termination is done internally, at an obligatory appearance of the student in the university. Testing is held with participation of representatives from CDE and the department of education quality monitoring, according to the approved schedule of examinations. The final assessment of knowledge of a course is entered in the total sheet.

The student can receive an electronic educational case on all disciplines, according to the written individual curriculum, written down on CD or the DVD carrier in CDE, and also to copy on the personal computer through an educational site of CDE of TARSU, having entered into system under the login and the password.

LITERATURE:

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Резюме

Қашықтықтан оқыту технологиясының іргелі мәселелерінің бірі компьютермен байланысты мамандықтар үшін толыққанды электрондық оқу ресурстарын (электрондық оқулық) өңдеу қарастырылған. «CONTENT» электронды оқу курсын автоматтандыру үрдісін құрудың бағдарламасы ұсынылған

Резюме

Рассматривается одна из фундаментальных задач дистанционной технологии обучения разработка полноценного электронного учебного ресурса (электронного учебника) для специальностей связанных с компьютерными технологиями. Предложена программа автоматизированного процесса получения электронного учебного курса «CONTENT»

Taraz state university named after M.K. Dulaty *Received 05.12.2012*

S.S. Uderbaev

ABOUT NEW EFFECTIVE METHOD OF MINERAL BINDING AGENT ADDITIONAL ACTIVATION

It is well-known that long keeping of binding agents in storehouses especially in unspecialized (unequipped) ones may lead to the loss of initial activity of binding agents.

Besides, in construction practice, for cement economy, its part is changed by active mineral additive. In this case additives are often of low activity, i.e inert, for example, some ashes of heating plant are inert.

Consequently it is necessary to restore initial activity of binding agents or its mixture with inert additives. To increase activity in this case we use different methods: repeated grinding using chemical additives in hardening system and others. But these methods of activation are not always effective.

We are the first in the construction practice to use the new method of binding agent activation. Before experimenting the idea to create principle of binding agent activation has appeared and realization of this principle depended on working out the method, mechanism for carrying out. It resulted in original systematic basis of the scientific experimental research. In the result the research was built according to the following logical line: 1) idea; 2) principle, 3) way; 4) mechanism.

The idea lies in using possibility of binding agent polarization under effect of electric field for additional activation of binding agents.

The ides became real owing to the realization of the following principal: additional activation effect may be achieved by simultaneous influence of two factors: electric field going through liquid phase and the process of pounding. The principal was called "principal of mechanical electric polarization (MEP) activation".

In virtue of experimental results of given principal examination the concrete method of activation has been worked out with the help of combination of two operations (the process of grinding & electric polarization) inside spherical mill.

For activation method realization the spherical mill, its construction is made in the following way: the shredding drum body is made like a through horizontal cylinder from dielectric material; outside the cylinder there are vertical walls which are put because of the shall vertical wall with the shell are combined as if intact construction.

Effectiveness of additional activation method in the given construction of the mill is achieved because of absolute potential opening of electric nature of binding agents, i.e. in increasing degree of polarization which is assisted by simultaneous mechanical pounding.

In the first table you can see data of cement experimenting, activated by the given method.

Table 1. **Influence of additional activation of golden cement binding agent to its durability**

№	Structure of astringents	The type of electric field	Water & solid reference	Time of wet pounding/ min	Voltage	Durability limit While compressing kg/sm ^{2} in 7 days
1.	Cement: Ashes mass 60:40%	Without electric field	0,5	10	-	90
2.	---/---	Alternating current	0,5	10	20	114
3.	----/----	----/-----	0,5	10	30	124
4.	-----/----	Direct current	0,5	10	25	156
5.	-----/----	-----/----	0,5	10	30	122
6.	-----/----	-----/----	0,5	10	35	118

It is seen from the table №1 that durability of binding agents increases to 70-80% comparing with durability of binding agent without electric processing. In electric field of direct current polarization of binding agents is more effective than of alternating current.

One of the reasons of increasing durability while activating is decreasing of electrically kinetical potential (table 2). Indexes were fixed with the help electrophorere method.

Table 2. **Measuring of electrically kinetical potential**

№	Structure %	Activation type	Time in seconds	Potential mB
1.	Cemend: ashes taking away	Without activation	41,3	- 42,2
2.	Cement: ashes taking away	Wet grinding	54,4	- 32
3.	Cement: ashes taking away	MEP	57,9	- 30,1

Note: Given in the table 1and 2 indexes of binding agent content are taken after chemical additions.

Table 2 shows that MEP activation potential decreases from - 32 till - 30,1 mB. Processing time of coagulation decreased to 9 minutes.

While researching the influence of electrocoagulators to the activation process there were accepted additivies of chloride alkaline soil metals type. In this case activating ability of electrocoagulators is increasing according to lyotrope line.

Technically new method, mechanism and acknowledged structure of binding agents are recognized to be invention & granted a preliminary patent.

To explain mechanism of binding agent hardening after activation in the mill there have been held a complex of phisico - chemical experiments. The result of roentgen phase analysis is that creation of new phases takes place, but the degree of hydration alumine, content of portlacement which is separated under hydration.

Specimen activated by new method undergo carbonization comparing with control specimen.

Results of microscope analysis allows us to consider that hydrated products of cement after additional activation with the given method are modified and micro structure components take crystallographical forms.

CONCLUSION

Simultaneous influence of electric field to binding agents and mechanical pounding lead to high results, the reason is explained with the fact that combination of two types of effect opens effectively potential of electric nature of the substance.

Consequently taken positive results of experimental research reflect to the rightness of the chosen methodology through the logic line: idea, principal, method, mechanism. This method and mechanism are profitable economically in case when additional activation is necessary for kept binding agents. Results have been examined while making arbolit (cement wood) on the basis of golden cement binding agent. Rice is used for filling. The durability has increased to 4 MPA.

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Резюме

Жұмыста минеральды байланыстырғыш заттарды қосымша белсендірудің жаңа тиімді әдісі туралы мәліметтер келтірілген. Күлдіцементті байланыстырғыштың беріктігіне қосымша белсендірудің әсерін эксперименталдық өшлеулердің нәтижелері келтіріліген. Байланыстырғыштың беріктігінің өсуінің себебін электрокинетикалық потенциалдың мәнінің төмендуі арқылы дәлелденді.

Резюме

В работе приведены сведения о новом разработанном способе активации минеральных вяжущих веществ. Приведены результаты экспериментальных измерений по влиянию дополнительной активации на прочность золоцементного вяжущего. Установлено уменьшение значения электрокинетического потенциала объясняющая причину повышения прочности вяжущего.

Kyzylorda state university named after Korkyt-ata *Received 12.11.2012*

UDC 621.311.1

A.B.Bekbaev,T.K.Koyshiev, R.U.Koshelekov

AN ANALYTICAL ENERGY CHARACTERISTICS EVALUATION OF THE REFLECTED SUNLIGHT

We can calculate the reflected sunlight density at the current point of the aperture surface by sommation of flux contributions of each mirror. But we need a fast and accurate method for calculating the brightness distribution generated by a single heliostat. This problem consists in solving a double integral which can be defined either over the reflecting surface or over the solar disk or over the image plane. From this starting point, two basic types of methods have been developed for fields of focusing heliostats:

1. The first method, called "cone optics", comes to a direct numerical resolution of the double integral. It can yield accurate results if both the reflecting surface and the receiving surface have been divided into sufficiently small elements. This requirement leads to using important memory storage and computing time.[1]

2. The second method treats the density integral as a convolution of two probabilistic distributions. The value of the convolution product is estimated through a two- dimensional Hermite function expansion[2]. This method is convenient for taking into account guidance errors and for saving computing time when the heliostat field is large. But its accuracy is disputable for small or medium size systems.

We propose a new approach based on a direct analytical convolution of the principal image of a heliostat with the radiation intensity distribution.

We characterize the relative position of the sun at any time by the direction of the "principal" ray, coming from the center of the solar disk. We note S_0 the unit vector of this principal direction, oriented toward the center of the sun.

If heliostat guidance is perfect, the principal ray reflected by the center of a heliostat, M_0, reaches the receiving surface at its center, P_0. The unit vector of the reflected principal ray at M_0 is

$$U_0 = \frac{M_0P_0}{\|M_0P_0\|} \tag{1}$$

and the unit normal vector at M_0 is

$$n_0 = \frac{U_0 + S_0}{\|U_0 + S_0\|} \tag{2}$$

We define the image plane as the plane passing through P_0 and perpendicular to U_0. If the heliostat geometry is known, from n_0 we can calculate the terrestrial coordinates of the current point M, and of the unit normal vector at M, n. Then, we get the expression of the principal reflected ray at M

$$r = 2(S_0 \cdot n)n - S \tag{3}$$

The principal reflected ray coming from M intercepts the image plane at point P. As shown on Fig. 1, the intersection of the cone with the image plane can be assimilated to a circle of center P.

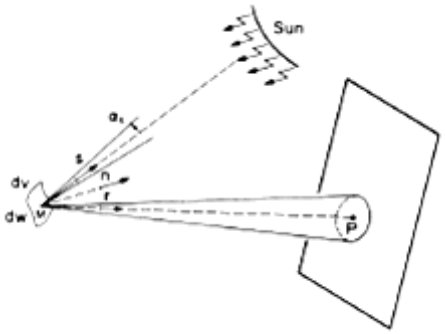

Fig. 1. Intersection of a cone of reflected rays with the image plane.

Any point Q inside the circle is the image of M by a mapping $T_{a\varphi}$ in which φ defines the azimuthal direction of MQ in the cone of reflected rays at M.

We can draw the relation between I_0(W • m ^{2} • sr^{-1}) and the normal flux density E_n(Wm^{-2}) at the considered time

$$E_n \int_0^a I(\alpha) \cdot 2\pi tg(1 + tg^2\alpha) d\alpha \tag{3}$$

In most power tower systems, the receiver aperture is either plane, spherical or cylindrical [3]. Calculation of flux density at the current point R of the receiving surface is performed after having projected R onto the image plane of each heliostat.

Expressions of the flux density produced by one heliostat. Let dS be an element of area in the reflecting surface, around M(υ, w). Let dS' be an element of area in the image plane, around Q(x, y), r is the unit vector of the principal reflected ray at M, U = (MQ/||MQ||) and α is the angle of direction MQ with direction MP.

The elementary flux density at Q produced by dS' depends on the value of α

$$\text{If } \alpha > \alpha_S,\ dF(x,y) = 0) \tag{4}$$

$$\text{If } 0 \le \alpha \le \alpha_S,\ dF\left(x,y) = \rho I(\alpha) \frac{dS \cos\theta \cos\beta}{d^2}\right) \tag{5}$$

where ρ is reflectivity of the mirror; θ is angle (S_0, n) = angle (n,r); β is angle (U_0, r); d is distance to the receiving surface.

Then, the elementary flux density at R(X, У) in the receiving plane is

$$\phi(X,Y) = \rho I dS \frac{\cos\theta \cos\theta'}{d^2} \tag{6}$$

$$\text{With } \theta' \approx angle(n', U_0)$$

$$\text{With } n' \equiv \begin{pmatrix} \sin\theta_c \\ 0 \\ \cos\theta_c \end{pmatrix}$$

The flux density at R due to one heliostat is

$$\phi(X,Y) = \iint_{\Sigma} \rho I(\alpha) \frac{\cos\theta\cos\theta'}{d^2} dS \tag{7}$$

Σ is the useful part of the reflecting surfase seen from Q.

It is made of all elements of area for wich $0 \le \alpha \le \alpha_S$

Since it is difficult to find an analytical expression of (7), we prefer to calculate the integral over the useful portion of the image plane Σ' relatively to Q.

$$\phi(X,Y) = \iint_{\Sigma} \rho I(\alpha) \frac{dS}{dS'} \frac{\cos\theta\cos\theta'}{d^2} dS' \tag{8}$$

The correspondence between Σ and Σ' can be expressed as follows

$$\Sigma' = T_0(\Sigma) \tag{9}$$

In expression (8) the term (dS/dS') can be interpreted as the inverse of the Jacobian $J_{\alpha\varphi\upsilon w}$ of $T_{\alpha\varphi}$ calculated at M(υ, w). We can define $C_{\alpha\varphi\upsilon w}$ such that

$$\text{If } \alpha > \alpha_S \quad C_{\alpha\varphi\upsilon w} = 0 \tag{10}$$

$$\text{If } 0 \le \alpha \le \alpha_S \quad C_{\alpha\varphi\upsilon w} = \frac{1}{J_{\alpha\varphi\upsilon w}} \tag{11}$$

Then we get a unique expression of ϕ(X, У) as an integral over the image plane

$$\phi(X,Y) = \rho \frac{\cos\theta\cos\theta'}{d^2} \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} I(\alpha) C_{\alpha\varphi xy} dxdy \tag{12}$$

A relatively good simplification of (12) is possible since α_S, is a small angle. The image of the mirror by $T_{\alpha\varphi}$ is very similar to the image by T_0 translated of vector

$$t = \begin{pmatrix} \xi \\ \eta \end{pmatrix} \text{ with } \begin{matrix} \xi = d \cdot tg\alpha\cos\varphi \\ \eta = d \cdot tg\alpha\sin\varphi \end{matrix} \tag{13}$$

Then $C_{\alpha\varphi xy} \cong C_0(x-\xi, y-\eta)$ and from expression (12) we obtain

$$\phi(X,Y) = \rho \frac{\cos\theta\cos\theta'}{d^2} \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} \tag{14}$$

$$L(\xi,\eta) C_0(x-\xi, y-\eta) d\xi d\eta \tag{15}$$

With

$$\begin{cases} L(\xi,\eta) = I(\alpha) \\ \alpha = Arctg\left(\dfrac{\sqrt{(\xi^2+\eta^2}}{d}\right) \end{cases} \quad (16)$$

85,44	85,44	85,65	85,83	85,84	86,13	86,25	86,40	86,61	87,04	87,26	87,65	88,00	88,35
85,38	85,53	85,58	85,67	85,75	85,94	86,11	86,40	86,50	86,85	87,15	87,30	87,78	88,06
85,55	85,61	85,63	85,66	85,73	85,91	86,10	86,19	86,52	86,70	86,95	87,18	87,52	87,84
85,42	85,51	85,39	85,57	85,68	85,72	85,86	86,08	86,30	86,36	86,73	86,98	87,30	87,52
85,50	85,62	85,56	85,64	85,68	85,81	85,85	86,03	86,10	86,36	86,64	86,76	86,98	87,29
85,60	85,57	85,48	85,54	85,53	85,63	85,81	85,94	85,96	86,23	86,29	86,50	86,72	87,07
85,73	85,55	85,55	85,61	85,59	85,69	85,63	85,75	85,85	86,23	86,10	86,43	86,75	86,81
85,74	85,59	85,55	85,70	85,47	85,65	85,66	85,69	85,77	85,95	86,02	86,33	86,40	86,63
85,92	85,72	85,78	85,60	85,51	85,61	85,44	85,64	85,76	85,93	85,85	86,01	86,23	86,41
85,81	85,79	85,67	85,72	85,49	85,45	85,61	85,66	85,62	85,74	85,83	85,99	86,15	86,29
86,07	85,88	85,77	85,56	85,51	85,66	85,57	85,63	85,58	85,66	85,65	85,67	86,04	86,01
86,28	86,02	85,92	85,83	85,68	85,62	85,48	85,51	85,48	85,63	85,61	85,68	85,95	85,93
86,34	86,00	85,96	85,73	85,63	85,60	85,63	85,51	85,42	85,51	85,50	85,55	85,73	85,71
86,45	86,33	86,18	85,92	85,77	85,76	85,48	85,47	85,53	85,55	85,38	85,47	85,57	85,60

factor of concentration 86,05

Fig. 2. Table of concentration factors

The convolution of L and C_0 can also be defined with C_0 as the kernel

$$\phi(X,Y) = \rho\frac{\cos\theta\cos\theta'}{d^2}\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} L(x-\xi, y-\eta)C_0(\xi,\eta)d\xi d\eta \quad (17)$$

With

$$\begin{cases} L(x-\xi, y-\eta) = I(\alpha) \\ \alpha = Arctg\left(\dfrac{\sqrt{(x-\xi)^2+(y-\eta)^2}}{d}\right) \end{cases} \quad (18)$$

$C_0(\xi,\eta)$ can be interpreted as the geometrical concentration from the mirror to the principal image at point $T(\xi,\eta)$. In the case of Fig. 1, we get the table of concentration factors of Fig. 2, each concentration factor being attached to one element of area in the reflecting surface.

For a typical principal image, variations of $C_0(\xi,\eta)$ are not important. We can assimilate this function to a step function defined as follows

if $Q(\xi,\eta)$ belongs to the principal image, $C_0(\xi,\eta) = C$

if not, $C_0(\xi,\eta) = C$

The average concentration factor, C, and the limits of the principal image characterize the relative positions of the sun, the heliostat and the receiver at the considered time. Then, expression (17) can be rewritten

$$\phi(X,Y) = \rho\frac{\cos\theta\cos\theta'}{d^2}C\int\int_{JQ} I(\alpha)d\xi d\eta \quad (18)$$

With J_Q useful portion of the principal image for point Q(x,y)

$$R(\xi,\eta) \in J_Q \Leftrightarrow 0 \le \frac{\sqrt{(x-\xi)^2+(y-\eta)^2}}{d} \le \alpha_S \tag{19}$$

J_Q is the intersection of the principal image with the disc of center Q and radius d tg α_S .

In the case of square or rectangular reflecting surfaces, we simply characterize the principal image by projecting the four corners of the mirror onto the image plane. We then assume that heliostat edges are simply transformed into straight segments. This assumption is generally satisfactory but in a few cases, when the concentration factor is very high, the quadrilateral image obtained by this method is not convex, and we have to shift one of its corners.

If the geometry of the reflecting surface is more complicated, it is still possible to obtain the principal image by projecting a number of points of the mirror boundary onto the image plane. Then the principal image boundary can be considered polygonal and the following results can be applied.

For each point R(X, Y) of the receiving surface, we want to calculate

$$\phi(X,Y) = \rho \cos\theta \cos\theta' C\varphi \tag{20}$$

With

$$\varphi \int\int_{JQ} I(\alpha) d\xi d\eta \tag{21}$$

In the sequel, we show that integral (21) can be analytically solved if I(α) is represented. For measured sunshape distributions, integral (21) must be solved by numerical techniques.

The integration domain of I(α) can be rather complicated since it is bounded by arcs of circle and segments. But integral φ can always split up into simpler expressions which all resolve into a combination of two basic cases for which analytical expressions exist.

In the case of Fig. 3, the expression of the streaked area is

$$S_1 = \int_{\mu}^{R} 2\rho Ar\cos\left(\frac{\mu}{\rho}\right) d\rho \tag{22}$$

with R = d tg α_S and μ: distance from Q to the edge of the principal image ($0 \le \mu \le R$). By integration of (22) we get

$$S_1 = R^2 Ar\cos\frac{\mu}{R} - \mu\sqrt{R^2-\mu^2} \tag{23}$$

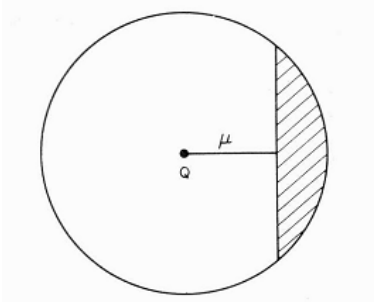

Fig. 3. Intersection of the apparent solar disk with one edge of the principal image.

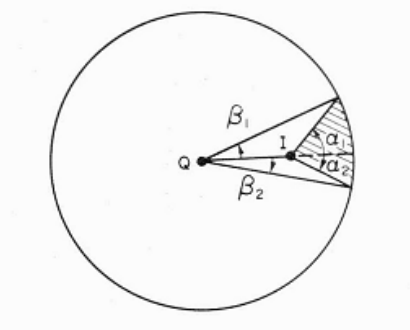

Fig. 4. Intersection of the apparent solar disk with one corner of the principal image.

And the integral of solar intensity over that surface is

$$\varphi_1 = \frac{I_0}{d^2}\left[S_1 - \frac{2\lambda}{R^4}\left[\frac{R^6}{6} Ar\cos\frac{\mu}{R} - \frac{\mu}{90}(3R^4 + 4R^2\mu^2 + 8\mu^4)\sqrt{R^2-\mu^2}\right]\right] \tag{24}$$

Now, if we want to solve a real case for which only one edge is intercepted by the circle (Q, d tg α_S) we must distinguish two possibilities:

If Q does not belong to the principal image, the flux density at Q is

$$\phi = \rho C \cos\theta \cos\theta' \varphi_1 \tag{25}$$

If Q lies inside the principal image,

$$\phi = \rho C \cos\theta \cos\theta' (\varphi_{\max} - \varphi_1) \tag{26}$$

With

$$\varphi_{\max} = \frac{I_0}{d^2}\pi R^2\left(1 - \frac{\lambda}{3}\right) \tag{27}$$

$$\varphi_{\max} = E_n$$

If more than one edge is intercepted by the circle, we have to determine whether or not the intersections lie inside the circle.

The integration area is represented on Fig. 4 we assume that

$$\begin{gathered} -\frac{\pi}{2} \le \alpha_1 \le \frac{\pi}{2} \\ -\frac{\pi}{2} \le \alpha_2 \le \frac{\pi}{2} \\ \alpha_2 < \alpha_2 \\ \nu = \|QI\| \\ \beta_i = \alpha_i - Ar\cos\left(\frac{\nu}{R}, \sin\alpha_i\right) \text{ for i=1,2} \end{gathered} \tag{28}$$

The expression of the streaked area is

$$S_2 = \int_{\nu}^{R}\left[\alpha_1 - Arc\sin\left(\frac{\nu}{\rho}\sin\alpha_1\right) - \alpha_2 + Arc\sin\left(\frac{\nu}{\rho}\sin\alpha_2\right)\right]\rho d\rho \tag{29}$$

and, by integration

$$S_2 = \frac{R}{2}\left[R(\beta_1 - \beta_2) - \mu(\sin\beta_1 - \sin\beta_2\right] \tag{30}$$

we note φ_2 the integral of solar radiation intensity over the streaked area.

$$\varphi_2 = \int_{\gamma}^{R}\left[\alpha_1 - Arc\sin\left(\frac{\gamma}{\rho}\sin\alpha_1\right) - \alpha_2 + Arc\sin\left(\frac{\gamma}{\rho}\sin\alpha_2\right)\right]I_0\left(1-\lambda\frac{\rho^4}{R^4}\right)\rho d\rho \tag{31}$$

And we obtain the analytical expression of φ_2 :

$$\varphi_2 = \frac{I_0}{d^2}\left[S_2 - \frac{\lambda}{R^4}(Q(\alpha_1) - Q(\alpha_2))\right] \tag{32}$$

With for i=1,2

$$Q(\alpha_i) = \frac{R^6}{6}\beta_i - \frac{\nu\sin\alpha_i}{90}\left[(3R^4 + 4R^2\nu^2\sin^2\alpha_i + 8\nu^4\sin^4\alpha_i)\sqrt{R^2 - \sin^2\alpha_i} - \right.$$
$$\left. - \nu^5\cos\alpha_i(15 - 20\cos^2\alpha_i + 8\cos^4\alpha_i)\right. \tag{33}$$

So far, we have assumed

$$-\frac{\pi}{2} \le \alpha_i \le \frac{\pi}{2} \text{ for i=1,2}$$

If real intersections are not of this type, we can still solve the problem by using expressions φ_2 and φ_1,. In the example of Fig. 5, Q is inside the principal image and $(\pi/2) \le \alpha_1 \le \pi$.

We then define $\alpha_1' = \alpha_1 - \pi$, which verifies $-\frac{\pi}{2} \le \alpha_1' \le 0$.

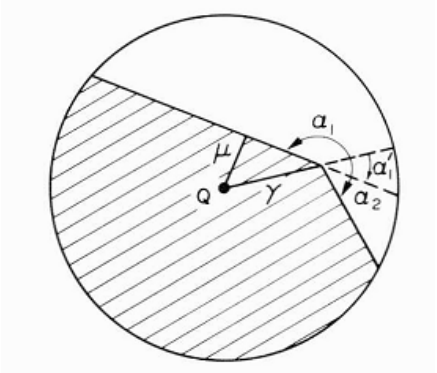

Fig. 5. A non trivial intersection configuration.

Expression φ_2 is applied to $(\mu, \alpha_1', \alpha_2)$ instead of $(\mu, \alpha_1, \alpha_2)$.

$$\phi = \rho C \cos\theta \cos\theta' (\varphi_{\max} - \varphi_1 - \varphi_2) \qquad (34)$$

An enumeration of all possible configurations would be tedious and useless since we have constructed an algorithm [4] which automatically classifies all intersections and calculates the appropriate combination of expressions φ_1, and φ_2

The use of analytical expressions and simple tests has considerably decreased the computation time necessary to simulate the flux produced by one heliostat.

On Fig. 6 we have reproduced a map of flux densities on an aperture surface 3 m x 3 m uniformly divided into 225 elementary cells. The input data are the same as for Figs. 1 and 2, and θ_C = 30°.

Maps of flux densities obtained by the cone optics technique depend on the size of elementary reflecting cells. They slowly converge to values close to the ones obtained by the analytical method.

For example, the previously considered mirror surface has to be divided into 100 x 100 elements in order to get the map of flux densities of Fig. 7 which is not too different from the map of Fig. 6.

The computing times are 2 sec for Fig. 6 and 54 sec for Fig. 7 on Pentium IV.

0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	1,13	2,82	3,88	4,22	4,49	4,32	2,38	0,73	0,02	0,00
0,00	0,00	0,00	0,67	4,19	8,67	12,35	14,76	15,78	14,34	9,91	5,41	2,07	0,30	0,00
0,00	0,13	2,62	7,51	13,84	19,94	24,66	27,48	25,82	20,30	13,33	7,24	2,85	0,46	0,00
0,06	1,59	5,41	11,27	18,41	25,05	29,97	31,41	28,21	21,98	14,19	7,27	2,48	0,21	0,00
0,26	2,14	5,89	11,31	17,86	23,91	27,96	27,91	23,98	18,21	11,13	4,65	0,76	0,00	0,00
0,20	1,71	4,72	9,00	13,81	17,02	17,31	15,71	12,52	8,02	3,00	0,05	0,00	0,00	0,00
0,02	0,69	2,38	4,68	5,92	5,61	5,31	4,69	3,11	0,97	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Fig. 6. Flux densities (kW m^{-2}) for a single heliostat.

0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,08	0,15	0,18	0,16	0,01	0,00	0,00
0,00	0,00	0,00	0,00	0,02	1,80	3,86	5,38	5,10	6,49	5,74	3,29	1,19	0,10	0,00
0,00	0,00	0,00	1,09	4,80	9,25	13,10	15,91	17,02	15,64	11,06	6,41	2,75	0,55	0,00
0,00	0,35	2,59	6,89	12,65	18,35	23,16	26,27	25,51	20,83	14,25	8,26	3,63	0,79	0,00
0,30	1,46	4,52	9,32	15,55	27,70	26,75	20,97	27,21	22,12	15,07	8,38	3,33	0,50	0,00
0,24	1,83	4,81	9,21	14,64	20,62	25,03	26,17	23,54	13,84	12,54	6,05	1,59	0,00	0,00
0,05	1,49	3,90	7,40	11,67	15,35	17,13	15,90	13,34	9,51	4,82	0,96	0,00	0,00	0,00
0,00	0,69	2,15	4,19	6,60	6,08	5,90	5,42	4,04	1,95	0,05	0,00	0,00	0,00	0,00
0,00	0,03	0,25	0,24	0,12	0,05	0,02	0,02	0,01	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Fig. 7. Flux densities computed by the cone optics technique

It can be observed that when applied to insufficiently small reflecting elements, the cone optics technique yields average values instead of local values and this fact tends to decrease high flux concentration values. However, this technique usually provides correct results when it is used to compute the total power received by the target.

Now, we want to get the global map of flux densities by calculating the contribution of all the heliostats and the shadow effects between them. For simplicity, we assimilate the shadow effect on each heliostat to a uniform decrease of its reflecting power. Of course this effect depends on the position of the sun, and we calculate the percentage of shaded area of each mirror by an analytical method [5].

0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,0	0,1	0,2	0,4	0,6	0,5	0,2	0,0	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,2	0,8	2,6	6,6	11,0	11,7	7,4	2,3	0,3	0,0	0,0	0,0	0,0
0,0	0,2	1,2	5,4	19,1	48,3	87,9	107,3	82,4	36,9	9,6	3,2	1,4	0,4	0,0
0,2	1,0	5,2	22,7	77,0	218,0	436,4	565,4	483,0	263,8	83,2	21,9	9,2	4,0	1,3
0,7	3,3	14,5	55,6	239,4	786,7	1572,1	2073,9	1699,3	941,0	355,4	76,1	24,1	9,7	3,5
1,8	6,8	25,4	108,6	595,4	1784,5	3909,2	4981,8	4179,5	1983,9	730,8	171,2	41,1	14,4	5,1
2,8	9,1	31,1	168,6	794,4	2300,7	4777,0	5614,1	5186,6	2657,9	916,7	215,5	48,3	15,6	5,1
2,9	8,8	27,3	138,8	659,1	1763,5	3806,2	4980,6	4320,2	2083,9	711,2	155,2	41,1	12,2	3,6
2,0	6,1	16,7	59,5	332,2	919,1	1703,0	2216,6	1786,7	938,9	321,7	85,3	25,0	6,6	1,6
0,6	2,6	6,8	17,2	77,8	273,0	516,3	632,6	517,8	279,5	108,7	35,9	9,9	2,0	0,4
0,0	0,2	1,0	2,7	8,1	36,0	87,5	121,1	106,3	62,9	27,5	9,0	2,2	0,5	0,1
0,0	0,0	0,0	0,0	0,2	1,8	6,7	11,9	12,2	8,1	3,5	1,2	0,4	0,1	0,0
0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,4	0,6	0,5	0,3	0,1	0,0	0,0	0,0
0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

Fig. 8. Flux densities for the collector field

0,0	0,0	0,0	0,0	0,6	1,4	2,2	2,3	1,6	0,4	0,0	0,0	0,0	0,0	0,0
0,0	0,0	0,2	1,3	4,3	9,0	13,8	15,2	13,8	8,6	1,5	0,0	0,0	0,0	0,0
0,0	0,1	1,3	6,9	18,0	39,7	64,0	74,3	69,3	89,0	21,9	8,6	0,3	0,0	0,0
0,0	0,9	6,3	20,3	67,7	145,3	198,9	212,6	187,8	138,9	72,7	26,6	5,1	1,5	0,3
0,3	3,2	15,1	54,4	185,3	345,5	571,1	673,2	330,4	331,3	180,0	61,2	18,0	5,0	2,1
1,4	7,2	31,1	144,5	365,9	448,1	1572,8	1880,0	1495,1	833,8	403,5	156,6	36,0	9,7	4,5
3,1	11,4	38,2	213,6	660,1	1681,0	3251,4	4171,8	3326,7	1702,5	635,1	233,8	63,1	15,8	6,3
3,8	13,6	77,8	256,2	622,2	2108,6	4353,0	5369,7	4653,2	2354,7	803,4	233,4	70,1	24,6	6,4
3,4	15,8	75,4	248,3	711,7	1754,3	3547,7	4665,7	3697,8	2061,8	683,7	190,0	55,6	16,4	5,2
2,0	12,4	49,2	176,3	444,3	1023,2	1847,5	2395,5	2016,9	1067,5	394,1	106,2	30,8	8,5	3,2
0,5	4,5	27,2	73,3	218,6	443,3	717,4	645,1	648,9	346,6	137,5	44,6	12,9	4,3	1,4
0,0	0,4	10,0	29,7	67,0	132,6	200,9	219,2	177,0	107,4	44,8	15,3	4,3	1,3	0,5
0,0	0,0	1,3	7,5	18,5	38,2	56,7	62,5	48,0	26,3	11,9	4,0	1,0	0,3	0,1
0,0	0,0	0,0	0,2	2,3	5,0	8,5	10,0	8,4	5,0	2,2	0,5	0,2	0,1	0,0
0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,5	0,7	0,3	0,0	0,0	0,0	0,0	0,0

Fig. 9. Flux densities for the collector field with guidance errors

The flux density map of Fig. 8 has been obtained for a cavity aperture 4 m x 4 m and for solar data of a winter day at 10 a.m. in the middle of Kazakhstan

$$\text{En}=0.76915 \quad \theta_i = 0.64258 \text{ rd} \quad \varphi_i = 0.67316 \text{ rd}$$

Total collected power $\approx$ 6 MW

A proper simulation of heliostat fields should also take into account guidance errors and imperfection of reflecting surfaces. On Fig. 9, we have simulated the heliostat field in the same condition as for Fig. 8 but with a uniformly distributed error for reflected rays between 0 and 3 mrd.

If the average divergence of reflected rays is $\in$ for a particular heliostat, the shift of its principal image on the image plane has the amplitude d tg$\in$. Guidance errors can therefore be simulated by random shifts of principal images proceeding from a random generation of divergence angles $\in_i$ according to a probabilistic law.

Simulation of guidance errors clearly shows that the sun spot on the recever tends to spread when precision decreases.

CONCLUSION

Description of the brightness distribution produced by a heliostat as a convolution integral is not just a technique constructed for faster calculation. It corresponds to the classical decomposition of light into its geometric and energetic features. In terms of technology, the energetic aspect is essentially external and the geometric aspect internal to the system. By external, we mean that radiation properties remain after reflection and concentration. The problem is how to convey and to transform energy with a sufficiently low rate of loss. This condition imposes technical constraints such as a limit distance between heliostats and the receiver, due to radiation divergence on the solar cone.

On the other hand, optical devices such as mirrors and lenses have been designed to modify some geometric properties of light. But they are not perfect, and not even perfectly adapted to their own purpose. For instance, focusing surfaces concentrate light on a point of their optical axis but their concentration power decreases when the target moves away from this axis. And the principal image of a heliostat mostly represents its intrinsic concentration limits.

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Резюме

Күндік «мұнара» жүйесіндегі концепциялық есеп беру мен осы шақ уақытындағы бақылау жүйесін, сонымен қатар тез қолданатын және нақты компьютерлік жүйедегі қабылдағыш ағын тығыздығының сараптап есептеуін қажет етеді. Классикалық «конитикалық оптика» және «Эрмиттің көпмүшесі» әдістерінің кейбір жылдамдық пен нақтылық шектеулері бар. Біз аналитикалық модель есебін құрастыра отырып күн жарығын гелиостатикалық көрсетілуіне бөлдік. (яғни «күн нүктесінің» белсенді бейнесі).

Резюме

Концепция, оценка и контроль в режиме реального времени солнечной "башенной" системы требуют использования быстрых и точных компьютерных программ для расчета распределения плотности потока на приемнике. Классические методы "конической оптики" и «многочлена Эрмита" имеют некоторые ограничения скорости и точности. Мы создали аналитическую модель для расчета сверки солнечного распределения яркости с основным изображением гелиостата (т.е. активный образ на "солнечную точку").

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DECOMPOSITION OF THE HEAT MODEL OF THE UNSTEADY NON-ISOTHERMAL LIQUID MOVEMENT IN THE PIPELINE

1. Introduction

ANSYS Fluent software contains the broad physical modeling capabilities needed to model flow, turbulence, heat transfer, and reactions for industrial applications ranging from air flow over an aircraft wing to combustion in a furnace, from bubble columns to oil platforms, from blood flow to semiconductor manufacturing, and from clean room design to wastewater treatment plants. Special models that give the software the ability to model in-cylinder combustion, aeroacoustics, turbomachinery, and multiphase systems have served to broaden its reach.

Modeling of the temperature interaction of the main pipeline with environment takes an important place in the issue of technological modes forecasting under the pipelines operation. That`s why one still pays quite much attention to the development of the oil transportation models in the main pipeline acceptable for on-line mode operation.

2. Research

Using of mathematical models in control devoted a lot of research, for example [1-4]. To create a process control fluid transport by pipeline is necessary to develop a thermal model of unsteady non-isothermal flow in a pipeline. In this case, unsteady non-isothermal liquid movement in the main pipelines should be considered as liquid-pipeline-soil system. Under this the model of the liquid flowing heat processes should presented as [5,6]:

$$
\begin{gathered}
\frac{\partial \rho \upsilon}{\partial t}+\frac{1}{s}\frac{\partial \rho \upsilon}{\partial z}=0 \\
\frac{\partial \rho \upsilon}{\partial t}+s\frac{\partial P}{\partial z}+\frac{1}{s}\frac{\partial \rho \upsilon^2}{\partial z}+\Delta P(v)+q\sin z=0 \\
c\frac{\partial \rho T}{\partial t}+\frac{1}{s}c\frac{\partial \rho \upsilon T}{\partial z}+q_1=0 \\
c_k\rho_k\omega_k\frac{\partial T_k}{\partial t}=F_1\alpha_1(T-T_k)-F_2\alpha_2(T_k-T_{гр}) \\
c_{гр}\rho_{гр}\omega_{гр}\frac{\partial T_{гр}}{\partial t}=\frac{\partial}{\partial x}\left(\alpha_{гр}\frac{\partial T_{гр}}{\partial x}\right)+\frac{\partial}{\partial y}\left(\alpha_{гр}\frac{\partial T_{гр}}{\partial y}\right)+q_2-q_3 \\
\Delta P(v)=\xi\rho\upsilon(\upsilon) \\
q_1=F_1\alpha_1(T-T_k) \\
q_2=F_2\alpha_2(T_k-T_{гр}) \\
q_3=F_3\alpha_3(T_{гр}-T_{воз})
\end{gathered}
\qquad (1)
$$

where: ρ, υ, p - density (kg/m^3), velocity (m/s), pressure ($\frac{n}{m^2}$) liquid correspondingly in the pipeline; S – cross section square (m^2) T_l, $T_к$, T_{soil} – correspondingly liquid temperature, pipeline wall temperature, soil temperature ($°C$), F_1, F_2 – heat exchange square (m^2) liquid-pipeline ($°C$), pipeline-soil; α_1 - heat exchange factor liquid -pipeline; α_2 - heat exchange factor pipeline-soil; $c_k\rho_k\omega_k$ - heat capacity, density, материала трубы reduced volume of the tube wall; $c_{soil}\rho_{soil}\omega_{soil}$ - heat capacity, soil density, reduced soil volume. λ_s - thermal conductivity of soil; T_{air} - environment temperature, q $\sin z$ - the drop conditioned with the pipeline height change, ξ - resistance.

The presented model (1) is referred to the nonlinear equation type in partial derivatives. The model realization is connected with specific difficulties which are determined with computing capacity of the used data processing machines.

That`s why the reduction methods for the indicated model is of great interest.

One should mentioned that it is the specialty of unsteady dynamic mode of the liquid-pipeline-soil system that the change speed for liquid variables (υ, ρ, T) is much higher that the soil temperature speed change (T_{soil})

The indicated preliminary proposition of the different-scale change in time for the liquid variable of the soil temperature can be the basis of the temporary model decomposition (1).

Under this we will use the small parameter method as the formal base for the procedures of the initial system reduction (1) to the standard type/ The procedures are offered in [7,8].

In the statement (1) the product of $c_{soil}\rho_{soil}\omega_{soil}$ is the big value, that`s why we will take $\mu = \dfrac{1}{c_{soil}\rho_{soil}\omega_{soil}}$ as the small parameter.

Taking into account the parameter smallness $\mu << 1$ we will neglect the right sides of the equation comprising μ and write down the equation system of «fast movement» for the time *t'*.

$$\frac{\partial\rho}{\partial t'} + \frac{1}{s}\frac{\partial\rho\upsilon}{\partial z} = 0$$

$$\frac{\partial\rho\upsilon}{\partial t'} + s\frac{\partial P}{\partial z} + \frac{1}{s}\frac{\partial q\upsilon^2}{\partial z} + \Delta P(\upsilon) + q\sin z = 0$$

$$c\rho\frac{\partial T}{\partial t'} + \frac{1}{s}c\rho\frac{\partial \upsilon T}{\partial z} + q_1 = 0 \qquad (2)$$

$$c_k\rho_k\omega_k\frac{\partial T_k}{\partial t'} = F_1\alpha_1(T - T_k) - F_2\alpha_2(T_k - T_{zp})$$

$$T_{zp} \approx const;\ \ q_1 = F_1\alpha_1(T - T_k)$$

Correspondingly, the equation system of the slow motion in the scale $\tau = \mu t'$ will be the following

$$\frac{\partial T_{zp}}{\partial\tau} = \frac{1}{\mu}\left(\frac{\partial}{\partial x}\left(\lambda_s\frac{\partial T_{zp}}{\partial x}\right) + \frac{\partial}{\partial y}\left(\lambda_s\frac{\partial T_{zp}}{\partial\lambda}\right)\right) + q_2 - q_3 \qquad (3)$$

$$q_2 = F_2\alpha_2(\overline{T}_k - T_{zp})$$

$$q_3 = F_3\alpha_3(T_{zp} - \overline{T}_{voz}) \quad \overline{T}_k = \frac{1}{\tau}\int_0^\tau T_k \quad \overline{T}_{voz} = \frac{1}{\tau}\int_0^\tau T_{voz}$$

Thus, as the result of the conducted temporary decomposition the local models with different times were obtained from the original one.

The model (2) describes unsteady one-dimensional liquid movement on the coordinate *z,* and the statement (3) describes heat distribution in the soil on the coordinates x and *y*.

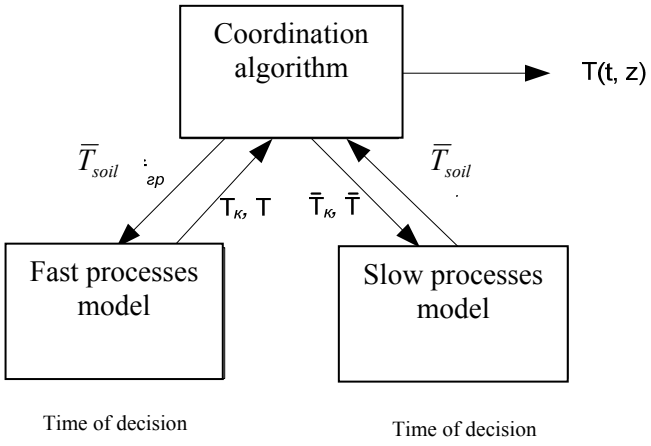
Thus it is suggested to use two –level model realization system (2) and (3) indications in the picture 1, where the coordinating interaction algorithm for the models (2) and (3) is located at the upper level, numerical algorithms which realizes the statement (2) and (3) are located at the low level.

Coordination includes the task solution:

For the time $\tau = \mu t'$:

- integrate the values $\overline{T}_k = \frac{1}{\tau}\int_0^\tau T_k dt; \quad \overline{T}_{air} = \frac{1}{\tau}\int_0^\tau T_{air} dt$

- generate limit values for the task solution (3)



Picture 1. Interaction scheme for the models (2) and (3)

At the moment τ :

-average on the coordinates *x* and *y* values $\overline{T}_{soil}$ for the task solution (2).

The outcoming coordinate of the whole system is the liquid temperature T(t, z) along the pipeline.

This approach allows to use different computing resources under the realization of the original model soundly (1).

3. Conclusion

The article offers the decomposition approach to the realization of unsteady non-isothermal liquid movement model in the pipeline. The obtained two –level system of interaction of the original model allows to realize it on different computing resources concurrently increasing the time of the computing procedures for original model solution.

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Резюме

Бұл мақалада құбырдағы стационарлы емес бейизотермиялық ағыстың жылулық моделінің декомпозициясы берілген. Модельді есептеу барындағы үрдісті анағұрлым тездететін екі деңгейлі есептеу жүйесі ұсынылған.

Резюме

Предложен декомпозиционный подход к реализации модели нестационарного неизотермического течения жидкости в трубопроводе. Полученная двухуровневая система взаимодействия исходной модели позволяет реализовать ее параллельно на разных вычислительных ресурсах, тем самым уменьшая время вычислительных процедур решения исходной модели.

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S. Baltushev, E. Orlova

INNOVATIVE MODERNIZATION OF FORGING AND STAMPING PRODUCTION BASED ON JSC JV «BYELKAMIT»

Industry of Kazakhstan is developing very rapidly. The greatest development observed in the oil and gas, mining industries.

Each year, for each of the branches is used more and more stringent requirements for forgings. The result is that we have to buy a higher quality and more expensive billet material from abroad. This is especially felt in the production of high quality forgings.

Today, main six companies with blacksmith shop are in Kazakhstan, specializing in the production of forgings:

1. JSC «VostokMashZavod» - produces 30 tons/month;
2. LLP «Casting» (KSP Stell) - produces 50 tons/month, cannot produce the large size;
3. JSC "AZTM" - produces 20 tons/month, with the installed equipment allows production of forgings up to 500 tons/month;
4. LLP "KazZincMash" - produces only for the needs of JSC "Kazzinc" - 40 tons/month;
5. JSC "ArcelorMittal Temirtau" - make for yourself;
6. JSC "PZTM" - do for themselves and for the needs of rail transport, production capacity is 110 tons per year extruded products.

Consequently, only four companies are the main competition in the market of Kazakhstan.

Ratio of forging products on the market of Kazakhstan is presented in picture 1.

After careful analysis of consumers and producers, managers of JSC JV "Byelkamit" decided to create the forging production according to international standards, with full reconstruction of the existing blacksmith shop.

It is planned to use existing machining equipment for made component from forgings produced hot stamping, hot rolling and forging.

The basis for the organization forging production will be Building №3 with existing equipment. Drawing of the Building №3 presented in picture 2.

Will be involved the specialists working in the factory. JSC JV "Byelkamit" will build on the experience of the staff, at the same time will provide training for this type of production.

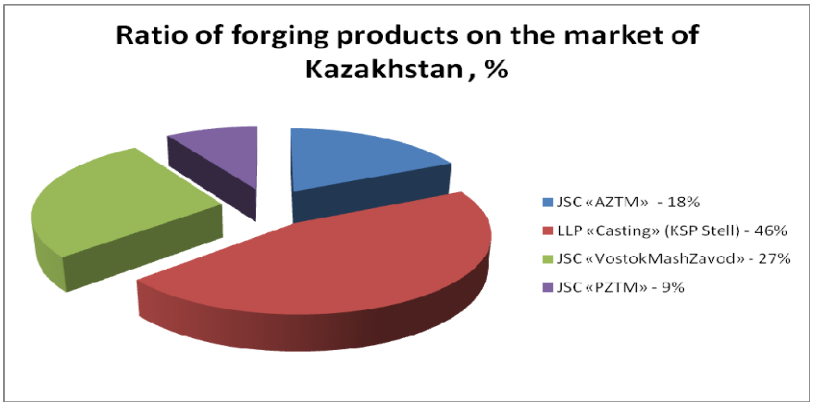
Planned to produce up to 7,500 tons of forgings per year, this figure is given with the purchase of a new advanced equipment and upgrade existing equipment.

Forging hydraulic press - the main equipment, which will be made up to 3 750 tons per year.

Forging complex is intended for all work performed during forging. Forging manipulator capacity of 5000 tons will be working with the press.

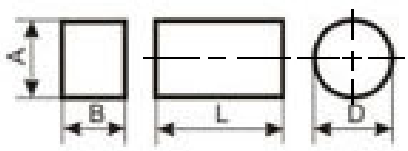
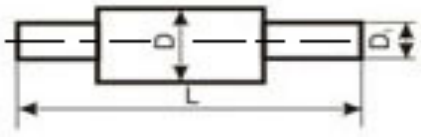
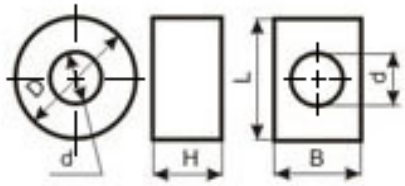
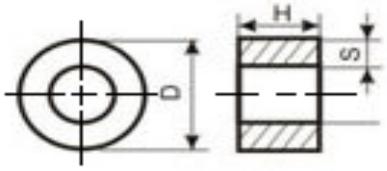
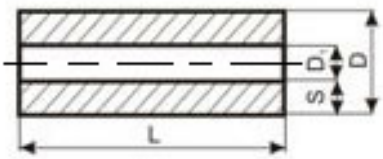
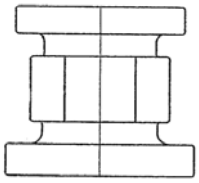
Main dimensions of forgings, which are planned to be produced on the press, are presented in table number 1.

JSC JV "Byelkamit" has own laboratory at the plant for testing forgings.



Picture 1. Production of forging products on the market of Kazakhstan

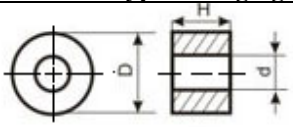
Table 1. **Main dimensions of forgings, which are planned to be produced on the press**

Name	Type of forging	Dimensions
Forgings with a uniform length square or circular cross-sections		D_{min} = 150 mm D_{max} = 550 mm A_{min} = 150 mm B_{max} = 800 mm L_{max} = 6000 mm
Shafts circular cross section with shoulders and flanges		$D_{f.min}$ = 150 mm D_{max} = 550 mm L_{max} = 6000 mm
Forgings circular and rectangular cross-section with holes and without holes		D_{max} = 1200 mm d_{min} = 100 mm d_{max} = 200 mm H_{max} = 150 mm B_{max} = 800 mm L_{max} = 200 mm
Rolled rings		D_{max} = 1600 mm D_{min} = 650 mm H_{max} = 200 mm H_{min} = 600 mm S_{max} = 100 mm
Hollow cylinders with uniform and variable size D		D_{max} = 650 mm $D_{f.max}$ = 280 mm $D_{f.min}$ = 150 mm L_{min} = 1500 mm L_{max} = 2500 mm S_{min} = 100 mm
Flow head		Plans of different types and sizes of up to 2 tons

Ring rolling machine will be purchased to obtain high-quality rolled rings. Production on the ring rolling machine will be up to 2500 tons per year.

Main dimensions of forgings, which are planned to be produced on ring rolling machine, presented in table number 2.

Table 2. **Main dimensions of forgings, which are planned to be produced on the ring rolling machine**

Name	Type of forging	Diameter	Height
Rolled rings		200 - 1250 mm	50 - 400 mm

Steam air stamping and steam air forging hammer - the existing equipment to be upgraded.

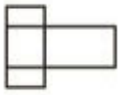
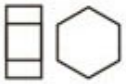
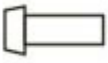
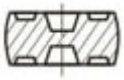
Steam air stamping hammer with a mass of falling parts 3.15 tons would be transferred to the hydraulic actuator, which will improve efficiency equipment. Production on the steam air stamping hammer will be up to 500 tons per year.

Main dimensions of forgings, which are planned to be produced on the vapor swage, are presented in table number 3.

Steam air forging hammer with a mass of falling parts 1 ton, which will also be transferred to the hydraulic actuator.

Production on the steam air forging hammer will be up to 1000 tons per year.

Table 3. **Main dimensions of forgings, which are planned to be produced on the steam air stamping hammer**

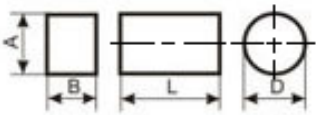
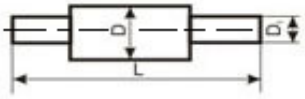
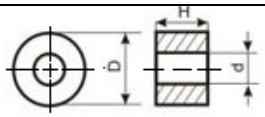
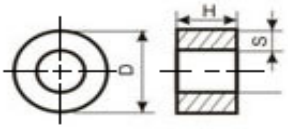
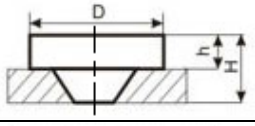
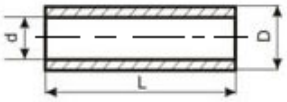
Name	Type of forging	Dimensions
Bolts		M16 – M64
Nuts		M36 – M64
Squares		Ø20 – Ø75
Tees		Ø20 – Ø75
Rivets		Ø16 – Ø30
Cotter		Ø30
Gear wheels		Ø129 – Ø288
Eyebolts		M8 – M72
Allen key head		S = 36 – 145

Main dimensions of forgings, which are planned to be produced on the steam air forging hammer, are presented in table number 4.

As well as various parts such as clips, washers, bushings, do not exceed the weight of 17 kg.

All products will be in according with international standards ASME, ASTM, and GOST.

Table 4.**Main dimensions of forgings, which are planned to be produced on the steam air forging hammer**

Name	Type of forging
Shafts smooth round and rectangular	
Round shafts and flanges with shoulders	
Cylinders and discs solid and perforated	
Rolled rings	
Bushing seating washer	
Hollow shafts	

The billets will be heated by two gas-flame furnace.

The blanks for stamping will be heated by furnace with high-frequency currents.

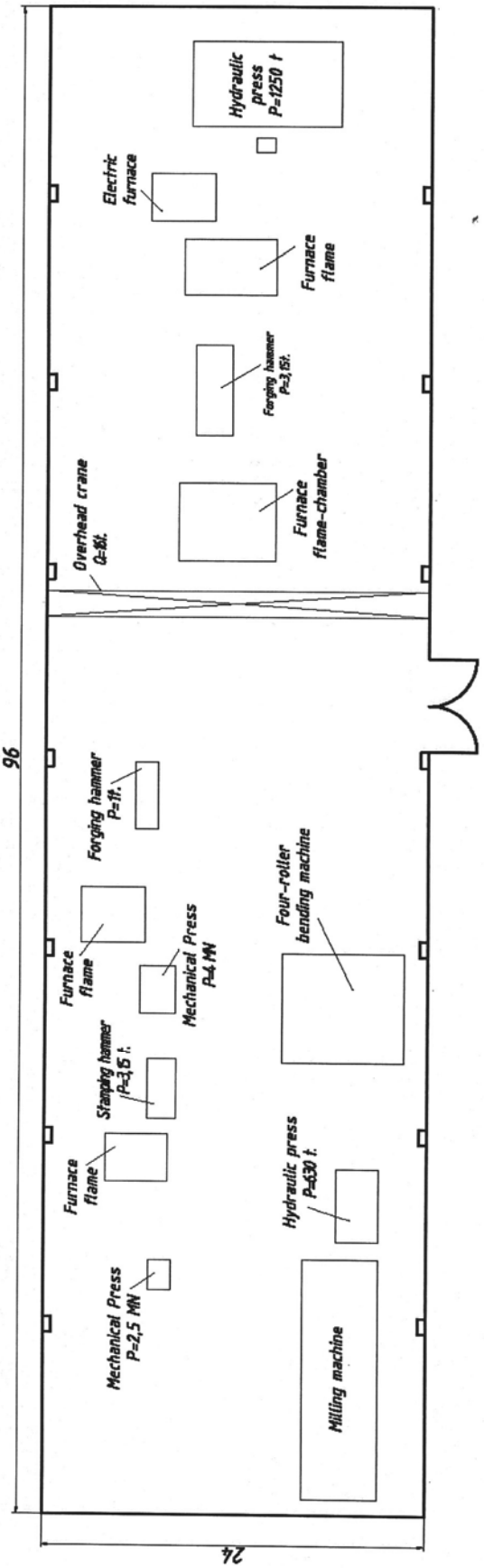
Two gas-flame furnaces with moving table will be purchased for heat treatment of forgings.

Layout upgraded blacksmith shop is presented in picture 3.

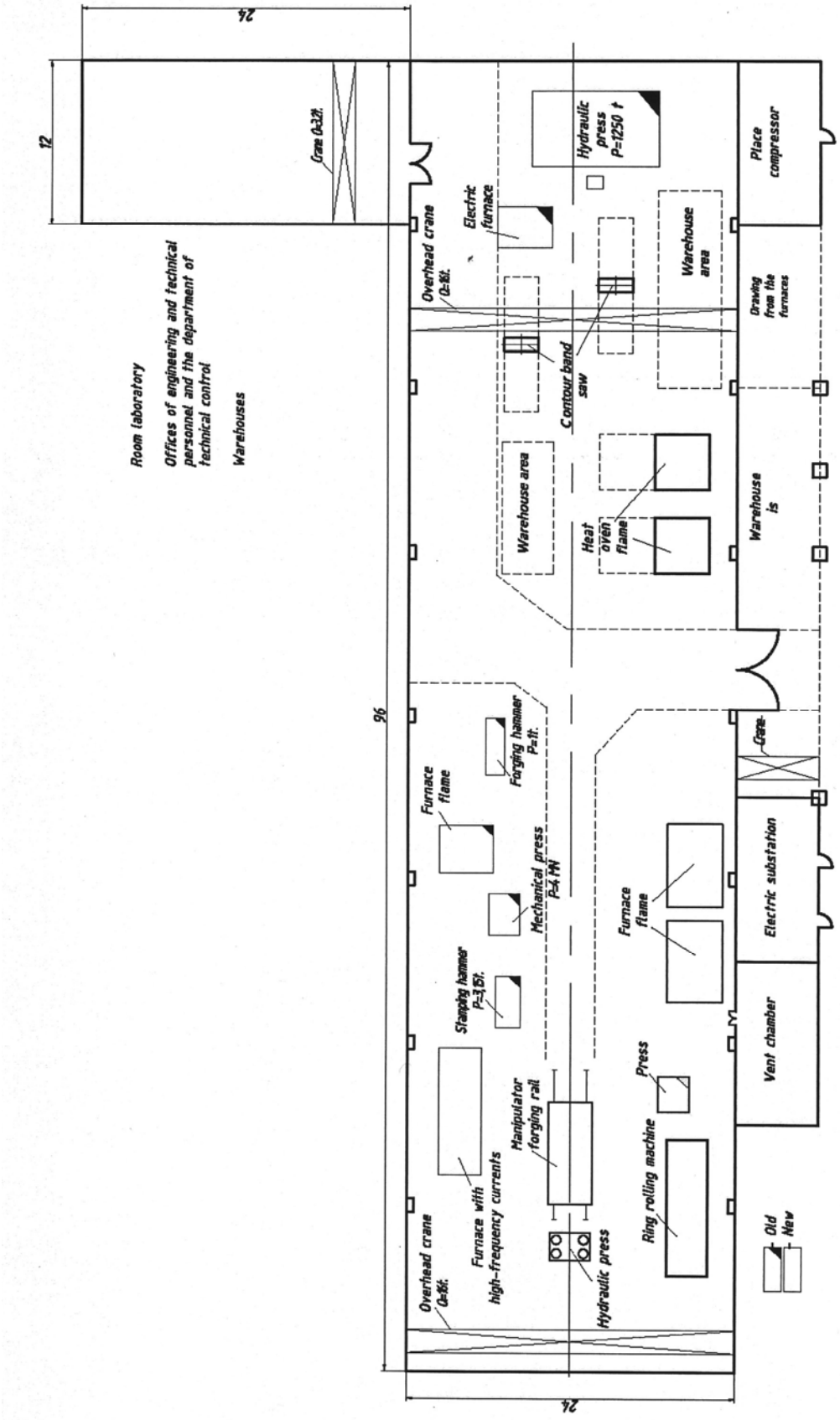
Current products will conform to international and republic standards. Forgings will have higher accuracy class, increased strength and durability.

For the organization forging production to be acquired a modern innovative forging equipment that complies with international standards. This will reduce the flow coefficient of the material, which significantly affect the cost of production.

To obtain forgings that meet international standards, will be used high quality material imported from Europe, the U.S. and South Korea.



Picture 2. Building №3 with existing equipment



Picture 3. Building №3 with planning equipment

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Резюме

Мақалада соғумен алынатын соғылмаларды өндіретін нарықтың салыстырмалы сараптамалары келтірілген. Негізгі бәсекелес компаниялар анықталды. АҚ «Белкамит» базасында ұсталық–қалыптау өндірісін жаңғыртуға арналған әдістер мен шешімдер қарастырылады. Өндіру жоспарланған соғылмалардың, негізгі типтері және өлшемдері келтірілген.

Резюме

Приведен сравнительный анализ рынка производителей кованых поковок. Выявлены основные конкурентные компании. Рассматриваются методы и решения для модернизации кузнечно-штамповочного производства на базе АО СП «Белкамит». Приведены основные типы и размеры поковок, которые планируется производить.

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S.B. Kosbolov, G.P. Tanzharikova, A. Zhauyt, A.B. Rakhmatulina

KINEMATICAL SYNTHESIS OF SIX-LINK LINKAGE WITH THREE DWELLS

INTRODUCTION

Compensation mechanisms are used on loom SWM type for controlling weft tension during the formation of tissue. Figure 1 shows a cyclorama of the working link movement of the mechanism for the battle angle 105^0 [1]. $S = S(\varphi)$ - function of the working link of the mechanism depending on φ - angle of crank mechanism. Slot *ab* - pulling weft after it cut at a certain position (output of the working link on the top position), *bc* - dwell of working link on the top position. It is needed for stability of color changing system work, *cd* –pickup of weft to reduce tension in the slot, *de* - dwell of working link in the down position, *ef* - extension of surplus flipping weft and creation of a certain tension during the cut, *fa* – dwell during the cut of weft.

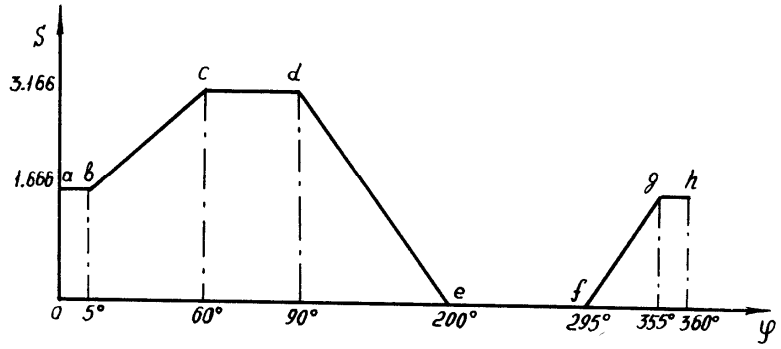

Figure 1. Cyclorama of the working link movement of the III class mechanism

On the base of analysis it was established that the position of working body of compensator group must be: on the top position S_b = 190mm, during the cut S_{cut}=100mm and on breakage S_{br} = 95mm. Cyclorama movement of the working body of the compensator which has three dwells is very complicated and therefore combination of cam-lever mechanisms is used.

Cam is the leading link connected with the main shaft of the loom. Working body moves on a plane which is perpendicular to the movement of weft thread. The main disadvantages of the combined mechanism are rapid wear of higher pairs elements of cam-roller mechanism and separation of roller from cam when the speed characteristics of the loom are increased. To eliminate these defects a new III class slider-crank mechanism which provides three dwells for a cycle of work was synthesized.

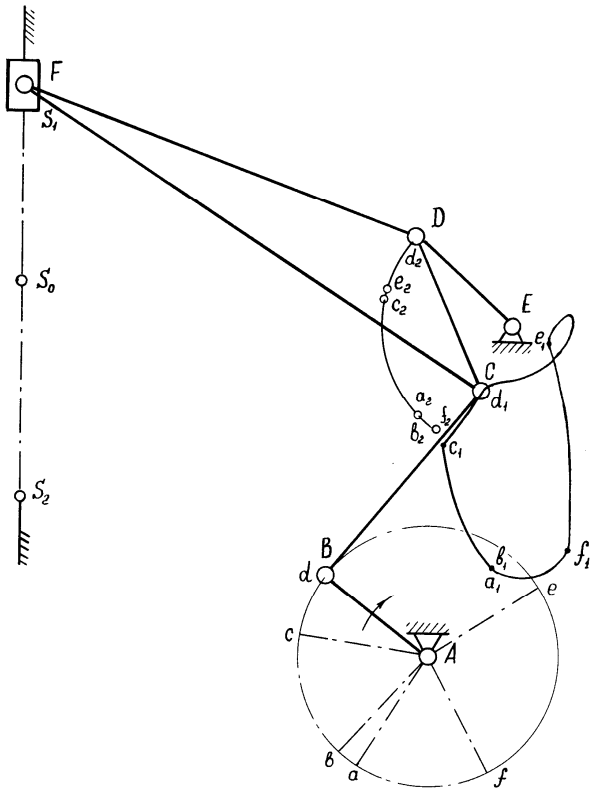

Figure 2. Working principle of III class transmission mechanism

Analytical method for the synthesis of linkage.

The initial data for the synthesis of the six link transmission mechanism of III class:

a) should coincide with axis *OY* of *OXY* system according to the movement of weft thread of guiding slide,

b) coordinates of the crank rotation must be following:

$1.8 \le X_A \le 2, -0.5 \le Y_A \le -0.8.$

Let's consider synthesis of the III class transmission mechanism by given law of motion of the driven link - slider in the displacement function of the input link - crank $S = S_i(\varphi_i)$, $i = \overline{1,N}$ (Figure 3).

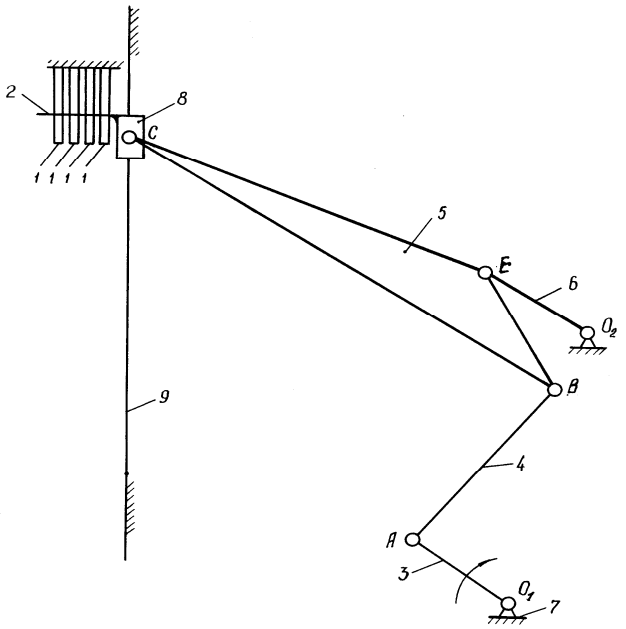

Figure 3. Transmission mechanism of III class

1 Statement of the problem

Let N be positions of two planes Q_1 and Q_2 (cross-sections of solids)

$$Q_1\left(X_A, Y_A, \varphi_i\right), \quad Q_2\left(X_{D_i}, Y_{D_i}, \psi_i\right) \ \left(i=\overline{1,N}\right), \tag{1}$$

relative to fixed plane Q. Coordinate systems OXY, Axy and $D_i\ x'\ y'$ are tightly associated with planes Q, Q_1 and Q_2.

1^0. Points $A(X_{A,}\ Y_A)$, $B(x_B,y_B)$, and $C\left(x'_C, y'_C\right)$ must be found according to planes Q, Q_1 and Q_2. Distance between points B and C defined by equation 1 must have a little difference from a constant value R.

Variable coordinates X_{B_i}, Y_{B_i} of the point B and X_{C_i}, Y_{C_i} of the point C in OXY system are expressed through their constant coordinates x_B, y_B and x'_C, y'_C in Axy and $Dx'y'$ systems known as linear transformation formulas:

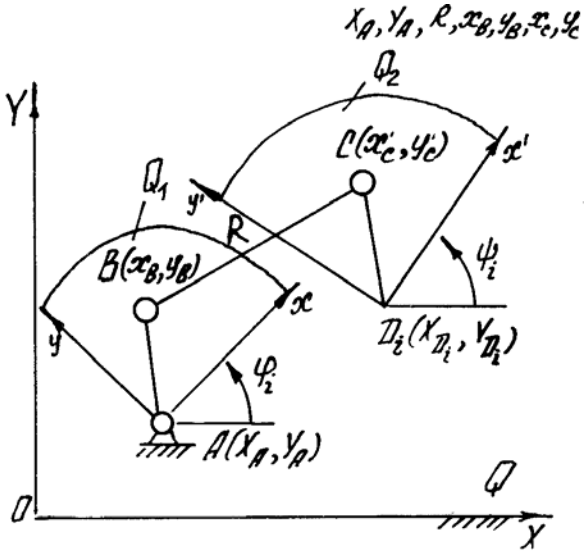

Figure 4. Four link initial kinematical chain $ABCD$ with rotational pairs

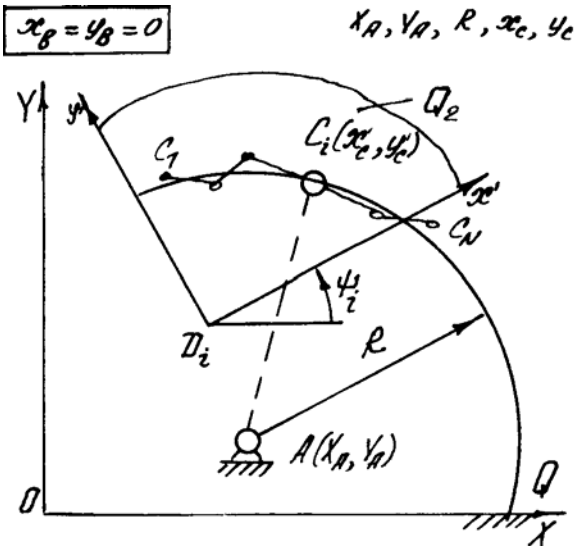

Figure 5. Two link initial kinematical chain ACD with rotational pairs

$$\begin{bmatrix} X_{B_i} \\ Y_{B_i} \\ 1 \end{bmatrix} = \begin{bmatrix} cos\,\varphi_i & -sin\,\varphi_i & X_A \\ sin\,\varphi_i & cos\,\varphi_i & Y_A \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_B \\ y_B \\ 1 \end{bmatrix}, \tag{2}$$

$$\begin{bmatrix} X_{C_i} \\ Y_{C_i} \\ 1 \end{bmatrix} = \begin{bmatrix} \cos\psi_i & -\sin\psi_i & X_{D_i} \\ \sin\psi_i & \cos\psi_i & Y_{D_i} \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x'_C \\ y'_C \\ 1 \end{bmatrix}, \tag{3}$$

There are seven unknown parameters in this problem. They are $X_{A,}\ Y_A$ coordinates of the point $A \in Q$, x_B, y_B coordinates of the point $B \in Q_1$, x'_C, y'_C coordinates of the point $C \in Q_2$ and the distance R between the points B and C.

Weighted mean difference for the i-th position of planes:

$$\Delta q_i = \left|\overrightarrow{B_iC_i}\right|^2 - R^2 = \left(X_{c_i} - X_{B_i}\right)^2 + \left(Y_{c_i} - Y_{B_i}\right)^2 - R^2, \quad \left(i=\overline{1,N}\right) \tag{4}$$

Weighted mean difference Δ_{q_i} is a function of seven parameters $X_{A,}Y_A$, x_B, y_B, R, x'_C, y'_C (Figure 4). By grouping these parameters as three with common parameter R, the weighted mean difference can be represented in three different forms. Expressing Δ_{q_i} through X_A, Y_A and R, we obtain the first form

$$\Delta q_i^{(1)} = \left(\widetilde{X}_{A_i} - X_A\right)^2 + \left(\widetilde{Y}_{A_i} - Y_A\right)^2 - R^2, \quad \left(i = \overline{1,N}\right) \tag{5}$$

$$\begin{bmatrix} \widetilde{X}_{A_i} \\ \widetilde{Y}_{A_i} \\ 1 \end{bmatrix} = -\begin{bmatrix} \cos\varphi_i & -\sin\varphi_i & 0 \\ \sin\varphi_i & \cos\varphi_i & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_B \\ y_B \\ 1 \end{bmatrix} + \begin{bmatrix} \cos\psi_i & -\sin\psi_i & X_{D_i} \\ \sin\psi_i & \cos\psi_i & Y_{D_i} \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x'_C \\ y'_C \\ 1 \end{bmatrix} \tag{6}$$

By forming the sum of squares of weighted mean difference for N positions, we get

$$S = \sum_{i=1}^{N} \left[\Delta_{q_i}^{(1)}\right]^2 \tag{7}$$

Necessary conditions for minimum sum of variables $X_{A,}Y_A$ and R

$$\frac{\partial S}{\partial X_A} = 0, \qquad \frac{\partial S}{\partial Y_A} = 0, \qquad \frac{\partial S}{\partial R} = 0 \tag{8}$$

with equations 5 and 7, we get the following system of equations

$$\begin{bmatrix} \sum_{i=1}^{N} \widetilde{X}_{A_i}^2 & \sum_{i=1}^{N} \widetilde{X}_{A_i}\widetilde{Y}_{A_i} & \sum_{i=1}^{N} \widetilde{X}_{A_i} \\ \sum_{i=1}^{N} \widetilde{X}_{A_i}\widetilde{Y}_{A_i} & \sum_{i=1}^{N} \widetilde{Y}_{A_i}^2 & \sum_{i=1}^{N} \widetilde{Y}_{A_i} \\ \sum_{i=1}^{N} \widetilde{X}_{A_i} & \sum_{i=1}^{N} \widetilde{Y}_{A_i} & N \end{bmatrix} \begin{bmatrix} X_A \\ Y_A \\ H_1 \end{bmatrix} = \frac{1}{2} \begin{bmatrix} \sum_{i=1}^{N} R_{A_i}^2 \widetilde{X}_{A_i} \\ \sum_{i=1}^{N} R_{A_i}^2 \widetilde{Y}_{A_i} \\ \sum_{i=1}^{N} R_{A_i}^2 \end{bmatrix}, \tag{9}$$

where $R_{A_i}^2 = \widetilde{X}_{A_i}^2 + \widetilde{Y}_{A_i}^2$

The system 9 allows to determine unknowns $X_{A,}Y_A$ and R for given values of variables x_B, y_B, x'_C, y'_C i.e. describes some correspondence between points B, C and A of Q_1, Q_2 and Q planes.

The solution of these equations systems by Cramer's rule can be written as

$$\left(X_{A,}Y_{A,}H_1\right) = \frac{1}{D_1}\left(D_{X_A,}\ D_{Y_A,}\ D_{H_1}\right) \text{ when } D_1 \neq 0 \tag{10}$$

where $R = \left(X_A^2 + Y_A^2 + 2H_1\right)^{\frac{1}{2}}$.

Expressing Δ_{q_i} through x_B, y_B and R we obtain the second form:

$$\Delta q_i^{(2)} = \left(\widetilde{X}_{B_i} - x_B\right)^2 + \left(\widetilde{Y}_{B_i} - y_B\right)^2 - R^2, \ \left(i = \overline{1,N}\right) \tag{11}$$

where

$$\begin{bmatrix} X_{B_i} \\ Y_{B_i} \\ 1 \end{bmatrix} = \begin{bmatrix} \cos\varphi_i & -\sin\varphi_i & 0 \\ -\sin\varphi_i & \cos\varphi_i & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} X_{D_i} - X_A \\ Y_{D_i} - Y_A \\ 1 \end{bmatrix} + \begin{bmatrix} \cos(\psi_i - \varphi_i) & -\sin(\psi_i - \varphi_i) & 0 \\ \sin(\psi_i - \varphi_i) & \cos(\psi_i - \varphi_i) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x'_C \\ y'_C \\ 1 \end{bmatrix}$$

Conditions for minimum sum of variables x_B, y_B и R

$$\frac{\partial S}{\partial x_B}=0, \qquad \frac{\partial S}{\partial y_B}=0, \qquad \frac{\partial S}{\partial R}=0 \tag{12}$$

reduce to the system of linear equations

$$\begin{bmatrix} \sum_{i=1}^{N}\widetilde{X}_{B_i}^2 & \sum_{i=1}^{N}\widetilde{X}_{B_i}\widetilde{Y}_{B_i} & \sum_{i=1}^{N}\widetilde{X}_{B_i} \\ \sum_{i=1}^{N}\widetilde{X}_{B_i}\widetilde{Y}_{B_i} & \sum_{i=1}^{N}\widetilde{Y}_{B_i}^2 & \sum_{i=1}^{N}\widetilde{Y}_{B_i} \\ \sum_{i=1}^{N}\widetilde{X}_{B_i} & \sum_{i=1}^{N}\widetilde{Y}_{B_i} & N \end{bmatrix} \begin{bmatrix} x_B \\ y_B \\ H_2 \end{bmatrix} = \frac{1}{2}\begin{bmatrix} \sum_{i=1}^{N}\widetilde{R}_{B_i}^2\widetilde{X}_{B_i} \\ \sum_{i=1}^{N}\widetilde{R}_{B_i}^2\widetilde{Y}_{B_i} \\ \sum_{i=1}^{N}\widetilde{R}_{B_i}^2 \end{bmatrix}, \tag{13}$$

where

$$\widetilde{R}_{B_i}^2=\widetilde{X}_{B_i}^2+\widetilde{Y}_{B_i}^2, \qquad H_2=\frac{1}{2}\left(R^2-x_B^2-y_B^2\right)$$

Expressing Δ_{q_i} through x'_C, y'_C and *R*, we obtain the third form:

$$\Delta q_i^{(3)}=\left(\widetilde{X}_{C_i}-x'_C\right)^2+\left(\widetilde{Y}_{C_i}-y'_C\right)^2-R^2, \quad \left(i=\overline{1,N}\right) \tag{14}$$

where

$$\begin{bmatrix} \widetilde{X}_{C_i} \\ \widetilde{Y}_{C_i} \\ 1 \end{bmatrix} = -\begin{bmatrix} cos\,\psi_i & sin\,\psi_i & 0 \\ -sin\,\psi_i & cos\,\psi_i & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} X_A-X_{D_i} \\ Y_A-Y_{D_i} \\ 1 \end{bmatrix} + \begin{bmatrix} cos(\varphi_i-\psi_i) & -sin(\varphi_i-\psi_i) & 0 \\ sin(\varphi_i-\psi_i) & cos(\varphi_i-\psi_i) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_B \\ y_B \\ 1 \end{bmatrix}.$$

Conditions for minimum sum of variables x'_C, y'_C and *R*

$$\frac{\partial S}{\partial x'_C}=0, \qquad \frac{\partial S}{\partial y'_C}=0, \qquad \frac{\partial S}{\partial R}=0. \tag{15}$$

reduce to the system of linear equations

$$\begin{bmatrix} \sum_{i=1}^{N}\widetilde{X}_{C_i}^2 & \sum_{i=1}^{N}\widetilde{X}_{C_i}\widetilde{Y}_{C_i} & \sum_{i=1}^{N}\widetilde{X}_{C_i} \\ \sum_{i=1}^{N}\widetilde{X}_{C_i}\widetilde{Y}_{C_i} & \sum_{i=1}^{N}\widetilde{Y}_{C_i}^2 & \sum_{i=1}^{N}\widetilde{Y}_{C_i} \\ \sum_{i=1}^{N}\widetilde{X}_{C_i} & \sum_{i=1}^{N}\widetilde{Y}_{C_i} & N \end{bmatrix} \begin{bmatrix} x'_C \\ y'_C \\ H_3 \end{bmatrix} = \frac{1}{2}\begin{bmatrix} \sum_{i=1}^{N}\widetilde{R}_{C_i}^2\widetilde{X}_{C_i} \\ \sum_{i=1}^{N}\widetilde{R}_{C_i}^2\widetilde{Y}_{C_i} \\ \sum_{i=1}^{N}\widetilde{R}_{C_i}^2 \end{bmatrix} \tag{16}$$

where

$$\widetilde{R}_{C_i}^2=\widetilde{X}_{C_i}^2+\widetilde{Y}_{C_i}^2, \quad H_3=\frac{1}{2}\left(R^2-x_c'^2-y_c'^2\right)$$

To obtain the necessary conditions for a minimum sum, equation 7 for all seven variables

$$\frac{\partial S}{\partial j}=0, \qquad \left(j=X_A, Y_A, R, x_B, y_B, x'_c, y'_c\right) \tag{17}$$

systems of equations 8, 12 and 15 must be considered together. Excluding the first three unknowns X_A, Y_A and *R* on the base of system equation 9, we get a system of four equations with four unknowns x_B, y_B, x'_c, y'_c, which can be conveniently represented as

$$\left.\begin{aligned}
&\sum_{i=1}^{N}\left[\widetilde{X}_{A_i}D_{X_A}+\widetilde{Y}_{A_i}D_{Y_A}+D_{H_1}-\tfrac{1}{2}R_{A_i}^2D_1\right]\cdot\widetilde{X}_{B_i}=0,\\
&\sum_{i=1}^{N}\left[\widetilde{X}_{A_i}D_{X_A}+\widetilde{Y}_{A_i}D_{Y_A}+D_{H_1}-\tfrac{1}{2}R_{A_i}^2D_1\right]\cdot\widetilde{Y}_{B_i}=0,\\
&\sum_{i=1}^{N}\left[\widetilde{X}_{A_i}D_{X_A}+\widetilde{Y}_{A_i}D_{Y_A}+D_{H_1}-\tfrac{1}{2}R_{A_i}^2D_1\right]\cdot\widetilde{X}_{C_i}=0,\\
&\sum_{i=1}^{N}\left[\widetilde{X}_{A_i}D_{X_A}+\widetilde{Y}_{A_i}D_{Y_A}+D_{H_1}-\tfrac{1}{2}R_{A_i}^2D_1\right]\cdot\widetilde{Y}_{C_i}=0.
\end{aligned}\right\} \qquad (18)$$

Equation system 18 coincides with two equations of ninth power about two unknown parameters x_B, y_B of the point $B \in e$ which is given in work [2]. In contrast to the mentioned work, in this case, we get a system of four equations relative to four unknowns x_B, y_B, x_c', y_c'.

Therefore, each equation of the system 18 is an algebraic equation of the ninth degree relative to x_B, y_B, x_c', y_c'. Total number of solutions is equal to 9^4 =6561, where the number of real is equal to 5^4 = 625 [1]. However, these solutions may correspond to minimum and maximum points, saddle points and rack points of surface $S=S(x_B, y_B, x_C', y_C')$. Matrix of second derivatives of function *S* must be explored in order to establish the form of an extreme point. However, this method of determining minimum points of function *S* is hardly advisable, because the solution of the nonlinear equations system 18 is laborious task itself. It is more efficient to use below given algorithm of searching minimum of function *S* which is based on the following theorem.

Theorem. If $S_1^{(1)}$, $S_2^{(1)}$, $S_3^{(1)}$ minimum values of sum S, determined for N positions corresponding to the pairs of points

$\left\{B^{(0)}\left(x_B^{(0)}, y_B^{(0)}\right)\in Q_1,\ \ C^{(0)}\left(x_c'^{(0)}, y_c'^{(0)}\right)\in Q_2\right\}$,

$\left\{A^{(1)}\left(x_A^{(1)}, y_A^{(1)}\right)\in Q,\ \ C^{(0)}\left(x_c'^{(0)}, y_c'^{(0)}\right)\in Q_2\right\}$,

$\left\{A^{(1)}\left(x_A^{(1)}, y_A^{(1)}\right)\in Q,\ \ B^{(1)}\left(x_B^{(1)}, y_B^{(1)}\right)\in Q_1\right\}$

such, that

$$S_1^{(1)} = \min_{X_A, Y_A, R} S\left[X_A, Y_A, R, x_B^{(0)}, y_B^{(0)}, x_C'^{(0)}, y_C'^{(0)}\right] = S\left[X_A^{(1)}, Y_A^{(1)}, R_1^{(1)}, x_B^{(0)}, y_B^{(0)}, x_c'^{(0)}, y_c'^{(0)}\right],$$

$$S_2^{(1)} = \min_{X_B, Y_B, R} S\left[X_A^{(1)}, Y_A^{(1)}, R, x_B, y_B, x_c'^{(0)}, y_c'^{(0)}\right] = S\left[X_A^{(1)}, Y_A^{(1)}, R_2^{(1)}, x_B^{(1)}, y_B^{(1)}, x_c'^{(0)}, y_c'^{(0)}\right],$$

$$S_3 = \min_{X_c', Y_c', R} S\left[X_A^{(1)}, Y_A^{(1)}, R, x_B^{(1)}, y_B^{(1)}, x_c', y_c'\right];$$

then $S_3^{(1)} \le S_2^{(1)} \le S_1^{(1)}$.

Proof. The system 9 when $D_1 \neq 0$ defines for any points $B^{(0)} \in Q_1$ and $C^{(0)} \in Q_2$ only one solution $\left(X_A^{(1)}, Y_A^{(1)}, R_1^{(1)}\right)$ corresponding to minimum sum S of variables X_A Y_A and *R* [3]. Therefore, the following equality can be written for a given pair ($B^{(0)}$, $C^{(0)}$)

$$S_1^{(1)} = \min_{X_A, Y_A, R} S\left[X_A, Y_A, R, x_B^{(0)}, y_B^{(0)}, x_C'^{(0)}, y_C'^{(0)}\right] = S\left[X_A^{(1)}, Y_A^{(1)}, R_1^{(1)}, x_B^{(0)}, y_B^{(0)}, x_C'^{(0)}, y_C'^{(0)}\right].$$

Similarly, the system 13 when $D_2 \neq 0$ defines for the points $A^{(1)} \in Q$ and $C^{(0)} \in Q_2$ only one solution $\left(X_B^{(1)}, Y_B^{(1)}, R_2^{(1)}\right)$ corresponding to minimum sum S of variables x_B, y_B and R :

$$S_2 = S\left[X_A^{(1)}, Y_A^{(1)}, R_2^{(1)}, x_B^{(1)}, y_B^{(1)}, x_C'^{(0)}, y_C'^{(0)}\right] = \min_{X_B, Y_B, R} S\left[X_A^{(1)}, Y_A^{(1)}, R, x_B, y_B, x_C'^{(0)}, y_C'^{(0)}\right] \leq$$

$$\leq \min_{X_B, Y_B} S_1^{(1)}\left[X_A^{(1)}, Y_A^{(1)}, R_1^{(1)}, x_B, y_B, x_C'^{(0)}, y_C'^{(0)}\right] \leq S_1^{(1)}$$

The system 16 when $D_3 \neq 0$ defines for the points $A^{(1)} \in Q$ and $B^{(1)} \in Q_1$ only one solution $\left(x_C'^{(1)}, y_C'^{(1)}, R_3^{(1)}\right)$ corresponding to minimum sum S of variables x_C', y_C' and R:

$$S_3 = S\left[X_A^{(1)}, Y_A^{(1)}, R_3^{(1)}, x_B^{(1)}, y_B^{(1)}, x_C'^{(1)}, y_C'^{(1)}\right] = \min_{x_C', y_C', R} S\left[X_A^{(1)}, Y_A^{(1)}, R, x_B^{(1)}, y_B^{(1)}, x_C', y_C'\right] \leq$$

$$\leq \min_{x_C', y_C',} S_2^{(1)}\left[X_A^{(1)}, Y_A^{(1)}, R_2^{(1)}, x_B^{(1)}, y_B^{(1)}, x_C', y_C'\right] \leq S_2^{(2)}.$$

Consequently $S_3^{(1)} \leq S_2^{(1)} \leq S_1^{(1)}$.

Algorithm for minimizing the function S:

1. We assign arbitrary points $B^{(0)} \in Q_1$, $C^{(0)} \in Q_2$ and check the condition $D_1 \neq 0$.
2. Solve the system of linear equations 9 and define $X_A^{(1)}$, $Y_A^{(1)}$, $R_1^{(1)}$.
3. Set points $A^{(1)} \in Q$, $C^{(0)} \in Q_2$ and check the condition $D_2 \neq 0$.
4. Solve the system of equations 13 and define $x_B^{(1)}$, $y_B^{(1)}$, $R_2^{(1)}$.
5. Set points $A^{(1)} \in Q$, $B^{(1)} \in Q_2$ and check the condition $D_3 \neq 0$.
6. Solve the system of equations 16 and define $x_C'^{(1)}$, $y_C'^{(1)}$, $R_3^{(1)}$.
7. Cyclically repeat steps 1 - 6, taking into account

$$A^{(i)} = A^{(i+1)}, B^{(i)} = B^{(i+1)}, C^{(i)} = C^{(i+1)}, \quad i = 0,1,2,...$$

We obtain a decreasing sequence of objective function values $S_1^{(1)}, S_2^{(1)}, S_3^{(1)}, S_1^{(2)}, S_2^{(2)}, S_3^{(2)}, S_1^{(3)}$..., having a limit equal to the value of the function *S* at a local minimum.

The iterative process of finding the minimum sum of function *S* can be completed if the inequalities is done

$$\left|R^{(k)} - R^{(k-1)}\right| \leq \varepsilon, \left|X_A^{(k)} - X_A^{(k-1)}\right| \leq \varepsilon, \left|Y_A^{(k)} - Y_A^{(k-1)}\right| \leq \varepsilon,$$

where - ε – error.

It should be noted that this algorithm can be applied to solve the problem of synthesis of the initial kinematical chain *ABCD* with rotational pairs only in the absence of any restrictions on its parameters.

After solving this problem the following points are determined

$$A(X_A, Y_A) \in Q, \quad B(x_B, y_B) \in Q_1, \quad C(x_C', y_C') \in Q_2$$

Combining them with flat joints, we obtain the initial kinematical chain in *ABCD* open chain form with three degrees of freedom (Figure 4).

Fixing or setting in various combinations of some unknown parameters of synthesis, we can get different modifications of initial kinematical chain (Figure 5).

The geometric relationship for elimination of this degree of freedom can be imposed in a unique way, namely, movement of link *AC* about rack. Therefore, parameters of the motion of link *BC* should be set to determine transmission angles γ_i on the slide *C*. In this case transmission angles γ_i can be changed in certain limits and joint *B* of link *BC* must move along a complicated trajectory in the areas of dwell of arcs with the center at a point *C*. To determine the parameters of the mechanism, the objective functions of the initial kinematical chain should be constructed (Figure 4) and expressed in terms of the mechanism parameters:

$$S_1 = \sum_{i=1}^{N}\left[\Delta q_i\left(X_{0_1}, Y_{0_1}, x_A, y_A, R, x_B, y_B\right)\right]^2 = \sum_{i=1}^{N}\left[\Delta q_i\left(X_{0_1}, Y_{0_1}, \varphi_0, a, b, \gamma_0, c\right)\right]^2,$$

$$S_2 = \sum_{i=1}^{N}\left[\Delta q_i\left(x_E, y_E, R, X_{0_2}, Y_{0_2}\right)\right]^2 = \sum_{i=1}^{N}\left[\Delta q_i\left(\beta_0, h, r, X_{0_2}, Y_{02}\right)\right]^2.$$

At the same time the following limitations were taken into account, which provide the work of mechanism in a given region:

a) on sizes of links

$0. \le \varphi_0 \le 2\pi$ $\quad$ $0.0 \le \beta_0 \le \pi$

$0.4 \le a \le 0.7$ $\quad$ $1.5 \le h \le 3$

$0.9 \le b \le 1.3$ $\quad$ $0.4 \le r \le 1$

$1.5 \le c \le 2.8$ $\quad$ $0. \le X_{0_2} \le 2.5$

$1.7 \le X_{0_1} \le 2$ $\quad$ $-0.5 \le Y_{0_2} \le 1.5$

$0. \le Y_{0_1} \le -0.9$

б) on transmission angles

$270^0 \le \mu_i \le 320^0$

c) on the condition of existence of the crank

$$(b + r - a)^2 \le \left[X_{0_1}^2 + \left(Y_{C_i} - Y_{0_1}\right)^2\right]^2.$$

By solving the problem of synthesis of the III class transmission mechanism 65 initial positions of input and output links were taken and besides values of coordinates were taken through one degree of crank turn. Minimization of the objective function $S = S_1 + S_2$ was performed by using the above algorithm.

According to algorithm the value of the global minimum S = 0,0078248 has been determined as well as the value of coordinates of the global minimum:

$\varphi_0 = 113^0 41'$ $\quad$ a = 0,6012 $\quad$ b = 1,108

c = 2,54153 $\quad$ X_{0_1} = 1,9 $\quad$ $Y_{0_1} = -0,7$

β = I2^0 9$^{'}$ $\quad$ h=1,925 $\quad$ r = 0,795

X_{0_2} = 2,275 $\quad$ Y_{0_2} = 0,823.

III class mechanism is designed that is shown at Figure 3 and working principle of this mechanism can be seen at Figure 2.

Results and Discussion

Three required dwells of output link for one turn of the crank *AB* were obtained as follow. Output link stops when a point *B* moves through the arcs *ab, cd, ef* of the circle. Crank *AB* makes rocker *BC* move and rocker makes three-hinged rigid contour *CFD* move. Joint *C* moves along a complex trajectory, which has three arcs a_1b_1, c_1d_1 and e_1f_1. The center of these arcs of a circle is the point of a slide *F* in the S_0, S_1, S_2 positions and link *CF* is the radius. Thus, the designed mechanism due to its structure and relations of sizes of links provides three essential dwells.

Figure 6 shows a graph of the deviation ΔS function.

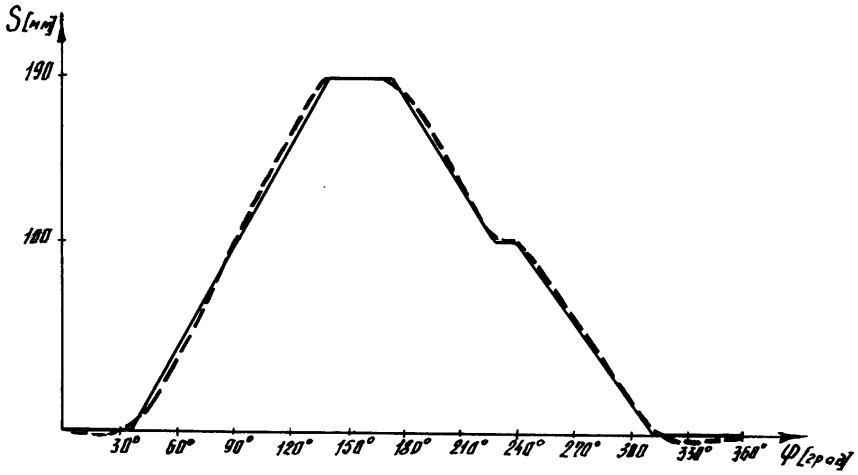

Figure 6. Graph of the deviation ΔS

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Резюме

Жұмыста алтыбуынды иінтіректі механизмді жетекші буын - сырғақ кіріс буыны – айналшақтың орын ауыстыру функциясы ретінде берілген қозғалыс заңдылығы арқылы кинематикалық синтездеу есебі қарастырылған. Бұл типті механизм тігін станоктарында қолданылады. Зерттелініп отырған жаңа синтездеу әдісі синтезделген механизмнің кіріс және шығыс буындарының қозғалыс заңдылығы түрінде екі жазықтықтың қозғалыс есебіне негізделген.

Резюме

В статье исследуется задача кинематического синтеза шестизвенного рычажного механизма с тремя выстоями по заданному закону движения ведомого звена – ползуна в функции перемещения входного звена - кривошипа. Такой механизм применяются на ткацких станках типа станок ткацкий бесчелночный для регулирования натяжения уточной нити во время формирования ткани. Исследуемый новый метод синтеза основан на задаче движения двух плоскостей как заданный закон движения входного и выходного звеньев синтезированного механизма.

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METHOD OF DISTRIBUTION OF DATA STREAMS IN A SWITCHING ELEMENT

For now existing networks and to local and global computer networks developed a large number of different types of switching devices**.**

The process of transferring the package consists of a number of stages. In the transition from one stage to another package may fail due to lack of resources or other reasons. In this situation, a protocol usually laid possibility of a limited number of repeated attempts to get the desired service. If they all end up in failed, the package has been lost and is not renewed. In overload conditions the number of such retries can significantly increase the input current load and severely degrade the performance of the communication system.

Load Regulation on the network adapters latest generation is provided by the analysis of the work environment and its self-tuning to ensure the best possible performance. The quality of self-tuning is highly dependent on the load. Performance of complex packet processing path includes elements such as hubs, routers, switches, global communication channels.

Let us examine a simple case of the system, load balancing, suppose you want to distribute the packets entering the system between N of servers. In addition, all of the same type of servers, each of which can handle only one bag. One time, the package can be maintained only for one unit completely, and other incoming packets can not interrupt the current and wait in lines.

Statement of the problem: it is necessary to construct a method of distribution of data flow between the devices, effectively using available resources and has reasonable implementation complexity.

Prospective solutions:

- When the packets arrive in the system, select the device with a minimum burst in the entire system and send the package to him, the average time the packet is in the system will be minimal. However, as the number of devices in the system, the implementation of this method is essentially difficult and costly.

- When a packet enters the queue for service randomly selected instrument, intuitively, that provide the same service time, the load will be distributed evenly among all of servers in the system. The disadvantage is that it is not efficient enough for the packets with different service time.

- A method for the implementation and effectiveness of this algorithm in which packets arrive at the system randomly selects a subset of all of servers. The distribution will be under the minimum, nominal and maximum load and load conditions are symmetric with the same probability of income and to test the method, calculations for asymmetric loading.

Spent analyzing the description of methods, we can conclude that the first proposed method is suitable for large centralized systems, and has the highest efficiency. The second method is simple to implement, but not effective enough, the application of large distributed systems. The third proposed method is optimal in complexity and efficiency and is suitable for use in various applications.

Calculation of the presented model can be performed by solving a linear system of equations of balance. The task of evaluating the characteristics of switching element (SE) stated as follows. Given the values of parameters to construct a mathematical model that provides analysis of the characteristics CE boot option [1,3,4].

Thus, for a two-input switch models, proposed a balanced load distribution terms, for switched flows, which provides distribution, depending on the load. For the calculation of the main characteristics of the SE, has been used the implemented program.

For the evaluation of the flow coefficient (), we find the density and distribution function of the load and on the basis of these results we calculate the mean and variance.

Estimate for the exponential distribution of data flow. Distribution function is a function $F(x)$, is determined for each value of x the probability that a random variable X takes a value less than x, i.e. $F(x) = P(X < x)$ [6].

The distribution function has the following properties:

Property 1. The value of the distribution function lie in the interval between [0;1] $0 \le F(x) \le 1$.

Property 2. The distribution function is a non decreasing function $F(x_2) \geq F(x_1)$, if $(x_2 > x_1)$.

Corollary 1. The probability that a random variable takes the value X, enclosed in (a, b), equal to the increment of the distribution function in this interval:

$$P(a < X < b) = F(b) - F(a) \quad (1)$$

Corollary 2. The probability that a continuous random variable X receives one specific value, for example: $x_1 = 0$: $P(X = x_1) = 0$.

Corollary 3. If all the possible values of the random variable X belong to the interval (a, b), then $F(x) = 0$ for $x \leq a$. $F(x) = 1$ for $x \geq b$.

Corollary 4. Will be the following limit relations:

$$\lim_{x \to -\infty} F(x) = 0, \lim_{x \to \infty} F(x) = 1 \quad (2)$$

Assume that the input of the SE receives k independent data streams with intensity $\lambda(t)$. Continuous transfer of data streams independent random variables.

Probability of falling in the interval (a,b) of the continuous random variable X, distributed according to the exponential law:

$$P(a < X < b) = e^{-\lambda a} - e^{-\lambda b} \quad (3)$$

Exponential is called the probability distribution of a continuous random variable X, which is described by the density:

$$f(x) = \begin{cases} 0 \ \ npu \ \ x < 0 \\ \lambda e^{-\lambda x} \ \ npu \ \ x \geq 0 \end{cases} \quad (4)$$

Given that the condition $a = 0.22; b = 0.54; \lambda = 2$, and using (3) we get:

$$P(0.22 < X < 0.54) = e^{-2*0.22} - e^{-2*0.54} = e^{-0.44} - e^{-1.08} = 0.30$$

This result shows that the probability that a random variable in the interval is 0.30. Each random variable is completely determined by its distribution function.

At the same time the solution of practical problems need to know some numerical parameters, which represent the main features of a random variable in a compressed form. These values are primarily the mean and variance.

The expectation -a number of which are concentrated around the values of the random variable.

The mean value of all random variables will tend to his expectation for a sufficiently large number of trials.

Expectation, variance and standard deviation of the exponential distribution is given by:

$$M(X) = 1/\lambda, \ D(X) = 1/\lambda^2, \ \beta(X) = 1/\lambda \quad (5)$$

Hence, $M(X) = 0{,}5$. The variance of the random variable characterizes the measure of the spread of a random variable around its expectation.

To determine the measures the spread of values of a random variable is often used standard deviation β, caused by dispersion.

The calculations were performed using the developed program.

Variance of $D(X) = 0{,}25$. Standard deviation equal to $\beta = 0{,}5$.

Thus, the mean and standard deviation of the exponential distribution load equal [3,4].

In determining the probability density distribution of load, for asymmetric loading showed that the density distribution of the data flow in the interval (a,b) is negligible and 0.11.

The density distribution of data streams in the interval (a,b), estimated the bandwidth usage of SE.

Score for a uniform distribution of data streams. The probability distribution of a continuous random variable X is called uniform if the interval (a, b), which contains all the possible values of X, the density is constant, namely, $f(x) = 1/(b-a)$ is the interval $f(x) = 0$ [5].

Given that the condition $a = 0.22; b = 0.54$, we find the density distribution of load

$$P(a < X < b) = \int_a^b f(x)dx = \int_a^b \frac{1}{x}dx = \ln X\Big|_a^b = \ln(0.54) - \ln(0.22) = 0{,}89 \quad (6)$$

The probability distribution of the flow of data on (a,b) equal to the value of 0.89, which indicates the maximum load distribution [3,5].

The mathematical expectation, variance and standard deviation of the uniform distribution of load will have the following values: $M(X) = 0{,}38$, $D(X) = 0{,}008$, $\beta = 0{,}09$.

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Резюме

Мақалада деректер ағынын үлестіру үшін әдістің есебі қойылып және оны жүзеге асыру тәсілі берілген.

Резюме

В статье поставлена задача метода распределения потока данных и представлен способ ее решения.

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NEW CLASS OF DISCRETE PROGRAMMING PROBLEMS

Abstract

The paper deals with the development and suggestion of a new class of applied problems definition and solution: lobe-symmetric models and discrete programming methods.

There is given a general definition of lobe-symmetric problems, that differs from the well-known ones by modularize properties (blocking), symmetry and by the presence of different types of arguments. To solve this class of problems there was developed the algorithm of iterative mappings having polynomial computational cost (complexity), that provide a solution of applied large-dimension problems. The paper gives a definition of clustering problems as an example of defining applied tasks in discrete programming.

Introduction

A large number of applied tasks used in various economy sectors come to discrete programming problems. Classic definitions and applied problem method-solving procedures in discrete programming are successfully used to solve many practical objectives for various domains of science, engineering and technology.

However, discrete programming problems are very complex and have significant limits to be used for a large range of numerous applications. First, to such limits we refer an exponential computational cost at solving applied problems, calculation accuracy, dimension of current problems and others.

Attempts to eliminate the difficulties are not always successful and there is not a single approach and theoretical foundations for overcoming this discrete programming situation. That is why researchers use the way of developing exact procedures for small size model examples, heuristic and approximate methods of solving discrete problems. Each result obtained in this sphere of research is to be carefully analyzed.

The paper deals with a new class of problem definition in discrete programming that has been used practically at solving various applied problems: lobe-symmetric problems of discrete programming (LSP).

1 General problem definition

As the development of discrete programming models and methods progresses from day to day there appears a need in developing new approaches and methods of solving such problems and one of such methods is lobe-symmetric models and methods [1, 2].

Let's consider a general definition and solution of lobe-symmetric discrete programming problems.

We have a given object set $A = \left\{a_i; i = \overline{1,I}\right\}$ and a given object set $B = \left\{b_j; j = \overline{1,J}\right\}$ having various types of elements and links between elements of the given object sets: they are calculated by the matrix

$$W = \left\|\omega_{ij}\right\|, \; i = \overline{1,I}, \; j = \overline{1,J},$$

whichever elements are integral or Boolean. One must intergrades elements of the object set A into disjoint subsets A_n, $n = \overline{1,N}$, and the elements of object set B – into disjoint subsets B_m, $m = \overline{1,M}$, in order for an extremum to reach a target function F (A_n, B_m).

For a formal definition of the problem we shall use the following variables. Let $X = \left\|x_{in}\right\|, \; i = \overline{1,I}; \; n = \overline{1,N}$ is a Boolean matrix, where $x_{in} = 1,$ if the i-th element is distributed into the n-th group, otherwise $x_{in} = 0$. Similarly $Y = \left\|y_{jm}\right\|, j = \overline{1,J}; \; m = \overline{1,M},$ where $y_{jm} = 1,$ if the j-th element is distributed into the m-th group and otherwise $y_{jm} = 0$. In general, matrixes of variables X and Y are integrals.

Let's find on the example set of A x B, a function F (X,Y), that depends on a distribution A and B set elements by A_n, B_m subsets. Respectively on A set, the function $\varphi_k(X), k = \overline{1,K},$ on B set – the functions $\psi_s(Y), s = \overline{1,S},$ correspondingly defining limits on the A and B sets.

The lobe-symmetric discrete programming problem is formulated as follows:

$$F(X,Y) \to extr, \tag{1}$$

with limitations

$$\varphi_k(X) \le \varphi_{Ko}, k = \overline{1,K}, \tag{2}$$

$$\psi_s(Y) \le \psi_{so}, s = \overline{1,S}, \tag{3}$$

In the constraint set (2) and (3) depending on problem definition the none quality signs can be reversed.

In a general case two-index matrix - the X and Y variables and a target matrix W can be integral.

Let see problem when the X, Y and W variables are the Boolean matrix. As a function F (X, Y) there is often used F (Z) type of function, where

$$Z = XWY \tag{4}$$

Let's see a formula (4) that is a product of X and Y matrix variables and of a target matrix W, which is defined as a target function. As opposed to traditional discrete programming problem definitions in the given definition there are two types of X and Y variables, the X and Y variables are relatively symmetric to a target matrix W.

In (1) - (3) tasks one can identify a number of limitations of type (2), depending on the X variable and a constraint set of type (3), depending on the Y variable.

So? Let's call a task of type (1) - (3) a lobe-symmetric discrete programming problem.

Let's see a formula (4). The formula says that the X and Y variables are relatively symmetric regarding to a target matrix W and the function (4) can be defined both from the left to right and vice versa, i.e.

$$Z = XWY = YWX \tag{5}$$

On the basis of a general definition we can define basic properties in a formulated class of problems that differ from traditional discrete programming problem definitions.

Property 1. Presence of two types of X and Y variables of different types presented in a kind of Boolean matrix, defined on a target matrix W.

Property 2. The bloxity of the problem is in allocation of separate lobes of functions of type (2) and (3) depending only on one X and Y variable.

Property 3. The symmetry of the problem is in making a calculation (5) in both directions the forward and reverse.

2 Solution

The analysis of characteristics and properties in a problem set allows us to offer efficient algorithms for solving this class of problems. Let's see how a solution of lobe-symmetric discrete programming problems is possible if X, Y and W are Boolean matrix. It is easy for us to prove the following statement.

Statement. Distribution of A set elements into disjoint sets A_n correspond to the Boolean add operation of $\| \omega_{ij} \|$ matrix rows and a distribution of B set elements into the disjoint sets B_m - to a logic adding operation of $\| \omega_{ij} \|$ matrix columns.

The results of this statement allow just calculating estimates and solution directions for the development of efficient algorithms.

Let's introduce a concept of a problem solution basis. The basis means a target composition of elements A_n and B_m subsets on the matrix W.

In the W matrix a basis is seen as a submatrix Z, whose elements are defined. This submatrix can always be identified in the upper left corner by way of reversing the matrix W rows and column numbers and their renumbering. This operation simplifies the evaluation procedure and a procedure of defining a solution direction search.

In order to solve a lobe-symmetric discrete programming problem if X, Y and W are the Boolean matrix there was developed an effective algorithm for iterative mapping. The algorithm consists of the following stages: [3].

1. In the Boolean matrix W we select a sub-matrix $Z = \|z_{nm}\|, n = \overline{1,N}; m = \overline{1,M}$ and define it as a basis for our problem solving.

2. So we shall be able to define a matrix direction $D = \|d_{i'n}\|, i^1 = n + \overline{1,I};\ n = \overline{1,N}$ for the X task by way of logic adding nonbasic rows of W matrix with basis rows thus calculating a value of estimates only by positions of the basis.

3. The estimates obtained enable us to make the A subset elements distribution into A_n subset. In the result we can fix the X solution and the intermediate matrix $\Pi = \|\pi_{nj}\|, n = \overline{1,I}; j = \overline{1,J}.$

4. Let's define a matrix $D = \|d_{j'n}\|,\ j^1 = \overline{m+1,I};\ \overline{m = 1,M}$, a search direction of Y solution by way of logic adding the nonbasic columns of interim matrix $\Pi = \|\pi_{nj}\|$ with basis columns and calculate the value of assessments only by basis positions of the matrix Π.

5. According to the estimates obtained regarding matrix Π we can distribute the B subset elements into B_m subsets. In the result we fix Y solution and a target objective matrix Z whichever indicates the meaning of a target function F (Z).

It should be noted that a problem solution search can be performed by the scheme $DX\ \tilde{D}Y$, and in opposite direction by scheme $\tilde{D}Y\ DX$.

Let's see an example of clustering functional task definition and documents they are used in at designing the automated information systems.

3 Applied task definition example

A stage of technical designing of automated information systems is a most long and complex task. At this stage there is formed an overall functional structure, a composition and a solution sequence of various applications, database structure along with a general system-wide control of a system under design.

A large number of applied problems and complex document management system occurring there comes a need in decomposing the whole system into clusters.

The cluster of applied tasks means a problem union into subsets and a cluster of documents i.e. integration of docs into subsets and defining liaisons between relevant subsets. The relationship between them reflect integrated liaison between clusters.

Works in designing data processing systems and a research made showed a need in decomposing the original system that on a technical stage of designing allows to analyze deeper clusters of tasks and documents, to parallelize the volume of works between designers and select data processing procedures and information elements necessary for the development of applied software and database of automated information systems.

So, as a performance criterion of the original system decomposing process we use a minimum of information liaisons between clusters tasks and documents.

For a mathematical definition of system decomposition we shall introduce the following variables and notations.

Let $A = \{\alpha_i, i = \overline{1,I}\}$ - are a set of processing applied data problems subject to automation; $B = \{b_j, j = \overline{1,J}\}$ - is a set of initial documents used for applied problem solution. So here we have a target matrix $W = \|\omega_{ij}\|,\ i = \overline{1,I},\ j = \overline{1,J}$, where $\omega_{ij} = 1,$ if the j-th initial document is used to solve the i-applied problem of the system and $\omega_{ij} = 0,$ otherwise.

Let's book the variables $X = \|x_{mi}\|,\ m = \overline{1,M},\ i = \overline{1,I}$ - is a variable that reflects the distributed by i-th the applied problems into the m-th cluster (group) tasks. In this case, we have

$$x_{mi} = \begin{cases} 1, \textit{ if } i-th \textit{ applied problem distributed in } m-th \textit{ claster}, \\ 0, \textit{ otherwise}. \end{cases}$$

Similarly, let's book a variable

$$Y = \|y_{jn}\|,\ n = \overline{1,N},\ j = \overline{1,J},\ \text{where}$$

$$y_{jn} = \begin{cases} 1, \textit{ if } j-th \textit{ document is distributed in } n-th \textit{ claster of documents}, \\ 0, \textit{ otherwise}. \end{cases}$$

In some cases at the given stage there are determined tasks and document characteristics. Let's book t_i - the i-th task development time; v_j - volume of the j-th document; c_{ij} - total cost of development of the i-th task and j-th doc; τ_j - development and preparation time of the j-th document; c_i - the development cost of the i-th task; s_j - the preparation cost of the i-th document.

One must break a system into subsets of applied problems and documents they use in order to minimize a liason between the applied task clusters and documents in engineering process of automated systems.

Let's define additional variables in the following way:

$$\alpha_{mj} = \begin{cases} 1, \; if \; \sum_{i=1}^{I} x_{mi} \, \omega_{ij} \geq 1, \\ 0, if \; \sum_{i=1}^{\mathrm{I}} x_{mi} \, \omega_{ij} = 0. \end{cases} \tag{6}$$

This variable reflects the use of the j-th document designed to solve tasks of the *m*-th cluster.

$$\beta_{in} = \begin{cases} 1, \; if \; \sum_{j=1}^{J} \omega_{ij} \, y_{jn} \geq 1, \\ 0, if \; \sum_{j=1}^{\mathrm{J}} \omega_{ij} \, y_{jn} = 0. \end{cases} \tag{7}$$

The variable β_{in} reflects the use of the *n*-th cluster documents during the process of solving the *i*-th problem.

Liaisons between applied task clusters and documents shall be defined in the expression:

$$\gamma_{mn} = \begin{cases} 1, \quad if \; \sum_{i=1}^{I} \sum_{j=1}^{J} \alpha_{mj} \, \beta_{in} \geq 1, \\ 0, \; if \; \sum_{i=1}^{\mathrm{I}} \sum_{j=1}^{J} \alpha_{mj} \, \beta_{in} = 0. \end{cases} \tag{8}$$

The task of clustering a projected automated system can be formulated as follows.

It is necessary to minimize the function of the type

$$\min \sum_{m=1}^{M} \sum_{i=1}^{I} \sum_{j=1}^{J} \sum_{n=1}^{N} x_{mi} \, \omega_{ij} \, y_{jn} \tag{9}$$

And restrictions on:

- adding each applied problem into only one cluster

$$\sum_{m=1}^{M} x_{mi} = 1, \; i = \overline{1, I}; \tag{10}$$

- adding a document into only one cluster of documents

$$\sum_{n=1}^{N} y_{jn} = 1, \; j = \overline{1, J}; \tag{11}$$

- time for engineering each cluster of tasks

$$\sum_{i=1}^{I} t_i \, x_{mi} + \sum_{j=1}^{J} \tau_j \, \alpha_{mj} \leq \mathrm{T_m}, m = \overline{1, M}; \tag{12}$$

- cost of designing each cluster of tasks

$$\sum_{i=1}^{I} c_i \, x_{mi} + \sum_{i=1}^{J} s_j \, \alpha_{mj} \leq \mathrm{R_m}, \; m = \overline{1, M}; \tag{13}$$

- number of applied tasks in a cluster

$$\sum_{i=1}^{I} x_{mi} \leq p_o, \; m = \overline{1, M}; \tag{14}$$

- number of initial documents in a cluster

$$\sum_{j=1}^{J} y_{jn} \leq g_o, \; n = \overline{1, N}. \tag{15}$$

The objective (6-15) refers to the lobe-symmetric problems of discrete programming.

Conclusion

1. There was developed and suggested a new class of problems –lobe-symmetric discrete programming problems, that differ from traditional problem definitions by the following properties: presence of different types of variables, modularize and symmetry.

2. There was designed a new algorithm of iterative mappings with polynomial computational complexity at a target basis enabling to solve practical problems of high dimensionality.

3. The reviewed lobe-symmetric models and methods were used at the problem definition and solution of a number of applied problems.

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Резюме

Қарастырылып отырған мақалада жаңа класс есептерінің қойылымы мен қолданбалы тапсырмаларды шешу: дискретті программалаудың блокты-симметриялық модельдері мен әдістері құрылып, ұсынылып отыр. Белгілі есептерден блоктылығы, симметриялылығы және әртүрлі типтегі айнымалысымен ерекшеленетін блокты-симметриялық есептердің жалпы қойылымы көрсетілген.

Резюме

В работе разработан и предложен новый класс задач постановки и решения прикладных задач: блочно-симметричные модели и методы дискретного программирования. Приведена общая постановка блочно-симметричных задач, отличающаяся от известных задач свойствами блочности, симметричности и наличием различных типов переменных.

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EFFECT OF TEMPERATURE CHANGES OF OIL CARGO ON WEIGHT DURING TRANSPORTATION

The most significant factors that determine the quality of cargo transportation by rail in the Republic of Kazakhstan along with regularity of services and cargo delivery date is safety in operation as well as preservation, that is reduction of losses and damage to cargo. In this regard, the researches on the development and implementation of specific rates of oil and oil products loading during their shipment to North (Pavlodar station) and Southern Kazakhstan (Shymkent station) become important.

Statistic data on temperature conditions of oil handling were gathered at points of loading and unloading for the period of 2010-2011. The analysis of data showed that they subject to normal distribution law pursuant to which the lowest possible cargo temperature at loading point and the highest possible temperature at point of unloading were defined by month with probability P-0,99. Overall results are presented on figures 1, 2.

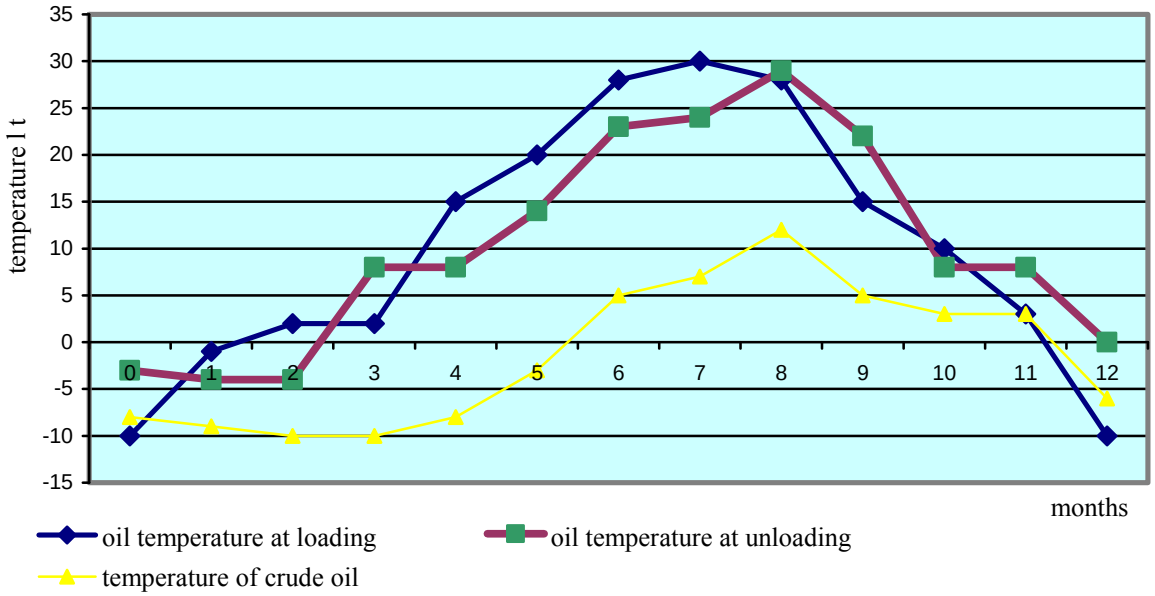

Figure 1. Minimum temperature of crude oil during loading and unloading by month of the year

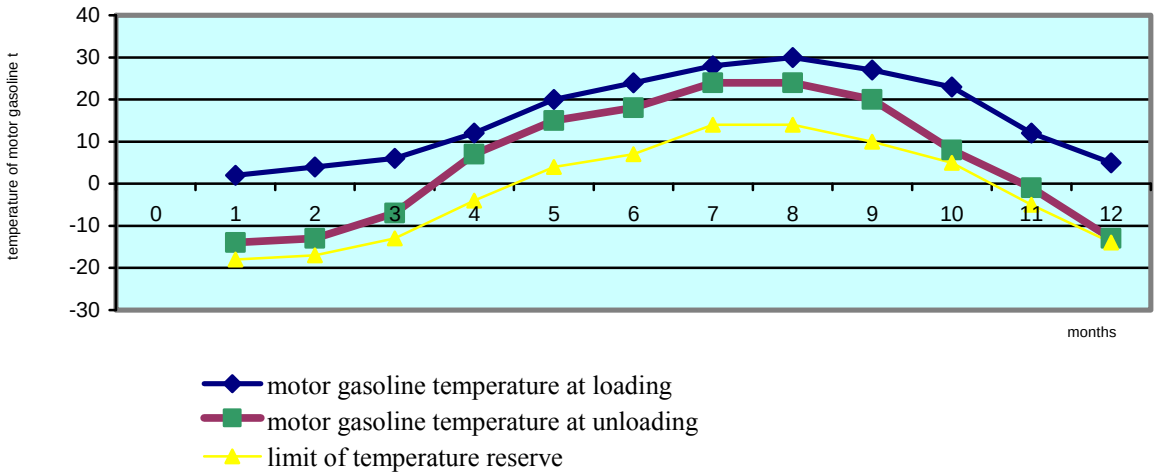

Figure 2. Minimum temperature of gasoline during loading and unloading by month of the year

As seen from the above schedules, temperature difference in loading and unloading of oil products is significantly higher of temperature reserve for their thermal expansion. As a result, transportation cargo losses significantly exceeding natural loss rates of oil products take place.

Analysis of gasoline transportation from Pavlodar station to Shymkent station for the sane period shows that difference between final and initial temperature of oil product during transportation has a major impact on cargo preservation (figure 3).

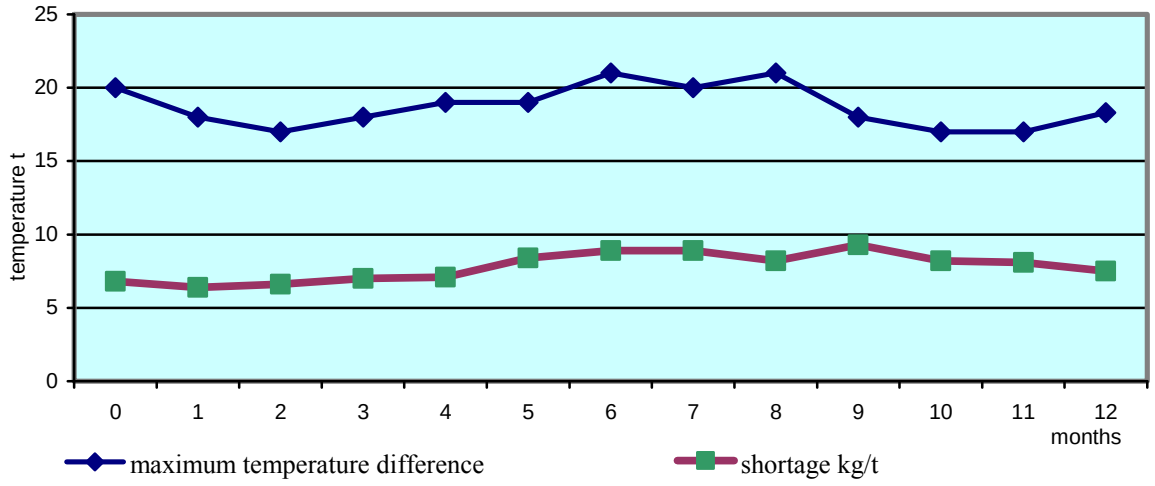

Figure 3. Influence of difference between final and initial temperature of gasoline on losses attributable to one shipped ton in average.

The collected and processed data were confirmed by results of test transportation.

67 four-axle cistern cars loaded with crude oil and 21 four-axle cistern cars loaded with light oil products, all of them with carrying capacity of 50-68 tons were put to test transportation.

Tests were performed in two stages: at loading stations and unloading stations. At loading stations the cistern cars were checked for serviceability both technically and commercially with completing reports. Preparation of cisterns for loading was performed according to the technology accepted at loading station. Loading was carried out in accordance with applicable Rules of Cargo Transportation [1].

Loading height, temperature and product density measurements were performed in accordance with GOST 2517-85, GOST 3900-85, rail tanks calibration schedules [2].

Quality check for hermetization of loading and unloading equipment of cistern cars was conducted after finishing loading at oil stations. Cars loaded with light oil products were sealed with lead.

Check of delivered cistern cars for technical and commercial serviceability with completing reports was made at unloading points, also cargo weight was performed by volume-weight statistical method. As a result of test transportation the following has been established. Loading of cisterns was conducted in compliance with applicable norms of oil products loading. Due to exceeding of final temperature over initial one for 17°C during transportation, the level of cargo was higher for 3-8 cm at the unloading station. In those cars where depreciation of joint packing did not exceed 25% and not less than 6 of 8 bolts were locked on manhole cover, amount of cargo losses ranged from 28 to 1611 kg. Average shortage in the car made 542 kg.

At the same time, the cisterns with incomplete set of closed swing bolts of manhole cover (dome) or with damaged joint packing (cuts, improper joint, depreciation) or its full or partial absence, as well as tilts of the manhole, the deficiency varied from 28 to 2092 kg, and on the sidewall of the tank there were traces of spillage of carried cargo. Average value of deficiency made 732 kg in cistern cars where hermetization was not provided properly.

The reason of cargo loss appears from the exceeding of final temperature of transportation over the initial temperature and as a consequence expansion of the product, its leakage through the manhole cover (dome) and safety valve [3].

At warming-up of the oil products its volume increases, that is thermal expansion, which should be taken into consideration when loading cistern cars. Thermal expansion is characterized by volume expansion factor β, i.e. additional volume to which oil-formation expansion occurs at heating for 1°C [4]. Volume of oil product at heating:

$$V_t = V_н(1 + \beta\Delta t) \quad (1)$$

where $V_н$ — volume of cargo at loading, m^3;
Δt — temperature difference, °C.
We can convert formula (1) to determine initial oil product volume:

$$V_н = \frac{V_t}{1+\beta\Delta t} = \frac{0{,}995V_n}{1+\beta\Delta t} \quad (2)$$

where V_n — full tank volume of the cistern car, m^3;
volume expansion factor β, in accordance with [5], is determined by formula:

$$\beta = \frac{\rho_{15} - \rho_{50}}{35\rho_{50}} \quad (3)$$

where ρ_{15}, ρ_{50} - product density at 15°C and 50°C accordingly, t/m^3 .

It should be noted that the lower density the oil product has at 20°C, the higher volume expansion factor it offers. The lightest oil products such as gasoline and oil have the highest volume expansion factors [6].

In accordance with this procedure the cistern filling ratio is determined in a fraction of the total tank volume.

Implementation of the said standards will allow to greatly reduce transport cargo losses, in addition to decrease probability of occurrence of emergency situations with such cargo in the process of transportation [7].

Calculation of expected economic benefit from reducing costs connected with compensation of oil product deficiency with regard to annual volume of motor gasoline transportation we perform by formula:

$$Э_{возм} = (i_1 - i_2)NP_{ст}Ц_{гр} \quad (4)$$

where i_1 — share of gasoline losses in transported volume according to statistical data;
i_2 — share of gasoline losses during transportation using specific loading rates;
N — average annual volume of gasoline transportation, cars;
$P_{ст}$ — average static loading of cistern car, t;
$Ц_{гр}$ — weighted average price of gasoline
In order to determine i_1, N, $P_{ст}$ we compile table 2, using data presented in table 1.

Table 1. **Average annual data on unpreserved transportation of motor gasoline from Pavlodar station to Shymkent station**

Title of index	Gasoline A-76	Gasoline AI-93	Weighted average value
Quantity of used cisterns N	2240	450	2690
Weight hauled, t	115920,5	24980,4	140900,9
Shortage by standards, kg	34473	7331	41804
Actual shortage, kg	526066	195666	721732
Average load of cistern $P_{ст}$, t	51,7	55,5	52,4
Shortage by standards i_2, kg/t		0,3	
Actual shortage i_1, kg/t	4,5	7,8	5,1

Thus, in prices as of the end of 2011 we receive

$$Э_{возм} = (0{,}0051 - 0{,}0003) \cdot 2690 \cdot 52{,}4 \cdot 7200 = 4871{,}4 \text{ thous. calculation indexes}$$

Calculation index is the coefficient for calculation of payments in accordance with the laws of the Republic of Kazakhstan established by the budget act for certain year. Any money depreciates over time. If

you prescribe a fixed amount in tenge, these amounts subject to changes over time due to inflation. Therefore, instead of indicating specific amounts this factor is used. The size of CI is estimated in planning and budgeting process, based on the expected amount of inflation in the coming year.

Conclusion. One of the most important factors determining the quality of transportation of oil products are safety and security. On conditions for the transport of liquid cargo in bulk in tank cars is significantly affected by the change in temperature of the surrounding air and the effects of solar radiation. The analysis showed that the transport of oil and oil products from North regions to the Southern regions, there is a definite relationship between the loss of cargo and temperature conditions of loading, transportation and unloading. Implementation of evidence-based filling volumes of oil and oil products will allow to make the best use of technology and transportation industries, safety of transported cargo and rail-road traffic safeguarding.

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Резюме

Мұнай өнімдерін тасымалдау кезінде негізгі факторларының бірі тасымалдау қауіпсіздігі және сақталуы. Сұйық жүктердің тасымалдау шартына күн сәулесінің және қоршаған ауаның температурасының өзгерістері әсер етеді. Мұнай өнімдерін оңтүстік аудандардан тасымалдау кезінде жүктің салмағының өзгерістерімен және температуралық шарттардың байланысы анықталды. Ғылыми зерттеу арқылы мұнайдың керекті құю көлемін және көліктің техникалық құрылғыларын қолайлы пайдалану шарттары көрсетілген. Мұнай өнімдерінің қауыпсіз тасымалдау шарттары көрсетілген.

Резюме

Одними из важнейших факторов, определяющих качество перевозок нефтяных грузов являются безопасность и сохранность. На условия перевозок жидких грузов наливом в вагонах-цистернах существенное влияние оказывает изменение температуры окружающего воздуха и воздействие солнечной радиации. Анализ показал, что при перевозках нефти и нефтепродуктов на Южные регионы существует определенная зависимость между потерями грузов и температурными режимами налива, транспортирования и слива. Внедрение научно обоснованных объемов налива нефти и нефтепродуктов позволит обеспечить оптимально использование технических средств транспорта и промышленных предприятий, сохранность перевозимых грузов и безопасность движения поездов.

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ELABORATION OF A NEW WAY OF OPENING AND EXPLOITATION OF HYDROGENIC URANIUM DEPOSITS

Elaboration of any hydrogenic uranium deposit is carried out by the most simple, highly effective and original method of drillhole in situ leaching. Basically this leaching method can be applied with success to manufacture of nonferrous metals in conditions of both underground and open-cast mining of their deposits.

Boreholes are the basic technical constructions providing injection of a chemical or biochemical solution, management of process of its filtration in a solid mass of a hydrogenic strata, processes of uranium leaching and output of product solutions to extraction wells on a daylight area for their processing. Thus, the system of the boreholes of different function drilled from the daylight area in depth to hydrogenic strata is represented in an image of underground mine.

For developing of hydrogenic uranium deposits, injection of biochemical solutions, and also pumpings out of product solutions are conducted vertical wells. According to the destination they are subdivided into the following: technological, observant, control and special.

The injection wells are wells through which the working solution consisting from usually sulfuric solution (H_2O + n% H_2SO_4+ microorganisms (Thiobacillus ferrooxidans) chutes in hydrogenic strata.

The extraction wells are wells through which the product solution is got out froum productive horizon on a daylight area.

In practice of exploitation of hydrogenic uranium deposits the injection and extraction wells can be applied as the extraction wells, and injection wells as the extraction wells, in other words each production well can be used in the capacity of both injection and extraction wells. Thus, reversing is carried out – change of a direction of working solutions movement in productive horizon on a angle of 180° for the increasing degree of valuable elements extraction from bowels.

Depending on a production well location the developing scheme of exploitation fields of hydrogenic uranium deposits is defined.

In practice of hydrogenic uranium deposits exploitation are adopted the following schemes of production well location: linear (or in-line), the areal (or cellular) and combined.

Linear systems of well location (fig. 1) consist of deposit rows area of consistently alternating injection and extraction wells. Depending on a filtration coefficient and uniformity of solid ore, the distance between rows and wells in rows fluctuate in extended limits (15-50 m and more). The winning cell usually consists of two injection and one extraction wells, belonging to three consistently located rows.

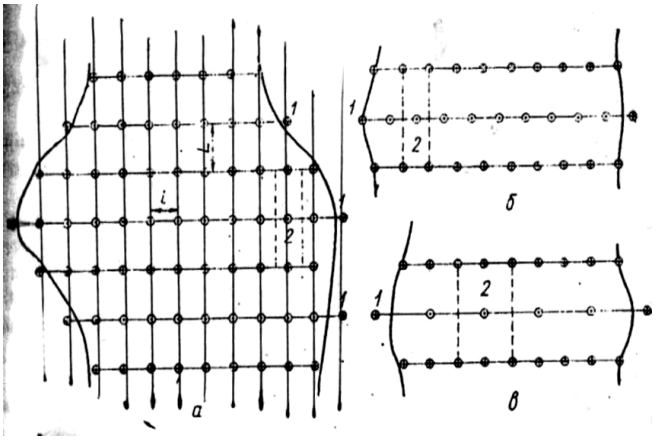

Figure 1*. Linear system of production well location

a- rectangular; b- staggered; c- a ratio of the number of extraction wells to the number of injection wells is ½, 1/3 et cetera; 1- lock well; 2- the winning cell; the distance between rows – L, between wells – l.

* The figure 1 was adopted from the paper [1]

As well as now, linear systems of well location were widely applied on uranium deposits in the USSR. They are most effective in development of the extensive hydrogenic uranium deposits composed of aqueous, well water-permeable (K_f > 1,0 m/days) ores and formations and being in difficult hydro-geological conditions.

It was established by researches [1] that the linear system with staggered well location is optimum in ratio 1:2 of the distance between wells in rows to the distanced between rows is the most favorable, the least favorable – system with a rectangular location of wells with correlation of distance in 1:1.

On pages 349-350 of this paper [2] it is noticed that in the domestic industry is mainly applied the scheme of alternating linear rows of injection and extraction wells with a 15-40м distance between wells in rows, 30-80м between rows. It is the scheme of a well location possesses the big advantage – it is a simplicity of a construction and its exploitation. The ore deposits extended in respect of the form with good indicators of permeability is most favorable for such technological network. Depending on particular conditions rows can be spaced along the strike or in a cross to the girtwise. Under conditions of equal outputs of extraction and injection wells ($Q_0 = Q_3$) the distance between wells in rows is also accepted as identical (fig. 2.1).

If outputs of extraction and injection wells are not equal, injection wells in rows is spaced more than extraction wells, and number both type of wells are in inverse ratio to their outputs (fig. 2.2).

"The three-row" system of wells is applied at exploitation of the narrow extended deposits in width up to 100-150м, i.e. extraction row is spaced down on the deposit axis, two injection rows– in the right and left of its parties (fig. 2.3). "Single-row" system of alternating extraction and injection wells is applied if the width of a deposit makes 40-80м (at sufficient permeability). (fig. 2.4).

Hexagonal, triangular and rectangular cells concern the areal (cellular) system of wells.

Square pattern with alternating extraction and injection wells can be applied for the isometric form ore deposits with relatively low permeability parameters, which also allows to recover equal outputs of wells ($Q_0 = Q_3$) (fig. 2.5). It is expedient to use hexagonal grid of injection wells with extraction well in the center of each cell for ore deposits with the difficult wrong form with low parameters of permeability (fig. 2.6). The correlation of outputs in such scheme is $Q_0 = 2Q_3$, and in the exploitation systems of shaftless in situ leaching the number of extraction wells is twice less than injection wells.

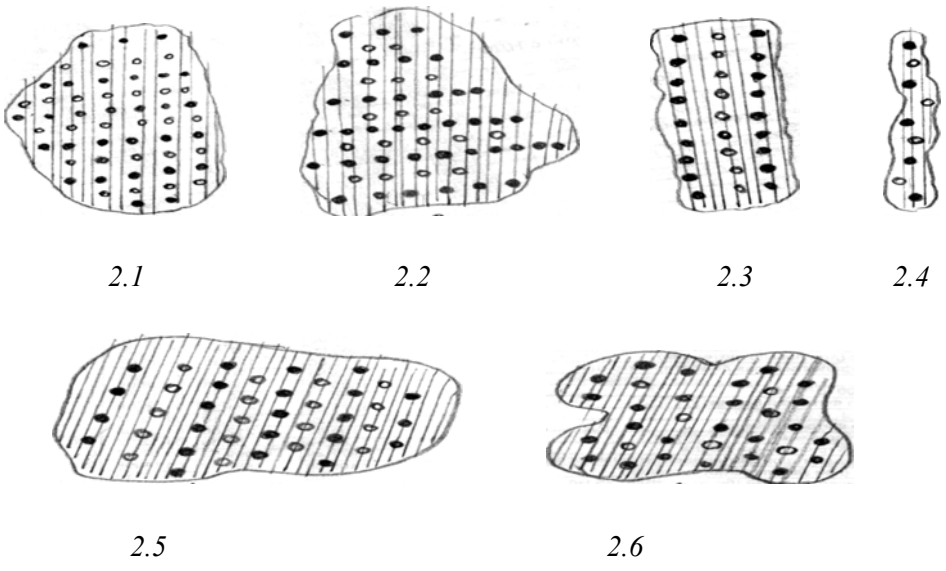

Figure 2*. The main schemes of production well location
*Hatched counter line– ore deposits, wells o – extraction wells, • - injection wells**

* The figure 2 was adopted from the paper [2]

In the paper [3] on page 168 are noticed that the second possible variant of increase of inter-well distances in extraction row to 40-50 m inevitably leads to formation of the considerable not elaborated "dead" area among extraction wells which total area can reach 30 % from the area of the operational block. Therefore the only adoptable decision, in particular hexagonal scheme, providing the ratio of the injection wells to the extraction wells at level 2,5÷4:1, is application of cellular schemes of deposit opening for the deep mine development (depending on the size of deposits) and simultaneously increase the inter-well distances in injection. Long-term successful exploitation of Northern Karamurun deposits is clear example of using of wells hexagonal grid with 40-50м radius as basic scheme of opening.

The combined scheme of production wells opening concern group of systems with the use of horizontal and vertical sealing curtains for limitation of leaching reagent spreading in horizontal and vertical directions – hydro sealing curtains and hydraulic formation fracturing for the purpose of creation of an artificial permeability barrier.

In the paper [1] on page 117 authors notice that the areal (cellular) systems of well location (fig. 3) is usually applied for deposit developing confined to aqueous stratified non-uniform ores and horizontal or low-inclined foldings formation, in condition of relativelty low water permeability of ores ($\kappa_f \approx 0{,}1 \div 1$ m/days). These systems represent uniform alternation of extraction and injection wells on the deposit area, forming cells among themselves (triangular, square, hexagonal, etc.) with small inter-well distances (8÷20 m). In Soviet Union the cellular well location was seldom applied.

The areal (cellular) schemes of well location will find wide application at the further involving in developing by drill-hole in situ leaching method more difficult in the morphological relation ore deposits with relatively low coefficients of filtration (up to 1 m/days), the big variability of physical and chemical properties of ores and containing formations, with the use high output pumps for extraction of solutions.

In the paper [3] on page 350 it is noticed that cellular systems of wells are less extended in domestic practice. So the breadboard model for ore deposits of the isothermal form with rather low, but allowing to recover equal outputs of wells parameters of permeability ($Q_o \approx Q_з$) is accepted by a square grid of alternating extraction and injection wells.

It is expedient to use hexagonal grid of injection wells with extraction well in the center of each cell for out of shape irregular form ore deposits with low parameters of permeability. A correlation of outputs in such scheme is $Q_o = 3Q_з$. The number of extraction wells is twice less than injection wells.

There are other possible arrangements of production wells in particular, triangular and pentagonal cells. There is a method of in situ leaching of stratified infiltration deposits of metals with a help of hexagonal drill hole leaching circuit, which we adopted as a prototype:

Patent of the Republic of Kazakhstan (19) KZ (13) B (11) 15192

(51) E21B 43/28 (2006.01)

(64) KZ(A) №15192. 15.12 2004 b. 12

(72) Yazikov V.T., Rogov Ye.I., Kaipbayev D.

(54) The method of in situ leaching of stratified infiltration deposits of metals.

In the method of in situ leaching of stratified infiltration deposits of metals including drilling-wells with a hexagonal system of their distribution, supply of leaching solution into injection wells and diversion of productive solution through the extraction well according to the invention, the second row of the border injection wells of hexagonal cells used in the reverse mode (Fig. 3). During the time T, is used as injection wells, after a period of time T is used as the extraction wells.

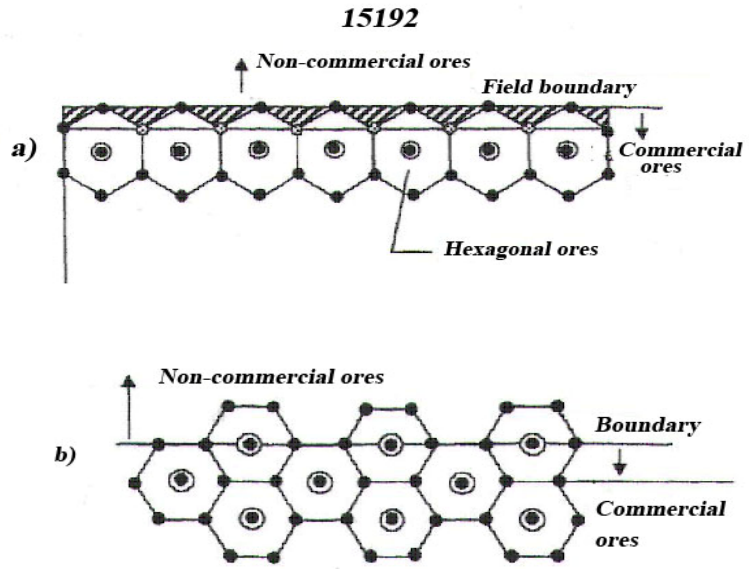

Figure 3

– not elaborated SR sites;
– extraction wells;
• – injection wells;
O – drill holes with reversing SR.

Further, the authors of this patent note that "... so, when working on the proposed new technical solution, the second row of injection wells of hexagonal cells 773 days will work as injection and then the time To = 470 days - as extraction that reduces the metal loss during the extraction of its in situ leaching."

The disadvantages of this patent are:

1. The use of the hexagonal system of wells location leads to the worst case of linear systems use of production wells location.

2. The second row of injection wells of hexagonal cells will act as 773 injection days, and then the same wells will work as 470 extraction days. In this case, there is a large number of the chemical solutions leaching loss.

3. Layout diagram of hexagonal cells (Fig. 3a and Fig. 3b) is the linear systems injection and extraction of the worst type wells location, as one linear row of extraction wells (Fig. row 3) served by four rows (Fig. 1.2, 4 , 5) of injection wells, which shows absurd technical solutions.

From the above brief annotations on the works of the CIS countries leading scientists in the field of hydrogenic deposits of uranium, it is clear, that the general acceptance to use of cellular well (hexagonal, triangular, rectangular cells) location systems during the development of hydrogenic deposits of uranium.

This kind of production wells location layout's separation (injection and extraction wells), used for the opening and operation of hydrogenic uranium deposits, is erroneous.

All area systems (hexagonal, triangular, rectangular) are linear systems of the worst type, the use of which in the construction and operation of uranium mines causing large-scale damage.

Proof

Figure 4* shows the area (cellular) system location of production wells: a - hexagonal cells, b - triangular cell.

Draw the lines, connecting all injection and extraction wells. We get in straight lines parallel to each other, i.e. on hexagonal cells we get straight lines (rows) 1, 2, 3, ..., 11, which are parallel. In this case, on the lines of the right and left sides of 3, 6 and 9 extraction wells there are two injection lines, on which injection wells are located in a checkerboard pattern (Fig. 2).

* The figure 2 was adopted from the paper [1]

All injection rows (1, 2, 4, 5, 7, 8, 10, 11) and extraction rows (3, 6 and 9) can be shown in the plan (Fig. 4) get the linear system of production wells location, each row of extraction wells (3, 6 and 9) is provided on the right and left rows of extraction wells (3), (6) and (9) are located by 2 rows of injection wells 1.2 - 4.5, 4.5 - 7.8; 7.8 - 10.11.

Similarly, we obtain the linear systems of wells location from triangular system (Figure 4).

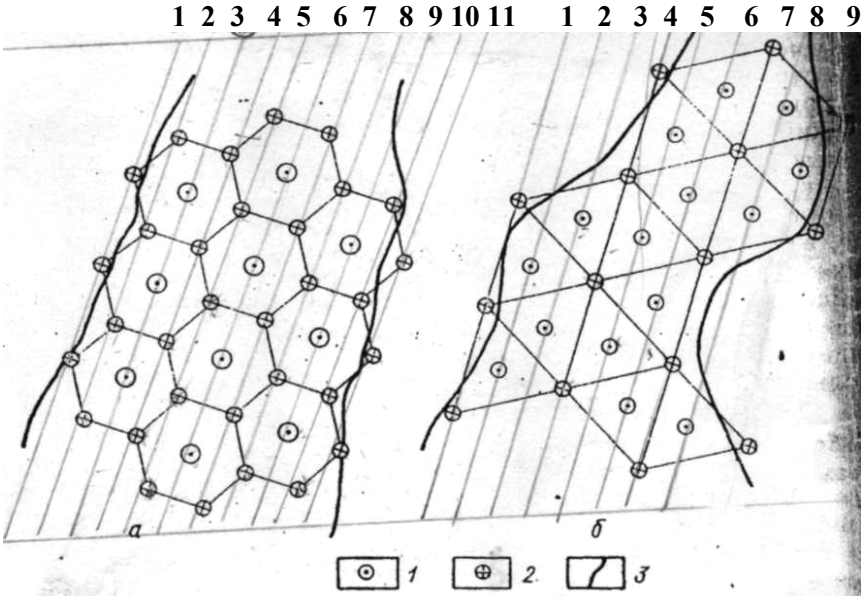

Figure 4. Cellular location of wells:
a - hexagonal cell, b - a triangular cell, 1 - extraction wells;
2 – injection wells 3 - outline of the ore deposit

From Figure 4 it is clear that at hexagonal system of production wells location around one row of extraction wells there are 4 rows of injection wells, and at the triangular system of production wells location around two rows of extraction wells there are two injection rows, i.e. between two injection rows there are two series of extraction wells.

From these figures it is seen that the hexagonal and triangular systems of wells location are nothing more than a linear systems.

Around two rows of extraction wells there are one row of injection series in each located.

In the first case, the ratio of the extraction wells number to the number of injection wells is 1:4, in the second case, the ratio is 2:2.

In all cases on practice, in terms, when the coefficient of filtration Kf> 5m/sutki, the ratio should be 1:1 or 1:2, i.e. one row of extraction wells served by two rows or one row of injection wells.

Thus, in the above first case, two rows of injection wells become redundant, and in the second case, one row of extraction wells of the two became unnecessary.

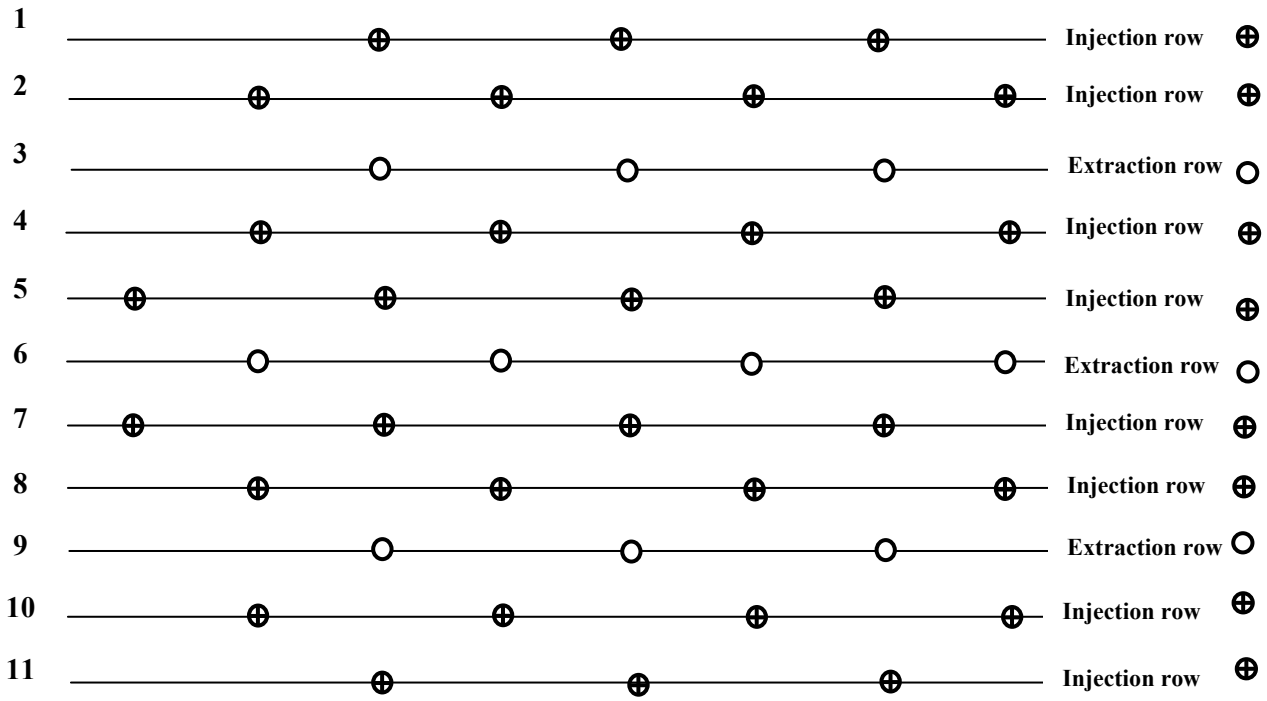

Figure 5

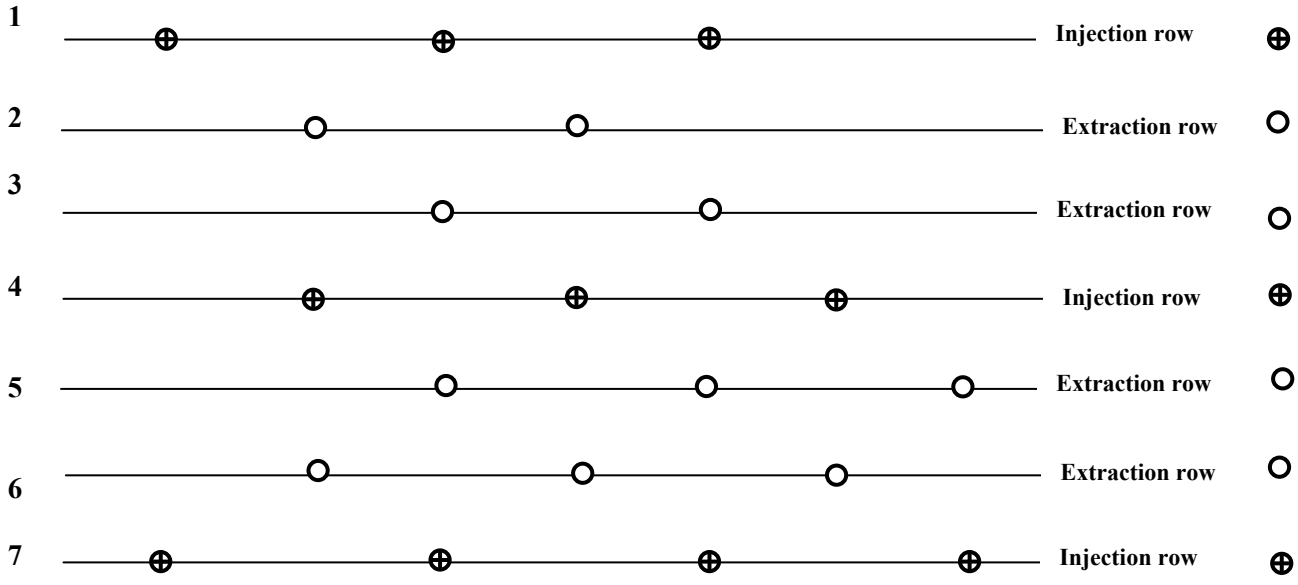

Figure 6

As explained by Kazatomprom [5] about successful development of Kazakhstan uranium mines, there is no information about use of bacterial leaching method in the process of uranium productive solutions mining.

According to references, use of uranium bacterial leaching allows to accelerate leaching process in 100 times more, than at the chemical one.

The bacterial leaching represents the most ecologically harmless technology, which in the long term can become the most cost-effective technology of metal extraction from ores.

High efficiency of use of gold bacterial leaching method from ore can be shown by the following example. In October, 2001 the gold mining company "The Polyus" reported that the Russia's first technological

complex on gold extraction from ore by means of special bacteria is put in commission to one of the largest in the country "Olimpiadinskoye" field, located in 600 km to the North from Krasnoyarsk. Since 2002 annually the Polyus company gives 30 tonnes of gold to the country. It's approximately the fifth part of all precious metal, extracted in Russia. If 720 gold mining companies across Magadan region mine 30 tonnes of gold in a year, the Polyus company takes the place of 720 companies, thanks to use of bacterial leaching technology. The Polyus company has employed 1000 people, and similar western or Russian companies – 11000 workers each.

Annually in the USA 300 thousand tonnes of copper and 4 thousand tonnes of uranium are extracted by leaching method. Researches on mining of Cu, Zn, Pb, Mn and other metals by leaching method are widely conducted.

Also Kazatomprom officially declared that "depending on a configuration of an uranium ore body two various types of ranges opening can be used: linear or hexagonal".

At initial uranium mines development and their exploitation, use of hexagonal system of production wells arrangement causes large-scale economic damage and that is inadmissible.

Conclusion

This research is devoted to development of a new method of hydrogenic uranium deposits opening and exploitation.

The core of this method is to reduce time of leaching, cut down the cost of production wells construction, economic efficiency increase of extraction of metals product solution by a drillhole in situ leaching.

The technical result of a proposed method is to reduce the number of production wells twice, to product solution with a high concentration and to decrease the losses of biochemical solution.

The technical result is achieved in that opening and exploitation of hydrogenic deposits by the method of the drillhole in situ leaching, is carried out by system of production wells with the linear network and use of each production well at the same time as the injection and extraction wells, so-called "piston wells", by means of which for some time discharge (pumping in) and recharge (pumping off) are carried out cyclically (repeatedly), forming the pulsed filtration flow of biochemical solution in the massif of the hydrogenic deposits, that accelerates the process of uranium leaching and increase of its concentration in the productive solution, which is pumped out on a day surface for processing, and also the minimum losses of biochemical solutions are ensured.

The distance between the piston wells, located on a linear series and between rows, is defined depending on the pressure head, under which biochemical solution to the massif of a hydrogenic deposit moves, and filtration coefficient of this massif.

For sake of brevity, proposed technology of leaching it is possible to call a *method of the piston wells*, which will allow to gain large-scale economic effect by reduction of technological wells quantity twice, i.e. by means of abandoning of injection wells linear rows, and acceleration of biochemical leaching process of uranium from the hydrogenic massif, and also decrease losses of biochemical solution and increase of uranium concentration and other valuable elements.

Executive summary:

1. The new method of drillhole in situ leaching of various valuable elements, among them uranium from the massifs of the hydrogenic deposits, including their opening and exploitation by system of technological wells is developed, characterized in that the linear system of "piston" wells (i.e. without rows of injection wells) is applied, by means of which for some time discharge (pumping in) and recharge (pumping off) are carried out cyclically (repeatedly), forming the pulsed filtration flow of biochemical solution in the massif of the hydrogenic deposits, that accelerates the process of uranium leaching and increase of its concentration in the productive solution, which is pumped out on a day surface for processing

2. Areal systems (hexagonal, triangular, etc.) are linear systems of the worst type, which bring enormous both economic and material damage.

3. Unlike the conclusions of Kazatomprom that "depending on a configuration of an uranium-mining body, two various types of ranges opening can be used: linear or hexagonal" [5], we consider that it is neces-

sary to refuse use of hexagonal system of technological wells arrangement when opening ranges, as unsuitable, bringing enormous damage in economic and social spheres.

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Резюме

Жұмыстың негізгі мақсаты гидрогендік уран кен орындарын ашу және пайдаланудың жаңа тәсілін іске асыру болып табылады.

Бұл жұмыстың негігі мақсаты сүзектеу процесінің уақытын қысқарту, технологиялық скажиналарды құруға кететін шығындарды азайту,металдарды сүзбелеу әдісімен алу процесінің экономикалық тиімділігін артыру.

Тәсілдің техникалық нәтежесі технологиялық скважиналардың санын екі рет азайту, өнімділік сілтелерінің концентрациясын өсіру және шығындарын азайту болып табылады.

Резюме

Данная работа посвящена разработке нового способа вскрытия и эксплуатации гидрогенных месторождений урана.

Сущность данного способа заключается в сокращении времени выщелачивания, снижении затрат на сооружение технологических скважин, повышении экономической эффективности извлечения продуктивного раствора металлов подземным скважинным выщелачиванием.

Технический результат предлагаемого способа заключается в сокращении количества технологических скважин в два раза, получении продуктивного раствора с высокой концентрацией и уменьшении потерь биохимического раствора.

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УДК 669.1(075)

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PROGRAM TRAJECTORIES SYNTHESIS OF ROBOT MANIPUPULATOR BY USING OF LANGRANGE INTERPOLATION POLLYNOMIALS

Keywords. Manipulating robot, degree of mobility, generalized coordinate, direct and inverse kinematics problem, program trajectory.

Introduction. Let us consider the motion of the manipulating robot gripper along a given circle. It is necessary to define the program trajectory by degrees of the robot mobility. It is proposed to interpolate trajectory programming Lagrange polynomials.

Given a manipulation robot (MR), which has three levels of movability, the first one, rotating around the axis OZ, the second 2 and third 3, rotating around a straight line parallel to the plane OXY (Figure 1). In this case, generalized coordinates are the angles of rotation, marked as φ_1, φ_2, φ_3.

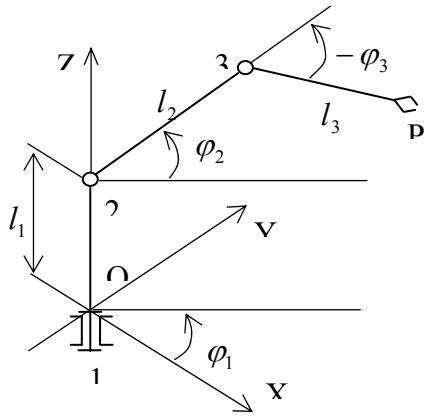

Figure 1

Let us determine the conventional sizes of MR links for the synthesis of program trajectory, which are equal to $l_1 = 3$, $l_2 = 6$, $l_3 = 4$ decimeter respectively. The limits of change of generalized coordinates will be the following $-90^\circ \le \varphi_1 \le 90^\circ$, $0 \le \varphi_2 \le 180^\circ$, $0 \le \varphi_3 \le 90^\circ$.

Let us suppose that it is required to perform (make) MR movement along the radius $R = 2$ decimeter, located at the height of $l_1 = 3$ decimeter, perpendicular to the OXY plane. The center of the circle is located at the point with coordinates $x_O = 7$, $y_O = 0$, $z_O = 3$ decimeter, respectively.

The given circle will be indicated with eight points at the circle, which are presented in Figure 2.

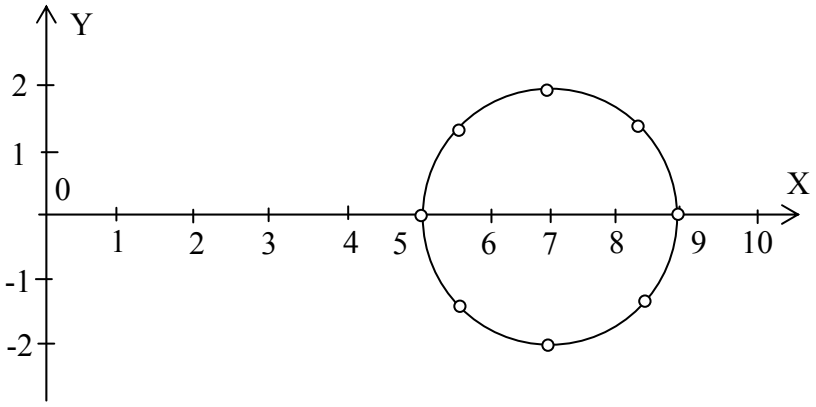

Figure 2. Indicated circle, along which the MR circumference is to move.

The coordinates of eight points indicated in the circle (Figure 2) are summarized in Table 1.

Table 1

The coordinates of indicated circle

Points coordinates	Number of points indicating circle							
	1	2	3	4	5	6	7	8
x_P	5	$7+\sqrt{2}$	7	$7-\sqrt{2}$	9	$7+\sqrt{2}$	7	$7-\sqrt{2}$
y_P	0	$\sqrt{2}$	2	$\sqrt{2}$	0	$-\sqrt{2}$	-2	$-\sqrt{2}$
z_P	3	3	3	3	3	3	3	3

To determine the law of change of generalized coordinates in level of the MP mobility, it is a necessity initially to solve the inverse kinematics problem. For the MR, which has three level movability, inverse kinematics problem is solved in an analytical way, using the following equations [1]:

$$\left.\begin{aligned}
&\varphi_1 = arctg\,(y_p / x_p);\\
&\varphi_2 = arctg\,\frac{z_p - l_1}{(x_p^2 + y_p^2)^{1|2}} \pm \arccos\frac{l_2^2 - l_3^2 + x_p^2 + y_p^2 + (z_p - l_1)^2}{2l_2[x_p^2 + y_p^2 + (z_p - l_1)^2]^{1|2}};\\
&\varphi_3 = \pm[\pi - \arccos\frac{l_2^2 + l_3^2 - x_p^2 - y_p^2 - (z_p - l_1)^2}{2l_2 l_3}].
\end{aligned}\right\}. \qquad (1)$$

As a result of solving the inverse problem, the figures of generalized coordinates are obtained according levels of the MR mobility, which are summarized in table 2.

Table 2

The figures of generalized coordinates for positioning the gripper in the indicated circle points

Points coordinates	Number of points indicating circle							
	1	2	3	4	5	6	7	8
φ_1	0	14,2148	15,953	9,546	0	-9,546	-15,953	-14,2148
φ_2	41,43	39,718	33,337	25,006	20,752	-25,006	-33,337	-39,718
φ_3	124,2	113,023	88,759	64,263	52,76	-64,263	-88,759	-113,023

To verify the results of the inverse problem, there is solved the direct problem of kinematics and compared the obtained points positioning the MR gripper with indicated points of the circle. In this case, the direct kinematics problem is solved by the following equations [1]

$$\left.\begin{aligned}
&x_p = l_2\cos\varphi_1\cos\varphi_2 + l_3\cos\varphi_1\cos(\varphi_2 - \varphi_3);\\
&y_p = l_2\sin\varphi_1\cos\varphi_2 + l_3\sin\varphi_1\cos(\varphi_2 - \varphi_3);\\
&z_p = l_1 + l_2\sin\varphi_2 + l_3\sin(\varphi_2 - \varphi_3).
\end{aligned}\right\}. \qquad (2)$$

Next, let's perform interpolation of generalized coordinates values $\varphi_1, \varphi_2, \varphi_3$ by the lagrange polynomials [2,3]. We consider in detail the procedure for the first generalized coordinate φ_1. Knowing the generalized coordinates values in nodal points, we form the lagrange polynomial as follows:

$$\varphi_1(t) = 0\cdot\frac{(t-1)\cdot(t-3)\cdot(t-4)\cdot(t-5)\cdot(t-6)\cdot(t-7)\cdot(t-8)}{(0-1)\cdot(0-3)\cdot(0-4)\cdot(0-5)\cdot(0-6)\cdot(0-7)\cdot(0-8)} + (-14,2148)\cdot$$
$$\frac{(t-0)\cdot(t-3)\cdot(t-4)\cdot(t-5)\cdot(t-6)\cdot(t-7)\cdot(t-8)}{(1-0)\cdot(1-3)\cdot(1-4)\cdot(1-5)\cdot(1-6)\cdot(1-7)\cdot(1-8)} +$$
$$14,2148\cdot\frac{(t-0)\cdot(t-1)}{(3-0)\cdot(3-1)}\frac{(t-4)\cdot(t-5)\cdot(t-6)\cdot(t-7)\cdot(t-8)}{(3-4)\cdot(3-5)\cdot(3-6)\cdot(3-7)\cdot(3-8)} +$$
$$(-15,953)\cdot\frac{(t-0)\cdot(t-1)\cdot(t-3)\cdot(t-5)}{(4-0)\cdot(4-1)\cdot(4-3)\cdot(4-5)}\frac{(t-6)\cdot(t-7)\cdot(t-8)}{(4-6)\cdot(4-7)\cdot(4-8)} +$$
$$15,953\cdot\frac{(t-0)\cdot(t-1)\cdot(t-3)\cdot(t-4)\cdot(t-6)\cdot(t-7)\cdot}{(5-0)\cdot(5-1)\cdot(5-3)\cdot(5-4)\cdot(5-6)\cdot(5-7)\cdot}\frac{(t-8)}{(5-8)} +$$

$$+(-9{,}546)\cdot\frac{(t-0)\cdot(t-1)\cdot(t-3)\cdot(t-4)\cdot(t-5)\cdot(t-7)\cdot(t-8)}{(6-0)\cdot(6-1)\cdot(6-3)\cdot(6-4)\cdot(6-5)\cdot(6-7)\cdot(6-8)}+9{,}546\cdot$$
$$\times\frac{(t-0)\cdot(t-1)\cdot(t-3)\cdot(t-4)\cdot(t-5)\cdot(t-6)\cdot(t-8)}{(7-0)\cdot(7-1)\cdot(7-3)\cdot(7-4)\cdot(7-5)\cdot(7-6)\cdot(7-8)}+0\cdot\frac{(t-0)\cdot(t-1)\cdot(t-3)\cdot}{(8-0)\cdot(8-1)\cdot(8-3)\cdot}$$
$$\times\frac{(t-4)\cdot(t-5)\cdot(t-6)\cdot(t-7)}{(8-4)\cdot(8-5)\cdot(8-6)\cdot(8-7)}.$$

Next we determine value $L_i(t)$

$$L_0(t)=0;$$
$$L_1(t)=-0{,}0028204\cdot t^7+0{,}09307\cdot t^6-1{,}255\cdot t^5+8{,}842\cdot t^4-34{,}279\cdot t^3+$$
$$+69{,}246\cdot t^2-56{,}8592\cdot t,$$
$$L_2(t)=-0{,}01974\cdot t^7+0{,}612\cdot t^6-7{,}601\cdot t^5+47{,}876\cdot t^4-158{,}218\cdot t^3+$$
$$+250{,}022\cdot t^2-132{,}671\cdot t,$$
$$L_3(t)=-0{,}05539\cdot t^7+1{,}662\cdot t^6-19{,}831\cdot t^5+118{,}986\cdot t^4-370{,}974\cdot t^3+$$
$$+549{,}398\cdot t^2-279{,}186\cdot t,$$
$$L_4(t)=-0{,}06647\cdot t^7+1{,}928\cdot t^6-22{,}135\cdot t^5+127{,}295\cdot t^4-379{,}826\cdot t^3+$$
$$+540{,}824\cdot t^2-268{,}019\cdot t,$$
$$L_5(t)=-0{,}02651\cdot t^7+0{,}742\cdot t^6-8{,}219\cdot t^5+45{,}607\cdot t^4-131{,}756\cdot t^3+$$
$$+182{,}745\cdot t^2-89{,}092\cdot t,$$
$$L_6(t)=-0{,}009469\cdot t^7+0{,}256\cdot t^6-2{,}737\cdot t^5+14{,}744\cdot t^4-41{,}573\cdot t^3+$$
$$+56{,}592\cdot t^2-27{,}273\cdot t,$$
$$L_7(t)=0.$$

Then we obtain interpolation polynomial in following way:

$$\varphi_1(t)=-0{,}1804\cdot t^7+5{,}293\cdot t^6-61{,}779\cdot t^5+363{,}352\cdot t^4-$$
$$-1116{,}627\cdot t^3+1648{,}829\cdot t^2-853{,}1014\cdot t.$$

Similarly, we can get the interpolation polynomials and other generalized coordinates:

$$\varphi_2(t)=-0{,}411\cdot t^7+12{,}075\cdot t^6-141{,}292\cdot t^5+834{,}197\cdot t^4-$$
$$-2580{,}135\cdot t^3+3856{,}4102\cdot t^2-2061{,}994\cdot t+41{,}4306,$$
$$\varphi_3(t)=-1{,}098\cdot t^7+32{,}302\cdot t^6-378{,}4906\cdot t^5+2238{,}408\cdot t^4-$$
$$-6938{,}001\cdot t^3+10400{,}169\cdot t^2-5590{,}514\cdot t+124{,}2.$$

The resulting interpolating polynomials are program trajectory in levels of the mobility of the 3-power manipulation robot, providing movement of gripper along the given circle.

Conclusion. Thus, the program trajectory synthesis problem can be represented by the following procedure. Let us to resolve the inverse kinematics problem for a given point of the circle. As the result, there will be determined the values of generalized coordinates by degrees of the robot mobility. The obtained values of the generalized coordinates are interpolated lagrange polynomials. The resulting polynomials are analytic description of the trajectory programs by degree of the considered robot mobility.

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Резюме

Бұл жұмыста шеңбер түрінде берілген траектория бойымен қармау қозғалысына арналған үш қозғалыс дәрежесі бар монипуляциялық роботтың бағдарламалық траекторияларына талдау сұрақтары қарастырылған.

Резюме

В работе рассмотрен вопрос синтеза программной траектории манипуляционного робота имеющего три степени подвижности для движения схвата вдоль заданной траектории в виде окружности.

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• CHEMICO-METALLURGICAL SCIENCES

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SYNGAS PRODUCTION FROM BIOGAS OVER THE BIMETALLIC Co-CONTAINING CATALYST

Introduction

Syngas (mix of H_2 and CO) is a source for the production of many chemical and petrochemical compounds like methanol, other oxygenates, and Fisher-Tropsch synthesis products, also it is used for reduction of iron ore [1-3]. The main methods of syngas production are coal gasification, methane conversion, and partial oxidation of hydrocarbons [3]. Natural gas is the basic source for methane [4]. Besides, biogas contains of methane. Since, the geographical location and hydrocarbon sources availability predetermine the syngas production from the traditional sources biogas is represented as a more universal type of source.

Biogas can be produced by anaerobic fermentation of biomass such as different wastes of human economic activity or the specific cultures. The main components of biogas are methane (45-70%) and carbon dioxide (30-45%) with non-significant admixtures of hydrogen sulfide and sulfur oxide [5].

The main industrial technologies for methane conversion are steam reforming, partial oxidation and dry (CO_2) reforming (equations 1-3 respectively) [6]:

$$CH_4 + H_2O = CO + 3H_2 \qquad \Delta H = +206 \text{ kJ/mol} \qquad (1)$$

$$CH_4 + 1/2O_2 = CO + 2H_2 \qquad \Delta H = -35.6 \text{ kJ/mol} \qquad (2)$$

$$2\,CH_4 + CO_2 = 2CO + 2H_2 \qquad \Delta H = +247 \text{ kJ/mol} \qquad (3)$$

Practically only steam reforming (1) is industrially used. The Ni-based catalyst is used for the process under elevated temperatures (700-900^{0}C) [7]. As regards the reaction (2), Shell has developed the non-catalytic technology carried out at the high temperatures (1100-1300^{0}C), which was implemented at the small plant in Malaysia [8-9]. Process on a base of reaction (3) is still at a laboratory and pilot level. It should be noted that dry reforming of methane or carbon dioxide conversion has an especial interest because allows utilizing both green-house gases – methane and carbon dioxide [10-11]. From this point of view biogas represents an ideal source for carbon dioxide reforming of methane.

According to stoichiometry of the reaction 3, in biogas with the content of carbon dioxide is less than 50% oxygen is in deficiency for appropriate syngas production. For example for Fischer-Tropsch synthesis syngas should has a ratio of H_2/CO~2. In this case the combination of two reactions: steam and dry reforming allows providing methane conversion with producing syngas with high hydrogen content.

The major precondition limited the wide industrial distribution of dry and bireforming of methane is carbon deposition especially over the traditional Ni-containing catalysts [12-13]. The main efforts are directed to development of catalysts resistant to coke formation.

This work deals with the catalyst containing Co in amount of 4.5 mas. % and metal from 8th Group of Elements in amount of 0.5 mas. % supported on alumina. The catalyst has been studied in dry and bireforming of a model biogas mixture with an equal ratio of methane and carbon dioxide.

Experimental

The Co-containing bimetallic catalyst promoted by M_1 supported on alumina has been used in both dry reforming and bi-reforming of the model biogas mix (methane/carbon dioxide=1/1). The content of metals (Co and Pt-Group metal) is 5 wt. % from total catalyst amount. The Co/M mas. ratio is 9/1.

The processes were carried out at a flow quartz reactor supplied with the programmed heating and controlled feeding velocity under conditions: atmospheric pressure, space velocity - 1000 hr^{-1} and varying temperature from 300 to 800°C. The volume ratio of a model biogas was 1/1 and steam additives was 15 vol. %.

The gaseous initial and final reaction products have been on-line analysed by the gaseous chromatographs. Liquid products were collected in a special cooling trap and analysed after reaction by using the GC.

Results and discussion

Dry reforming of methane was carried out over the 5%Co-M_1(9:1)/Al_2O_3 catalyst at varying temperature in a range of 350-770°C, atmospheric pressure and ratio of CO_2:CH_4=1:1. The effect of temperature on conversion of methane and carbon dioxide is presented in Figure 1.

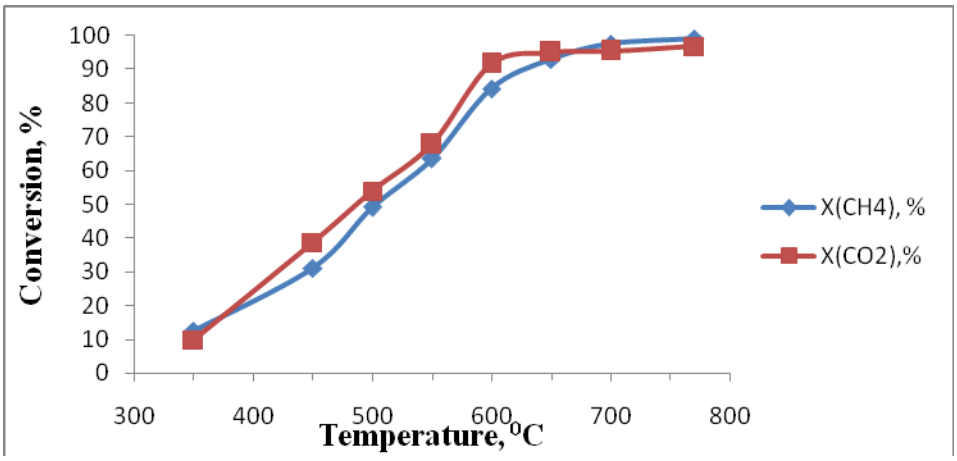

Figure 1. Effect of temperature on CH_4 and CO_2 conversion at dry reforming over the 5 %Co-M_1 (9:1)/Al_2O_3 catalyst (CH_4:CO_2=1:1, P=0,1 MPa, S.V.=1000 h^{-1})

Conversion of methane and carbon dioxide is increased with growing temperature. For example, the conversion of methane grows from 12.5 to ~ 100 % with increase in temperature from 350 to 770°C, and the conversion of carbon dioxide rises from 9.8 to 96.9 % under the same conditions. In the range of temperatures of 700-770°C the methane conversion is slightly changed. Further increase in temperature is not desirable from the point of view of energy saving and prevention of coke formation.

Syngas is a main product of methane dry conversion over the 5%Co-M_1 (9:1)/Al_2O_3 catalyst in the entire temperature region studied. The product yield is 95-100% depending on temperature. The H_2/CO ratio in syngas at temperature 770°C is 0.84, while the conversion degree of methane and carbon dioxide are equal to ~100 and 96.9 % respectively (Table 1).

Table 1. **Dry reforming of methane over 5% Co-M_1(9:1)/Al_2O_3 catalyst under P=0.1 MPa, S.V. =1000 h^{-1}, CH_4: CO_2 = 1:1**

t, °C	Conversion, %		Reaction products	
	CH_4	CO_2	H_2/CO ratio	Yield of oxygenates, %
650	93.0	95.1	0.96	traces
700	97.6	95.5	0.91	traces
750	99.0	96.4	0.84	traces
770	~100	96.9	0.84	traces

It is necessary to note that the hydrogen content in syngas is decreased with temperature increase that can be caused by strengthening of carbon oxide formation under high temperatures. For example, temperature growing from 650 to 770°C causes decrease in the H_2/CO ratio from 0.96 to 0.84 (Table 1). The yield of oxygenates doesn't exceed 1 % and corresponds to traces amounts (Table 1). The main oxygenate is acetic acid, which content in liquid fraction varies from 60 to 90 % depending on the process conditions.

The results obtained demonstrate that the 5% Co-M_1(9:1)/Al_2O_3 catalyst has the high activity in conversion of biogas dioxide into syngas, but the ratio of H_2/CO below 1 (0.84). It is known that there is no complete methane conversion over the known catalysts at temperatures < 800°C [7].

For the purpose of increasing the amount of hydrogen in syngas, the combined steam and dry reforming of methane, by other words bireforming of methane, has been studied with using the 5% Co-M_1(9:1)/Al_2O_3.

Bireforming of methane over 5% Co-M_1(9:1)/Al_2O_3 catalyst was carried out with adding 15 vol.% of water steam. The dependence of conversion of a biogas mixture with the equal volumes of CH_4 and CO_2 from temperature is shown in Figure 2. Other parameters were constant: atmospheric pressure, speed velocity - 1000 h^{-1}, additive of water - 15%. Conversion of methane and CO_2 grows and reaches the values of 98.2 and 68.5% respectively with temperature increasing from 400 to 750°C.

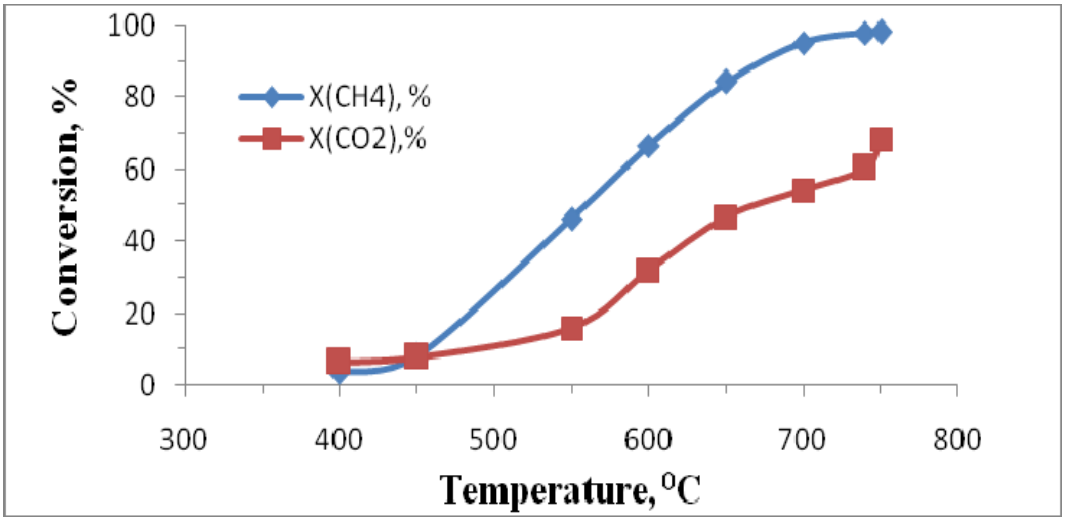

Figure 2. The effect of temperature on CH_4 and CO_2 conversion at bireforming of methane over the 5% Co-M_1(9:1)/Al_2O_3 catalyst (CH_4:CO_2:H_2O=1:1:0.15, P=0.1 MPa, S.V.=1000 h^{-1})

The main product of the reaction is synthesis gas. At the process temperature - 750°C synthesis gas has a ratio of H_2/CO = 0.95 (Table 2). In bireforming, H_2/CO ratio drops from 1.05 to 0.95 with increasing temperature from 650 to 750°C. But it should be noted that in bireforming hydrogen yield is higher than in dry reforming in the whole temperature range (see Tables 1 and 2). In the bireforming also trace amounts of oxygenates are produced (Table 2).

Table 2. **Bireforming of methane over the 5% Co-M_1(9:1)/Al_2O_3 catalyst at P=0.1 MPa, S.V. =1000 h^{-1}, CO_2: CH_4: H_2O=1:1:0.15**

t, °C	Conversion, %		Reaction products	
	CH_4	CO_2	H_2/CO	Yield of oxygenates, %
650	84.3	46.8	1.05	traces
700	95.2	54.2	1.00	traces
750	~100	68.5	0.95	traces

Comparative data of dry reforming and bireforming of biogas at complete conversion of methane over the 5%Co-M_1(9:1)/Al_2O_3 catalyst are collected in Table 3. The complete conversion of methane is carried out in bireforming at a lower temperature - 750°C and synthesis gas has H_2/CO = 0.95.

Table 3. **The effect of water for the reforming of biogas over the 5% Co-M_1(9:1)/Al_2O_3 catalyst at P=0.1 MPa, S.V. =1000 h^{-1}, CO_2: CH_4 =1:1**

Process	V_{H2O}, vol.,%	t,^{0}C	Conversion, %		H_2/CO	Difference between bireforming and dry reforming indexes		
			CH_4	CO_2		ΔH_2/CO	ΔX_{CO2}	Δt,^{0}C
Dry reforming of methane	0	770	~100	~100	0.84	+0.11	-31.5	-20
Bireforming	15	750	~100	68.5	0.95			

These results indicate that the simultaneous reactions of carbon dioxide and steam reforming of methane are occurred over the catalyst 5%Co-M_1(9:1)/Al_2O_3. Water steam inhibits carbon dioxide reforming resulting in lower carbon dioxide conversion of 31.5% in bireforming in comparison with dry reforming. Adding water has a positive effect on the conversion of methane over the 5%Co-M_1(9:1)/Al_2O_3 catalyst: process temperature is reduced ($\Delta t = -20^0$C) and H_2/CO ratio is increased (ΔH_2/CO = +0,11) (Table 3).

Conclusion

1. The synthesized catalyst on a base of Co promoted by VIII-Group metal - M_1 in amount of 0.5 mas.% demonstrates the high activity in biogas conversion. Almost complete methane conversion is occurred at 770^{o}C and space velocity 1000 h^{-1}. The main product of biogas conversion over the catalyst is syngas with a ratio of H_2/CO=0.8.
2. The effect of steam on biogas reforming has been studied. The adding water into the initial biogas leads to improving the process indexes over the 5%Co-M_1/Al_2O_3: temperature of complete methane conversion is decreased by 20^{o}C and ratio of H_2/CO in syngas is increased by 0.11.
3. Except syngas traces of oxygenates are formed over the 5% Co-M_1(9:1)/Al_2O_3, basically acetic acid.
4. The catalyst studied is a stable one. The 5% Co-M_1(9:1)/Al_2O_3 catalyst worked during 3 months without decreasing in its activity.

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Резюме

Жұмыста 5% Co-Mi(9:1)/AI_2O_3 катализаторындағы биогаздың, метан мен көміртек диоксидінің арақатынасы CH_4:CO_2=50/50, өзгерістері қарастырылған. Биогаз конверсиясына температураның, су буларының эсері анықталған.

Метанның құрғақ және бу қосылған риформинг кезіндегі арақатынасты синтез-газ арақатынасы Нг/СО= ~1 шығуы көрсетілген. Белгі бір жағдайларда оттегі қосындылары, сіркесу қышқылы ұлғаймалы пайда болады.

Резюме

Рассмотрено превращение биогаза, содержащего метан и диоксид углерода в соотношении CH_4:CO_2=50/50, на 5% Co-Mi(9:1)/AI_2O_3 катализаторе. Определены влияние температуры, введений паров воды в исходную смесь на конверсию биогаза. Показано, что при углекислотной и пароуглекислотной конверсии метана на данном катализаторе образуется преимущественно синтез-газ соотношением H_2/CO= ~1. В определенных условиях образуются оксигенаты, преимущественно уксусная кислота.

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B.M. Nuranbaeva

METHOD FOR THE RECOVERY OF PRODUCED VANADIUM FROM OIL

Today in Kazakhstan opened more than 200 oil fields, its guaranteed reserves are estimated at 3.6 billion tons, but even so significant reserves are not infinite, because they correspond to only the volume of annual world oil production. However, the bowels of the earth are full of so-called "non-traditional" UV-minerals: high-viscosity oils, natural bitumen, oil and tar, fuel and carbonaceous shales. All of them in HC composition are a good alternative to oil and are of great interest to the chemical industry. Many of these minerals with properties peculiar natural sorbents, contain a large amount of valuable as (Ti, V, Ni, Mo, Pd, Ag, Pt, Au, etc.), and toxic (S, As, Se, Br , Cd, Sb, etc.) trace elements. The success of the integrated development of oil fields directly related to the need for information about their composition and essentially depends on the degree of effectiveness used for its production of analytical methods. To date more than 60 oil discovered trace, of which the most important and studied is vanadium.

Vanadium content in hydrocarbons is low (from 10^{-6} to 10^{-2}%), they negatively affect many catalytic conversion processes. Corrosive properties of vanadium and its compounds into the oil causing great damage to refining plants oil is burned settings, disabling catalysts reduce the life of turbo, diesel, gas turbine engines and boilers, as the combustion of vanadium-containing fuels are formed adhesive and corrosive inorganic vanadium compound is one of the main causes of intense ash drift and high-temperature corrosion surfaces. Vanadium can be using heat-resistant, corrosion resistant and superconducting alloys in high demand. Pure vanadium is used in nuclear power and electronic devices, in the textile, paint and glass production. Negligible production of vanadium, and insane price it is easily explained, despite the fact that the earth's crust contains a lot of vanadium about 0.2% (i.e., 15 times more than lead, and 2000 times more than silver), its clusters are found on the ground is extremely rare. Ore containing 1% of vanadium is extremely rich, industrial processing ore is subjected even those that contain only 0.1% of this valuable and scarce item.

Given the low vanadium content in the ores (maximum of 1500 g / t), its climb extracting oil and bitumen is relevant. In the world there is a direct and practical experience of vanadium extraction from oil. Foreign experience of industrial development of vanadium oils confirms the economic feasibility of using oil as a raw material for the production of vanadium content of its 200 grams and up to 1 ton of raw material. Apparently, the efficiency can be improved by using crude oil for extraction of vanadium with its preconcentration in the high part.

Overseas small-scale extraction of vanadium from combustion products of petroleum and petroleum products is a long time. Semi work on vanadium recovery of bitumen and heavy oil is held in England, Venezuela, Mexico, Italy. The U.S. patented method of extracting vanadium from Venezuelan oil, containing 0, 03% V. The company Petrofina Canada since 1965 extracts vanadium from petroleum residues of heavy Venezuelan crude. The process of extracting vanadium includes the following process steps: oil desalting, atmospheric distillation, coking residue, coke ashing, extraction of vanadium from the ashes of sulfuric acid, oxidation of vanadium to the pentavalent state perchlorate and sodium ammonia deposition. Then hydrated

vanadium oxide is melted and cast into pellets. The mechanism of the formation of sulfuric acid salt of vanadium. The methods for extraction of vanadium and other metals from the soot deposits. In this connection it is interesting to note that the extraction of vanadium from the soot obtained by burning oil around Lake Maracaibo in Venezuela, has developed into an industrial process. The article analyzes of petroleum coke Wells reporting that 0, 22% V_2O_5 in bitumen breccia of Terlingua (Texas); 0,043% V_2O_5 (equivalent to 61% ash) in the asphalt of Baoby (hole 1) (Lake Bermudas, Venezuela), 12, 2% in the ash from the vicinity gragamita Pedzh (Oklahoma) and 45% in the ash asphalt from Nevada.

For example, of the Venezuelan oil in Canada, the United States and Italy recovered it for decades, and there is no more vanadium than Buzachinsky. According to estimates by our scientists, 1 million. tonnes of contained 440 tons of vanadium pentoxide. This is not so little, given the scale of production and consumption of oil on the world today. It is necessary to mention that the highest content of different metals so-called heavy and extra-heavy oil. The ones who would run the production is limited due to the difficulty of processing. In general, the geological reserves in its oil Buzachi peninsula, done at a depth of 300-600 meters, is estimated hundreds of thousands of tons. It is not difficult to imagine what benefit would receive land, extracting its oil this scarce metal.

Methods of extracting vanadium from oil and oil products

Method 1, ways of extracting vanadium from petroleum coke by mixing with alkali metal salts, baking batch at a temperature below the melting point of added salts and subsequent transfer of vanadium in aqueous solution, from which it can be precipitated by known methods.

Method 2, the method for extracting vanadium from petroleum coke by total gasification of coke, and vanadium extraction from the ashes.

Method 3, method of processing of petroleum coke, including heat treatment in the presence of air at a temperature of 425-575^oC for 0.5-2 hours, for further processing in a 20% solution of H_2SO_4 at S: L = 1: 10 in the presence of NaOCl at 70, 80°C for 4 hours.

Method 4, petroleum coke is crushed to a size <100 microns, in the presence of air is kept at a temperature of 380-420^oC for 2-6 hours, the air supply is adjusted so that the weight loss amounted to 40-70% of coke leached for 2-3 h at T: L of 1:3 to 1:5 and a temperature of 90-100^oC.

Oil studies in Kazakhstan, in Table 1 and showing that the vanadium presents in all oil fields.

Table 1. **The vanadium content in the oil fields in Western Kazakhstan**

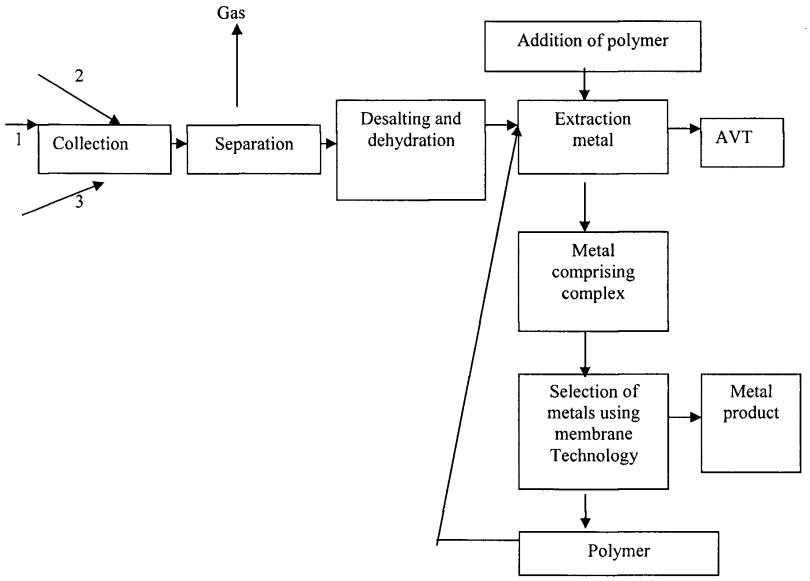
Field	Content, g/t	Field	Content, g/t
Mangistau region		Aktobe area	
North. Buzachi	100-300	Bozoba	50-120
Karazhanbas	70- 300	Sinelnikovskoye	5-50
Kalamkas	60- 300	Zhanazhol	1- 10
Zhalgyztobe	60- 200	Kenkiyak	1- 10
Karaturun	70- 140	Ostansuk	1-5
Besoba	70- 140	Atyrau area	
Uzen	0,5-5	Karaarna	40-70
Asar	0,5-5	Tortay	10-80
North. Rakushechnoe	0,5-5	Kumshety*	10-60
Zhetybai	0,1-1	Biikzhal	5-40
Shinjiro	0,1-1	Tengiz	0,1-1
Tasbulat	0,05- 0,5	West Kazakhstan region	
Oymasha	0,01-0,1	Gremyachinskoye	20-50
North. Karagie	0,01-0,05	Zap. Teplovsko	1- 10
Uylyuk	0,001-0,01	Karachaganak	0,05- 0,5
Zhilindy	0,001-0,01		
Aschisor	0,001-0,01		

Different types of trace elements, not only in oil but also in the bitumen and shale. Here is an example in Table 2 that the concentration of vanadium in these products.

Table 2. **The vanadium content in the oil and bituminous rocks of the Western Kazakhstan**

Field	Content, g/t	Field	Content, g/t
Aktobe region		Atyrau region	
Akbulak	50- 400	Imankara	20-80
Dongeleksor	20-70	Akshoky	10-70
Mortuk	10-70	Kolzhan	30-50
Field	Content, g/t	Field	Content, g/t
Shilikty	20-50	Karamurat	20-50
Copa	1-20	Munayly	10-30
Mangistau region		Karasaj	5-30
Tyubedzhik	10-70		
Karasyaz-Taspas	5-30		
Beck-Taspas	5-30		
Tyubkaragan	1-20		

In Kazakhstan, oil fields such as (North Buzachi, Karazhanbas, Kalamkas Zhalgyztobe, Karaturun, Besoba, Bozoba, Sinelnekovskoe, Karaarna, cakes, etc. Kumshety) contains vanadium in concentrations of 10 to 300 grams per ton of oil produced. However, to date not a technology of vanadium extraction. In this connection it is of interest to create advanced ion exchange resins for the extraction of produced rare metals from crude oil and petroleum products. A general technological scheme of the collection and preparation of oil and oil products, the extraction of rare metals and polymer membrane technology. Based on these studies, we propose (Fig. 1), the following flow chart extraction of produced precious metals, allowing for preparation in the field and refinery processing to extract them from the oil and oil products, thus improving the quality of the latter.



1, 2, 3 – of produced metal-mine, AVT – atmospheric and vacuum distillation of the Oil
Figure 1. A new flow sheet gathering and treatment with extraction of produced metal

Thus, these problems can be solved by the introduction of the oil industry of sorption processes for the extraction of metals based on polymers with membrane technology. This corresponds to the integrated development of the oil fields.

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Резюме

Мақалада мұнай және мұнай өнімдеріненжолшыбай өндіруде ванадийді сорудың инновациялық әдісі ұсынылады. Мембраналық технологиямен полимер негізіндегі сорбциялық үрдіс мұнай және мұнай өнімдерінен ванадийді сору мұнай саласына енгізу әдісі негізінде қарастырылған. Бұл мұнайдың сапасын арттыру мен өндіруден бастап тұтынушыға дейін оның тасмалдану тиімділігі мұнай кен орындарын кешенді игерудің талаптарына сәйкес келеді.

Резюме

Предлагаются инновационный способ извлечения попутно-добываемого ванадия из нефти и нефтепродуктов. В основе способа предусматривается внедрения в нефтяной отрасли сорбционных процессов для извлечения ванадия из нефти и нефтепродуктов на основе полимеров, а также мембранной технологии. Это соответствует требованиям комплексного освоения нефтяных месторождений, повышения качества нефти и эффективности ее транспортировки с мест добычи до потребителя.

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B.M. Nuranbaeva

HOW TO IMPROVE THE GOLD HEAP LEACHING WITH WASTE OF URANIUM INDUSTRY

The aim of this work is to improve the efficiency of leaching while waste disposal and leaching of radioactive ores. The way to develop the tailings that is including, the minimum grain size of the ore, density of the surface tension of the leach solution and the contact angle [1], as well as a method for treatment of ores. [2].

In contrast to the above methods, the proposed method is mixing the leach ore radioactive waste (rock, sludge, etc.), which will increase the temperature and heat transfer between the solution and leach ore, which in turn leads to rapid oxidation of the ore, and thus increase the yield of ions in the solution of useful components. To increase the heat in the heap's surface is covered with the same radioactive nuclear waste. All this leads to more efficient leaching, in addition, to avoid the emergence of new waste is proposed to form a heap leaching in waste pits for subsequent disposal on-site leaching.

Leaching process was implemented on the models in the laboratory. Particle size analysis is carried out by the gravimetric method with a certain amount of ore. Particle size distribution of the leach ore is presented in Table 1.

Table 1. **Particle size distribution of ore leaching**

№	V, m^3 volume	Size distribution of the ore, %, m				
		0-0,20 m	0,21-0,40 m	0,41-0,60 m	0,61-0,80 m	0,81 m
1	7,7	50,2	21,5	13,4	12,6	2,2
2	8,1	53,1	22,2	12,7	10,4	1,5
3	9,0	55,5	21,5	12,5	8,7	1,7
4	7,0	56,6	21,7	11,7	7,6	2,3
5	10,2	57,4	20,6	13,4	7,3	1,2
6	9,5	47,4	19,4	15,9	15,0	2,2
7	8,5	52,5	21,0	12,3	11,7	2,4

As can be seen from Table 1, the percentage of fraction 0-0,20 m this fraction should be subjected to a more detailed analysis of the particle size on the screens by the gravimetric method. The results of particle size analysis of fraction 0-0, 20 m are presented in Table 2. And we take this fraction as a hundred percent, and define the other factions.

Table 2. **Particle size fractions of ore 0-0, 20 m**

Number of fraction	Interval of fraction, mm	1	2	3	4	5	6	7
		φ_1, %	φ_1, %	φ_1, %	φ_1, %	φ_1, %	φ_1, %	φ_1, %
1	0-1,0	4,5	4,3	5,2	5,0	3,7	3,5	4,1
2	1,0-2,5	6,0	5,8	6,5	6,1	7,0	6,9	6,0
3	2,5-5,0	7,3	7,5	6,9	8,0	7,2	7,5	7,2
4	5,0-7,5	6,4	6,6	7,9	8,5	7,5	8,5	6,9
5	7,5-10,0	7,7	7,3	9,2	8,7	9,3	9,4	7,3
6	10,0-12,5	9,4	9,0	9,6	9,3	9,6	10,4	9,0
7	12,5-15,0	8,9	9,2	10,7	9,5	10,2	9,1	9,2
8	15,0-17,5	9,9	10,0	7,2	8,5	11,0	7,7	9,4
9	17,5-20,0	7,3	6,7	6,5	4,8	4,1	4,5	9,8
10	20,0-30,0	6,5	7,5	7,0	8,5	6,8	6,9	6,7
11	30,0-40,0	5,9	5,5	5,1	4,5	5,3	6,6	7,5
12	40,0-50,0	6,0	5,8	4,9	4,4	5,9	6,8	5,5
13	50,0-100	5,4	5,6	5,1	4,0	4,5	4,0	5,8
14	100-150	4,8	5,0	4,5	5,3	4,7	5,2	3,6
15	150-200	4,0	4,2	3,8	4,5	3,2	3,0	2,0

To create a physical model of the leaching of ores, we represent it as a disconnected environment with heterogeneous porosity. Represent the real volume leach ore, consisting of fractions from these $N = N - N_1$; large fractions constituting the main skeleton of leachable ore, and fractions are filling, considering the volume ratio of the filler and the skeleton of a real object obtained relationship between porosity and aggregate real object [1]:

$$m_{N_1} = \frac{m_p}{\varphi_{N_1}} - \sum_{i=1}^{N_1} \varphi_i^{/} \qquad (1)$$

Where m_{N_1} - porous aggregates;

m_p - Porosity of the real object;

$\sum_{i=1}^{N_1} \varphi_i^{/}$ - Amount of volume fraction ratio of the each share, the aggregate, which refers to the total volume of the real object, which should be defined as the ratio:

$$\sum_{i=1}^{N_1} \varphi_i^{/} = \frac{\sum_{i=1}^{N_1} \varphi_i}{\varphi_{N_1}} \qquad (2)$$

Here φ_i - Share of the aggregate amount of each fraction referred to the total volume filler;

φ_{N_1} - Share of the total aggregate, referred to the total volume of a real object;

To select a model porous aggregate is computed by (1) using the tables 1 and 2. If the porosity is less than the aggregate porosity of the real object, the separated fraction of the aggregate transfer one or part of one or more major factions of the skeleton of a real object and continue the calculation as long as the porosity of the aggregate will be equal to the porosity is not a real object $\left(m_{N_1} = m_p\right)$. Number of fractions, N_1 where $m_{N_1} = m_p$ should be selected as a model of a real object.

In some cases, the porosity of the aggregate may be higher porosity of the real object, in this case, adding the skeleton of a real object or a part of one, or a few more fines in the pre-selection, the computation

of aggregate as long as the porosity of the aggregate will not equal porosity real object, i.e., $m_{N_1} = m_p$. Number of fractions N_1 where $m_{N_1} = m_p$ should be selected as a model for laboratory studies.

The same principle was selected porosity of radioactive waste, which is leached ore is stirred. The results of calculation of porosity model leach ore and radioactive waste were subjected to experimental verification. The calculated and experimental porosity of leached with radioactive waste coincided with a relative error of 15%. It can be concluded that in this way the chosen model is adequate to the real object, No. 10 (H) porosity model (aggregate) is the porosity of the real object. As the model is taken to the tenth inclusive fractions in the same percentage as shown in Table 2, i.e., the following fractions 0-1,0; 1,0-2,5; 2,5-5,0; 5,0-7,5; 7,5-10,0; 10,0-12,5; 12,5-15,0; 15,0-17,5; 17,5-20,0; 20,0-30,0 (intervals in mm). Thus, the model is formed on a concrete slab with a hole for drainage, leaching solution. The concrete slab is concave, so that the solution flowed out of the hole. The model pile was formed in such a way that the ratio of the volume of ore V_p c volume of radioactive waste V_{po} consistent $\frac{V_p}{V_{po}} = 3$, and its surface is covered with radioactive waste.

The model pile was watered 2% sulfuric acid solution. Pregnant solution was analyzed to identify it mineralization.

Leaching gold ore with mixing radioactive waste in relation to the volume $\frac{V_p}{V_{po}} = 3$ and coated surface radioactive waste allowed increased output of gold pregnant solution by an average of 20. The results of the leaching of gold ore on the models in the laboratory are shown in Table 3.

Table 3. **Results of the leaching of gold ore on the models in the laboratory**

№	Type of ore and radioactive waste	Extraction Au from a productive solution	
		prototype	The proposed method
1	Sulfide ore deposits containing gold Akbakai 1,6 g/t	75-78	80-85
2	Gold ore 2,0 g/t	87-96	93-97

Thus, the proposed method can improve the leaching of ore leaching efficiency and reduce the environmental impact on the environment due to leaching of waste disposal and the nuclear industry in the waste pits.

To extract gold from the pregnant solution leach ore commonly used sorption technology, in this case as sorbents used costly imposed from abroad sorbents (tar, coal and others.) To reduce the cost of obtaining gold from leach solutions proposed for use in sorption technologies domestic polymers [3, 4]. In this regard a study of the sorption capacity of polymers in relation to ions of gold. Implementation of the project will address a number of environmental challenges of our waste disposal, reduce man-caused environmental burden to mining and oil and oil regions of Kazakhstan. Based on these studies suggest the following innovative technological scheme to extract gold (Figure 1).

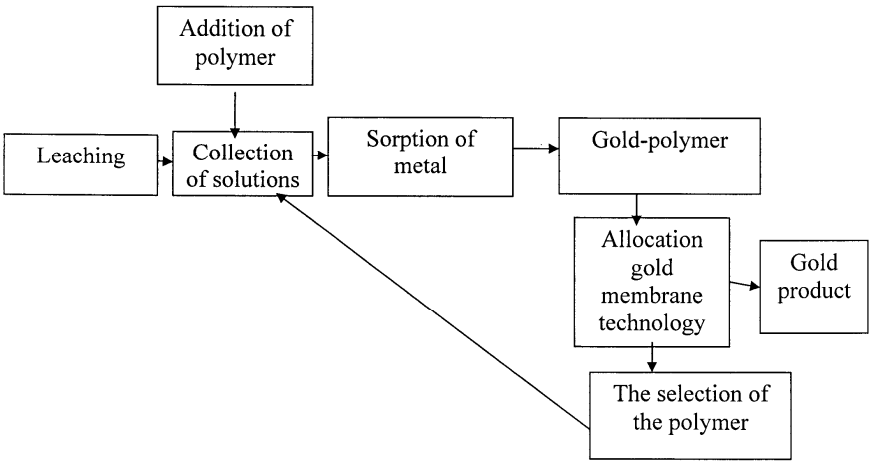

Figure 1. Scheme showing the new technological for gold extraction operation

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Резюме

Мақалада қорларды және қиын байытылатын кендерді түсті және асыл металдармен үймелеп сілтілеу әдісі ұсынылады, мысалы үйкелу нысанында беткі өңдеудің алдында ұсақ кеуекті материалдарды қабатпен жабу арқылы, яғни қалдықтардан уран қорларын өңдеу және шығару, сонымен қатар полимерлердің алтын ионына қатынасты сорбциялық қабілеттерінің зерттеулері келтірілген.

Резюме

Предлагается способ выщелачивания отвалов (куч) забалансовых и труднообогатимых руд цветных и благородных металлов, в котором перед обработкой поверхности выщелачиваемых объемов покрывают слоем из мелкопористого материала, например, отходы добычи и переработки урановой руды, а также проведено исследование сорбционной способности полимеров по отношению к ионам золота.

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ANALYTICAL SOLUTION OF THE MATHEMATICAL PROBLEM OF LINEAR ELECTRONIC CIRCUIT ANALYSIS

Introduction. It is known that an important step in the design of electronic circuits is their analysis [1,2]. The analysis procedure consists of determining the properties of a given or chosen description. The analysis allows estimating the degree of satisfaction of the design solution to the given requirements and its suitability. The analysis results make it possible to change the scheme under investigation, to consider its various options and choose the best option for the given criteria.

Problems in analysis of electronic circuits are quite complex. Traditional approaches, when the designer relies on his knowledge and experience, do not always yield the desired results. Therefore, mathematical methods, focused on the application of computer technology, are widely used to solve them during recent years [1-5].

Nowadays, computers have been successfully used in various stages of electronic circuit design. However, the design process with the use of the computer will only succeed if there is a good mathematical description of each of its stages. Therefore, mathematical modeling of the problem precedes the use of computer analysis methods for electronic circuits. Mathematical modeling, in turn, leads to the formulation of a mathematical problem.

Depending on the problem definition for the analysis of electronic circuits, various mathematical problems can be supplied. In many cases, the solution of these mathematical problems is associated with certain difficulties because of their complexity. In particular, when the voltage (or current) source is a complex function of time and when the system of differential equations is being solved [5]. Therefore, the search for and choice of effective methods to solve them are an immediate problem. This article discusses the analytical solution of one of such problems of linear electronic circuit analysis.

General problem statement. Analysis of linear electronic circuits in many cases leads to a system of linear differential equations. In general, the matrix form of such system has the form [3]:

$$\frac{dU}{dt} = F(U, t) \tag{1}$$

Here U (t) and F (U, t) can be n - dimensional vectors. Parameters that describe this scheme comprise the components of the vector U (t). They are the unknown functions of time t. In this case, analysis of the circuit is performed in the time domain, and therefore all major parameters depend on the independent variable t. The right-hand side of (1) is a vector F (U, t), whose components can be complex functions that depend on the unknown functions and time t. They can be both linear and nonlinear functions.

Note that the form of the function F (U, t) depends on a specific scheme and may have a different structure.

For the solution of system of equations (1) some initial conditions should be specified:

$$t = 0,\ U(0) = U_0 \tag{2}$$

and the Cauchy problem (1) - (2) for a system of n first order differential equations. In the given formula (2) U_0 is some given vector describing the initial state of the scheme in consideration at t = 0.

The existence and uniqueness issues of the Cauchy problem solutions for a system of differential equations (1) - (2) are considered in sufficient detail in the mathematical literature [6]. There are various methods for solving this problem. For simple linear circuits analytical methods, or the method of operational calculus, using the Laplace transform [2-4], can be used but for complex or non-linear problems, these methods cannot be used. Therefore, to solve these problems approximate or numerical methods are used. For the implementation of numerical methods the use of a computer is required.

Depending on the structure of the analyzed scheme the number of differential equations in (1) can be quite large. However, the principle and solution process of the Cauchy problem (1) - (2) for any number of equations will be the same. [6] It can therefore be restricted to the analysis of a simple electronic circuit.

This article describes an example of the solution of the analysis problem for one simple circuit. For a more complex scheme a solution of the Cauchy problem for differential equations for several variables is required.

Problem statement for a system of two equations. Let's consider as an example the following simple scheme, representing a linear RC-circuit (Figure 1).

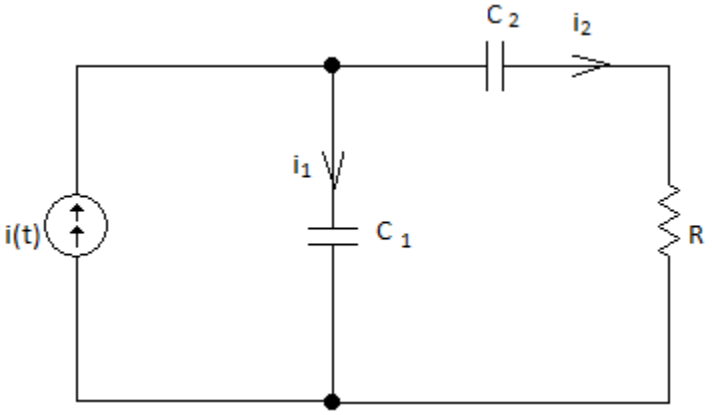

Figure 1. Linear RC-circuit

It is known [2-4], that there are different ways to set up the state equations of the circuit in normal form. Here we use one of these methods. For this circuit (Figure 1) based on Ohm's and Kirchhoff's laws the following well-known formulas can be written:

$$i_1(t)+i_2(t)=i(t);\quad i_1(t)=C_1\cdot\frac{du_1}{dt};\quad i_2(t)=C_2\cdot\frac{du_2}{dt};\quad u_1=u_2+i_2R. \tag{3}$$

From these formulas, after simple transformations, the following first-order equations for the functions $u_1(t)$ and $u_2(t)$ can be obtained:

$$\frac{du_1}{dt}=\frac{u_2-u_1}{RC_1}+\frac{i(t)}{C_1},\qquad \frac{du_2}{dt}=\frac{u_1-u_2}{RC_2}. \tag{4}$$

In these formulas, functions of time are: $u_1(t)$ and $u_2(t)$ - the voltage on capacitors, i (t) - current. Constants: R - resistor (resistance), C_1 and C_2 - capacitors. Here i(t) can be a given function.

Without loss of generality, for simplicity's sake, we can assume that at the initial time (t = 0), the capacitor voltage is zero. Then the initial conditions for the system of differential equations (4) can be written as follows:

$$t = 0,\ u_1(0) = 0,\ u_2(0) = 0. \tag{5}$$

Thus the Cauchy problem (4) - (5) for a system of two differential equations is obtained.

Analytical solution of the problem. For the convenience of writing the formulas in further calculations it is useful to introduce the following denotations:

$$a=\frac{1}{RC_1};\qquad b=\frac{1}{RC_2};\qquad f(t)=\frac{i(t)}{C_1}. \tag{6}$$

Taking into account these denotations (6), formulas (4) can be written in the following normal form:

$$\frac{du_1}{dt} = a \cdot (u_2 - u_1) + f(t), \qquad \frac{du_2}{dt} = b \cdot (u_1 - u_2). \tag{7}$$

From the second equation (7) it follows that

$$u_1 = u_2 + \frac{1}{b} \cdot \frac{du_2}{dt}$$

Subject to the given expression a differential equation of the second order will be obtained from the first equation (7)

$$\frac{d^2u_2}{dt^2} + (a+b) \cdot \frac{du_2}{dt} = b \cdot f(t). \tag{8}$$

Initial conditions for the solution of the given differential equation (8), satisfying the conditions (9), can be written in the following form:

$$t = 0, \qquad u_2(0) = 0, \qquad \frac{du_2(0)}{dt} = 0. \tag{9}$$

Partial solution of the equation (8), satisfying the initial conditions (9), can be written in the following form:

$$u_2(t) = b \cdot \int_0^t Z(x) \cdot \exp[-(a+b) \cdot x] dx. \tag{10}$$

Voltage u_1 can be found by substituting the obtained solution (10) into the second equation (7):

$$u_1(t) = u_2(t) + Z(t) \cdot \exp[-(a+b) \cdot t]. \tag{11}$$

In the formulas (9) and (10) function Z(t) is the following integral:

$$Z(t) = \int_0^t f(x) \cdot \exp[(a+b) \cdot x] \cdot dx. \tag{12}$$

If the function f (t) is given, i.e. function that determines the change of the current i (t), then using formulas (10) and (11) the capacitor voltage u_1 (t) and u_2 (t), followed by (3) – i_1(t) and i_2(t) can be determined.

Now it is necessary to go to the original notation of the constants (6). Then the formulas (10), (11) and (12) will be written in the form of the following formulas:

$$u_2 = \frac{1}{RC_2} \cdot \int_0^t \exp(-\frac{C_1 + C_2}{RC_1C_2}) \cdot Z(x) dx$$

$$u_1 = u_2 + \exp(-\frac{C_1 + C_2}{RC_1C_2}) \cdot Z(t), \tag{13}$$

$$Z(t) = \frac{1}{C_1} \int_0^t i(t) \cdot \exp(\frac{C_1 + C_2}{RC_1C_2}) dx$$

Thus, the analytical solution of the problem, depending on the change of the current i (t) will be obtained. If the function i (t) is given, then the calculation of the integrals in the first and third formulas (13) gives the solution to the problem.

Suppose, as an example a special case where the current is a periodic function is considered:

i (t) = A sin (ω t), A - amplitude, ω - frequency.

In this case, the integral (12) is easily calculated and is given by:

$$Z(t) = A \cdot \frac{RC_2}{C_1 + C_2} \cdot [\exp(\alpha t) \cdot \sin(\omega t) + \frac{\omega}{\alpha} \cdot (1 - \exp(\alpha t) \cdot \cos(\omega t))], \tag{14}$$

where $\alpha = \frac{C_1 + C_2}{RC_1C_2}$.

Values of $u_1(t)$ and $u_2(t)$ for the special case, when the current is alternating with the frequency ω, can be found by substituting formula (14) into (13):

$$u_2(t) = \frac{A}{C_1 + C_2} \cdot \left[\frac{1}{\omega} \cdot (1 - \cos(\omega t) - \frac{1}{\alpha} \sin(\omega t) + \frac{\omega}{\alpha^2} \cdot (1 - \exp(-\alpha t)) \right]$$

$$u_1(t) = u_2(t) + A \cdot \frac{RC_2}{C_1 + C_2} \cdot \left[\sin(\omega t) + \frac{\omega}{\alpha} \cdot \exp(-\alpha t) - \frac{\omega}{\alpha} \cdot \cos(\omega t) \right] \quad (15)$$

By differentiating the functions u_1 and u_2 (formulas (15)) over t, and multiplying by respectively C_1 and C_2, formulas for the current in circuit branches can be obtained:

$$i_1(t) = -\frac{1}{R} \cdot \exp(-\alpha t) \cdot \frac{A \cdot RC_2}{C_1 + C_2} \cdot \left[\exp(\alpha t) \cdot \sin(\omega t) + \frac{\omega}{\alpha} (1 - \exp(\alpha t) \cdot \cos(\omega t)) \right] + A \cdot \sin(\omega t)$$

$$i_2(t) = \frac{1}{R} \cdot \exp(-\alpha t) \cdot A \cdot \frac{RC_2}{C_1 + C_2} \left[\exp(\alpha t) \cdot \sin(\omega t) + \frac{\omega}{\alpha} \cdot (1 - \exp(\alpha t) \cdot \cos(\omega t)) \right] \quad (16)$$

Conclusion. In conclusion, it should be noted that the solution to the problem of the linear electronic circuit analysis, when the current source is a complex function, can be reduced to the solution of the Cauchy problem for ordinary differential equations of the first order. In this paper, using a simple circuit as an example, formulation of a mathematical problem and the possibility of its analytical solution are demonstrated. Analytical solution of the Cauchy problem in this case is obtained in the form of analytical formulas depending on the given function of current i(t). These formulas allow us to determine the capacitor voltage and current in the circuit.

A special case when the current of the source is a variable described by a sine function is considered. Specific analytical formulas for determining the voltage across the capacitors and the current in the circuit are obtained.

In general, the paper shows the possibility of analytical solution to the problem of linear circuit analysis, when it is reduced to a solution of system of two differential equations. The solution of such a problem for more complex circuits can be realized in this way.

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Резюме

Статья посвящена аналитическому решению задачи Коши для системы двух дифференциальных уравнений, описывающих линейную RC-цепь. В качестве примера рассмотрена простая схема, состоящая из резистора и двух конденсаторов. Результаты решения задачи представлены в виде определенных интегралов.

Резюме

Сызықтық RC-тізбегін сипаттайтын екі дифференциалдық теңдеулер системасының Коши есебін аналитикалық шешуге арналған. Мысал ретінде резистор мен екі конденсатордан тұратын қарапайым схема қарастырылған. Есептің шешуінің нәтижесі анықталған интегралдар түрінде бейнеленген.

AUEC *Received 05.11.2012*

• ECONOMICAL SCIENCES

B. Akhmetov

BUSINESS INTELLIGENCE AS UNIVERSITY MANAGEMENT TOOL

1 Introduction

Management of the university aims to improve performance of the university, such as research, the opinion of employers, teaching and internationalization. But how to achieve optimal performance, as excessive pressure or lack of exactingness from the management results to a decrease in performance. The same is true for teachers who want to increase the performance of students (Fig. 1).The task of top management is convergent in finding this optimal point where the interests of each objects match. Well known that variety of factors impact the status of the student such as the atmosphere in society, the basic training, etc. Typically, university administration does not know what's going on in a particular faculty or department and why does it happening.When raises the question why performance in one faculty or department higher and in other lower at the same condition that in each of the departments and faculties excellent local managers, teachers and students to top university managers is difficult to answer.To solve these problems and improve performance could take years, but competition can be played. For the universities are valid business requirement faced by the typical company. To win the competition, many companies have resorted to a variety of information-analytical systems for the timely response to emerging issues [1–3].

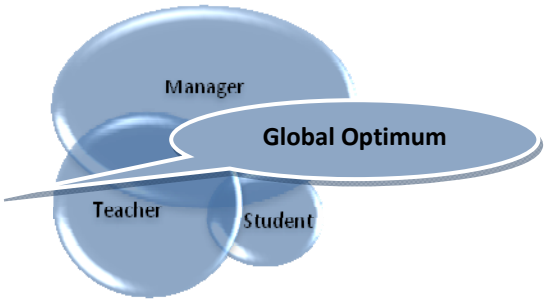

Figure 1. Optimal point

2 Developing university BI system

The problem to any university manager is to find this global optimum. It is not achievable without help of information technology, as the number of students and teachers are many and each of them has his own performance. Need some technology for collecting, processing, analysis and forecasting of all data, indexes, and all related information of each object. This technology, which is widely used today, is known as business intelligence. Business intelligence (BI) is a set of technologies and processes that allow people at all levels of an organization to access and analyze data. Actuality and practical value of this approach in the management of the study confirm the «META Group», under which up to 95% of the world's leading companies actively use BI technology to achieve competitive advantage and getting big return on their investment. According to the «International Data Corporation», for three years on average, they received a 400 percent return on their investment in BI systems [2–5].

The most important activities of the university is teaching, research and educational work, as for student, also for teacher and managers. Due to the global informatization of society, many universities have increased their level of maturity as in the provision of information also in control of knowledge . In order to apply business intelligence technology as a tool for university top management this system at least have to contain the following components: [1,3,4]

- Integration component (ETL);
- Data warehouse;
- OLAP;
- Data mining;
- Predictive component;
- Interactive visualization;
- Ad hoc query and report.

Based on the above can be presented University business intelligence system (Fig 2).

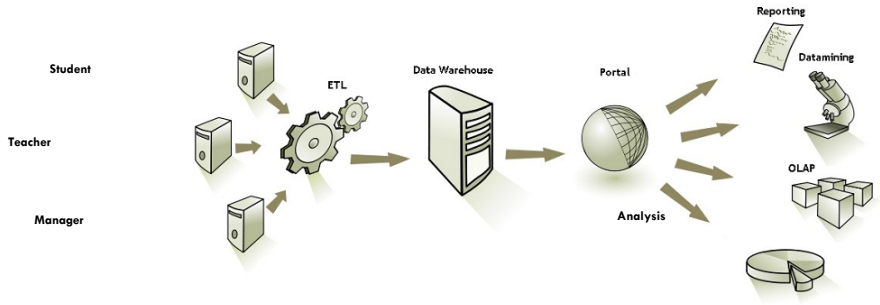

Figure 2. University business intelligence system

2.1 Calculation of "teacher's value"

Quantitative data is base for business intelligence and their absence results unfitness of the given tool and technology in general. In a university subject the basic difficulty in reception of an objective assessment of indicators because many estimations are subjective and presents serious difficulties implementing BI systems. For example, how to quantify the indicators as the value of the teacher, student, faculty dean and etc. [6,7]

There is provided a method of receipt quantitative assessment of "teacher`s value" based on the fuzzy logic. By "teacher`s value" we will understand a numerical value that reflects the utility of teaching to all subject of university such as students, colleagues, managers and etc.

This indicator depends on many factors such as teacher responsibility, professional competence, professional improvement, relationship with students and colleagues and etc. For example, in al-Farabi Kazakh National University teachers have following indicative: number of published books, number of published papers, courses in English, academic mobility, the relationship with the students and colleagues, etc. For simplicity, we would take only three indicators of teacher: number of published books, number of published papers and courses in English. In addition, there would be two types of published papers: "Journals with Impact factor" and "Journals without Impact factor".

On the basis of the selected indicators considered the following scheme of numerical definition «teacher`s value» with use of the fuzzy logic (Fig.3).

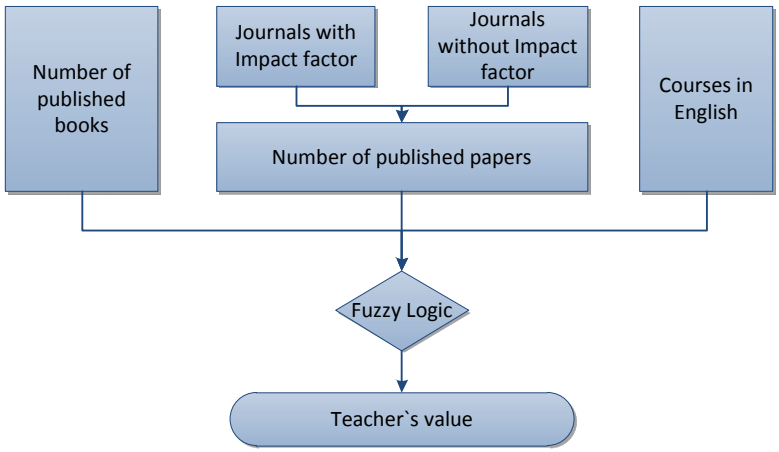

Figure 3. Scheme to obtain the teacher`s value

To obtain quantitative estimation of "teacher`s value" we will enter corresponding linguistic variables: "books", "papers" and "english courses". We define the possible values for these variables: "bad", "normal" and "excellent". Furthermore, the linguistic variable "papers" we will be depend from another two linguistic variables: "Journals with Impact factor" and "Journals without Impact factor".[9,10]

In Fig.4 membership function of linguistic variables "Journals with Impact factor" and "Journals without Impact factor" is presented.

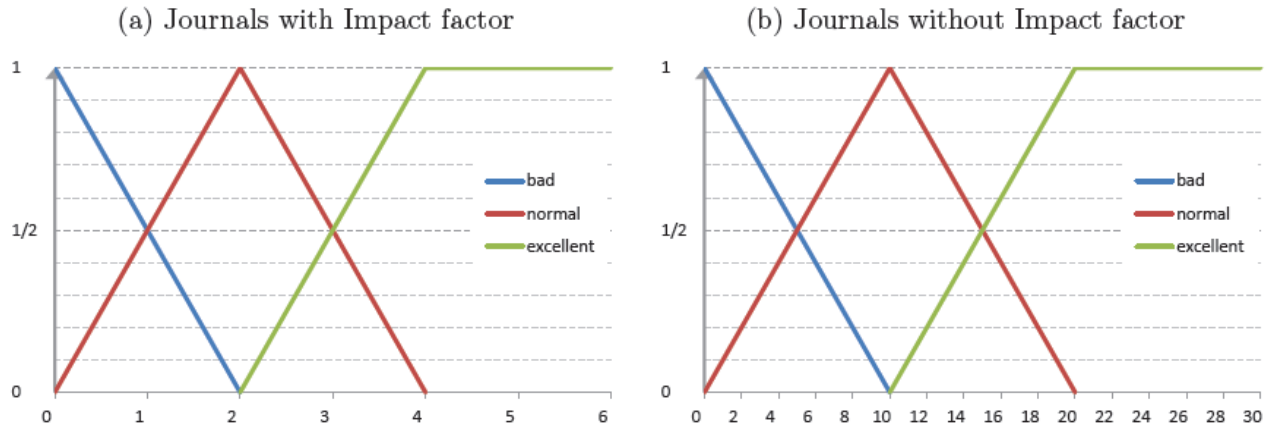

Figure 4. Membership function of linguistic variables

Using these linguistic variables we can determine the value of linguistic variable "papers" with the following production rules:

Rule 1.1. If the linguistic variable "Journals with Impact factor" has the value "bad", "normal", "bad" and the linguistic variable "Journals without Impact factor" has the value "bad", "bad", "normal" respectively then the linguistic variable "papers" would have a value "bad".

Rule 1.2. If the linguistic variable "Journals with Impact factor" has the value "excellent", "normal", "bad" and the linguistic variable "Journals without Impact factor" has the value "bad", "normal", "excellent" respectively then the linguistic variable "papers" would have a value "normal".

Rule 1.3. If the linguistic variable "Journals with Impact factor" has the value "excellent", "normal", "excellent" and the linguistic variable "Journals without Impact factor" has the value "normal", "excellent", "excellent" respectively then the linguistic variable "papers" would have a value "excellent".

In Fig.5 membership function of linguistic variables «books» and «english course» is presented.

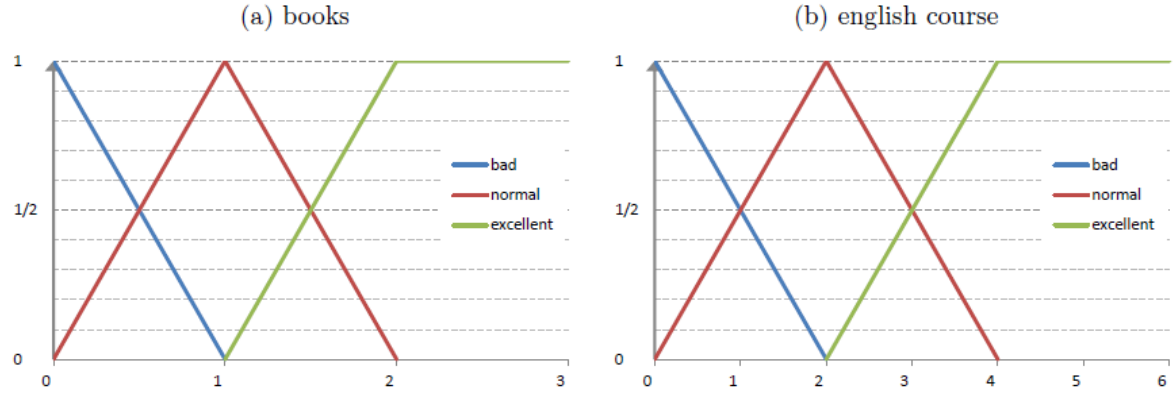

Figure 5. Membership function of linguistic variables

In Fig.6 the membership function of linguistic variable "teacher`s value" which is a function of above three linguistic variables.

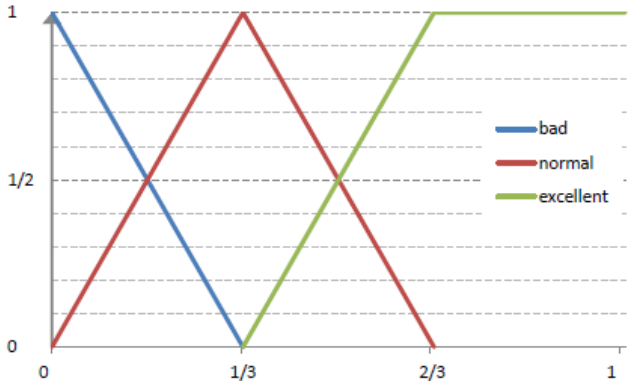

Figure 6. Membership function of linguistic variable "teacher`s value"

Based on the foregoing we can determine the value of linguistic variable "teacher`s value" with the following production rules:

Rule 2.1. If the any two linguistic variables have the values "bad" or any one linguistic variable has the value "bad" and another two linguistic variables have the values "normal" then the linguistic variable "teacher`s value" would have a value "bad".

Rule 2.2. If the any two linguistic variables have the values "excellent" and another linguistic variable has the value "normal" or "excellent" then the linguistic variable "teacher`s value" would have a value "excellent".

Rule 2.3. In all other cases the linguistic variable "teacher`s value" would have a value "normal".

In (1) - (3) an analytical description of membership functions of linguistic variables reviewed.

Membership functions to the term "bad":

$$\mu_{a(x)} = 1 - 3x,\ x \in [0, 1/3],$$

$$\mu_{a(x)} = 0, x \in (1/3, 1].$$

Membership functions to the term "normal":

$$\mu_{b(x)} = 3x, x \in [0, 1/3],$$

$$\mu_{b(x)} = 2 - 3x, x \in (1/3, 2/3],$$

$$\mu_{b(x)} = 0, x \in (2/3, 1].$$

Membership functions to the term "excellent":

$$\mu_{c(x)} = 3x - 1, x \in [1/3, 2/3],$$

$$\mu_{c(x)} = 1, x \in (2/3, 1].$$

Let`s consider an example of calculating "teacher`s value". Let reviewed teacher had written one paper in impact factor journal, eleven papers in journals without impact factor, one book and had proposed three courses in english language.

According to the Fig.5a papers with impact factor concerns to the term "bad" with probability 0,5 and with probability 0,5 to term "normal". According to the Fig.5b papers without impact factor concerns to the term "normal" with probability 0,9 and with probability 0,1 to term "excellent".

In accordance production rules 1.1-1.3, the linguistic variable "papers" would have value "bad" - 0,5, "normal" - 0,5 and "excellent" - 0,1. In accordance production rules 2.1-2.3. the linguistic variable "teacher`s value" would have value "bad" - 0,5, "normal" - 0,5 and "excellent" - 0,1 (Fig 7).

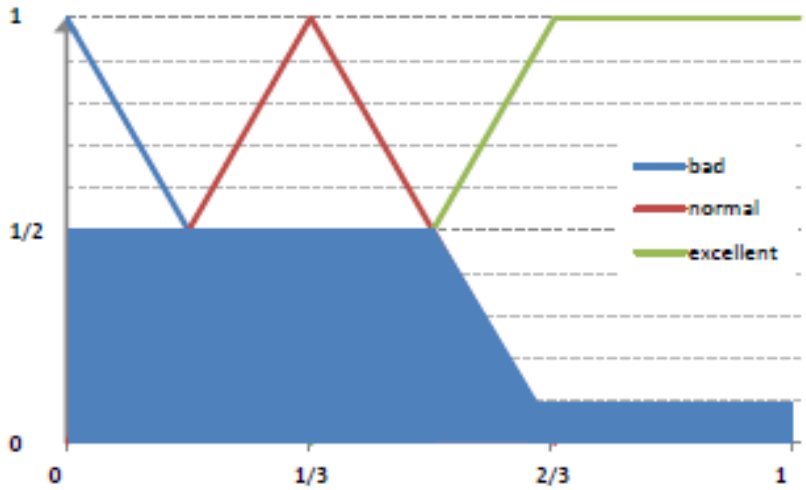

Figure 7. Fuzzy set of "teacher`s value"

This function can also be written as follows:

$$\mu_{(x)} = 0{,}5 \; x \in [0, 1/2];$$

$$\mu_{(x)} = 2 - 3 \cdot x \in [1/2, 19/30];$$

$$\mu_{(x)} = 0{,}1, \; x \in (19/30, 1].$$

With using the formula of the maximum center of gravity we calculate the teacher`s value T_i:

$$T_i = \frac{\int_{X_{min}}^{X_{max}} x \cdot \mu_i(x)dx}{\int_{X_{min}}^{X_{max}} \mu_i(x)\,dx}$$

where: X_{min}, X_{max} boundaries of the interval of a fuzzy set; x - input variable $x \in X$ where X - domain of the conditions of fuzzy production rules; $\mu_i(x)$ - membership function.

Aftersimplecalculations, we obtain:

$$T = \frac{\int_0^{1/2} x \cdot 0{,}5d(x) + \int_{1/2}^{19/30} x(2-3\cdot x)d(x) + \int_{19/30}^{1} x \cdot 0{,}1d(x)}{\int_0^{1/2} 0{,}5d(x) + \int_{1/2}^{19/30} (2-3\cdot x)d(x) + \int_{19/30}^{1} 0{,}1d(x)} \approx 0{,}35$$

2.1 Loss of student knowledge

Let's see how does "teacher's value" influence to knowledge of students. Below the questions of quantification students knowledge loss as a result of low "teacher's value" is proposed and the quantity of students' knowledge that they should get after graduation is correlated with the cost of study.The structure of the object is a three-level whose representatives occur in differentgroups of objects (Fig. 8). For generality, we assume that in a direct subjection of the university and faculty there are no teachers, they are all assigned to the relevant departments.[11,12,13]

The top level - faculties (1)

$$F = \{F_1,..., F_{NF}\}, \quad (1)$$

where: NF - number of faculties.

Middle level formed by departments D_{ij} , $i = \overline{1, NF}$, $j = \overline{1, ND_{ij}}$, included in the relevant faculties (2).

$$F_1 = \{D_{11}, D_{12},...., D_{1ND_1}\},$$
$$F_2 = \{D_{21}, D_{22},..., D_{2ND_2}\}, \quad (2)$$
$$\cdots\cdots\cdots\cdots\cdots\cdots$$
$$F_{NF} = \{D_{NF1}, D_{NF2},..., D_{NFND_{NF}}\},$$

where: ND_i – number of departments in faculty i,i – index of current faculty, j – index of current department.

Departments distributed intofaculties (3).

$$\bigcup_{j=1}^{ND} D_{ij} = F_i, \quad \bigcap_{i=1}^{NF} D_{ij} = \varnothing. \quad (3)$$

The bottom level consists of department teachers. In this case, for the teacher T_{ijm} , $i = \overline{1, NF}$, $j = \overline{1, ND_{ij}}$, $m = \overline{1, NT_{ijm}}$ could be written (4)

$$\bigcup_{m=1}^{NTij} T_{ijm} = D_{ij}, \quad \bigcap_{j=1}^{ND_i} T_{ijm} = \varnothing, \quad (4)$$

where: NT_{ij} – number of teachers of department j of faculty i.

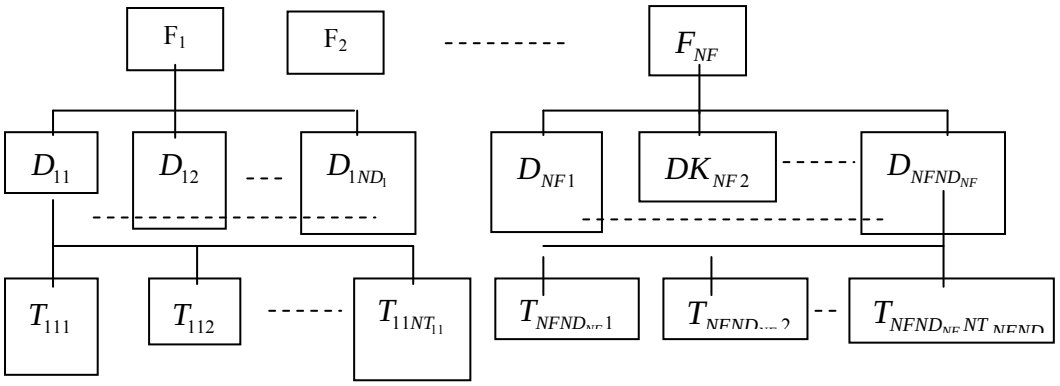

Figure 8. Structure of university

Deduce a formula for calculating the loss Lof department teachers follow the abovestructural model (5).

$$L_{abc} = C_0 \cdot (1 - T_{abc}) \sum_{i=1}^{NG} g_i \cdot NC_i, \quad (5)$$

where: C_o – payment of student for one credit, NG – number of groups studied by given teacher, T_{abc} – «teacher's value»of teacher c department b faculty a, g_i – number of students in the group i, NC_i - number of credits in the group i according to academic plan.

Generalizingthe formula (5) for all the teacher we obtain the formula for calculating the loss of students' knowledge (6).

$$L = C_o \sum_{a=1}^{NF} \sum_{b=1}^{ND} \sum_{c=1}^{NT} (1 - T_{abc}) \sum_{i=1}^{KG} g_i \cdot NC_i, \quad (6)$$

where: C_o – payment of student for one credit, NF - number of faculties, ND - number of departments, NT – number of teachers in the department, NG – number of groups studied by given teacher, T_{abc} – «teacher's value» of teacher c department b faculty a, g_i – number of students in the group i, NC_i - number of credits in the group i according to academic plan.

3 Conclusion

The problem of improving the quality of education can be achieved in different ways. The paper discusses one way of its increasing by using technology of business intelligence, which has been widely used in recent years. BI is next step of evolutionof decision support systems with extensive use of information technology for analysis. Also in the paper proposed the model of quantitative evaluation of teachers by using fuzzy logic and its impact on knowledge of the students.The proposed model allows the performance of subjects to a single digit which allows the university manager to make decisions on improving the quality of academic, educational, social, scientific and research of the university.

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Резюме

Білім беру қызметі нарығындағы бәсекелестікті жоғарылату білім сапасын жоғары білім бәсекелестігінің негізгі факторы ретінде қабылдайды. Қаржыландыру және басқа да экономикалық факторлардың шектеулілігі көптеген университеттер басшылықтарының дәстүрлі әдістерді қайта қарастырып, ұзақ мерзімді болашағын есептей отырып, жоғары білім және ғылымның стратегиялық дамуына ой тоқтатуда. Ұсынылып отырған модель университет басшылығына білім беру, әлеуметтік, және университеттің ғылыми жұмысының сапасын жақсарту тұрғысынан шешім қабылдауына көмек беретін жоғары білім объектілерінің өнімділігін бір санмен бағалауға мүмкіндік береді.

Резюме

Повешение конкуренции на рынке образовательных услуг сделало качество образования основным фактором конкурентоспособности высшего образования. Ограниченное финансирование и ряд других экономических факторов заставило высшее руководство большинства университетов пересмотреть традиционные методы и сосредоточиться на стратегическом развитии высшего образования и науки, которая принимает во внимание долгосрочные перспективы. Предложенная модель позволяет оценить производительность объектов высшего образования одной цифрой, которая позволит руководству университета принимать решения по улучшению качества образовательной, социальной и научной деятельности университета

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FORMATION OF REGIONAL MANAGEMENT AS AN EFFECTIVE MECHANISM OF TERRITORY MANAGEMENT

In the 70s of XX century the idea of regional development based on principles of sustainability, equity and social orientation became popular [1]. Of course, the experience of regional management in countries with market economy can be used in newly independent states (NIS), which include Kazakhstan, featuring the territorial organization (huge uninhabited area with planetary significance, the diversity of natural and climatic conditions, ethnic and cultural composition, significant reserves of mineral and raw materials).

For us regional management appears as a science and a practice of managing socio-economic processes in the region in order to achieve effective management and positive dynamics of parameters of quality of life. Its methodological base consists of system of scientific knowledge, including principles, methods, models and mechanisms of regulating territorial development. Relying on the mentioned research methods, the authors have reviewed problems and perspectives of developing regional management in relation to a particular region - the South Kazakhstan region.

The region has abundant resources that make up the potential of its unique competitive advantage. This include large working-age population, which is 15.1% of the total population of the country; large reserves of barite, coal, iron and polymetallic ores, uranium, bentonite, vermiculite, talc, limestone, granite, marble, gypsum, quartz sand and etc. [2]. 156 subsoil users carry out their activities in this region, 13 of which are enterprises with foreign capital that are involved in the extraction of uranium, gold, oil, plaster and other raw materials. Transit potential of the region is in economically advantageous location at the crossroad connecting the countries of the Asian region, Middle East and Europe.

Of course, over the years of independence there have been dramatic shifts in the national economy: development institutions were designed, economy is transforming from resource into an investment economy, and now it is in a transition to an innovative economy. There is an active search for innovative methods and tools in managing the economy of the country, the reforms are transferred to the regional level of management [3].

Thanks to the State program of forced industrial-innovative development for 2010-2014 large investment projects launched in traditional sectors of the economy oriented to export [4]. A policy of maximum import substitution was adopted, increasing the local content of products and food and energy security. The use of these business opportunities should provide a multiplier effect on the entire spectrum of industries of national economy.

However, today, economic growth is ensured thanks to the intensive development of non-renewable mineral resources, which threatens the economic security of the country due to technological backwardness of enterprises. That being said, the increase in the population outstrips the increase in production of some products, as a result, needs are met not at the expense of domestic production, but at the expense of imports from other regions and countries. There is an increase in the difference between the rate of growth of average wages, cost of living and real income per capita among the regions of Kazakhstan, which affects the stratification of society, creates social divergence of the cost of living.

The experience of developed countries shows that the new knowledge embodied in technologies, equipment and organization of production must be accompanied by dramatic, institutional changes in the socio-economic structure of society, in this case, changes in the regional governance. In the authors' view, *the transition from the traditional system of managing territorial economy to regional management* in the NIS consists of the following changes:

- The orientation of the region's development to solve social problems, to create conditions for a high level of human life as the highest value of society;
- The formation of the organizational and economic preconditions for the implementation of principles of economic freedom and independence of decision making by the authorities of the region;
- Carrying out investment and structural policy in the region, aimed at meeting consumer demand, import substitution, output of product, which has a high value-added part and export-oriented;
- The transition from the regional statistics to development monitoring of the area using modern IT-technologies, the methods of systematic analysis of socio-economic, political and environmental situation in the region;
- Assessment of the final result of the regional management through social standards, budgetary provision for a person, the optimal structure of income and expenditure of families, food and environmental safety.

With the deepening of policy reforms in Kazakhstan, regional management policy should consist of *redistribution of functions between government structures, implementation of the principle of separate competence, regulation of property relations. Marketing and innovative activity should be a priority for the regional managers.*

A special place in the regional management is assigned to the stimulation function. Businesses and organizations of different ownership forms operate in a mixed economy of the region, but the methods of direct influence by the regional managers are legitimate only to the objects of municipal and communal property. For other entities methods of indirect effects, i.e. stimulating of activity can be effective.

The stimulating function of regional management is recommended to implement through the leverage of interests of businesses, organizations and social groups. Thus, the Mayor's Office of region can not bind the company under private ownership, to allocate funds for the construction of a facility with regional significance. However, the regional administration may enter into a contract with this company on the conditions of partnership, under which the company finances part of the construction and the administration will create business stimulating environment (the exemption or privileges to specific taxes, the provision of engineering and social infrastructure on preferential terms, and etc.) for it.

A new industrial zone on the territory of former phosphate plant in Shymkent city operates on this principle, where 23 new companies were started, state budget have provided significant preferences and privileges. Businesses are provided with a minimum set of infrastructure, discounts on water and electricity are also provided.

Redistribution of functions between the republican and local government structures are proposed to implement on the principle of *separate competence*, i.e. every business have well-defined functions, a certain competence in the statutory field of activity. The fact is that the regional management by itself does not guarantee social and economic stability in the country, does not eliminate the differentiation of the levels and quality of life in the regions, therefore the principle of a separated competence becomes an effective instrument of regulation.

It is known that state and municipal enterprises, which are also called unitary enterprises, enter into economic relations with local authorities. These relations are defined by the fact that the latter are established on the initiative of local bodies that define the operation parameters of enterprises, specialization and production profile; regulate their activities through the development of regional programs, with purchase orders and contracts. Today in the state of regional property the following features can be mentioned:

1. There are various property relations due to different forms of them, changes in legislation during privatization, the adoption of different, sometimes contradictory decisions by local authorities.

2. Differences in the provision of territories by mentioned forms of ownership determine substantial irregularity in the socio-economic arrangement of the regional entities.

3. State and municipal property in the regions is often costly property. If there are shortfalls in revenues, that was the case, for example, during a crisis, maintaining objects of regional property becomes burdensome.

For efficient use of regional property it is proposed to sell, lease or transfer it into a trusted management, use of other mechanisms of "dumping" unprofitable municipal property that is not carrying any social stress. According to the authors, the central and local authorities could have increased their influence on unitary enterprises by performing the delegated functions of state property management.

Global modern challenges, challenges of post-crisis development, present new perspectives for regional managers:

1) First of all, economic and social transformation of the region's economy is needed; the former entities, inherited from the planned economy, do not correspond to market realities, do not contain elements of innovation;

2) There is a need of optimizing financial flows in the regional sphere, because the development of market relations created new development institutions, business structures, subjects of financial market, which require formation of more efficient conditions and mechanism of regulating economic activity in the region;

3) New structural, investment, science and technology policy should be formed; infrastructure facilities that meet the standards of civilized countries should be created in the regions.

New ways of regional development should be researched, since previous methods, forms and structures are unsuitable, they do not meet the new relations. Today the fight for a world-class production increases. Norms of control are changing, mobility of labor is increasing. It must be assumed that changes in political system occurring in some regions of the world will be fundamental.

The new trends include:

1. Strengthening of the role of information society – government once was defined by labor, capital and natural resources; over time government is becoming dependent on information.

2. The complexity of the world and information explosion will strengthen the abilities of human mind, the role of intelligence increases, the intuitive decision-making will become important. There will be a reduction in middle management, many problems can be solved with the help of computers and innovative work methods.

3. Mobility and globality of economy lead to the fact that the workforce is increasingly characterized by variety of languages, cultures and value systems, maturity of civil society increases, the influence of nongovernmental organizations increases.

Principles of regional management should be changed and re-formed. Thus, in the framework of decentralization the decision-making functions of the national bodies will shift to the agents of the market. This will limit the monopoly of the regional management on the absolute power, will expand the freedom of economic entities in the region and a more democratic system of polycentric decision-making will develop.

The factors of competitiveness, which distinguish this region from others should be identified and activated. It is expedient to place main emphasis on creation of such advantages as well-developed infrastructure, modern communications, security system (personal and business), the availability and

effectiveness of institutions supporting the business, efficient industrial policy, presence of qualified personnel, and presence of advantageous conditions for the investments.

An essential element of regional management is *monitoring* – the flow of necessary information about the behavior of the object of observation, control of the situation, keeping track of the condition of the territory as a system and timely notification of emersion of a qualitatively new processes in the economic, environmental and social subsystems. It is also about preempting of critical situations. On the basis of accurate knowledge about the sources and factors of the regional development, one can:

- identify factors that cause economic and social threats now and in the future;
- accelerate the changes, if they are desirable for the territorial community, and maximize final results;
- in advance take adequate measures to future events, thereby enhancing stability and security of population activity.

First of all, regional monitoring acts as a regulatory mechanism that ensures stable development and management in critical situations; secondly, as a special method of accumulating knowledge about the contradictions and regularities of forming socio-economic space in the region; and thirdly as a basis for identifying the causes of deviations from the normal course of events, for programming and planning.

Researchers have noted that in any complex event, where the movement is the result of interaction of many factors, it is always possible to establish the main sources of development. In terms of system characteristics only some of many factors are important. In most systems 20% of factors determine 80% of the properties of the system, while the remaining 80% of factors determine only 20% of its properties [5].

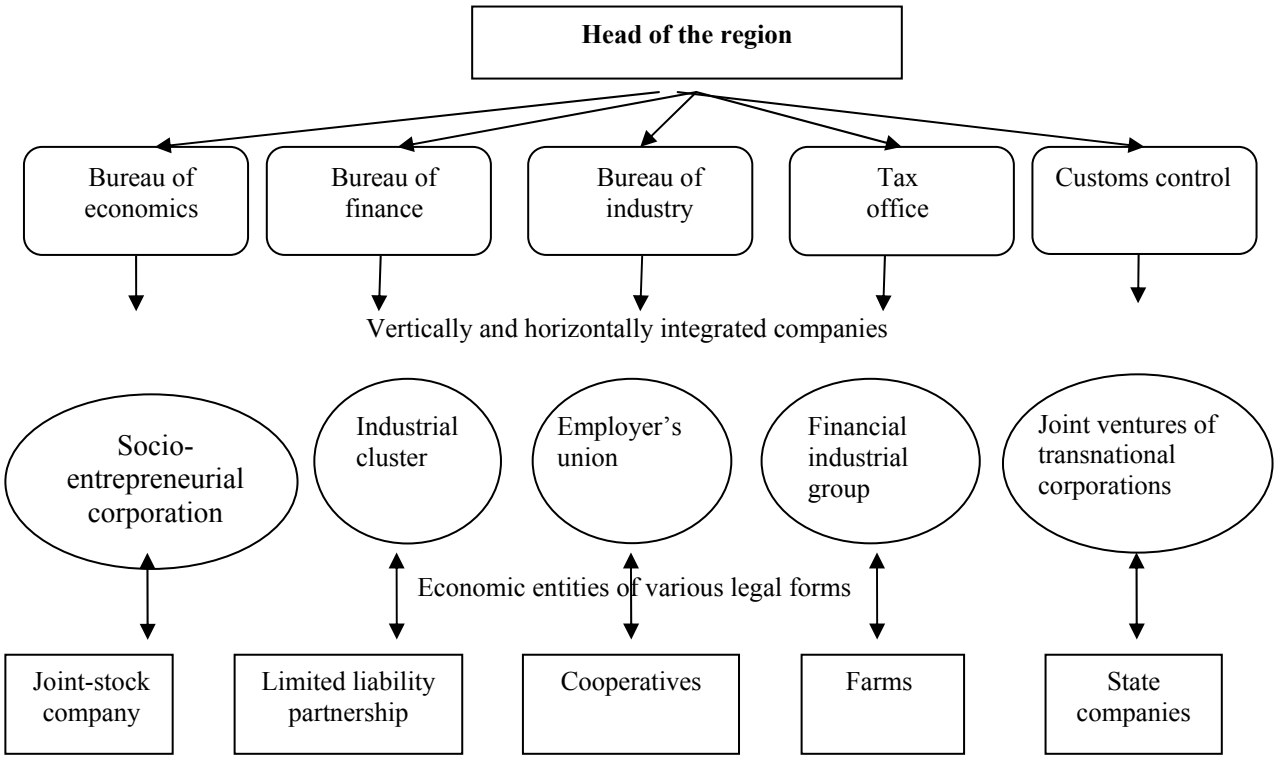
This allows and encourages regional monitoring means to seek substantial reasons and conditions for the development of territories. As part of regional development management we propose to develop the ability to innovate among administration employees, by cultivating and encouraging personal characteristics as transparency, the ability to accept new experiences, flexibility, willingness to abandon outdated ideas and models, tolerance for others and different views.

One of the factors of achieving a stable leadership in leading innovative companies was the creation of a motivating vision among the employees [6]. In our view, this approach is also productive when applied to the activities of local authorities. *Vision is a set of representations of the organization workers about what organization should be in the future.* The vision is an image, project of future state that motivates people to make independent creative actions.

Ability of vision is more important task than forming of traditional plans. The creation of vision involves not only understanding, but also emotion, that's why its formation also involves cultural elements of the organization. Vision has a powerful stimulating effect. It places members before the challenge and helps to move towards future. Imaginative idea of where would follow one or another local community helps each employee of administration independently set goals that are compatible with the common aspiration of the people. Research of the International Development Organization at the United Nations (UNIDO) indicates that the status of various factors to attract financial resources to national economies has changed. Traditional factors (rich resource base, cheap labor) have less impact on the investment. New factors are becoming more efficient:

- medicine, a strong educational system and the development of science;
- competent bureaucracy;
- well developed industrial and social infrastructure.

Search for innovation by leaders and managers of local government structures becomes an element of success. At the same time a powerful impetus to the implementation of innovation into the governance structure of the region gives the appearance of new business structures [7]. In general, the transformation of the ideology of management at the regional level can be represented in the following organizational structure (Figure 1).



Note: developed by the authors.

Figure 1. Organizational structure of the interaction of the economic sphere of territorial formation

Interaction of local government and business entities in this model, in our opinion, will promote a positive image of the region, city, and will provide competitive advantage for the territory. For the business environment this can be represented as a chain of successive steps: the formation of companies as national leaders, which are gradually transformed into a multinational, the formation of a national competitive market with mainstream companies that are focused on global markets. Local authorities are assigned to form incentives of entrepreneurs in order to make them adopt decisions necessary for the development of the region. This is achieved in particular by reduction of local taxes or by provision of cheap capital using the tools of the loan, grants, guarantees, and even direct loans.

Scheme shown in the Figure 1 was adopted for the implementation within the framework of corporate economy formation, the financial component of which will be reinforced by the release of municipal securities for the innovative projects that have social significance for the region.

Different systems and strategies for management of regional business have developed in the world. There are different points of view on how to manage them, including the concept of corporate governance [8]. It comes from the fact that every inhabitant of the region is a co-owner of all that is in the area on the principle of equal and joint ownership. To dispose and manage this property under contract managers and professionals are employed.

Private property, formed by the population of the region on the principles of equal co-ownership, can be nothing but a basis for acquiring the corporate benefits and formation of corporate profits, which satisfy the interests of the community. Every resident of the city (region) is the owner of only part of the corporate property, which he can use for his benefit (for example, shares of financial institutions, co-owned by residents). Primary goals are interests and needs of their regional population (the consumer), that's why the regional corporate entity is presented in the form of an inverted pyramid (Figure 2).

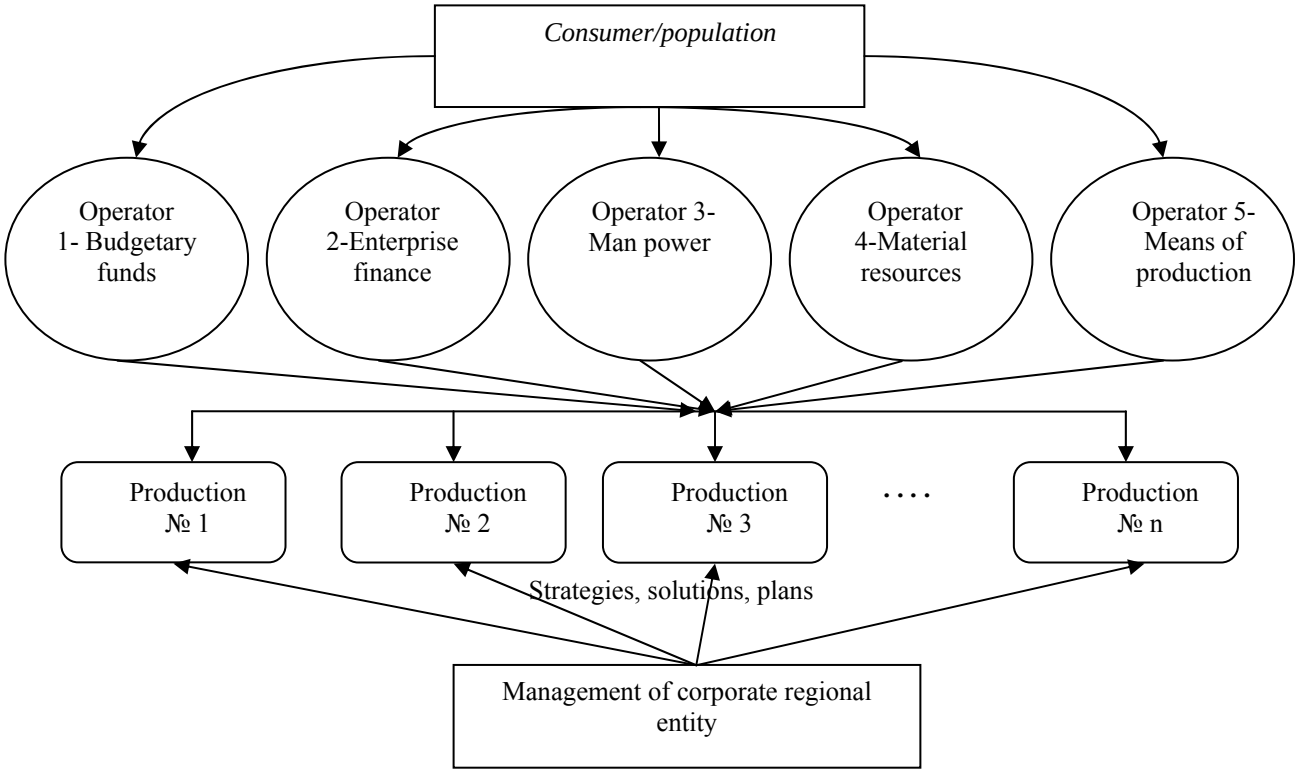
In the presented below scheme, each entity may make an independent decision. The right to make decision is transmitted to the level that can best handle the problem. The entities that do not produce or produce not enough gross added value are removed, the entity must meet the requirements of a complex market. Other services exist in order to provide financial resources. The task of each inline employee is to

provide service to the customer. Management of regional corporate entity provides production managers with plans, decisions and resources.

The introduction of civilized market relations eliminates the vertical connections, creates and stabilizes horizontal, intra-and inter-relationships. There is a reduction in the institutional and hierarchical structures, increasing the role of indirect methods of interaction between the subjects and objects on the regional level. The regional leaders must not only implement goals of the top government, but show initiative in the effective implementation of plans, accomplish them with low costs, become popular, take the initiative and independence. It is advisable to liaise with the public - to show that the region's management is not only an agent of the unitary state government's idea, but also a successful manager foreseeing the results with a plan of actions, long-term development strategy for the region. Uncertainty in the actions of regional managers may be the result of frequent changes in leadership, political risks, changes in economic policy and / or legislation.

The regional entities of the future will be influenced by the following new trends:

- Capital will remain an essential component of production, but due to the deterioration of the resource base its use will be optimized, raw materials will become expensive, valuable and rare natural resource;
- Increasingly it will be recognized that time is more valuable resource than talented employees;
- It will be possible to build bridges through immigrants in a foreign country, the significance of foreign customers will decline; the partnership of suppliers and customers will strengthen;
- Decline of bureaucracy is reflected in the fact that small groups with people with the same status achieve better results; personality groups, the skills of which go beyond the structural and disciplinary boundaries, will be developed; the proportion of routine work will be reduced;
- In the organizations of future autonomous units will be widespread, they work better and more responsibly when selling, promoting products, the role of informal structures, cooperation and partnerships will increase.



Note: developed by the authors.

Figure 2. The inverted pyramid of regional corporate entity

This way the regional management solves the problem of rational distribution of enterprises and industries, the formation of areas of sales, the organization of space in urban areas to improve the welfare of

the population. Modern problems of humanity require improvement and update of management procedures in the regional power structures, and therefore the authors recommend:

1. Local Authorities (Akimat) bespeak the support of the population. In Kazakhstan informing the public about what is being done or decided by Akim (Governor) is well-placed, but the approval and support of the population is not required, ready solutions come from the top.

2. Positive resolution of existing problems. Most of the employees/ performers of regional authorities are engaged in responding to current and sometimes crisis situations; assigning official status to the program of resolving problems increases the efficiency of its implementation.

3. Careful monitoring of developments. This is a weak spot in the work of regional authorities; the monitoring is rare; review, in-depth analysis should be carried out, careful understanding of what worked and what did not work should be developed.

4. Distribution and empowerment – every manager must be aware of its purpose and role in the management hierarchy. This should be supported by controlled feedback, so that people would feel their responsibility and necessity.

5. Establishing relations with shareholders and investors under the socio-entrepreneurial corporations, cluster schemes, and other businesses. An understanding of why local authorities are establishing relations with shareholders and what it will give to the public should be formed. Communication programs (publications, presentations, personal visits to the company, communication with the public, the press, experts in securities and etc.) should be developed.

A global approach was a crucial factor for the successful competition of countries and regions. In Kazakhstan 12 regions out of 14 are the cross-border regions, interactions with neighboring countries has always been mutually beneficial, it is necessary to build relationships in the new format, because the world is changing. What industry is promising, what industry is interesting for the country? For example, for Uzbekistan livestock products and wheat from Kazakhstan are important, for Russia - early vegetables and fruits.

According to UNDP, 160 of more than 200 countries are considered promising for the business [9] and establishing joint venture. Moreover, when making a deal regional power authorities should consider following:

- The level of economic development of the country (for example, in some Central Asian countries, market relations are weak and it is difficult to conduct a business);

- The availability of commercial contacts: if the country is actively interacting with the outside world, for regional managers will be easier to establish relations;

- Control of activities: if the country has strict regulation of business operations, conducting the business becomes difficult, only few opportunities for innovation exist; in some countries, regardless of the level of development, there are significant limitations, barriers and restrictions;

- Development level of private sector: in many countries, certain activities and industries are run by the state, if the region and its private sector businesses do not consider interested industry as high priority industry, the country is of limited interest for investors. No doubt, realization of the ideas of regional management makes fundamental changes in institutional, industrial, social structure of society, stimulates business activity and protects the environment of human life. Ultimately, this creates positive image of the region, promoting regional product.

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Резюме

Мақалада аймақтық менеджмент ғылым мен тәжірибені басқарудың әлеуметтік-экономикалық қозғалысының аймақтық үрдісі ретінде түсінік беріледі. Аймақтық менеджменттің мақсаты – тұрғындардың сапалы өмір сүруінің оң қозғалысымен аймақтық шаруашылықтың тиімді жетістігі. Авторлар құрылым аралың биліктің қызметін, біліктіліктің белгіленген қағидасын қолдана отырып,қайта қарауын ұсынады.ҚР-ның 2010-2014 жылдардағы Мемлекеттік бағдарламаның жылдамдатылған индустриалды – жаңашыл дамуы,аймақтық менеджменттің талабы бойынша жасалуы мүмкін.

Резюме

Дано понятие регионального менеджмента как науки и практики управления социально-экономическими процессами в регионе. Цель регионального менеджмента - достижение эффективного хозяйствования территории и позитивной динамики параметров качества жизни населения. Авторы предлагают перераспределение функций между структурами власти, используя принцип выделенной компетенции. Делается заключение, что Государственная программа форсированного индустриально-инновационного развития Республики Казахстан на 2010-2014 годы может быть успешно реализована при условии развития регионального менеджмента.

SKSU named after Auezov *Received 05.11.2012*

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