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PAPERS IN ENGLISH

COMPUTER SCIENCE, COMPUTER ENGINEERING AND MANAGEMENT

СТАТЬЯ УДАЛЕНА ПО ЗАПРОСУ ПРАВООБЛАДАТЕЛЯ

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APPLICATION OF FUZZY LOGIC IN THE GAS TRANSPORTATION CONTROL SYSTEM

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ПРИМЕНЕНИЕ НЕЧЕТКОЙ ЛОГИКИ В СИСТЕМЕ УПРАВЛЕНИЯ ТРАНСПОРТОМ ГАЗА

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ABSTRACT

The article deals with the problem of automating the control of technological parameters of gas transportation using fuzzy logic. An information model and a system of differential equations for the flow of natural gas through a pipeline are presented. To simplify calculations, it is proposed to use a triangular membership function, for all fuzzy values

АННОТАЦИЯ

В статье рассматривается задача автоматизации управления технологическими параметрами транспортировки газа с применением нечеткой логики. Приведены информационная модель и система дифференциальных уравнений течения природного газа по трубопроводу. Для упрощения вычислений предложено применение треугольной функции принадлежности, для всех нечетких значений

Keywords: hydraulic resistance, gas transmission system, natural gas, membership function, transportation.

Ключевые слова: гидравлическое сопротивление, газотранспортная система, природный газ, функция принадлежности, транспортировка.

Introduction

In the global gas industry, in particular, in the field of storage and transportation of gas, research is being carried out to improve existing technologies, increase production efficiency and the capacity of technological units. Much attention is paid to the solution of theoretical problems of parametric identification and adaptive control of technological processes in conditions of uncertainty and their practical application in various fields [1].

Currently, the Republic of Uzbekistan pays great attention to automation and control of technological processes and industries, including the creation of advanced control systems that save energy and resources in the automation and management of gas storage and transportation [1].

The complexity of technologies for storage, transportation and treatment of gas and gas condensate requires the development of highly efficient methods and algorithms for controlling technological processes in conditions of uncertainty using the achievements of modern information technologies and technical means. In this regard, it is necessary to develop a control system with computer technologies for the preparation, storage and transportation of natural gas, which will allow analyzing technological solutions at a qualitatively new level and monitoring the main indicators of production, storage and transportation of gas and gas condensate [2].

Research Methods and the Received Results

Mathematical modeling of the processes of trunk transportation of natural gas is significantly complicated due to the presence of uncertainties in the initial data.

The uncertainty of the initial data can be taken into account in mathematical models using two types - probabilistic models, as well as taking into account the methods of the theory of fuzzy sets [2].

The uncertainty of some parameters of gas production systems is rather ambiguous from the point of view of probability and, accordingly, can be described in the form of fuzzy sets, which are also called fuzzy numbers. The actual drag coefficients of gravity pipes are usually close to the design values, but both also differ from them due to the error in calculating the impact and gravity resistance on the inner walls [3].

The most important task of developing an intelligent control system is not only the collection of relevant information, but also the selection or creation of effective models for demonstrating knowledge, which will allow it to be effectively processed in the decision-making process. This task is directly related to the development of highly efficient algorithms for modeling, predicting and adapting the parameters of the control system operating under conditions of uncertainty to create an appropriate knowledge base that includes the necessary information

about the problem area and decision-making methods in this area.

The tasks of mathematical modeling of the processes of storage and transportation of natural gas are significantly complicated by the presence of uncertainty in the initial data.

To simulate the processes of storage and transportation of gas, one has to use fuzzy information about the state and characteristics of wells, pipelines and electrical equipment [3].

The information model is shown in Fig. 1.

Figure 1. Information model of the gas transportation system.

Natural gas flow is described by the following system of differential equations:

$$\begin{cases} \frac{\partial \rho}{\partial t} + \frac{\partial}{\partial x}(\rho v) = 0, \\ \frac{\partial}{\partial t}(\rho v) + \frac{\partial}{\partial x}(\rho v^2) + \frac{\partial \rho}{\partial x} + \rho g \sin \alpha + \frac{1}{4r} \lambda \rho v |v| = 0, \\ \frac{\partial}{\partial t} \left(\rho \varepsilon^{(v\partial)} + \rho v \left(\frac{v^2}{2} + h^{(v\partial)} + gH \right) \right) = -\frac{2}{r} K(T - T_{tm}), \end{cases}$$

where P is the pressure in the gas pipeline; T – gas temperature, ρ – gas density; v – gas flow rate;

x – the coordinate of the length of the gas pipeline; t – time; d – is the inner diameter of the pipe;

λ – coefficient of hydraulic resistance; α – the angle of rotation of the gas pipeline in relation to the horizon; H – the height of the gas pipeline relative to sea level; ε – comparative gas resistance,

h – is the comparative enthalpy of the gas, that is, the function of the state of the thermodynamic system H is equal to the sum of the internal energy U and the derivative of pressure P and volume V . $H = U + PV$. g – the acceleration of gravity, T_{tm} – the ambient temperature, K – the coefficient of heat release into the environment [4].

Problems of mathematical modeling of the main transportation of natural gas. The main initial indicators when planning long-term operating modes of the gas transmission system (GTS) are the volumes of gas production and consumption. Depending on factors that are very difficult to predict, gas demand can lead to significant changes.

Firstly, this is the weather conditions - natural gas, compared to the cold winter time, is significantly reduced in hot seasons [4].

Secondly, it is the rate of economic growth of countries with different economic and political-economic conditions, for example, the rate of economic growth of countries consuming energy resources. A certain degree of unreliability of the condition of pipes and power equipment plays an important role in the planning of medium and short-term modes.

Let us consider the system of main gas transportation in which some parameters are not reliable, we will use a fuzzy expression for these parameters. The following is not known for certain:

- gas consumption at the inlet and outlet of the system;
- coefficients of hydraulic resistance of pipes;
- maximum compressor power;
- production rate of wells.

All these values can be designated as fuzzy numbers, the membership functions of which are determined by expert methods. Simplifying calculations only without loss of generality, we use triangular membership functions for all fuzzy values:

$$\mu_j(x) = \begin{cases} 1, \text{ arap } x \leq x_{j,min}, \\ \frac{x_{j,max} - x}{x_{j,max} - x_{j,min}}, \text{ arap } x_{j,min} \leq x \leq x_{j,max}, \\ 0, \text{ arap } x_{j,max} < x. \end{cases}$$

At the inlet of the GTS, the flow rate is indicated as a fuzzy number $(x, \mu_q(x;p))$. The variable p is taken as a

parameter: we will assume that for each p there corresponds a fuzzy flow rate. The computational module converts the membership function (MF) of the flow rate ($x, \mu_q(x;p)$) into the MF of the flow rate ($x, \mu_q^-(x;p^-)$) at the output. The intersection of fuzzy sets is determined by the formula $\mu_{A \cap B}(x) = \min(\mu_A(x), \mu_B(x))$, using the operator $\mu_q(x;p) \rightarrow \mu_q^-(x;p^-)$ taking into account that the coefficient of hydraulic resistance ($x, \mu_N(x,p)$) and ($x, \mu_N(x,p^-)$) fuzzy variables.

The p -value in KC is expressed as follows:

$$\bar{p} = \bar{p}_{KC}(\underline{p}, \underline{q}, N), \quad (1)$$

and on transmission lines according to the following formula:

$$\bar{p} = \bar{p}_{ЛВ}(\underline{p}, \underline{q}, \lambda). \quad (2)$$

p on the transmission line is calculated exactly, and in the CS it is chosen by the optimal method, since the CS power N is a variable of the control action [5].

The solution was found by the ordered search method (dynamic programming). In the process of dynamic application, the inlet pressure given to the outlet flow rate ($x, \mu_q^-(x;p^-)$) MF is determined to ensure the maximum level of membership in this inlet pressure:

$$\mu_{\bar{q}}(x, \bar{p}) = \min_{\underline{p}} \{ \mu_{\underline{q}}(x, \underline{p}), \mu_N(x) \}, \quad (3)$$

in addition, in the operation of obtaining the maximum (3), p, N, p^- values must be related by relation (1).

In practice, the situation is complicated even by the lack of partial or complete information on the statistical characteristics of the noise. Therefore, to solve the estimation problem it is proposed to use the theory of fuzzy sets.

Consider a nonlinear dynamic system with discrete time:

$$x_{k+1} = F_k(x_k, w_k), k = 1, 2, \dots \quad (4)$$

for this system, its size and state are interrelated:

$$z_k = H_k(x_k, v_k). \quad (5)$$

In these equations, the index k corresponds to the k -moment of time;

F_k, H_k - k -nonlinear functions of suitable arguments;
 x_k - dynamic state of the system;
 w_k is a fuzzy disturbance defined for each time instant k of the MF $\mu(w_k)$;

v_k - measurement error with a known membership function $\mu(v_k)$.

To determine the best estimate of the state x_k at time k for a given expression for the MF $\mu(x_k | \bar{z}_k)$, we use the formula:

$$\mu(x_k^0) = \max_{x_k} \mu(x_k | \bar{z}_k).$$

In the presence of some conditional MF $\mu(x_{k+1} | \bar{z}_k)$, the optimal point estimate of the current state of the system for the moment $(k+1)$ can be determined as follows:

$$\mu(x_{k+1}^0) = \max_{x_{k+1}} \mu(x_{k+1} | \bar{z}_k).$$

For fuzzy constraints $C_k \subset U$ characterized by the MF $\mu_{C_k}(u_k)$, a control action u_k is introduced at each time instant k and it is assumed that the initial state x_0 is given. Let's say there is a fuzzy goal $\mu_{G_N}(x)$ (x) that needs to be achieved in time N [5].

Conclusion

Optimally known control actions $u_0^0, \dots, u_{N-1}^0$ can be defined, [54]:

$$\begin{aligned} \mu_G(u_0^0, \dots, u_{N-1}^0) &= \max_{u_0, \dots, u_{N-2}, u_{N-1}} \{ \mu_{C_0}(u_0) \wedge \dots \wedge \\ &\mu_{C_{N-1}}(u_{N-1}) \wedge \mu_{G_N}(F(x_{N-1}, u_{N-1})) \} \\ &= \max_{u_0, \dots, u_{N-2}} \{ \mu_{C_0}(u_0) \wedge \dots \wedge \mu_{C_{N-2}}(u_{N-2}) \wedge \\ &\mu_{G_{N-1}}(x_{N-1}) \}, \end{aligned} \quad (6)$$

$$\begin{aligned} \mu_{G_{N-1}}(x_{N-1}) &= \max_{u_{N-1}} \{ \mu_{C_{N-1}}(u_{N-1}) \wedge \\ &\mu_{G_N}(F(x_{N-1}, u_{N-1})) \}, \end{aligned} \quad (7)$$

here the function $\mu_{G_{N-1}}(x_{N-1})$ can be considered as the MF at time $N-1$, which is induced by the final goal G_N at time N .

Thus, it is possible to find an effective exact control u_k^0 at an arbitrary time instant k knowing the current nonlinear state $\mu(x_k)$, the nonlinear constraint $\mu_{G_k}(u_k)$, and the induced nonlinear target $\mu_{G_N}(u_N)$ based on (6), (7).

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WRITING CONTROL PROGRAMS FOR COMPUTER NUMERAL CONTROL MACHINES

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НАПИСАНИЕ ПРОГРАММ УПРАВЛЕНИЯ ДЛЯ КОМПЬЮТЕРНЫХ ЧИСЛОВЫХ УПРАВЛЯЮЩИХ МАШИН

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ABSTRACT

This article discusses methods for creating a program for processing parts on computer numeral control machines used in mechanical engineering and manufacturing enterprises.

АННОТАЦИЯ

В статье рассмотрены методы создания программы обработки деталей на станках с числовым программным управлением, применяемых в машиностроении и производственных предприятиях.

Keywords: CNC, Software, programming, G-code, design, technology, CAD, CAM, CAE.

Ключевые слова: ЧПУ, программное обеспечение, программирование, G-код, дизайн, технологии, CAD, CAM, CAE.

Introduction

Today, all industries are at the peak of their development. Digitalization is also taking place in the field of mechanical engineering. Digital software-controlled (RDB) machines are now being used in production instead of the usual conventional machines. The production process is carried out on automatic lines.

Methodology

RDB devices can be thought of as a system of 3 blocks: a control program (a device for reading it); RDB devices and the machine itself.

On RDB machines, the processing of details is done by creating a machining program. There are three methods of programming for RDB machines:

- Manual programming;
- Programming on the control panel of the RDB machine;
- Programming with CAD / CAM system.

1. Manual programming.

Manual programming is the creation of a management program by a programmer without the use of special software based on knowledge of these commands.

Hence, it is clear that this programming method is the most time consuming, it is used to create a simple detail processing management program.

Manual programming consists of the following steps:

- preparation of technological information;
- calculation and analysis;
- coding;
- recording the program;
- Adjustment and preparation for production.

Discussion

The most time-consuming phase is the program development and implementation phase, which accounts for 30% of the programming time [6-10]. The first stage (preparation of technological data) is integral to any programming method. At the stage of technological preparation of the control program, the development of operational technology, selection of tools, selection of the working sequence and sequence of technological transitions, selection of cutting rhythms, etc. are carried out.

The computational and analytical phase consists of determining the coordinates of the trajectory points of the intersecting instruments, e.g., intersection points, the attempt of straight lines by an arc, and so on. Technological points are needed to change the cutting tools, as

well as to change the processing modes (amount of thrust, spindle speed, etc.)

Figure 1. A program designed to process a detail on an RDB machine

Results

Processing in RDB is usually programmed in a language called ISO 7 bit language or G and M code language. The G and M code languages are based on the rules of the International Organization for Standardization (ISO) and the Electronic Industry Association (ESA).

Advantages:

- Almost unlimited possibilities in software development.
- Allows you to change any process parameters (for example, cutting speed, cutting depth, thrust, etc.).
- Produces RDB programs more efficiently than most CAM systems.

Disadvantages:

- G-code requires knowledge of programming language.
- Manual calculations and checks are time consuming
- Numerous calculations increase the probability of a programmer error
- A difficult process that requires the full involvement of the RDB programmer
- Lack of programming staff to implement programs at this level

2. Programming in the RDB control panel.

This method involves creating and entering programs directly on the RDB bench control panel using the keyboard and display. In this case, the parameters required for detail processing are entered in the control panel. For example, the rotational frequency of the machine spindle, the amount of thrust, the location of the part, the coordinate of the cutting tool, and so on.

Figure 2. Creating a part machining program using the RDB drilling rig and its control panel.

Advantages

- Easy to learn and simple to use.
- Does not require G-code to write the program.
- Installation and programming times have been reduced
- Fewer software errors.
- More economical than CAM system

Disadvantages

- Coordinate geometry is limited.
- It is difficult to program for complex and shaped details.
- The cutter does not support the tool shop.
- Does not offer CAM system flexibility.

3. Programming with CAD / CAM system.

To succeed in the market today, an industrial enterprise has to work on reducing production time, reducing costs, and improving quality. The rapid development of computer and information technology has led to the emergence of CAD / CAM / CAE systems, which are the most effective means of solving these problems.

Figure 3. Creating a detail processing program using the CAM system of Siemens NX software.

CAD systems (computer-aided design) - a software that automates the work of an engineer in the design and allows you to solve problems of product design and technical documentation using a computer.

CAM systems (computer-aided manufacturing) - Automate the calculation of the path of cutting tools for processing on RDB machines and provide computer-aided management software.

CAE-systems (computer-aided engineering) - (computer-assisted engineering calculations) are designed to solve a variety of engineering problems, such as power calculations, thermal process analysis, calculation of hydraulic systems and mechanisms.

Conclusion

In general, the process of writing a management program in a CAD / CAM system can be expressed in the form of 3 main stages:

The first step is to create a 3D model of the detail and the blank. This process is performed by the designer-programmer in the CAD system;

The second step is the creation of the processing trajectory in the CAM system by the technologist-programmer;

The third step is to deploy and verify the Management Program.

Advantages

- Does not require the programmer to perform mathematical calculations.
- Automates the programming process to increase overall production.
- It is easy to create a program for processing complex and shaped surface details.
- Virtual simulation reduces machine downtime due to software errors.

Disadvantages

- Effective program management still requires basic knowledge of manual programming.
- Requires software that supports PC and CAD / CAM systems (such as Siemens NX, Catia, Compass 3D).
- Requires the programmer-designer-technologist to be able to work with the above software.

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DEVELOPMENT OF LIGHTING CONTROL SOFTWARE FOR “SMART CLASS”

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РАЗРАБОТКА ПРОГРАММНОГО ОБЕСПЕЧЕНИЯ
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ABSTRACT

This paper presents the results of using the software of the automatic control system for artificial lighting. To automatically control lighting used microcontroller Arduino-Uno, which includes a special program software. A control algorithm has been developed to record the continuity of changes.

АННОТАЦИЯ

В данной работе представлены результаты использования программного обеспечения системы автоматического управления искусственным освещением. Для автоматического управления освещенностью использован микроконтроллер Arduino-Uno включающей специальное программное обеспечение. Для фиксации непрерывности изменений разработан алгоритм управления.

Keywords: photoresistor, motion sensor, thermometer, resistance, actuator, microprocessor, radio frequency identification, remote control, interface.

Ключевые слова: фоторезистор, датчик движения, термометр, сопротивление, исполнительный элемент, микропроцессор, радиочастотная идентификация, удаленное управление, интерфейс.

Conservation of energy resources, efficient use of energy, and production potential is one of the important tasks of modern society.

Currently, solving lighting problems is a very urgent issue. The load on the human eye, particularly in an educational institution is very significant and, for this, requires high-quality illumination in classrooms.

The system of automatic lighting control developed by us allows reducing the energy consumption in the educational institution when controlling the switching off light in places where the level of illumination is sufficient for conducting classes. Also, with the help of a motion sensor, autonomous work with illumination in the classroom is achieved.

The aim of the perfect work is the development and manufacture of a typical classroom with fully automated individual lighting, as well as the development of a remote control system based on the Arduino UNO microcontroller [3].

As a rule, it is recommended to use luminaires with a prismatic diffuser to illuminate classrooms.

The developed automatic lighting control system is proposed to be used to create comfortable conditions in the classroom and save energy. When using an automated lighting control system, luminaires with light-level control sensors are used. A photoresistor sensor is installed in the luminaires to automatically maintain a given illumination level. A photoresistor sensor detects the intensity of external light coming through the windows. In clear sunny weather, when the resistance of the photoresistor changes, the luminous flux in the luminaire is automatically reduced, in cloudy weather or at night, the luminous flux in the luminaires automatically increases.

The adjustment is smooth, almost imperceptible to the human eye, in the range from 5 to 100% of the luminous flux of the lamp. When regulating, a given standard illumination level is maintained.

In addition, there is a motion sensor in the automatic light control system. With the help of a motion sensor, the switching on and off of illumination is controlled when there is movement in the classroom. That is, this system allows you to automatically turn on the lighting when a person is in the room. But this compares indications of current natural lighting, based on which and lighting changes. When there is no person in the room, completely disable the light, regardless of the current state of natural light.

Unfortunately, the solution to the issue of additional automatic switching on of artificial lighting depends solely on the individual attitude of teachers to this issue, among whom there is still a widespread opinion about the dangers of mixed lighting, and they prefer to study even in the twilight. This opinion is very harmful to the human eye, as an adaptation to low light is accompanied by excessive eye strain. With frequent repetition, this can be one of the causes of visual impairment.

Meanwhile, research shows that mixed lighting is harmless. It is only necessary to ensure that under mixed lighting, two completely separate light fluxes are not felt.

Due to this fact, when using additional artificial lighting, the best and most promising solution is to use

an automatic control system for artificial lighting. This system automatically turns on artificial lighting when the level of natural light drops below 400 lux.

The developed smart classroom control system is based on artificial lighting control, automatic door lock control (entry-exit control), remote control of the tribune, as well as a video control system in the classroom [9].

The smart class system uses a photoresistor, motion sensor, RF-ID, and DHT -22 as control sensors.

To control light in the classroom using an LDR sensor. A photoresistor (or LDR) is a component that changes resistance depending on the amount of light falling on it. In complete darkness, it has a maximum resistance of hundreds of Kilo ohm, and as the illumination increases, the resistance decreases to tens of Kilo ohm.

On its basis, it is very easy to create a circuit (Fig.1), which provides information about the illumination level in the form of an analog signal to the controller. For this chain, a voltage divider created, wherein a resistor is a photoresistor, a second – a resistor 100 ohms.

The Arduino motion sensor allows you to track the movement of objects that emit heat in a closed area. The developed system uses a PIR-sensor (Figure 2) : passive infrared transducer to or pyroelectric second sensor, which first react to movement.

Figure 1. Photoresistor connection diagram

Radiofrequency identification (RFID) is a technology for automatically contactless identification of objects using a radio frequency communication channel.

Objects are identified by a unique digital code, which is read from the memory of an electronic tag attached to the identification object. The reader contains a transmitter and an antenna, through which an electromagnetic field of a certain frequency is emitted. RF tags that fall within the coverage area of the reading field “respond” with their own signal containing information (user data). The signal is picked up by the reader's antenna, the information is decrypted and transmitted to the controller for processing.

Figure 2. Connection diagram of the motion sensor

The DHT-22 sensor is used to control the temperature and humidity in the classroom (Fig.3).

The sensor consists of two parts – a capacitive temperature sensor and a hygrometer. The first is used to measure temperature, the second is for air humidity. The chip inside can perform analog-to-digital conversions and output a digital signal that is read by the microcontroller [1].

The DHT22 temperature and humidity sensor have one digital output, so you can take readings no more often than once every 1-2 seconds.

Figure 3. Wiring diagram for temperature and humidity sensor

An electromagnetic lock is used as an actuator in the automatic door opening control system.

The electromagnetic lock is a locking device based on magnetic interaction.

The Arduino UNO microcontroller is used for software control.

Arduino is an electronic designer and a convenient platform for the rapid development of electronic control systems. The device is programmable via USB without using programmers.

Arduino – based devices can receive information about the environment through various sensors, and can also control various actuators.

The microcontroller on the board is programmed using the Arduino language and the Arduino development environment.

The Arduino platform, used in the designed system is based on a microcontroller and Atmel ATmega328.

The Arduino device programming language is based on C / C++.

To create remote control and data exchange with the server, an Arduino Ethernet shield is used.

Ethernet shield comes in shield format, i.e. installs on top of the Arduino board. The board has a slot for connecting microSD cards. The Arduino board communicates with both the W5100 and SD card using the SPI protocol. At the same time, it can be active on only one device.

To connect the Arduino board to the network, you need to configure the IP addresses.

The Ethernet library is used to program the networking.

By default, the interface is shown in Fig.4.

1- main menu; 2- main screen; 3- information window.

Figure 4 . The appearance of the application interface

When opened, the size of the application adapts to the user's screen. Optionally, you can resize the application window.

When you open the application, the video surveillance is displayed on the main screen. It is also possible to view an archive of video recordings of a smart class.

The main menu contains the "Report" item. When you click on the "Report" item, a report on the conduct of classes in a smart class is generated. The report reflects the data by whom and at what time the office was opened, the duration of the activation of artificial lighting, a projector, and an intelligent tribune, as well as the amount of electricity consumed.

The information window displays information about the current state, that is, the degree of openness of the door, the degree of natural and artificial illumination, the degree of operation of the projector, and the smart stand.

Hisobot oynasi

id	uqituvchi_fio	eshik_ochilish_vaqti	eshik_yopilish_vaqti	lampa_holati	proektor_holati
1	Shodiyev.J	12:05:44	13:25:27	Yongan	O'chgan
2	Rasulov.Sh	10:00:00	11:20:00	Yongan	O'chgan
3	Rasulov.Sh	8:30:00	9:55:02	Yongan	O'chgan
4	Raxmatov.S	13:35:07	14:58:02	O'chgan	Yongan
5	Sharipova.N	15:00:07	14:58:02	O'chgan	O'chgan
6	Rasulov.Sh	8:30:00	9:55:02	Yongan	O'chgan
7	Raxmatov.S	13:35:07	14:58:02	O'chgan	Yongan
8	Sharipova.N	15:00:07	14:58:02	O'chgan	O'chgan

Figure 5. Report form

The developed lighting control system for the “Smart Class” was implemented at the Bukhara engineering and technology institute. The following results were obtained based on analysis of system performance: with daily average electricity savings in the classrooms, E was about 12%, and in the office for the teaching staff - about 20-25%, and also extends the life of the service lighting with Independent user 200-250 hours.

Studies have shown that in classrooms located in the northern part of the building of the institute, based on one-day working time, the duration of the use of arti-

cial lighting is on average 5.5 hours. After the introduction of an automatic lighting control system, the duration of the use of artificial lighting is reduced by 35 minutes.

The current electricity tariffs for budgetary organizations are 450.0 soums per 1 kWh (according to the decree of the Cabinet of Ministers of the Republic of Uzbekistan dated July 30, 2019 No. 633). With the introduction of the lighting control system, the economic efficiency will average 72 thousand sums per day for each office.

It should be emphasized that the district National Board of the use of electricity, is one of the most important tasks for the preservation of natural resources.

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MECHANICAL ENGINEERING AND MACHINE SCIENCE

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SELECTION OF FILTER MATERIAL AND ANALYSIS OF CALCULATION EQUATIONS
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E-mail: ilkhomjonmamarizayev@gmail.com*ВЫБОР ФИЛЬТРУЮЩЕГО МАТЕРИАЛА И АНАЛИЗ РАСЧЕТНЫХ УРАВНЕНИЙ
МАССООБМЕННОГО ПРОЦЕССА В РОТОРНО-ФИЛЬТРУЮЩЕМ АППАРАТЕ**Тожиев Расулжон Жумабаевич***д-р техн. наук, проф.,
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ABSTRACT

The article describes the properties of the mass exchange process in a rotary filtration apparatus for wet cleaning of harmful gases formed during the production of mineral fertilizers and released into the atmosphere, the device of the working body of the apparatus, a film layer formed during the production of mineral fertilizers. described are a filtering material and a process of transferring a substance in a liquid bath. The article also proposes equations for the separate calculation of the coefficients of substance transfer in the gas and liquid phases for the rotor-filter apparatus.

АННОТАЦИЯ

В статье описаны свойства массообменного процесса в роторно-фильтрующем аппарате для влажной очистки от вредных газов, образующихся при производстве минеральных удобрений и выбрасываемых в атмосферу, устройство рабочего тела аппарата, пленочный слой, образующийся при производстве минеральных удобрений. описан фильтрующий материал и процесс переноса вещества в жидкой ванне. В статье также предложены уравнения для раздельного расчета коэффициентов содержания вещества в газовой и жидкой фазах для роторно-фильтрующего аппарата.

Keywords: rotor-filter, dusty gas, hydrodynamics, substance permeability, substance transfer coefficient, fluid flow, gas velocity, filter layer.

Ключевые слова: ротор-фильтр, запыленный газ, гидродинамика, проницаемость для вещества, коэффициент переноса вещества, расход жидкости, скорость газа, фильтрующий слой.

Introduction

As the world's population grows, so does the demand for more food, especially agricultural products. It is known that mineral fertilizers are widely used in the cultivation of agricultural products. Due to the fact that the processes and equipment for the production of mineral fertilizers are obsolete and need to be modernized, various gaseous raw materials and exhaust gases are released into the atmosphere.

This is causing environmental degradation, especially the depletion of the ozone layer, and global warming. Therefore, the creation of waste-free technologies and the retention of toxic gases and dust emitted into the environment through the modernization of existing machines and equipment is an urgent task. In the production of nitrogen, phosphorus and fluorine-bred mineral fertilizers, various dust gases are released, in particular, the hydrogen-fluoride gas in the dust formed in the production of superphosphate has a serious negative impact on the environment.

Therefore, the creation of effective methods and devices for the purification of such gas is attracting the attention of scientists. Fergana Nitrogen JSC also has a department for the production of superphosphate mineral fertilizers, from which the dust of superphosphate fertilizers and hydrogen fluoride gas is released into the atmosphere. The main goal of the study is to capture this emitted gas, return it to the technological process and separate it as a raw material for other related industrial enterprises.

Materials and methods

The capture of hydrogen fluoride gas was accomplished by absorbing it into various absorbents. It is known that the absorption of a gas phase into a liquid is a process of mass transfer, ie absorption. The proposed rotor-filter apparatus is a type of apparatus in which the process of mass transfer is carried out, forming a film layer. Therefore, in calculating the process of mass transfer in the apparatus, the laws and equations used in other apparatus with similar hydrodynamics and phase contact surface were used [1]. The calculation of the mass transfer process in single-rotor dusting rotor apparatus has been studied by many researchers [2; 3; 4; 5].

The mass transfer in the rotating rotor apparatus in the working fluid contact elements is poorly studied [2; 6; 7]. When combining the results of experimental tests, the proposed calculation formulas differ from each other because the authors used different research methodologies. Given the physical and chemical properties of the dusty gas, the solubility of hydrogen fluoride and ammonia gas in the rotor-filter apparatus, it is advisable to use water, calcium technical soda and washing soda as absorbents. The main working body of the rotor-filter metabolism apparatus shown in Figure 1 is the rotor of various filtering materials. As a filter material in the rotor is used paronite with a hole diameter of 2; 3; 4 mm and a thickness of 1.5 mm, stainless metal mesh with a hole diameter of 1; 2; 3 mm.

a

б

Figure 1. General view of filter materials:

a). paronite with a hole diameter of 3 mm;

b). grid 2x2 mm metal mesh

In the proposed rotor-filter apparatus, a stream of dusty gas and an absorbent form mass transfer zones as follows.

1 - a layer of liquid film at the inlet of a dusty gas diffuser;
 2 - the second layer of liquid film at the outlet of the dusty gas from the filter to the confuser;
 3 - The contact surface formed as a result of the liquid in the bath hitting the surface.

Figure 2. Scheme of contact surfaces formed in the rotor-filter apparatus

Initially, the liquid from the injector spreads evenly over the rotor filter and forms the first film layer along the length of the falling surface. A stream of dusty gas entering from the diffuser hits the film layer and flows through the filter holes into the rotor. A stream of dusty gas moves through the rotor towards the confuser, where a relatively thin second film layer is formed, as on the diffuser side, and the gas is purified once more. In this contact zone, the components of the gas passing through the filter surface between the diffuser and the confuser are absorbed into the film layer. The third mass transfer zone is the liquid in the bath in which the rotor sinks, the gas stream entering from the diffuser hits the surface of the water collected in the bath, and a certain amount of dusty gas is removed by contact. Analysis of the mass transfer process in the wet-cleaning rotor filter apparatus shows that due to the complexity of determining the velocity and thickness of the film layer formed in the filter, the linear mass density of irrigation is used to determine the mass transfer coefficient in the liquid phase [8]:

$$\Gamma = \frac{\omega \cdot S \cdot \rho_c}{\Pi} \quad (1)$$

ω - The average velocity of the liquid film, m/s;

S - Film-forming surface, m²;

Π - the perimeter of the surface on which the film is formed, m.

Using this equation, the hydrodynamic regime of the film is calculated [7]. If the mode is laminar, the average velocity of the film flow is:

$$\omega = \frac{\Gamma}{\rho_c \cdot \delta} = \sqrt[3]{\frac{\Gamma^2 \cdot g \cdot \cos \beta}{3 \cdot \mu_c \cdot \rho_c}} \quad (2)$$

if turbulent, equation (3) can be used,

$$\omega = 2,3 \cdot \left(\frac{g}{\rho_c} \right)^{1/3} \cdot \frac{\Gamma^{7/15}}{\mu_c^{2/15}} \quad (3)$$

where, Γ is the mass density of irrigation, kg/m³s; - working fluid density, kg/m³; μ_c - coefficient of dynamic viscosity of the working fluid, Pa*s; $\cos \beta$ - the angle of inclination of the film layer relative to the horizontal plane. According to the law of similarity criteria, the mass transfer coefficient in the liquid phase can be calculated as follows:

$$Nu_c = A \cdot Re_m^m \cdot Pr_c^n \quad (4)$$

In this, the A, m, n - magnitudes depend on the device design and are determined by experimental tests. As a result of the introduction of a dusty gas stream into the apparatus at high temperatures, partial evaporation is observed in the working fluid, which is observed in the gas phase mass transfer, it is recommended to determine the mass transfer coefficient in the gas phase using the following equations:

(5) can be used if it is possible to determine the coefficient of friction in the contact zone where the gas stream moves [8],

$$Nu_r = \frac{\lambda}{8} \cdot Re_r \cdot (Pr_r)^{1/3} \quad (5)$$

where, λ is the coefficient of friction.

If the dimensions and hydrodynamic characteristics of the rotor located in the working volume of the apparatus are known, then the use of (6) or (7) is recommended [8].

$$Nu_r = 0,407 \cdot Re_r^{0,655} \cdot (Pr_r)^{1/3} \quad (6)$$

$$Nu_r = 0,167 \cdot Re_r^{0,74} \cdot (Pr_r)^{1/3} \cdot \left(\frac{l}{d_{\text{эКВ}}} \right)^{0,47} \quad (7)$$

in this, l is the length of the surface on which the film layer is formed, m;

$d_{\text{эКВ}}$ is the equivalent diameter of the surface at the outlet of the gas stream diffuser, mm.

For the complexity of the hydrodynamics of the apparatus, the Stenten criterion, which takes into account the coefficient of hydraulic resistance, can also be used in the calculation of mass transfer [9],

$$St = \frac{\beta}{\omega} = \frac{\psi \cdot \zeta}{8} \quad \text{ёки}$$

$$St = \frac{Nu_c}{Re \cdot Pr_c} \quad (8)$$

$$St = \frac{Nu_c}{Re \cdot Pr_c} \quad (9)$$

It can be seen from the above equations that the following general equation is used to calculate the mass transfer coefficients in the liquid and gas phases,

$$\beta = \frac{Nu_c \cdot D_c}{l} \quad (10)$$

Analyzing the above equations, it is expedient to calculate the process of mass transfer in the liquid phase

in the rotor-filter apparatus by the following general equation,

$$\Sigma M_c = M_1 + M_2 + M_3 \quad (11)$$

in this, M_1 is the amount of substance absorbed into the first film layer, kg or kmol.;

M_2 is the amount of substance absorbed as a result of hitting the surface of the liquid in the liquid bath, kg or kmol;

M_3 is the amount of substance absorbed into the second film layer, kg or kmol.

Conclusion

It follows from the above equations that its hydrodynamics play an important role in the calculation of the transfer process in a voluntary metabolic apparatus. In the production of mineral fertilizers, in particular, the production of superphosphate, fluoride briquettes are metabolic processes using the hydrodynamics of a rotor-filter apparatus designed to absorb and purify toxic gases from liquids;

The device has three main metabolic zones, the filter layer at the entrance of the dusty gas from the diffuser at the front, the layer at the entrance of the primary purified gas to the confuser at the back of the drum and the liquid partially collecting bath;

Equation (8) shows that the high hydraulic resistance, low gas velocity and increased fluid consumption, and the thickening of the film layer improve the metabolism in the liquid phase.

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INFLUENCE OF VARIOUS ROAD AND CLIMATIC OPERATING CONDITIONS ON THE PROCESS OF WEAR OF VEHICLE PARTS

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ВЛИЯНИЕ РАЗЛИЧНЫХ ДОРОЖНЫХ И КЛИМАТИЧЕСКИХ УСЛОВИЙ ЭКСПЛУАТАЦИИ НА ПРОЦЕСС ИЗНОСА ДЕТАЛЕЙ АВТОМОБИЛЯ

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ABSTRACT

The article presents the results of work on a qualitative assessment of the degree of influence of various causes on the wear of parts of automobile engines operating in conditions of high temperature and dusty air in the Central Asian zone. Based on the analysis, specific conclusions and proposals are proposed for increasing the durability of cars by applying an effective system for protecting engines from mechanical (dust) particles of pollution that enter them along with air, fuel and oil.

АННОТАЦИЯ

В статье представлены результаты работы по количественной оценке степени влияния различных причин на износ деталей автомобильных двигателей, работающих в условиях высоких температур и запыленного воздуха в зоне Центральной Азии. На основе анализа, конкретные выводы и предложения предложены для повышения долговечности машин путем применения эффективной системы для защиты двигателей от механических (пыли) частиц загрязнений, которые входят в их вместе с воздухом, топливом и маслом.

Keywords: Car, engine, engine oil, road and climatic conditions, wear, abrasive, corrosive, mechanical, road dust.

Ключевые слова: Автомобиль, двигатель, моторное масло, дороги и климатические условия, износ, абразивная, коррозионная, механическая, дорожная пыль.

The operation of motor vehicles in various operating conditions, especially in quarries, where the increased dust content of the air causes increased wear of their parts and mechanisms, and with the increase in the wear of the car parts, the consumption of fuel and other operating materials increases, and frequent failures and breakdowns occur.

Deterioration of steering and braking system parts impairs vehicle handling, making it less safe to drive. The wear of parts, assemblies and mechanisms causes a change in the original dimensions of the parts and their geometric shape, subsequently this leads to a significant

increase in the gaps between rubbing parts, the appearance of noise, knocking and vibration.

The largest number of malfunctions and failures in units and mechanisms occurs due to the natural process of wear of parts. An increase in the clearance in mating parts is allowed up to a certain limit, which is different for different mates and depends on their design and purpose. When the mechanism operates with a clearance that exceeds the permissible limit, wear of parts increases intensively and can lead to a significant increase in fuel and operating materials consumption, to a strong

emission of toxic substances that pollute the atmosphere and to a decrease in the efficiency of the car.

When designing cars and their engines, as a rule, they are designed to work in a temperate flat climate, although various natural and climatic conditions, especially extreme ones, have a significant impact on the reliability of operation and wear resistance of engines.

Due to the fact that the climatic conditions of the European zones are moderate, we believe that the influence of such operating conditions on the process of wear of machine parts is minimal in comparison with other extreme cases. When operating cars in temperate climatic zones, the main influence on the wear of parts is mainly provided by the technical factors of maintenance and repair.

A large number of cars are operated in the climatic conditions of the Far North and in hot, dry, highly dusty zones of Central Asia. If the temperature in the Far North in winter drops to -50°C , then in Central Asia the heat can reach $+50^{\circ}\text{C}$ and higher. Let us consider what effect

these climatic operating conditions have on the intensity and type of wear of car parts.

Due to the fact that engine parts are subject to the greatest friction and wear, as well as 43% of all costs for spare parts of a car fall on the engine, in order to reduce a large amount of work, we consider it appropriate to further consider the nature and degree of influence of climatic conditions on the intensity of wear parts as applied to the engine [15].

There are the following main types of wear of engine parts: abrasion and scuffing of rubbing surfaces. Under normal operating conditions of the engine, mainly abrasion occurs on the cylinder liners, piston rings, liners and bearings. The nature of abrasion can be mechanical, corrosive and abrasive. Under normal operating conditions, it is the abrasion of the parts that determines the life of the engine. The table shows the components of the total operational wear of cylinders of automobile engines for the temperate climatic zone and the Far North [5].

Table 1.

Components of total wear of cylinders of automobile engines in operation (in percent)

Components of general wear and tear	Moderate climatic zone				Far North
	ZIL-130	ZMZ-53	YMZ -236	YMZ -238	YMZ -238*
General operational **	100	100	100	100	100
From the normal warm regime	15,1-32,1	15,8-30,8	19,8-29,7	19,3-29,0	15,3-22,9
From reduced thermal conditions	5,0-10,7	5,3-10,3	4,2-6,3	4,1-6,1	33,6-50,4
Inter-shift starts	10,9-23,4	2,4-4,7	8,412,7	8,9-13,3	15,9-23,9
from dust entering the engine	33,8-68,9	54,3-76,5	51,3-67,7	51,6-67,5	2,8-35,2

* When transporting ore.

** Including unsettled engine operation modes in terms of speed and load.

Engine operation in the Far North in the cold season is considered extremely difficult. Extremely low ambient temperatures can cause a drop in power and increase fuel consumption, cylinder seizure and others. With a decrease in the temperature of the cooling liquid from 80°C to 60°C , the wear of parts increases by 30%, and with a decrease to 40°C - by 140% [13]. In this case, the wear of parts is corrosive and with a decrease in the temperature of the coolant of the cooling system, the magnitude of this type of wear increases greatly.

Changes in the rate of wear of engine cylinders at low temperatures are due to the following reasons: the presence of semi-dry friction between the cylinder walls and piston rings; corrosive destruction of the surface layers of metals.

Reduced thermal conditions, including cold starts, unsteady modes, increased load and speed modes, as well as the rigidity of the working process, affect the wear rate of engine parts in different ways. However, in ordinary operation, the wear of parts of the cylinder-piston group is most influenced by abrasive dust, which gets into the engine from the ambient air in various ways [6,8].

High and dry ambient temperature contributes to the appearance of knocking combustion in the engine, which is also one of the reasons for the increased wear rate of the cylinder, piston rings and piston. It is known that with a strong detonation, the engine overheats, as a

result of which a molecular-mechanical type of wear, fumes and breakage of compression rings and piston grooves can occur.

High heat with ineffective operation of the cooling system leads the engine to overheating, as a result of which the engine power decreases, and the specific consumption increases.

The climate in Central Asia is sharply continental: summers are long and very hot, and winters are short and cold. During the day, the absolute maximum air temperature in the shade reaches $+45^{\circ}\text{C}$, $+47^{\circ}\text{C}$, sometimes $+50^{\circ}\text{C}$ and more, and at night it drops to $+5^{\circ}\text{C}$... 10°C . In mountainous regions, after intense heat ($40-47^{\circ}\text{C}$), a car passing through mountain passes falls into conditions when the air temperature is $0-1^{\circ}\text{C}$, i.e. a sharp drop in temperature is $40-46^{\circ}\text{C}$. At a mountain height, the density and pressure of air decreases by 18.5% and 21.5%, respectively (at an altitude of 2000 m above sea level) [13].

As a result, the filling of the cylinders decreases, the mixture is enriched, incomplete combustion and smoke of the engine occurs, excessive fuel consumption and intensive wear of the parts of the cylinder-piston group.

Road and atmospheric dust has a significant effect on the wear rate of parts. The dust content of the air in a significant part of the territory of Central Asia reaches

3.5 g / m³, and during strong winds and storms -17 g / m³, which is more than 10 times higher than the dust content of the air in the temperate zone (0.003 ... 1.42 g / For clarity, it is enough to say that when the air is dusty 0.8-1.2 g / m³, visibility is completely lost [6].

Dust getting into the engine causes abrasive wear of its parts. This is due to the fact that the dust contains quartz, the content of which ranges from 50 to 95%. The hardness of quartz (1000-1200 kg / mm²) is greater than the hardness of structural materials, which is why it causes abrasive wear of rubbing engine parts. Underestimation of this factor in the design and operation of the

engine can lead to an unjustified increase in the intensity of wear of parts and a sharp decrease in its reliability [5, 6].

Abrasive particles that enter the engine have different effects on the wear of its parts. Abrasive dust entering the engine together with air and fuel causes the greatest wear of the cylinders in the upper part, i.e. in the zone where the piston stops at top dead center, the upper compression rings and piston grooves. Abrasive particles entering the engine along with the oil cause the most wear on the crankshaft bearings, mid-section cylinders, oil scraper rings, piston pin and bushings (Fig. 1).

Figure 1. The degree of influence of an abrasive dust particle on the process of wear of engine cylinders under various operating conditions [3]:

1-moderate natural and climatic conditions; 2-moderate dustiness of the air (0.4 g / m³); 3- oil contaminated with abrasive dust; 4-intake of dust into the engine with air and oil; 5-boost engine operation in dusty air, oil and fuel

Figure 1 shows that with an increase in the amount of dust entering the engine along with air, fuel and oil (line 5), the wear rate of its parts increases and in this case the wear is abrasive. It should be noted that the wear rate of rubbing parts depends on the ratio of the surface hardness of parts and abrasive particles. The lower the surface hardness of the parts and the higher the hardness of the abrasive, the greater the abrasive wear.

An increase in fuel temperature affects its density and viscosity. A decrease in density and viscosity causes a decrease in the mass supply of fuel to the cylinders, and increases the amount of fuel flowing through the gaps in the plunger pairs. In this case, the high temperature of the fuel pump causes semi-dry and dry friction in the plunger pairs and parts lubricated with fuel, which leads to their intense wear. The listed reasons lead to a decrease in the service life of the fuel equipment by 1.5-2 times compared with operation at normal temperature.

This, the analysis of the influence of various factors on the wear process allows us to draw the following conclusions: the wear of automobile engine parts is influenced by many factors, such as load and speed modes of operation, which mainly determine the magnitude of molecular-mechanical wear and thermal mode of operation, including periods start-up and warm-up, which determined the value of corrosion-mechanical wear.

From this it follows that with insufficient protection of the engine from dust particles of pollution, abrasive wear of parts sharply increases and this becomes of particular importance for vehicles operating in the conditions of the Central Asian zone, where there is a high temperature and dustiness of atmospheric air.

We believe that the most affordable and cost-effective way to reduce wear of engine parts is to effectively clean air, fuel and oil and seal all places where dust can enter the engine.

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**KINEMATIC ANALYSIS OF A NEW GEAR-LEVER DIFFERENTIAL TRANSMISSION
MECHANISM WITH SYMMETRICAL DISPLACEMENT OF THE CENTERS
OF ROTATION OF THE DRIVEN AND DRIVING GEARS**

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**КИНЕМАТИЧЕСКИЙ АНАЛИЗ НОВОГО МЕХАНИЗМА ПЕРЕДАЧИ
ДИФФЕРЕНЦИАЛЬНОЙ ПЕРЕДАЧИ С СИММЕТРИЧНЫМ СМЕЩЕНИЕМ
ЦЕНТРОВ ВРАЩЕНИЯ ВЕДОМОЙ И ВЕДУЩЕЙ ШЕСТЕРНИ**

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ABSTRACT

One of the main directions in the development of domestic machinery is the improvement and creation of high-performance, resource-saving devices and mechanisms of rolled technological machines. This is especially common in machines with a symmetrical moving roller, the center of rotation of the free-running shaft, and is therefore a very important issue in this field of mechanical engineering.

АННОТАЦИЯ

Одним из основных направлений развития отечественной техники является совершенствование и создание высокопроизводительных, ресурсосберегающих устройств и механизмов прокатных технологических машин. Это особенно часто встречается в машинах с симметричным движущимся роликом, центром вращения свободно вращающегося вала, и поэтому является очень важной проблемой в этой области машиностроения.

Keywords: link, plane, convulsive, power, linear, rings, lever arm

Ключевые слова: звено, плоскость, судорожный, степень, линейным, колец, рычаг.

Below is considered one of the options developed by us toothed-lever differential transmission mechanisms, which can be used in roll machines with a variable center distance of the working shafts, where the axes of both

working shafts have the ability to rotate around their own axes and move symmetrically along a straight line passing along the axes rotation of these working shafts.

Figure 2.1. Structural - kinematic diagram of a roller machine with a gear - lever differential transmission mechanism

1,2 - working shafts; 3,4 - tires of the working shafts; 5,6 - driven and driving gears; 7,8,13 - levers; 9,10 - axes of intermediate gear wheels; 11,12 - intermediate gear wheels; 14-18 – sliders

Figure 2.1. the structural and kinematic diagram of a roller machine with a developed transmission mechanism is shown.

A mechanism installed on a two-roll technological machine, for example, on a machine for squeezing wet leather, consisting of two working shafts 1 and 2 (Figure 2.1) on the surface of which tires 3 and 4 are put on, where both working shafts have the ability to rotate around their own axes O1 and O4 and move using levers 15, 16, 17 and 18, in a straight line passing through the axes of rotation (O1 and O4) of the working shafts (1, 2) consists of: driven and driving gears 5 and 6 rigidly mounted at the output ends of the working shafts 1 and 2 and pivotally mounted levers 7 and 8, which are supports for axes 9 and 10. On axes 9 and 10, intermediate gears 11 and 12 are installed. The axes of rotation of the intermediate gears are kinematically interconnected by a lever 13, which is located parallel to the line passing along the axis of rotation of the working shafts 1, 2. The lever 13 in its middle is rigidly fixed with the slider 14 at a right angle.

The mechanism works as follows: the torque from the working shaft 1 to the working shaft 2 is transmitted by means of the gear wheels of the drive 6, intermediate 11, 12 and driven 5. When the processed material with variable thickness passes between the working shafts 1 and 2, the center distance O1O4 changes (Fig. .one). In this case, the slider 14 provides the lever 13 (O2O3) with a movement perpendicular to the line passing through the axes of rotation (O1 and O4) of the working shafts 1 and 2. The system of levers and gear wheels provide synchronous movement and rotation of the working shafts 1 and 2, since the axes of rotation of the intermediate gears (O2 and O3 i.e. 9 and 10) will receive a relative speed equal in magnitude and parallel in direction, and intermediate gears will receive angles of rotation equal in magnitude and opposite in direction, thereby compensating for the angles of rotation of each other.

Consequently, with a change in the center distance O1O4, there is no difference in the angles of rotation of

the gear wheels of the driven 5 and the driving 6, and the synchronization of rotation of these gears is ensured. Since the gear wheels, driven 5 and driven 6, are rigidly fixed at the output ends of the working shafts 1 and 2, these working shafts will also rotate synchronously.

The kinematic analysis of the above-described mechanism is carried out in order to determine the angular and linear velocities and accelerations of the links of the mechanism depending on the angular speed and acceleration of the driving link (gear 5 or 6) and the linear speed and acceleration of the centers of rotation of the driven links (gear 5 or 6), and also to prove the equality of the linear velocities of the surfaces of the working shafts at the points of contact of these shafts with the material being processed.

Figure 2.2 shows the design diagram of the kinematics of the mechanism under consideration, figure 2.3 shows the design diagram of the kinematics of the lever contour of this mechanism.

In the considered mechanism, the diameters of the driving and driven gears and parasitic gears are equal in pairs or the diameters of all gears are equal to each other. Thus, the transmission mechanism we are considering are special cases of some generalized transmission mechanism. Synchronous rotation of the driven and driving gears (working shafts 1 and 2) at the time of changing the center distance of the working shafts is performed under the condition

$$d_1 = d_4, d_2 = d_3 \quad (2.1)$$

or

$$d_1 = d_4 = d_2 = d_3 = d \quad (2.2)$$

and with a plane-parallel movement of the lever relative to the line passing through the points and (Figure 2.1).

1, 4 - driving and driven gear wheels; 2, 3 - intermediate gear wheels; 5, 6, 8, 9 - levers; 7 - slider.

Figure 2.2. Design diagram of the kinematics of a gear-lever differential transmission mechanism with a symmetrical movement of gear wheels

The laws of motion of the levers 5 and 9 are determined by the vibration equation, which depends on the change in the thickness of the material being processed and, which we will consider given. Also known are angular

velocities and angular accelerations in the relative motion of the driving and driven gears. The lever moves together with the slider 7 along the guide 00 perpendicular to the line of the gear wheels, which are rigidly fixed to the output ends of the working shafts (Figure 2.2).

Figure 2.3. Design scheme for determining the speeds and accelerations of the characteristic points of the lever contour

The lever moves together with the slider 7 along the guide 00 perpendicular to the line passing along the axes of rotation of the driving and driven gears. The lever contour of the gear-lever differential transmission mechanism (Figure 2.3) is designed so that the centers of rotation of the master with the driven (,) and the centers of rotation of the intermediate gears (,) move mirror-symmetrically relative to the cross slide 7, therefore, it can be written

$$\bar{V}_{O_1} = \bar{V}_{O_4}, \quad (2.3)$$

$$\bar{a}_{O_1} = \bar{a}_{O_4}, \quad (2.4)$$

$$\bar{V}_{O_2} = \bar{V}_{O_3}, \quad (2.5)$$

$$\bar{a}_{O_2} = \bar{a}_{O_3}. \quad (2.6)$$

by virtue of formulas (2.1) - (2.6), we write

$$\begin{aligned} \omega_1 = \omega_4, \quad \Delta\omega_1 = \Delta\omega_2, \\ \varepsilon_1 = \varepsilon_4, \quad \Delta\varepsilon_1 = \Delta\varepsilon_2, \end{aligned} \quad (2.7)$$

Where $\Delta\omega_1, \Delta\omega_2, \Delta\varepsilon_1, \Delta\varepsilon_2$ – angular velocities and angular accelerations arising from a change in the center distance of the working shafts $O_1 O_4$, hence

$$\Delta\omega_1 = \Delta\omega_4 = \varphi$$

Determine the speed and acceleration of points O_2 and O_3 . Lever 8 ($O_3 O_4$) moves in a plane-parallel manner. The directions of the velocities ($\bar{V}_{O_3}$ and $\bar{V}_{O_4}$) of the two points (O_3 and O_4) and the speed value is known ($\bar{V}_{O_4}$) points O_4 lever 8 ($O_3 O_4$), therefore, one can find the speed ($\bar{V}_{O_3}$) second point (O_3), having previously determined the instantaneous center of rotation (P_8) this link (8) and angular velocity ($\Delta\omega_8$) this lever.

$$\Delta\omega_8 = \frac{\bar{V}_{O_4}}{O_4 P_8}. \quad (2.8)$$

$O_4 P_8$ is determined from the solution of the triangle $O_4 O_3 P_8$

$$O_4 P_8 = \left(\frac{d_3}{2} + \frac{d_4}{2} \right) \cdot \sin \alpha \quad (2.9)$$

Taking into account formula (2.9), formula (2.8) takes the form

$$\Delta\omega_8 = \frac{2 \cdot \bar{V}_{O_4}}{(d_3 + d_4) \cdot \sin \alpha} \quad (2.10)$$

Taking into account formula (2.2), formula (2.10) takes the form

$$\Delta\omega_8 = \frac{\bar{V}_{O_4}}{d \cdot \sin \alpha} \quad (2.11)$$

Angular velocity ($\bar{V}_{O_3}$) points O_3 is determined by the formula

$$\bar{V}_{O_3} = \Delta\omega_8 \cdot O_3P_8. \quad (2.12)$$

Taking into account formula (11), formula (12) takes the form

$$\bar{V}_{O_3} = \frac{\bar{V}_{O_4}}{d \cdot \sin \alpha} \cdot O_3P_8. \quad (2.13)$$

Out of the triangle $O_4O_3P_8$

$$O_3P_8 = \left(\frac{d_3 + d_4}{2} \right) \cdot \cos \alpha. \quad (2.14)$$

Taking into account formulas (2) and (14), formula (13) takes the form

$$\bar{V}_{O_3} = \bar{V}_{O_4} \cdot \operatorname{ctg} \alpha. \quad (2.15)$$

Point speed N ($\bar{V}_N^8$) in lever 8 is determined by the formula

$$\bar{V}_N^8 = \Delta\omega_8 \cdot P_8N, \quad (2.16)$$

where P_8N is determined by the solution of the triangle $O_4O_3P_8$,

$$P_8N = \frac{1}{2} \cdot \sqrt{d_4^2 \cos^2 \alpha + d_3^2 \sin^2 \alpha} \quad (2.17)$$

Taking into account formula (2.2), formula (2.17) takes the form

$$P_8N = \frac{d}{2}. \quad (2.18)$$

Hence,

$$\bar{V}_N^8 = \frac{\bar{V}_{O_4}}{2 \sin \alpha}. \quad (2.19)$$

Point speed m ($\bar{V}_m$) in the gear wheel 4 is determined by the formula

$$\bar{V}_m = \Delta\omega_8 \cdot mP_4, \quad (2.20)$$

mP_4 is determined by the solution of the triangle mO_4P_4

$$mP_4 = \frac{1}{2} \cdot \sqrt{d_4^2 + (d_4 + d_3)^2 \cdot \sin^2 \alpha}. \quad (2.21)$$

Taking into account formulas (2.21) and (2.10), formula (2.20) takes the form

$$\bar{V}_m = \frac{\bar{V}_{O_4} \cdot \sqrt{d_4^2 + (d_3 + d_4)^2 \cdot \sin^2 \alpha}}{(d_3 + d_4) \cdot \sin \alpha}. \quad (2.22)$$

Taking into account formula (2.2), formula (2.22) will be written

$$\bar{V}_m = \frac{\bar{V}_{O_4} \cdot \sqrt{1 + 4 \sin^2 \alpha}}{2 \cdot \sin \alpha}. \quad (2.23)$$

Point speeds m и n в master and slave ($\bar{V}_m^r$ и $\bar{V}_n^r$) gear wheels corresponding to the contact points of the working shafts with the processed material is determined by the formula

$$\bar{V}_m^r = \bar{V}_n^r = \frac{\bar{V}_{O_4} \cdot \sqrt{d_4^2 + (d_3 + d_4)^2 \cdot \sin^2 \alpha}}{d_3 + d_4} \cdot \operatorname{ctg} \alpha. \quad (2.24)$$

For a mechanism with the same cogwheels

$$\bar{V}_m^r = \bar{V}_n^r = \frac{1}{2} \cdot \bar{V}_{O_4} \cdot \sqrt{1 + 4 \sin^2 \alpha} \cdot \operatorname{ctg} \alpha \quad (2.25)$$

Thus, the final angular speeds of the working shafts are determined by the formula $\Omega = \omega_1 \pm \Delta\omega_1$, (2.26) where

$$\pm \Delta\omega = \frac{\bar{V}_m^r}{d_4}. \quad (2.27)$$

The (+) or (-) sign is determined depending on the direction. $\bar{V}_m^r$. For roller machines with working shaft diameters D , the speed of the point of contact of the working shafts with the processed material is determined by the formula

$$\bar{V}_m^{Dr} = \bar{V}_n^{Dr} = \frac{\bar{V}_{O_4} \cdot \sqrt{d_4^2 + (d_3 + d_4)^2 \cdot \sin^2 \alpha}}{(d_3 + d_4) \cdot d_4} \cdot D \cdot \operatorname{ctg} \alpha \quad (2.28)$$

and by the formula

$$\bar{V}_m^{Dr} = \bar{V}_n^{Dr} = \frac{\bar{V}_{O_4} \cdot \sqrt{1 + 4 \sin^2 \alpha}}{2 \cdot d_4} \cdot D \cdot \operatorname{ctg} \alpha \quad (2.29)$$

respectively, for mechanisms with pairwise identical (2.28) and identical (2.27) diameters of gears.

The acceleration of the characteristic points of the transmission mechanism and the working shafts of roll machines arising from the speed and acceleration of the centers of rotation of the working shafts is determined by the formulas

$$\Delta\varepsilon_1 = \Delta\dot{\omega}_1, \quad (2.30)$$

$$a_{O_4} = a_{O_1} = \dot{V}_{O_1} = \dot{V}_{O_4}, \quad (2.31)$$

$$\Delta\varepsilon_8 = \Delta\varepsilon_6 = \Delta\dot{\omega}_8 = \frac{\dot{V}_{O_4} \sin \alpha - V_{O_4} \omega \cos \alpha}{\left(\frac{d_3 + d_4}{2} \right) \sin^2 \alpha}, \quad (2.32)$$

$$a_{O_2} = a_{O_3} = \dot{V}_{O_2} = \dot{V}_{O_3} = \dot{V}_{O_4} \operatorname{ctg} \alpha - \frac{V_{O_4} \Delta\omega_1}{\sin^2 \alpha}. \quad (2.33)$$

For mechanism with pitch diameters
 $d_2 = d_3 \neq d_4 = d_1$,

$$a_m = a_n = \dot{V}_m = \frac{\dot{V}_{O_4} \left(d_4^2 + (d_3 + d_4)^2 \sin^2 \alpha \right) - \Delta \omega_1 V_{O_4} d_4^2 \operatorname{ctg} \alpha}{(d_3 + d_4) \sin \alpha \sqrt{d_4^2 + (d_3 + d_4)^2 \sin^2 \alpha}}, \quad (2.34)$$

$$a_m^r = a_n^r = \dot{V}_m^r = -\frac{\Delta \omega_1 \cdot V_{O_4}}{d_3 + d_4} \cdot \left[\frac{d_4^2 + (d_3 + d_4)^2 \cdot \sin^4 \alpha}{\sqrt{d_4^2 + (d_3 + d_4)^2 \cdot \sin^2 \alpha} \cdot \sin^2 \alpha} \right], \quad (2.35)$$

$$a_m^D = a_n^D = \dot{V}_m \cdot \frac{D}{d_4} = \frac{\dot{V}_{O_4} \left(d_4^2 + (d_3 + d_4)^2 \sin^2 \alpha \right) - \omega V_{O_4} d_4^2 \operatorname{ctg} \alpha}{(d_3 + d_4) \sin \alpha \sqrt{d_4^2 + (d_3 + d_4)^2 \sin^2 \alpha}} \cdot \frac{D}{d_4}, \quad (2.36)$$

$$a_m^{Dr} = a_n^{Dr} = -\frac{\omega \cdot V_{O_4}}{d_3 + d_4} \cdot \left[\frac{d_4^2 + (d_3 + d_4)^2 \cdot \sin^4 \alpha}{\sqrt{d_4^2 + (d_3 + d_4)^2 \cdot \sin^2 \alpha} \cdot \sin^2 \alpha} \right] \cdot \frac{D}{d_4}. \quad (2.37)$$

For mechanism with pitch diameters
 $d_1 = d_3 = d_4 = d_2 = d$

$$a_m = a_n = \dot{V}_m = \frac{\dot{V}_{O_4} (1 + 4 \sin^2 \alpha) - \Delta \omega_1 V_{O_4} \operatorname{ctg} \alpha}{2 \sin \alpha \sqrt{1 + 4 \sin^2 \alpha}}, \quad (2.38)$$

$$a_m^r = a_n^r = -\frac{1}{2} \cdot \Delta \omega_1 \cdot V_{O_4} \cdot \left[\frac{1 + 4 \sin^4 \alpha}{\sin^2 \alpha \cdot \sqrt{1 + 4 \sin^2 \alpha}} \right], \quad (2.39)$$

$$a_m^D = a_n^D = \dot{V}_m \cdot \frac{D}{d} = \frac{\dot{V}_{O_4} (1 + 4 \sin^2 \alpha) - \Delta \omega_1 V_{O_4} \operatorname{ctg} \alpha}{2 \sin \alpha \sqrt{1 + 4 \sin^2 \alpha}} \cdot \frac{D}{d}, \quad (2.40)$$

$$a_m^{Dr} = a_n^{Dr} = -\frac{1}{2} \cdot \Delta \omega_1 \cdot V_{O_4} \cdot \left[\frac{1 + 4 \sin^4 \alpha}{\sin^2 \alpha \cdot \sqrt{1 + 4 \sin^2 \alpha}} \right] \cdot \frac{D}{d}. \quad (2.41)$$

The results of the kinematic analysis show that the rotational and symmetric displacement of the driving and driven working shafts was determined at the same angular velocities. as a result of changing the axial distances of the differential transmission mechanism and the drive gears, their gear ratios also change, which creates a geometric displacement between the working shafts and the workpiece. Thus, taking into account the results of the analysis performed, it is possible to reduce the geometric displacement between the working shafts and the workpiece by using the proposed transmission mechanism.

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METALLURGY AND MATERIALS SCIENCE

DEVELOPMENT OF THE SCIENTIFIC BASIS FOR THE CREATION OF MULTICOMPONENT COATINGS FROM LOCAL RAW MATERIALS FOR ELECTRODES FOR MANUAL ARC WELDING OF LOW-CARBON AND LOW-ALLOY WELD STEELS

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РАЗРАБОТКА НАУЧНЫХ ОСНОВ ДЛЯ СОЗДАНИЯ МНОГОКОМПОНЕНТНЫХ ПОКРЫТИЙ ИЗ МЕСТНОГО СЫРЬЯ ДЛЯ ЭЛЕКТРОДОВ ДЛЯ РУЧНОЙ ДУГОВОЙ СВАРКИ НИЗКО УГЛЕРОДИСТЫХ И НИЗКОЛЕГИРОВАННЫХ СВАРОЧНЫХ СТАЛЕЙ

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АННОТАЦИЯ

На развитие сварочного производства приходится более 50% валовой продукции крупнейших промышленно развитых стран мира. Во всем мире ведутся научные исследования по прогнозированию химического состава сварных швов. В этом направлении возможен выбор сварочных материалов, обеспечивающих эксплуатационные характеристики металла еще на стадии проектирования.

ABSTRACT

The development of welding production accounts for more than 50% of the gross output of the world's largest industrialized countries. Scientific research is underway around the world to predict the chemical composition of welds. In this direction, it is possible to select welding materials that provide the operational characteristics of the metal at the design stage.

Keywords: energy, metal, electrodes, materials, solid, thermodynamic.**Ключевые слова:** энергия, металл, электроды, материалы, твердое тело, термодинамика.

Introduction. In this regard, it is important to improve the quality characteristics of the electrodes on the basis of modernization of the composition of the coating shaft to reduce the cost of the electrode. At the same time, in order to improve the characteristics of the welded joint, it is necessary to develop a methodology

that allows optimizing the coating composition of welding electrodes, which determines the chemical composition of the molten metal [1,2].

Extensive research focused on the development of energy and resource-saving welding technologies in the world is carried out by the world's leading research

centers and higher education institutions, including: Stanford University (USA), International Institute of Welding (France), Technische Universitaet Wien (Austria), Polytechnic Institute of Viseu (Portugal), University of Nagoya (Japan), National Technologies Institute of Kumoh (South Korea), N. Moscow State Technical University named after Bauman (Russia), I.M. Extensive research is being conducted by the Gubkin Russian State University of Oil and Gas (Russia), Kiev Polytechnic Institute (Ukraine) and other research institutions [3].

A number of scientific studies are being conducted around the world to calculate the composition of the weld metal and the thermodynamic and physicochemical properties of welding slag in arc welding with coated electrodes, including: (Stanford University (USA)) , (Scientists of the International Institute of Welding (France) have developed methods to reduce the amount of harmful compounds in the weld metal, such as hydrogen, oxygen, sulfur, phosphorus, in order to achieve the required welding-technological characteristics, (Moscow State Technical University named after N. Bauman (Russia))) Scientists have determined the degree of dependence of the base metal, slag and metal bath masses due to the characteristics of welding electrodes for low-carbon and low-alloy steels, (Technische Universitaet Wien (Austria)) arc with coated electrodes Experimental-theoretical methodology for

determining the average and partial coefficients of transition of elements in butt welding was developed [4,5].

I.I. from scientists of the CIS countries. Frumin, G.L. Petrov, I.S. Ioffe, I.K. Походня, Э. Votnova, V.V. Podgaetsky conducted and developed research on the development of coating electrodes for arc-welded welding with physical and mechanical properties, given the comparison of the composition of the weld metal and the initial composition. Uzbek scientists M.A. Abralov, R.U. Abduraxmanov, R.M. The Saidovs developed electrodes for spring-arc welding of low-carbon and low-alloy steels.

The cycle of obtaining coated electrodes for arc welding includes a method of selecting the components of the electrode coating shaft on the basis of an improved classification scheme, taking into account their functional application, from their design (formation of high-characteristic weld seam) to production working technology.

Three-way systems of the melting diagram were used, taking into account the substantiation coefficient (Fig. 1) in the selection of the slag base of the electrode coating for spring-arc welding. These three-sided systems have an area where the melting temperature of the slag is 1300 °C. This temperature satisfies students who are exposed to welding slag when welding steels [7].

a)

б)

B)

Г)

Figure 1. State diagram of three-dimensional systems: a) $\text{SaO}-\text{Al}_2\text{O}_3-\text{MgO}$, b) $\text{Al}_2\text{O}_3-\text{SiO}_2-\text{CaO}$, c) $\text{Al}_2\text{O}_3-\text{SiO}_2-\text{MgO}$, d) $\text{Al}_2\text{O}_3-\text{SiO}_2-\text{K}_2\text{O}$, e) $\text{Al}_2\text{O}_3-\text{SiO}_2-\text{Na}_2\text{O}$, f) $\text{SaO}-\text{SiO}_2-\text{CaF}_2$ g) $\text{SaO}-\text{SiO}_2-\text{MgO}$

The melting point of $\text{SiO}_2-\text{SaO}-\text{MgO}$ in the system is 1300°C , ie when the content is $\sim 50\%$ SiO_2 , 30% SaO and 20% MgO , $\text{SiO}_2-\text{SaO}-\text{Al}_2\text{O}_3$ - $\sim 50\%$ SiO_2 , $\sim 30\%$ SaO and $\sim 20\%$ Al_2O_3 is limited. $\text{SiO}_2-\text{SaO}-\text{Al}_2\text{O}_3$ forms several chemical compounds in the system, along with two or three chemical compounds. These are: $\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SiO}_2$, 20% CaO , 37% Al_2O_3 and 43% SiO_2 and soluble at 1550°C and $2\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SiO}_2$, 41% CaO , 37% Al_2O_3 and 22% SiO_2 with a melting point of 1590°C . (Figure 1). The observed system has a large area of melting temperature of alloys not exceeding 1600°C , which ensures the widespread use of slags based on $\text{SiO}_2-\text{SaO}-\text{Al}_2\text{O}_3$. The slag in this system is converted to powder on cooling when the SaO content is $48-54\%$ [8].

In the $\text{SiO}_2-\text{SaO}-\text{CaF}_2$ system, which is the basis for the preparation of the main types of electrodes, the melting temperature ranges are much wider and the slag content is close to $\sim 50-60\%$ SaO , $15-25\%$ CaF_2 and $5-15\%$ SiO_2 . In the arc zone, CaF_2 dissociates to form fluorine ions of fluorspar, thereby reducing the amount of hydrogen and sulfur in the weld metal.

The effect of K_2O , Na_2O , MgO , Al_2O_3 oxide additives on the $\text{SiO}_2-\text{SaO}-\text{CaF}_2$ system is the effect on the density of the slag (Figure 2) and the viscosity of the slag (Figure 3), as well as the separation of the slag (Figure 4) and the coating properties of the slag (Figure 5). researched. Experiments show that when the amount of K_2O and Na_2O is increased, the viscosity of the slag density and the separation of the slag shell decrease. When the amounts of MgO and Al_2O_3 are increased, the density and viscosity of the slag increase [9].

Figure 2. The density of slag relative to the type and amount of oxide in the slag in the system SiO₂-SaO-CaF₂

Figure 3. The viscosity of slag relative to the type and amount of oxide in the SiO₂-SaO-CaF₂ system is given

Figure 4. In the SiO₂-SaO-CaF₂ system, the separation of slag relative to the type and amount of oxide in the slag is given

Figure 5. The SiO₂-SaO-CaF₂ system shows the slag coverage relative to the type and amount of oxide in the slag

Steel St3sp was selected for the preparation of weld specimens. Before welding, the electrodes were rolled at a temperature of 180-200°C [11].

Figure 6. Histogram of values of yield strength and strength limit of welds made with electrodes 1-4

Figure 7. Histogram of the value of the relative elongation δ of welds made with electrodes 1-4

Based on the results of the research, a technological guideline for the preparation of coatings for electrodes of basic and acidic types was developed.

The reserves of mineral resources of the Republic of Uzbekistan are sufficient, they are the basis of welding materials (marble, dolomite, quartz sand, kaolin, feldspar). As a result, it is possible to improve the technological properties of slag in arc-welded welding of elements in the form of one-component (marble, quartz sand).

Taking into account the basicity coefficient and solubility diagram, the slag-based compositions of base and

acid-type welding electrode coatings based on local raw materials were recommended. As a result, the strength characteristics of the welded casting structure can be increased by 10-15%.

The technology of preparation of coatings for welding electrodes of basic and acidic types using materials with low ionization potential has been developed. This technology allows to increase the strength characteristics of the welded casting structure by 12-14%.

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**INSTRUMENTATION, PRECISION AND ACCURACY,
DATA MEASUREMENT TOOLS AND SYSTEMS**

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DEPENDENCE OF MATERIALS ENLIGHTENMENT ON TEMPERATURE**Tulkun Nasirov**

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ЗАВИСИМОСТЬ ПРОСВЕТЛЕНИЯ МАТЕРИАЛОВ ОТ ТЕМПЕРАТУРЫ**Насиров Тулкун Закирович**

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ABSTRACT

We presented the calculation results for enlightenment coefficient by laser radiation plastic, organic glass and laundry soap at different temperatures. One has carried out experiments on range of temperature $0 \div 100$ °C. For materials enlightenment we used semiconductor laser diode ATC-C500-200 type, radiating on wavelength 668 nm. We showed that enlightenment effect influences on laundry soap better than other materials. One has revealed that in all samples at temperatures at range of $0 \div 40$ °C the enlightenment effect does not appear practically. At range of $40 \div 60$ °C the dependence of enlightenment coefficient on temperature is linear practically and when temperature is growing further from 60°C then values of this coefficient is increasing sharply.

АННОТАЦИЯ

Представлены результаты расчетов коэффициентов просветления под действием лазерного излучения пластмассы, органического стекла и хозяйственного мыла при различных температурах. Измерения проводились при температуре $0 \div 100$ °C. Для просветления материалов использовали полупроводниковый лазер ATC-C500-200, излучающий на длине волны 668 нм. Показано, что эффект просветления у хозяйственного мыла проявляется сильнее по сравнению с остальными материалами. Выявлено, что в интервале температур $0 \div 40$ °C эффект просветления практически не проявляется. В интервале $40 \div 60$ °C зависимость коэффициента просветления практически линейная, далее с увеличением температуры от 60 °C значения коэффициентов растут существенно.

Keywords: saturation coefficient, enlightenment effect, plastic, organic glass, laundry soap, materials.

Ключевые слова: коэффициент просветления, эффект просветления, пластмасса, органическое стекло, хозяйственное мыло.

Introduction

Since appearing nanoobjects and deal with them physical phenomena, the essential progress in optics had been taken. We can safely said that today development this science dominates, basically, in practical application while leaving behind to study the theoretical aspects any new physical effects. The enough interest and comparative little studied aspects of modern applied optics is enlightenment effect of materials.

This effect is very interesting because of practically in any substance has a definite temperature range (or additionally some parameters) by which one begins pass visible light radiation to some extent. Other words, substance will becomes somewhat transparence. It is interesting to investigate the conditions by which the substance becomes transparency in such parameters, at which most optoelectronic devices at present is working.

For example, in paper [1] had been investigated the optical properties of insulator medium where shown that presence of nanocavities layers near the borders section "environment-vacuum" which is able to increase the system transparency in a wide range of wavelength up to 100 %. And in Ref. [2] had shown that growing possibility of values of collimated coefficient of skin transmission 20÷40 times on dependence of wavelength and decreasing diffuse reflection coefficient up to 16 % by influencing water solution of glycerin.

Analogically enlightenment possibility of insulator with Ag nanoparticles having no spherical shape had been shown in paper [3] where introduction their nanoparticles directly to enlightenment material in sub wavelength had been proposed.

Passing transverse electromagnetic wave via heterogeneous medium and appearing in some layer's soliton like wave field bursts with its essential forcing due to sharp recline of wave vector value. In Ref. [4] based exactly solvable model task had been investigated.

In paper [5] the conditions and frequency band of total absorption of electromagnetic radiation in flat layer of absorbing insulator with covered to it of two enlightenment and non-absorbing layers, one of themselves has quarter wave thickness, had been found.

The enlightenment task in classical point of view considered in Ref. [6] where it had been introduced to case of many layers magnet-insulator systems. The possibilities of transmission of electromagnetic energy via thick (several skin-layers) insulator screen constructed from high attenuation coefficient in over high frequencies in paper [7] had been investigated.

It should be also noted that in Ref. [8] the increasing method of enlightenment zone in spherical surfaces of optical parts having great curvature by covered themselves the combined layers formatted using circular aperture in vacuum equipment had been proposed. By modeling spectral characteristics of Ge sub element of

three GaInP/GaAs/Ge transmitting solar elements had been shown [9] that using GaInP nuclear layer creating thin diffuse p-n junction in Ge allows increase Ge sub element photo generated current in comparison of values in case of GaAs nuclear layer.

In the present paper the analysis of investigations results carried out in usual home conditions on studying of enlightenment process of some materials has been presented. Measuring the light radiation intensity by transferring via different thicknesses we calculated values of absorbing coefficients and enlightenment ones. The light beam in experiments we obtained from semiconductor laser diode ATC-C500-200 type working at 668 nanometer wavelength.

The theoretical review

It is known, that by single photon absorbing of monochromatic radiation the enlightenment effect by this representation is described

$$\frac{dI}{dx} = -k(I)I. \quad (1)$$

Here I is the wave intensity in x point, $k(I)$ is the absorbing degree depending on the intensity. Its form is defined with concrete physical enlightenment mechanism and character of absorb line broadening. For example, if enlightenment effect conditioned by saturation and absorb line is broadened uniformly then

$$k(I) = \frac{k_0}{1 + \alpha I}. \quad (2)$$

Here k_0 is the absorb degree which figures in Buger-Labbert law, α is the saturation coefficient. Its physical meaning we shell find substituting condition

$$\alpha = \lim_{k_0 \rightarrow \infty} \frac{x}{I},$$

That is the angle coefficient of linear dependence for x and I by $k_0 \rightarrow \infty$. After integrating equation (1) with substituting representation (2) we obtain

$$x = -\frac{1}{k_0} \left(\ln \frac{I}{I_p} + \alpha I \right). \quad (3)$$

Here I_p is the integrating constant. Its value we find easily substituting $x=0$

$$I_p = I_0 \exp(\alpha I_0), \quad (4)$$

I_0 is the radiation intensity in entering moment to sample.

Further substituting representation (4) to one (3) we rewrite it as

$$x = -\frac{1}{k_0} \left[\ln \frac{I(x)}{I_0} + \alpha (I(x) - I_0) \right]. \quad (5)$$

As we see from representation (5), that the enlightenment investigate task of concrete sample leads to definition the k_0 and α constants values. For convenience we will introduce following remarks

$$A(I) = -\ln \frac{I(x)}{I_0}; \quad B(I) = -(I(x) - I_0). \quad (6)$$

In result from representation (5) we will obtain the algebraic equation for two unknowns parameters, k_0 and α

$$x = \frac{1}{k_0} [A(I) + \alpha B(I)]. \quad (7)$$

Considering parameters values k_0 and α are constant and also taking into account that intensity we will measure by different x values equation (7) can be rewritten as

$$x_i = \frac{1}{k_0} [A_i + \alpha B_i], \quad i = 1, \dots, N. \quad (8)$$

Here N is the measures quantity.

Onwards, because of in different measures the calculated values of k_0 and α parameters can be differ from each other we will take the following procedures.

The first, in all calculations of k_{0i} and α_i parameters values we will calculate ones using x_i and I_i values of i -th and previous ($i-1$)-th measurements. In this case,

after solving equation (8) regarding k_0 and α parameters we will obtain following representations

$$\alpha_i = \frac{x_i A_{i-1} - x_{i-1} A_i}{x_{i-1} B_i - x_i B_{i-1}}; \quad k_{0i} = \frac{A_{i-1} B_i - A_i B_{i-1}}{x_{i-1} B_i - x_i B_{i-1}}; \quad i = 2, \dots, 11. \quad (9)$$

The second, in each measurement of k_{0i} and α_i parameters values we will calculate separately and then their required values will find by averaging.

Experimental equipment

In order to obtain quantitative comparative picture as the samples we have prepared on 10 materials of white plastic, white organic glass and white laundry soap having rectangular parallelepiped shapes with wideness and height dimensions 2×2 centimeters and lengths from 1 up to 10 centimeters in normal thermodynamic conditions. The sample length in experiments we chose as x -axis.

The sequential structure scheme of experimental equipment in Figure 1 has been presented. In order both to exclude the ingress of external lighting to sample and radiation dissipation to environment we investigations have carried out in the darkened chamber. In that for measuring intensity entering to sample radiation from laser diode between radiation source and investigating sample we established the first luxmeter. After that we have measured the intensity this luxmeter for a definite period is removed. The light can be dissipated partly when it is passing by sample. Namely because of in exit of sample the collecting lens have been established. On its focus length the second luxmeter for measuring intensity of exit radiation has been established.

Figure 1. The sequential structure scheme of experimental equipment

For establishing saving and measuring the temperature values in the darkened chamber we used the air heater, spiral oven and thermometer.

Changing consistently the samples by increasing their length from zero up to 10 centimeters for each of materials and supporting them approximately 2-3 seconds we have measured for each case the corresponding x_i and I_i values. Using measured results we calculated values

for A_i and B_i parameters with which one defined k_{0i} and α_i parameters values and finally their averaged values and absolute errors. These results in Table 1 have been presented.

As seen in Table that light passes via laundry soap better in comparison of plastic and organic glass. As to the absorb coefficient that its value for plastic greater than ones for organic glass and laundry soap.

Table 1.

Numerical results for α and k_0 parameters obtained on experimental data

i	x_i , cm	I_i , lux	A_i	B_i , lux	α_i , cm/lux	k_{0i} , cm ⁻¹	$\bar{\alpha}$, cm/lux	$\bar{k}_0$, cm ⁻¹	$\overline{\Delta\alpha}$, cm/lux	$\overline{\Delta k_0}$, cm ⁻¹
Measurements with white plastic										
1	0	7976	0.00000	0						
2	1	6463	0,21034	1513	0,000172	4,447468	1,3757×10 ⁻⁴	3,667	4,29×10 ⁻⁶	9,87×10 ⁻¹⁷
3	2	5102	0,44680	2874	-0,000086	1,360769				
4	3	4314	0,61457	3662	0,000254	4,742606				
5	4	3319	0,87677	4657	0,000248	4,375247				
6	5	2467	1,17343	5509	0,000236	4,074407				
7	6	1772	1,50433	6204	0,000248	3,9977				
8	7	1223	1,87513	6753	-0,000044	2,883115				
9	8	965	2,11206	7011	0,000031	3,288273				
10	9	727	2,39527	7249	0,000179	3,83763				
11	10	502	2,76559	7474	0,000172	4,447468				
Measurements with white organic glass										
1	0	7976	0.00000	0						
2	1	6667	0,179267	1309	-0,000990	-10,87361	1,3968×10 ⁻⁴	2,767	7,55×10 ⁻⁵	1,48×10 ⁻¹⁶
3	2	5309	0,407034	2667	-0,000076	1,419208				
4	3	4511	0,569918	3465	0,000032	2,656637				
5	4	3691	0,77054	4285	0,000622	7,487976				
6	5	2771	1,057229	5205	0,000958	8,676197				
7	6	1902	1,433531	6074	0,000608	5,694770				
8	7	1223	1,87513	6753	-0,000044	2,883115				
9	8	965	2,112064	7011	0,000025	3,274243				
10	9	729	2,392519	7247	0,000121	3,687466				
11	10	520	2,730364	7456	-0,000990	-10,87361				
Measurements with white laundry soap										
1	0	7976	0.00000	0						
2	1	6675	0,178068	1301	-0,000840	-8,950530	3,1185×10 ⁻⁵	2,292	1,63×10 ⁻⁵	5,40×10 ⁻¹⁶
3	2	5315	0,405904	2661	0,000017	2,481600				
4	3	4314	0,614571	3662	0,000254	4,742606				
5	4	3319	0,876773	4657	0,000281	4,619920				
6	5	2452	1,179533	5524	0,000209	3,912386				
7	6	1772	1,504328	6204	0,000248	3,997700				
8	7	1223	1,875130	6753	-0,000055	2,839700				
9	8	973	2,103808	7003	0,000004	3,199031				
10	9	746	2,369467	7230	0,000165	3,789940				
11	10	521	2,728442	7455	-0,000840	-8,950530				

Numerical results and their discussion

At the same time values for enlightenment coefficients which more relevant to enlightenment effect that its values obtained for plastic and organic glass are similar practically and for laundry soap in comparison of these materials is approximately 4 times less. It follows that the intensity dependence of the passing via itself light on thickness for laundry soap less in comparison of plastic and organic glass.

Further temperature in experiments we varied in range of 0÷100 °C with 10 °C interval. Taking into account of melting possibility of samples by temperature influence in the darkened chamber we put them to quartz cuvettes.

Dependence of enlightenment coefficients values of samples on the temperature obtained based on experimental results have been presented in Figure 2, where solid line corresponds to plastic, dashed and dotted lines correspond to organic glass and laundry soap, correspondingly.

As seen in this Figure in all samples at temperatures range 0÷40°C the enlightenment effect does not appear practically. At 40÷60°C temperatures range dependence of α coefficient on the temperature is linear practically and beginning from 60°C its values is growing sharply.

It should be also noted that from studied three samples the enlightenment effect in case of laundry soap appears better in comparison of other two kind of materials.

Figure 2. Dependence of enlightenment coefficients values of samples on the temperature obtained based on experimental results: solid line corresponds to plastic, dashed and dotted lines correspond to organic glass and laundry soap, correspondingly

Conclusion

Thus, based on analysis of results obtained from investigations of enlightenment effect of white plastic, organic glass and laundry soap at temperatures range 0÷100°C we can conclude the following.

The values obtained for enlightenment coefficients which more relevant to enlightenment effect that its values obtained for plastic and organic glass are similar practically and for laundry soap in comparison of these materials is approximately 4 times less. It follows that the intensity dependence of the passing via itself light on thickness for laundry soap less in comparison of plastic and organic glass.

For all chosen for studying materials at temperatures range 0÷40 °C the enlightenment effect does not

appear practically. At 40÷60 °C temperatures range dependence of α coefficient on the temperature is linear practically and beginning from 60 °C its values is growing sharply.

It should be also noted that from studied three samples the enlightenment effect in case of laundry soap appears better in comparison of other two kind of materials.

Finally, from results presented on Table we can obtain the true values ranges estimations for α parameters of plastic, organic glass and laundry soap for normal thermodynamic conditions

$$\alpha_{pl} = (0,9467 \div 1,8047) \times 10^{-4} \text{ centimeter/lux};$$

$$\alpha_{og} = (0,6418 \div 2,1518) \times 10^{-4} \text{ centimeter/lux};$$

$$\alpha_{ls} = (1,4885 \div 4,7485) \times 10^{-5} \text{ centimeter/lux}.$$

Acknowledgment

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PROCESSES AND MACHINES OF AGROENGINEERING SYSTEMS

ANALYTICAL RESEARCH ON DETERMINING THE COEFFICIENT
OF USE OF CHANGEOVER TIME DURING USE OF SURFACE PLANNING MACHINE*Sobirjon Norov**Art. Lecturer,
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Republic of Uzbekistan, Bukhara*АНАЛИТИЧЕСКИЕ ИССЛЕДОВАНИЯ ПО ОПРЕДЕЛЕНИЮ КОЭФФИЦИЕНТА
ИСПОЛЬЗОВАНИЯ ВРЕМЕНИ СМЕНЫ ПРИ ИСПОЛЬЗОВАНИИ
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ABSTRACT

The article presents theoretical attempts to determine performance of surface planning machine depending on coefficient of use of changeover time. Dependence of coefficient of use of changeover time on some factors, i.e. speed of unit movement, length of field working sections and time spent on elimination of technical defects is given.

АННОТАЦИЯ

В статье представлены теоретические попытки определения производительности планировщика в зависимости от коэффициента использования времени смены. Дано зависимость коэффициента использования времени смены на некоторых факторов: скорость движения агрегата, длина рабочих участков поля и затраты времени на устранение технических неисправностей.

Keywords: changeover time, length of working stroke and grasp width, translational working speed of the planning unit, operative time of changing the tractive power of the tractor, specific soil resistance.

Ключевые слова: время смены, длина рабочего хода и ширина захвата, поступательная рабочая скорость планировочного агрегата, оперативное время смены тяговой мощности трактора, удельное сопротивление почвы.

World and domestic farming practices have proved that planning or leveling field surfaces are the main reclamation measure aimed to eliminate the roughness in the form of various heights and lowlands in the sown areas.

Planning of the land surface creates the basis on which irrigated agriculture can develop properly with a steady increase in crop yields [1, 2,3].

Planning of the land is an integral operation, both in reclamation and agricultural production. It is one of the effective agricultural measures ensuring increase of yield of all agricultural crops, reduction of water consumption during irrigation and improvement of working conditions during subsequent operation of agricultural machinery. As known, irrigation farming is based on surface watering methods that require careful planning. During operation, the surface of the earth is subjected to

deformations under the influence of various factors, which must be eliminated by the so-called operational planning.

Long-phase planners of various brands and modifications are widely used for its implementation. The performance and quality of the planning unit mainly depends on the speed of movement, the length of the run of the section and the correct selection of the movement scheme.

As we know, the maximum productivity of long-base planners depends on the speed of movement, the grasp width of the unit, the length of run, the specific resistivity of the soil and the tractive power of tractor.

The performance of the long-base planner per hour of changeover time is less than the theoretical productivity and depends on the total coefficient of use of changeover time. [1, 4]

The amount of coefficient of use of changeover time is influenced by many factors, the main of which are:

- speed of unit movement, length of working sections of field, time spent on elimination of technical defects, etc.

In order to consider the impact of these factors, we will express the coefficient of use of changeover time through the net operation time T_p and the total time $T_{га}$ to the assigned hectare of treated area. i.e:

$$\tau = \frac{T_p}{T_{га}} \quad (1)$$

The net operation time is determined as:

$$T_p = \frac{1}{W_m} \cdot \eta_{ac} \cdot \eta_{za} \quad (2)$$

where, W_m - theoretical productivity per hour of net operation, ha / hour.

The total treatment time of one ha ($T_{га}$) can be expressed as:

$$T_{га} = T_{онга} \frac{T_{см}}{T_{он}} \quad (3)$$

where $T_{онга}$ - operational time for processing 1 ha/hour:

$T_{см}$ - changeover time, hour;

$T_{он}$ - operative changeover time, hour.

Time $T_{онга}$ is determined as:

$$T_{онга} = T_{пга} + T_{повга} + T_{перга} + T_{тога} \quad (4)$$

Here T_p , $T_{пов}$, $T_{пер}$ - accordingly, the elements of the time spent on processing 1 ha of operational time, turnover time, movement time and maintenance. The operational changeover time is determined as:

$$T_{поп} = T_{см} - (T_{то} + T_{физ}) \quad (5)$$

where $T_{то}$, $T_{физ}$ - time during the changeover spent on maintenance and physiological needs, which are not directly dependent on the area being processed. [4, 5]

After substituting in equation (1) the values coming from equation (2) and (3), we obtain:

$$\tau = \frac{T_{он}}{W_m \cdot T_{онга} \cdot T_{см}}$$

By replacing the incoming values with their values from equations (4) and (5) we have:

$$\tau = \frac{T_{см} - (T_{мо} + T_{физ})}{W_m (T_{пга} + T_{повга} + T_{перга}) T_{см}} \quad (6)$$

In the obtained equation, the time $T_{пга}$ is determined by equation (2). And time of turns $T_{повга}$ per one ha can be expressed by the time of one turn $t_{пов}$, grasp width B and length of working stroke L by the following dependence:

$$T_{пов} = \frac{t_{пов}}{0.36 \cdot B \cdot L}, \quad \frac{\text{час}}{\text{га}}$$

In this case the equation (6) has the following form:

$$\tau = \frac{T_{см} - (T_{мо} + T_{физ})}{W_m \left(\frac{1}{w_m} + \frac{t_{пов}}{0.36 \cdot B \cdot L} + T_{перга} \right) T_{см}}$$

After the conversion, the resulting equation will slightly change:

$$\tau = \frac{1 - K_{мо} - K_{физ}}{1 + V \left[\frac{t_{пов}}{3.6L} + 0.1B(T_{пер}) \right]} \quad (7)$$

where $K_{мо} = \frac{T_{мо}}{T_{см}}$; $K_{физ} = \frac{T_{физ}}{T_{см}}$ - coefficients tak-

ing into account the time spent on maintenance and physiological needs during changeover [3].

$T_{то}$ and $T_{физ}$ - proportional durations of the changeover.

V - progressive working speed of the planning unit, km/h;

$t_{пов}$ - duration of one turn, sec;

L , B - length of working stroke and grasp width, m;

$T_{перга}$ - travel time per one ha, sec.

The analysis of works [6] shows that along with the main parameters of the long-base planner, the volume of work performed during the season (year) can affect the effectiveness of its use. Aggregates with a large grasp width at a small annual load can be less economically efficient relative to units with a smaller grasp width. Thereby, the selection of economically optimal parameters of a long-base planner requires a comprehensive approach, which will be considered in the subsequent part of this section.

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CIVIL ENGINEERING AND ARCHITECTURE

**THE IMPACT OF CLIMATIC CONDITIONS ON THE OCCURRENCE
OF WHEEL TRACK DEFORMATION ON ASPHALT PAVEMENT ROADS**
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**ВЛИЯНИЕ КЛИМАТИЧЕСКИХ УСЛОВИЙ НА ВОЗНИКНОВЕНИЕ ДЕФОРМАЦИИ
КОЛЕСНЫХ ГУСЕНИЙ НА ДОРОГАХ С АСФАЛЬТОВЫМ ТРАЙМОМ**
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ABSTRACT

When the car moves, a vertical, longitudinal and transverse dynamic force is generated, where there is a link between the road cover and the wheel. Repeated loads from vehicles and the impact of climatic factors lead to deformation in the pavement and pavement of the road.

АННОТАЦИЯ

Когда автомобиль движется, создается вертикальная, продольная и поперечная динамическая сила там, где есть связь между дорожным покрытием и колесом. Повторяющиеся нагрузки от транспортных средств и воздействие климатических факторов приводят к деформации дорожного покрытия и дорожного покрытия.

Keywords: highways; coating; wheel track; deformation; heavy load; temperature; vertical strength; climate factors; disturbances; maintenance; storage; movement intensity; road beam grunt; asphalt concrete coating; cement concrete coating; wafer trail deformation yield cycle.

Ключевые слова: автомобильные дороги; покрытие; колесная колея; деформация; тяжелый груз; температура; вертикальная прочность; климатические факторы; нарушения; Обслуживание; место хранения; интенсивность движения; грунтовка дорожная балка; асфальтобетонное покрытие; цементобетонное покрытие; Цикл текучести деформации следа пластины.

Introduction: Deformation of the wheel track on highways is a specific type of road construction (road pavement, road beam), on the surface of the road, honeycombs are formed along the length. Even if the wheel track deformation occurs in the upper layer of the road pavement, it also affects the road junction and Road beam layers [1].

Deformation of the wheel track–asphalt concrete pavement can be formed in all types of road pavements, but the change in their formation and depth will be different [2].

Despite the strength of the road beam and asphalt coating layers materials, the formation of the deformation of the wheel track is absorbed in the upper layer of asphalt coating under the influence of the wheel of vehicles. In real conditions, a wheel track is formed as a result of these processes. Like many other deformations, the formation of the wheel track deformation is caused by two negative factors:

- External factors—the effect of the load, climatic factors, especially air turbidity and sun rays, as well as the wetting of the grunt layer;

- Internal factors—the physico-mechanical properties of road construction, the strength of silica, structural condition, the strength and density of road pavements:

Method and materials: according to the longitudinal profile shape of the highway motion belt, The Shape of the deformation of the wheel track can be seen on the roads; the wheel trail on the roads with asphalt concrete pavement can be formed from two or more. Total depth of deformation of the wheel track–2...It can be 150 mm and more. Norms of deformation of wheel tracks on asphalt concrete pavement highways in the Republic of Uzbekistan are presented in the documents (Table 1) [3].

Table 1.

Norms of deformation of wheel tracks on asphalt concrete pavement highways in the Republic of Uzbekistan

Approximate speed of movement, km/h	Wheel track depth, mm	
	Fixed	Limit allowed
>120	4	20
120	7	20
100	12	20
80	25	30
60 and more	30	35

Development of recommendations to prevent the occurrence of wheel track deformation in hot climatic conditions on asphalt pavement roads widely spread in the Republic of Uzbekistan.

- to examine the appearance of wheel track deformation on asphalt concrete pavement highways;
- measurement of temperature in asphalt concrete coatings and analysis of results;
- to examine the impact of vehicles and air-climate factors on the deformation of the wheel track formed in asphalt concrete pavement;

In the Republic of Uzbekistan, a traditional measuring instrument (3-meter reyka) is used to measure wheel track deformation, but now several different instruments are used in the measurement of wheel track in developed foreign countries:

- KP-514 MP (Russia);
- Laser RST (AKSH va Sweden);
- SCRIM (England);

- ANDERA, Grip Tester, SIRONA (France);
- ARAN (Canada, Netherlands, Czech Republic);
- WUD (Czech Republic);
- SRT-3 (Skid Resistance Tester) (Poland)
- OSCAR (Norway) [34].

The norms and procedure for measuring and evaluating the wheel track on the road pavement (3 - meter Rail) are given in the normative document IQN 05-2011.

Discussion and results: from the measurement work done above, it can be seen that when the air temperature is high, that is, the temperature will be higher than 50s (50° C will be projected according to the normative documents when designing). We need to limit the entry of heavy trucks in the part of the day when the air temperature is high, but these measures are not an exhaustive solution to the problem. The air temperature has a direct effect on the appearance of a wheel trail (picture 1).

Picture 1. The dependence of air temperature on the wheel track

In 2007-2008, the old normative documents on the calculation of road junctions were re-adopted for the design of roads and highways, cargo calculated on the axis of 100-130 kN [4]. According to re ishlangan SHNK 2.05.02-2007 "highways", in the design of road junctions,

we select loads corresponding to normal loads on the axis of the two-axle cars calculated. If the calculated load in the project task is not specified separately, for the calculated load, we take the load corresponding to the project machine of Group A (Table 2) [5, 6, 7].

Table 2.

The calculated load in the project of Group A

Downloads calculation group	Normal static load on the axle, kn	Normal static load from the wheel of the selected TV to the surface of the coating, Qрасч, kN.	Accounting parameters of loading	
			P, МПа	D, см
A ¹	100	50	0,60	37/33
A ²	130	65	0,60	42/37

Note: in the photo – for the moving wheel, in the denominator – for the moving wheel.

Based on the Table (Table 2), it is possible to determine the value of the coefficient that leads to the calculated car and the approximate speed of movement.

In order to understand the measurement processes (Figure 2), dynamic voltages obtained from the optical device (a) and then (b) can be seen below. Analysis of

the obtained regression equations showed that asphalt concrete was determined to accelerate the formation of Wheel Trail deformation due to the effect of the temperature on the pavement and the forces of tension falling from the vehicles.

Figure 2. Graphic representation of measurements. A) before exposure of vehicles; b) after exposure.

The quantitative assessment of this phenomenon requires forecasting the process of changing the temperature of the coating, taking into account the variety of climatic conditions of objects in different regions. In the process of changing the temperature in the road pavement construction occurs under the influence of external air, such as air temperature, intensity of solar radiation, wind speed and direction.

Conclusions: recommendations against the appearance of wheel track deformation on asphalt pavement roads. Avoid deformation of the wheel track by adding "Unirem" modifier to the composition of asphalt concrete mixtures.

To prevent the appearance of deformation of the wheel track on the roads with asphalt concrete coating,

it is possible to recommend the modifier "Unirem", which is produced by the firm "Unikom". The main component of this modifier is the active rubber powder, which is obtained from the tires of vehicles that are excluded from the use of high-performance. It has long been using outdated automobile tires as a bitumen modifier in some developed states. Some companies in the US have been producing polymer powders used for road coatings from rubber waste in the 60 years [8].

To add to the composition of asphalt concrete mixtures, the polymer additive "Unirem" was brought to the optimal appearance. The modifier Univer is produced in two forms: in the form of poroshok (unirem-001) and granular (univer-002) (Figure 3) [9].

Picture 3. Views of the modifier Univer: 1) poroshok Form; 2) granulometric form.

When using the "Unirem" modifier, laying and condensation of a mixture of asphalt concrete is carried out in accordance with the requirements of SHNQ

3.06.03. Results of laboratory testing of a type of asphalt concrete mixture "Unirem" were determined to improve the physico-mechanical properties (Table 3) [9].

Table 3.

Results of laboratory testing

Pointers	The amount of "Unirem", %			GOST 9128 requirements
	0	0.8	1.0	
Silica durability R, MPa 20 S;	3,25	3,5	4,4	It should not be less than 2.2
50 °C	1,25	1,37	1,4	It should not be less than 0,9
0 °C	6,17	6,8	7,81	Should not be greater than 1.2
Water resistance, no less	0.95	0.97	0.99	It should not be less than 0.85
Water resistance, long saturated to water, should not be underestimated	0.83	0.91	0.95	It should not be less than 0.75
Internal friction coefficient	0.81	0.87	0.9	It should not be less than 0.87

We can see the economic effect of "Unirem" at the bottom of the repair intervals. On the roads with the usual asphalt concrete coating, we can see an increase in the repair period by an average of 5 years, when the modifier is added, on average, 7 years [8].

When the modifier "Unirem" is added to the composition of the CHMA, the cost of the asphalt

concrete mixture may slightly increase, that is, the cost of 100 tons of the CHMA is 45.211.998 sum, the cost of 100 tons of the modifier "Unirem" is 48.495.953 sum, the difference between them is 3.283.955 sum. It was concluded that the repair period exceeds 5 years to 7 years.

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IMPROVEMENT OF METHODS FOR CALCULATING THE MAXIMUM FLOW RATE OF MUDFLOW FLOODS AND OPENINGS OF BRIDGES IN THE DESIGN OF CULVERTS ON ROADS AND RAILWAYS

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УСОВЕРШЕНСТВОВАНИЕ МЕТОДОВ РАСЧЁТА МАКСИМАЛЬНЫХ РАСХОДОВ СЕЛЕВЫХ ПАВОДКОВ И ОТВЕРСТИЙ МОСТОВ ПРИ ПРОЕКТИРОВАНИИ ВОДОПРОПУСКНЫХ СООРУЖЕНИЙ НА АВТОМОБИЛЬНЫХ И ЖЕЛЕЗНЫХ ДОРОГАХ

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ABSTRACT

The article formulates the basic requirements for the design of small bridge crossings in the foothill mudflow channels. A new approach to hydrological calculations in determining their holes, based on morphometric dependence, is proposed. A method is given for calculating the maximum flow of mudflow and their parameters, subject to the law of "vertical zoning" characteristic of the foothill territories of the Republic of Uzbekistan.

АННОТАЦИЯ

В статье сформулированы основные требования к проектированию малых мостовых переходов в предгорных селевых руслах. Предлагается новый подход к гидрологическим расчетам при определении размеров мостового отверстия, основанный на морфометрической зависимости. Приведена методика расчета максимального стока селей и их параметров с учетом закона «вертикального зонирования», характерного для предгорных территорий Республики Узбекистан.

Keywords: mudflow, maximum flow rate, selenium content coefficient; maximum 10-minute intensity, channel slope, flow rate.

Ключевые слова: селевой поток, максимальный расход, коэффициент селевой активности; максимальная 10-минутная интенсивность, наклон канала, скорость потока.

1. Introduction

In practice, when designing road crossings through mudflow channels, designers usually take the characteristics of mudflows purely "water" flows, although they

contain, in varying quantities, and a solid phase. As a result, on piedmont road structures this often leads to massive plugging of pipe holes and destruction of bridge supports, etc. (fig. 1).

Figure 1. Impact of mudflows on culverts

According to SM Fleishman [21], if the relative volume of the solid phase exceeds 10-15%, such a flood (which corresponds to the volume of watercourses in small catchments of the foothills of Uzbekistan [16]) refers to mudflows. From the point of view of Yu.M. Denisov [8], mudflows should be considered from a single point of view, as objects containing liquid and solid phases in different ratios. We have taken just such an approach in the development of this work. Note that the increase in the cases of mudflows in Uzbekistan [9,10,11] is caused by an increase in the amount, frequency and intensity of precipitation, as well as in connection with the intensity of the development of foothill territories; the issue of designing bridges and calculating the opening of bridge crossings acquires both scientific and practical interest.

2. Goals and objectives of the work.

The purpose and task of the work is to develop the definition of the opening of bridge crossings on small foothill mudflow channels. The object of research is the foothills of the Republic of Uzbekistan.

3. Main part (results and discussion)

The design of bridge crossings and calculations of the holes of road structures began in the 60s of the last century. These works are linked by the names of Russian scientists - O.V. Andreev, E.V. Boldakov, V.A. Bolshakov, A.A. Kurganovich and other authors [1,2,3,4]. However, in these and subsequent works [6,13,14,21], the calculations of the openings of bridge crossings in the case of mudflow channels were not considered.

As a result of visual surveys, culverts through mudflow channels and, on the basis of published works [21, 22], we formulated the following basic requirements for small bridge crossings, as well as the principles of hydrological and hydraulic calculations of their openings:

- bridge crossings over mudflow channels should be designed in areas where the longitudinal slope of the channel at the crossing section provides a transit passage of mudflows with the full flow depth;
- crossings of mudflow channels should be carried out normally to the dynamic axis of the flow at the design site;
- in other cases, either special measures should be provided for the arrest or passage of mudflows, or in the calculation formulas for determining the height of the hole, the increment of the mark of the bridge channel for

the estimated period of operation of the structure should be taken into account;

- when the mudflow passage is constrained by the household flow width, a device is required to guide the structure from the entrance to the mudflow passage to the area where the flow channel is rigidly fixed by natural banks that do not have sharp breaks and turns.
- it is desirable to avoid intermediate supports when passing mudflows. If the implementation of intermediate supports is inevitable, one should strive to place them outside the dynamic axis of the flow - on the peripheral sections of the mudflow channel and give a zero width of the frontal edge of each intermediate support;
- it is not allowed to back up the mudflow in front of the entrance to the mudflow passage, since such backwater causes a blockage of mudflows in front of the structure.

The main design characteristics when calculating the openings of mudflow passages should be: design depth of mudflow – h_{calc} , width – B_{calc} , design flowrate – Q_{calc} , and channel slope – J .

The initial material for the calculation are: the catchment area in front of the structure – F , the catchment height Z and the root-mean-square deviation of the height – σ . These characteristics are determined from a topographic map.

Let us describe the methodology for the approach of hydrological calculation of the openings of bridge crossings.

Let us consider in the case when the longitudinal slope of the watercourse ensures the pass of mudflows with the full depth h_{calc} through the mudflow check canal. In this case, the width of its B_{calc} and h_{calc} according to S.M. Fleishman [22] shall be determined by the transfer of B and h from stable hydraulic gates, broken in the transit zone and reduced to the design capacity, while the flow depth shall be determined by the maximum (highest marks). According to the proposed option, the hydraulic parameters B_{calc} and h_{calc} are recommended to be obtained from hydromorphological dependencies (such dependencies were used to calculate the maximum water discharge of rainfall floods [12]). For the sub mountain rivers of Uzbekistan, these dependencies shall have:

$$h_{calc} = 0,07 \left(\frac{Q_{mcalc}}{\sqrt{gJ}} \right)^{0,34}, \quad (1)$$

$$B_{calc} = 3,62 \left(\frac{Q_{mcalc}}{\sqrt{g}} \right)^{0,33} \quad (2)$$

where: Q_{mcalc} is the estimated maximum discharge of the mudflow flood; J is a channel slope $g = 9,81 \text{ m}^2 / \text{sec}$;

When deriving these equations, we used the field data of G.V Vafin [5].

The slope of the watercourse is determined by the empirical formula:

$$J = kJ \frac{\sigma Z}{L} = \frac{kJ \sigma Z}{k_L \sqrt{F}}, \quad (3)$$

where: $\frac{k_j}{k_L}$ - proportionality factor equal to 1.79. σZ is the standard deviation of the catchment height.

$$\sigma z = 0.647 \ln(Z) + 0.061. \quad (4)$$

The maximum flow rate of a mudflow flood Q_{mc} is calculated by the "indirect method", which is the multiplied water flow rate Q_{mv} by the selenium density factor ψ :

$$Q_{mc} = \psi Q_{mv}. \quad (5)$$

In the literature, there are a number of dependencies for calculating rain maximums [1,7,13,15]. To calculate Q_{mv} when determining the maximum discharge of rainfall flood, we adopted the formula we proposed, based on the "method of limiting intensity", derived for the conditions of small water collections from sub-mountains of Uzbekistan [18]:

$$Q_{max} = 16,67 a_{10} kt F \alpha \varphi. \quad (6)$$

Here a_{10} is the intensity of a shower with hourly duration, mm / min; kt is the transition factor from the intensity of 10 minutes duration to the intensity of the shower with estimated duration; F is the water collection area;

α is the flow factor; φ is the reduction factor.

Let us present the calculation of the parameters included in formula (6).

Maximum 10 minute rain intensity (a_{10}). Maximum, 10-minute rain intensity, is determined by the expression:

$$a_{10} = m i. \quad (7)$$

Here m is the transition factor from average to maximum rain intensity, taken equal to $m = 4$.

In the absence of pluviographs, the average rain intensity is found by the well-known formula:

$$i = \frac{\Delta}{T^n}, \quad (8)$$

where Δ is the meteorological force of rain; T is the duration of the rain; n is the exponent.

The variable parameters in formula (8) Δ , n and T are determined by empirical formulas obtained for the territory of the foothills of Uzbekistan, governed by the law of "vertical zoning", i.e. the change in these values with increasing terrain height. Here are the calculation formulas and its correlations (R):

Meteorological rainfall

$$\Delta = \frac{496,7}{Z^{0,70}}, R = 0.66 \quad (9)$$

where Z is the water collection height, m.

Exponent n and rain duration T

$$n = 0,52 \Delta^{0,15} \cdot R = 0,57 \quad (10)$$

$$T \text{ Д} = A_r \cdot r^b \cdot R = 0,91 \quad (11)$$

In the formula (11) A_r is a unit of time measurement; b - parameter; in average, $A_r = 15.1$ and $b = 2.01$; r is the relative humidity of the air.

$$r = 0,584 Z^{0,099} \cdot R = 0,82 \quad (12)$$

Transient factor of 10 minute intensity to intensity of calculated duration (kt). This parameter is closely related to the flow rate (v) and the length of the main watercourse (L). The value of the factor is determined by the formula:

$$kt = \left(\frac{10 v}{L} \right)^{0,66}, \quad (13)$$

The structure of the formula for calculating this speed is adopted in the form [16]:

$$v = k J m \text{ km} / \text{min}, \quad (14)$$

where k is the factor associated with the channel roughness $k = 0.22$; J - watercourse slope; m - exponent, $m = 0.201$.

Runoff factor (α). According to our research, the runoff factor α is taken depending on the intensity of rain, so for the average intensity:

$$i_{cp} < 0,5 \text{ mm/min } \alpha = 0,5 \text{ and } i_{cp} > 0,5 \text{ mm/min } \alpha = 0,7.$$

Reduction factor (φ). The reduction factor (φ) is determined by the well-known formula:

$$\varphi = \frac{1}{(F+C)^m}. \quad (15)$$

where C is the correction factor to the area F , less sharp decrease in the maximum modules of rainfall in the zone of small water collection areas; n_r is an indicator of the degree of reduction of maximum runoff modules from changes in the water collection area. For the sub-mountain rivers of Uzbekistan, $n_r = 0.35$.

According to [13], the C value for areas $F < 5 \text{ km}^2$ can be taken from 1 to 2.30.

Selenium density factor ψ - we obtain by the empirical formula proposed by us [19]:

$$\psi = \frac{1,22}{(F \cdot J)^{0,04}}, \quad (16)$$

where F is the water collection area; J - water course slope.

On the basis of the described method, using formula (5), the norms of modules of maximum discharge (q_m) were calculated for 21 watercourses located in various hydrological regions of the sub-mountains of Uzbeki-

stan. Table 1 presents the materials of comparison between the calculated and actual rates of the modules of maximum discharges for some rivers of the Chirchik-Akhangaran hydrological region of Uzbekistan.

Table 1

Comparison of calculated and actual values m odul maximum water discharge on some rivers of the Chirchik-Akhangaran hydrological region

River - post	F, км2	q m м3/с· км2	q2m м3/с· км2	Difference between calculated and actual values	
				м3/с· км2	%
Karankulsay - Karankul	15,6	1,60	1,16	-0,44	-27,5
Aktashsay – Aktash	19,3	0,88	0,95	+ 0,07	+7,95
Parkentsai – Kirghiz	39,7	0,82	0, 69	- 0,13	-15,8
Altinbelsai - Kyrgyz	19,1	1,06	1,10	+0,04	+3,77

Note: F is the water collection area; q_m - actual rate modulus of maximum flow rate; q_{2m} - calculated module norms of maximum water flow rates according to formula (5).

Comparison between the calculated and actual values of the maximum discharge rate in general for the watercourses of Uzbekistan showed good convergence, while the standard deviation was $\sigma = 27.6\%$. If we take into account the accuracy of determining the actual value of the measured maximum water flow rate $\sigma = \pm 18\%$ (according to experts), then the error in determining the maximum mudflow water flow rate according to the proposed method will be equal to:

$$\sigma = \sqrt{\sigma_{\text{comp.}}^2 - \sigma_{\text{фак.}}^2} = \sqrt{27,6^2 - 18,0^2} = \pm 18,0\%$$

Here we note that in order to calculate the maximum rainfall discharge of the required supply, its variation factors C_{vm} and asymmetry C_{sm} should be determined. The variation factors of the maximum discharge for the rivers under consideration in the territory of Uzbekistan turned out to be well related to the heights of water collections:

$$C_v = \frac{1,89}{Z^{1,74}} R = 0.71. \quad (17)$$

The third statistical parameter for calculating the availability of maxima is the asymmetry factor C_{sm} is found according to its given ratio K_{sm} to the variation factor to C_{vm} , that is:

$$K_{sm} = C_{sm} / C_{vm}$$

or

$$C_{sm} = K_{sm} C_{vm}. \quad (18)$$

According to studies [17] of the sub-mountain rivers of Uzbekistan, the value of K_{sm} varies from 1.50 to 3.77.

Conclusions

As a result of the research conducted by the author

- formulated the basic requirements for the design of small bridge crossings of foothill mudflow channels, as well as the principles of hydrological calculations when determining their holes;
- a method for calculating the openings of bridge crossings, based on the use of hydromorphological dependencies, does not require additional field work.

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IMPROVING THE EFFICIENCY OF REPAIR AND CONSTRUCTION PRODUCTION IN THE REPUBLIC OF KAZAKHSTAN

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ПОВЫШЕНИЕ ЭФФЕКТИВНОСТИ РЕМОНТНО-СТРОИТЕЛЬНОГО ПРОИЗВОДСТВА В РЕСПУБЛИКЕ КАЗАХСТАН

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ABSTRACT

This article discusses the issue of increasing efficiency of the repair and construction production due to energy-saving technologies. The foreign method of carrying out repair and construction production, as well as their significance in the XXI century, is analyzed.

АННОТАЦИЯ

В данной статье рассматривается вопрос повышения эффективности ремонтно-строительного производства за счет энергосберегающих технологий. Проанализирован зарубежный метод проведения ремонтно-строительного производства, а также их значимость в XXI веке.

Keywords: MR-Major repairs, AB-Apartment building, EST-Energy-saving technologies, EF-Energy efficiency, under-repair, emergency housing.

Ключевые слова: КР-Капитальный ремонт, МКД-Многоквартирный дом, ЭСТ-Энергосберегающие технологии, ЭФ-Энергоэффективность, недоремонт; аварийное жилье.

If we take the total amount of energy consumed in Kazakhstan, then the residential sector consumes about 50% of energy. The remaining part of the energy is directed to the transport industry, industry and other areas. In Russia and Europe, the proportion is about the same as in Kazakhstan, but the residential sector still consumes a little less energy. This is a shocking statistic. Given this information, we can say that Kazakhstan has a very low energy efficiency of buildings, primarily residential facilities. This mainly applies to residential buildings built in the 50s and 70s.

Amendments to the Housing Code of the Republic of Kazakhstan, the addition of a whole chapter on the organization of the system of capital repairs (hereinafter KR) of common property in apartment buildings (hereinafter MCD) provided the creation of a mechanism that will reduce the amount of under-repair by increasing the repaired area of the multi-apartment housing stock. The use of modern energy-saving technologies in the course of the CD MCD will lead to a reduction in the cost of citizens to pay for housing and communal services, by improving the thermal characteristics of

buildings. Modern conditions for the organization of major repairs impose new requirements for modeling repair and construction production, in terms of the mandatory use of energy-saving technologies in the course of work. The specific features of repair and construction production (hereinafter referred to as RSP) significantly complicate the application of existing methods of modeling the organization of construction in the production of repair and construction works for major repairs (hereinafter referred to as CR).

The analysis of information sources related to the problem of implementing energy-saving technologies (hereinafter referred to as ECT) during major repairs showed that the main tasks were set and solved in a fragmentary, haphazard manner, and the issues of modeling the organization of repair and construction production using energy-saving technologies were not studied or developed at all.

Along with the direct implementation of the state policy on energy efficiency, the Institute for the Development of Electric Power and Energy Conservation (IRE) oversees three important blocks of work on energy efficiency.

- The first block: creates and maintains the State Energy Register, which includes all major electricity consumers (1,500 / + tons of conventional fuel per year for the industry and 100 / + tons of conventional fuel per year for the public sector).

- Second block: generates, manages, and selects projects for the energy efficiency map.

- The third block: conducts activities for the implementation of Step # 59: "Attracting strategic investors in the field of energy conservation through the internationally recognized mechanism of energy service contracts" within the framework of the Plan of Nations "100 concrete steps for the implementation of five institutional reforms", announced by the first President in May 2015.

There is a significant gap in the level of scientific approach and research methods in the works devoted to solving the problems of modernization, reconstruction and major repairs of buildings, and new construction. Thus, the scientific developments of organizational and technological reliability of construction, carried out by A.A. Gusakov, S.N. Bulgakov, Yu.B. Monfred,

B.V. Prykin, P.P. Oleinik, T.N. Tsai, V.A. Afanasyev, E.M. Zavadekas and others for the conditions of new construction, have not yet found application in the field of repair and construction production. Adaptation of the obtained results to the conditions of repair and construction work can lead to fundamentally new solutions that significantly change the understanding of the process of repair and construction production. Repair and construction production (hereinafter referred to as RSP) has specific features in the design and technology of work, the organization of the production process, the use of materials (in small batches), and the limited use of high-performance equipment.

In accordance with the set goals and solved tasks, the conducted research corresponds to the following points of the specialty passport: Development of new and improvement of existing methods and forms of organization of housing, industrial, civil and other types of construction (reconstruction). Theoretical and experimental studies of the efficiency of technological processes; identification of general patterns by modeling and optimizing organizational and technological solutions. Development of principles for organizing the construction of large national economic facilities and complexes; development of flow methods, network and other construction models; improvement of calendar planning methods.

Conclusion

In accordance with the set goals and solved tasks, the conducted research corresponds to the following points of the specialty passport: Development of new and improvement of existing methods and forms of organization of housing, industrial, civil and other types of construction (reconstruction). Theoretical and experimental studies of the efficiency of technological processes; identification of general patterns by modeling and optimizing organizational and technological solutions. Development of principles for organizing the construction of large national economic facilities and complexes; development of flow methods, network and other construction models; improvement of calendar planning methods.

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TRANSPORT

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ROAD TRANSPORTATION ACCIDENTS WITH PARTICIPATION PEDESTRIANS

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ДОРОЖНО-ТРАНСПОРТНЫЕ ПРОИСШЕСТВИЯ С УЧАСТИЕМ ПЕШЕХОДОВ

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ABSTRACT

This article deals with road traffic accidents (accidents) involving pedestrians. Causes of the accident. Cases of material liability of participants of road accidents are considered. As well as foreign experience in preventing accidents involving pedestrians.

АННОТАЦИЯ

В этой статье рассматриваются дорожно-транспортные происшествия (ДТП) с участием пешеходов. Причины аварии. Рассмотрены случаи материальной ответственности участников ДТП. А также зарубежный опыт предотвращения аварий с участием пешеходов.

Keywords: Road accidents involving pedestrians, hitting pedestrians.

Ключевые слова: ДТП с участием пешеходов, наезд на пешеходов.

Introduction. It is no secret that most warriors allow themselves to break the rules in small ways. Despite the fact that every person has an excuse ready, do not forget: it is small violations that often lead to serious consequences. Any person, whether a driver, pedestrian or passenger, who has violated the Traffic Rules (hereinafter referred to as Traffic Rules) can be held liable. The procedure for bringing to justice most often begins with an inspector of the State Road Safety Inspectorate (hereinafter referred to as the Traffic Police), but, despite this, as a result of a road traffic accident (hereinafter referred to as an accident), in addition to the persons involved in the accident, another subject is included in the resolution of this situation, namely the insurance company [6, 7, 4].

For example, the story that changed the life of a teenager began in November 2017 at an intersection near the governor of the city of Namangan. On an unregulated crossing, Akmal (the boy's name) was hit by a Lada Granta car. He was taken to the hospital, where doctors diagnosed a compound fracture of the lower leg. On the same evening, the driver offered the parents compensation of 4,200,000 Sums, but they refused it. After that,

the case went to the court of first instance, which decided that the accident was the fault of the child. Allegedly, the motorist did not violate the rules, drove at a speed of up to 50 km / h and could not pass a pedestrian. The boy's family protested the verdict, as a result of which the regional court found her right. In the new lawsuit, the family also demanded to recover from the driver half a million sums for moral suffering and 50 thousand material damage.

However, when Akmal was recovering, he received a letter from the insurance company demanding compensation for the repair of the headlights of the car that hit him.

Having considered a number of examples from court practice in cases related to road accidents, it can be concluded that on average in 10% of the studied cases as a result of an accident, the pedestrian is responsible, while in the remaining 90% the burden of responsibility lies with the driver of the vehicle. This is not surprising, because if you look at the statistics of road accidents for 2019 (Fig. 1), you can make sure that in most accidents on the roads, the perpetrators are the persons driving the vehicle.

Figure 1. Causes of road accidents in Uzbekistan in 2018

So, examining the data given in the diagram, we see that 59% of accidents, which is more than half, are caused by drivers, 21% of the responsibility lies on the shoulders of the Administration of a particular city due to the unsatisfactory condition of roads and streets [4, 8, 1, 9] and only 20% are guilty of pedestrians who violated traffic rules [2, 5, 9]. That is why payments for compensation for damage caused, most often have to be carried out by the drivers of the vehicle.

Since in the territory of the Republic of Uzbekistan there is legislation according to which "owners of vehicles are obliged, on the terms and in accordance with the procedure established by this Republican Law and in accordance with it, to insure the risk of their civil liability,

which may occur as a result of causing harm to the life, health or property of other persons when using vehicles", a significant part of the payments for causing harm as a result of an accident is assigned to insurance companies, but as for the example I gave with George, then the insurance company demanded compensation for the repair of the headlights of the car that hit him. Interestingly, according to the law, the claims of insurers are legitimate, although they are quite rare. The whole point is that if the insurer compensates for the damage caused to the car during the collision, the company can demand payment of the costs from the person regardless of his guilt. Another thing is that the victim has the right to apply to the court with a demand to recover compensation

for moral damage from the driver. The situation is certainly interesting. After all, if (as the court of first instance decided), the student is to blame, then his parents must pay for the damage caused to the car. In this case, the insurance company took advantage of, which states, " Unless otherwise provided by the property insurance contract, the insurer who paid the insurance indemnity shall, within the amount paid, have the right of claim that the policyholder (beneficiary) has against the person responsible for the losses compensated as a result of the insurance." However, the parents were absolutely right to file a counterclaim for compensation for non-pecuniary damage. Following the logic of the law, even if the damage was caused by intent, that is, the student deliberately ran across the road in front of an approaching car, he can still receive compensation. Yes, in this case it can be reduced, but not completely excluded. That is, it is likely that the driver himself will have to pay. It is on this example that you can make sure that everything fundamentally depends on whose fault the accident occurred.

If we turn to foreign experience and see how such situations are resolved there. For example, in Germany, as in Uzbekistan, video recorders or the so-called Dashcam are becoming increasingly popular. But according to German law, such a video is not material evidence, since it was not made by an expert. This is what hinders the process of proving who caused the accident. The recorded video may, at the discretion of the judge, perform only an auxiliary function.

Just as in Uzbekistan, it is not uncommon for pedestrians or cyclists to become victims of road accidents. There is a misconception that a pedestrian hit by a zebra is always right, no. A pedestrian is also a participant in the movement and should not insist on their priority right to cross. Not all drivers "respect" the zebra or simply do not always see it on the road, and then the transition ends with moving to the hospital ward. German courts require pedestrians to be particularly careful. Not only drivers, but also pedestrians were held liable for accidents (and reimbursed for car repairs). Despite the green light or the presence of a pedestrian crossing, the courts recognize up to 50% of the pedestrian's guilt. And when crossing in the wrong place, the fault can reach 100%, because it is possible that the behavior of pedestrians is the cause of the accident. It is for this reason that German motorists need to be vigilant when participating in road traffic in order to remain healthy and maintain their financial situation, without paying for their treatment and repair of the vehicle as a result of a collision with which an accident occurred. It is this judicial practice that acts as a prevention of accidents with pedestrians. It should be noted that the prevention of road accidents in Uzbekistan is also a success. Over the 12 months of 2019, the trend of reducing the number of road accidents and the number of victims continued in the Republic of Uzbekistan. At the same time, the analysis of the structure and dynamics of accidents indicates the presence of problematic components of indicators of

road traffic injuries. In particular, along with the reduction in accidents, certain components were identified, the values of which increased. Their analysis and accounting in the future will increase the effectiveness of preventive activities.

1. In the regions of the Republic of Uzbekistan, there was an increase in one, two or three main indicators of accidents, which had a negative impact on the process of improving road safety in the country. At the same time, the number of such subjects increased in comparison with 2019 (21 subjects).

2. Throughout the year (including for 3, 6, 9 months), the most dangerous day of the week in the country was Saturday, and the time of day was the period from 17:00 to 19:00 hours.

3. Among the total number of road accidents and the number of victims due to the fault of drivers of motor vehicles, accident rates due to traffic violations by bus and trolleybus drivers were particularly negative.

4. In 2020, there was an increase in accident rates due to traffic violations by drivers who are in a state of intoxication. In addition, there was a significant increase in the number of accidents due to traffic violations by drivers associated with oncoming traffic.

5. There was a deterioration in the situation related to the accident rate of vehicles belonging to legal entities. The increase in the number of accidents and the number of injured in them due to traffic violations by drivers of these vehicles was more than 11%.

6. In the structure of accident rates due to traffic violations by drivers of different ages, the number of accidents and the number of injuries committed by drivers of the age group over 60 years continued to increase.

7. Accidents involving child passengers were of particular concern. The increase is due to an increase in the number of road accidents and the number of injured child passengers up to 12 years old.

In general, from 2011 to 2019, the dynamics of the annual number of road accidents, the number of deaths and injuries had a pronounced downward trend, since their absolute values can be approximated by a straight downward trend line. In this regard, it is predicted that the values of accident rates will continue to decline, which is based on retrospective data for the years and timely determination of the current situation on the country's road network, including at the expense of new, modern cars [1, 3, 4]. Both versions of the forecast values provide for a favorable development of the situation, in particular, a decrease in the number of deaths relative to the values of 2019: based on the average annual decline in the period from 2008 to 2019 by more than 4.0% and more than 12.0% – based on the steady rate of decline in the last three years. Summing up the work done, it should be said that regardless of whether you are on a regulated pedestrian crossing or vice versa, you need to be 100% sure of your safety, especially if the pedestrian is a child [9] and only then start moving. If you are driving a vehicle, be careful and do not be distracted by third-party items, because one moment can cost someone their life.

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ANALYSIS OF THE ECOLOGICAL CLASS OF FUELS USED IN CARS

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АНАЛИЗ ЭКОЛОГИЧЕСКОГО КЛАССА ТОПЛИВА, ИСПОЛЬЗУЕМЫХ В АВТОМОБИЛЕ

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ABSTRACT

This article is reflected in the cars on the basis of poisonous gases coming from a trusted source. The chemical composition of gases and their negative effects on human health and the environment have been studied.

АННОТАЦИЯ

В данной статье рассматривается выбросы выхлопных газов автомобилей на основе надежных источников. Изучены химический состав газов, их негативное влияние на здоровье человека и окружающую среду.

Keywords: energy vehicle, fuel, carbon monoxide, nitrogen oxide, hydrocarbon, environmental class, toxic gases, Euro-3, Euro-6, monomethylamine.

Ключевые слова: энергия транспортного средство, топливо, окись углерода, окись азота, углеводороды, класс окружающей среды, токсичные газы, Евро-3, Евро-6, монометиламин.

It is known that the main energy source that drives a car is fuel. Today, cars produced for a variety of fuels (gasoline, diesel, gas, etc.). The power of cars depends on the heat capacity of the fuel. When using fuels, it is advisable to study their technical characteristics. The reason is that after the combustion of fuel, the exhaust gases contain toxic gases such as carbon monoxide CO, nitrogen oxide NO_x, hydrocarbons CH, which have a serious impact on the environment and human health. That is why the fuel class has been developed.

These gases are harmful to man and nature to the effect that fuel quality is setting the standard class requirements. This class of vehicle fuel standard for the environmental requirements of the class set 1-6. But the requirements of this standard have nothing to do with the octane number of gasoline. This standard fuel natural and man aimed at reducing the impact of harmful gases from car engines.

Despite the high octane content of gasoline, its harmful effect on the atmosphere is Euro-3, while this

effect of Ai-91 gasoline is similar to Euro-6, and Ai-91 (6) gasoline is environmentally friendly^[2].

We describe the environmental class of the car. The system of environmental classification of vehicles is based on research on the composition of exhaust gases. It was found that on average, 1 machine consumes about 4 tons of oxygen per year and releases the following products into the air as a result of its processing^[3].

- carbon monoxide - about 800 kg;
- carbon - 200 kg;
- nitrogen oxides - 40 kg.

Some of the sources, transport vehicles% of the greenhouse gases that pollute the surrounding environment to give^[1]:

- Cars - 83%;
- Trucks - 12%;
- Special cars - 2.8%;
- Buses - 2.2%;

At the same time, according to statistics, the number of new cars on the roads is increasing every day. The continued growth of toxic waste environmentalists concerned about the serious negative impact on the ecosystem. The maximum amount of harmful substances in exhaust gases contained in the rules on the introduction of many decisions have been made in the countries of the world. This decision is one of the "Euro".

At the beginning of 1990 has significantly decreased the purity of the atmosphere of the planet. The most harmful to the environment were cars running on gasoline and diesel engines. In 1992, road transport in Europe, to limit the amount of waste emitted into the atmosphere known as the "protocol" developed a special regulation. The first protocol called "Euro 1", Cars in the document issued by the parameters of the toxic waste was established ^[4]. This protocol is reviewed annually and is carried out by reducing the amount of greenhouse gases (Euro-1 and Euro-2 and Euro-3, Euro-4 and Euro-5 and Euro-6) and indecisive. For example, in Euro-6 gasoline;

- carbon monoxide (CO) - 1.0 g / km;
- hydrocarbon (CH) - 0.1 g / km;
- nitric oxide (NO_x) - 0.06 g / km;
- suspended particulates (RM) - 0,005 g / km;
- hydrocarbons and nitrogen oxide (CH + NO_x) - 0 g / km

At the present time, for example for fuel in Russia, K4, K5, K6 classes. They gasoline determines the amount of harmful emissions. We describe the amount of sulfur and monomethylamine. The chemical composition of GOST 32513-2013 lead added to gasoline in terms of requirements. Sulfur and monomethylamine MMA is very harmful, but Oktay additions increase the number. MMA is now banned. However, it is in the present period is also contained in some gasoline. The following are the sulfur levels belonging to the gasoline grades ^[5].

- K2- sulfur content of 1 kg to 500 mg, monomethylamine MMA does not exceed 1.3%;
- K3 - up to 150 mg / kg and 1% MMA;
- K4 - up to 50 mg / kg and 1% MMA;
- K5 - up to 10 mg / kg and complete absence of MMA.

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Consider the environmental and human health impact of greenhouse gas emissions:

Carbon Monoxide CO. Hydrocarbon fuels are not enough oxygen is formed by turns, and can also be thickened combustible composition of this gas will be used. This gas stops the activity of the active centers that produce hemoglobin. As a result, the process of oxidation in the human body (breathing) is broken, which can lead to death. When the amount of carbon monoxide in the air exceeds 0.01% by volume, the body is significantly poisoned. Poisoning causes headaches, tinnitus, difficulty breathing and weakness.

Nitric oxides. Nitric oxide is formed under the influence of free oxygen. The higher the temperature of the combustion process in the engine, the more nitric oxide is formed. Nitric oxide combines with moisture to form nitric acid. This acid absorbs lung tissue, inflames the mucous membranes of the eyes, causes irreversible diseases of the cardiovascular system.

Hydrocarbons. When an excessively thick or liquid combustible mixture burns incompletely, unburned hydrocarbons form CH. Hydrocarbons have a strong toxic effect and have a detrimental effect on the formation of new blood, the central nervous system.

Aldehydes. This oxidized hydrocarbons, small engine load and cold startup. Aldehyde is also formed in detonated combustion. Aldehydes irritate the respiratory tract and mucous membranes. Damages the central nervous system, liver and kidneys.

Lead compounds. Lead is added to petrol to increase its resistance to detonatsiyaga (tetraethyl lead) of fluids. When the mixture burns, the lead forms toxic compounds. Lead compounds are dangerous to the surrounding population, the driver of the car, and the workers who maintain the ICE. This compound leads to disruption of metabolism and blood formation processes in the body. Therefore banned the use of leaded petrol. This is a strong influence on the nature of the compound, the slow development of plants, reduces the fertility of the earth.

The following conclusions can be drawn from the scientific research. Exhaust gases from the engine have a negative impact on the environment. From year to year, a lot of scientific research is being done to reduce these toxic gases. As the number of cars increases, so does the amount of toxic gases. By changing the quality of the fuel composition, it is possible to reduce the harmful effects of exhaust gases on the environment and humans.

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IMPROVEMENT OF THE COOLING SYSTEM OF MINE COMPRESSOR UNITS

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ABSTRACT

The existing cooling systems of compressor units have a number of significant disadvantages due to the peculiarities of their operation. An analysis of the operation of them shows that the undercooling of the air in reciprocating compressors for every 5-6 °C increases the energy consumption for air compression by 1 %, and the productivity decreases by 8-10%, which leads to significant economic losses in the production of compressed air.

This article discusses ways to improve the operating of the cooling system, and offers new technical solutions, the implementation of which will reduce the energy intensity of the operation of compressor units.

АННОТАЦИЯ

Существующие системы охлаждения компрессорных установок имеют ряд существенных недостатков, обусловленных особенностями их эксплуатации. Анализ эксплуатации компрессорных установок показывает, что недоохлаждение воздуха в поршневых компрессорах на каждые 5-6 °C увеличивает расход электроэнергии на сжатие воздуха на 1 %, а производительность снижается на 8-10%, что приводит к ощутимым экономическим потерям при производстве сжатого воздуха.

В данной статье рассмотрены способы улучшения работы, системы охлаждения, предложены новые технические решения, реализация которых позволят снизить энергоёмкости эксплуатации компрессорных установок.

Keywords: compressor, cooling system, temperature, compressed air, heat transfer, intermediate refrigerator, power consumption, feed rate.

Ключевые слова: компрессор, система охлаждения, температура, сжатый воздух, теплопередача, промежуточный холодильник, расход электроэнергии, коэффициент подачи.

In lots of industries, along with electrical energy and pneumatic energy, compressed air power is widely used.

Compressed air, being one of the main types of energy in quarries and mines, is used for powering fans and pumps, in airlift installations for pumping out pulp or

water, drilling, tunneling, mining and loading machines, for pneumatic laying of underground mine workings, in pneumatic balloon supports [1].

The widespread use of compressed air in the mining industry is due to the fact that pneumatic equipment is

safe, especially in mines that are dangerous for gas and dust, in cases where the use of electricity in underground mining is unsafe due to unpredictable gas emissions.

Along with this, pneumoenergy has a number of significant drawbacks. The main disadvantage of compressed air, as an energy carrier, is its high cost relatively to electricity. The reason of it is the consumption of a large amount of electrical energy by compressors in the production of compressed air.

Mining compressors are energy-intensive installations, the share of which in the consumption of electricity in mining enterprises is a significant one [2].

Given such a wide use of pneumatic energy, it is necessary to reduce operating costs by developing resource-saving technical solutions in the production of compressed air in industrial enterprises.

The efficient operation of the compressor unit is largely dependent on cooling. The cooling system of the compressor unit solves three tasks: it reduces the energy consumption of the compression process in the cylinder, eliminates the possibility of ignition of lubricating oils, and improves the operating conditions of the compressor operating units [3, 4]. Violations of the cooling system, as a rule, are associated with a forced stop of the compressor and an increased specific energy consumption for the production of compressed air.

An analysis of the operation of compressor units shows that the undercooling of the air in the intermediate refrigerators of the reciprocating compressor increases

the energy consumption for air compression by 1% for every 5-6 °C [5].

The water used for cooling has a high content of salts and various impurities. In most cases, the total water hardness, reaching more than 20 mg-eq/l, is almost 3 times higher than the permissible values, which is the main reason for the rapid contamination of heat exchange surfaces. The decrease in the intensity of heat exchange processes, due to the growth of deposits in the form of scale, contributes to a decrease in the safety and efficiency of the compressor equipment.

The presence of a 0.1 mm thick scale layer reduces the cooling of the air in the refrigerator by 10-15 %. The scale layer reduces the heat transfer coefficient by adding additional thermal resistance [6].

At the outlet of the intermediate refrigerator, the normal temperature of the compressed air should not exceed the temperature of the cooling water at the inlet by more than 5-10 °C. If the temperature difference increases to 20 °C, the power consumption, all other things being equal, can increase by 14 %. The scale on the inner walls of the tubes dramatically reduces the heat transfer to the cooling water. Figure 1 shows the graphical dependence of the heat transfer coefficient on the thickness of the scale layer [7].

From the graph shown in Fig. 1, it is observed that, with an increase in the thickness of the scale layer, the heat transfer coefficient deteriorates.

Figure 1. Change in the heat transfer coefficient depending on the thickness of the scale layer

Frequent formation of contamination on the heat exchange surfaces, a decrease in the intensity of heat exchange, observed due to the formation of a layer of scale on the walls of intermediate and end refrigerators can lead to spontaneous combustion of carbon-oil deposits in air communications, which is the cause of detonation explosions.

In order to improve the energy efficiency of operation of reciprocating compressor units, based on the factors, we offer the following technical solutions.

Increasing the efficiency of the cooling system of compressor units is possible due to the intensification of the heat exchange process between the cooled (compressed air) and the cooling (water) heat carriers. This is

primarily realized by preventing scale and sludge deposits in refrigerators. To date, the softening of water hardness is achieved by chemical means. The chemical method of preventing the formation of scale is effective, however, it requires constant costs, strongly pollutes the environment and harms the health of service personnel. Prevention of scale formation is possible due to electromagnetic treatment of recycled cooling water [8].

We have developed an installation for electromagnetic treatment of circulating water in the laboratory. In order to determine the effectiveness of the developed installation of electromagnetic treatment of circulating water, we conducted experimental tests. A schematic view of the experimental setup is shown in Figure 2.

Figure 2. Schematic view of an experimental setup for testing an electromagnetic water treatment device.
1-tank with an electric heater, 2-temperature controller, 3-circulation pump, 4-device for electromagnetic water treatment, 5-point for measuring the temperature of water, 6-valve, 7-metal pipe, 8-tank with water

Experimental work was carried out in two stages. The first stage of experimental research was carried out without the use of a device for electromagnetic water treatment. The second stage is using a device for electromagnetic water treatment. The duration of the experimental work for each cycle was 48 hours, and the average water hardness was 25 mg-eq/l.

The main objective of the experimental work was to establish the dependence of the formation of a scale

layer on the surface of a metal pipe on the temperature of the circulating water, with the use of a device for electromagnetic water treatment and without it.

The experimental tests made it possible to obtain the dependence of the scale formation on the metal surface on the temperature of the circulating water with and without the use of a device for electromagnetic water treatment, the graphical dependence is shown in Fig. 3.

Figure 3. Graphical dependence of the formation of scale thickness on the temperature of the circulating water.
1-without using a device for electromagnetic water treatment, 2- using a device for electromagnetic water treatment

From the graph shown in Fig. 3, it is clear that electromagnetic treatment of circulating water reduces the formation of scale on metal surfaces by an average of 70-80%.

Figure 4 shows a microscopic photograph of the metal pipe inner surface after the experimental work

is completed. Analysis of the microscopic photographs shows that the use of electromagnetic processing reduces the formation of a layer of scale on the walls of the metal pipe.

a)

б)

Figure 4. Microscopic photograph of a metal pipe wall.
a) operation of the pipe without using a device for electromagnetic water treatment,
b) using a device for electromagnetic water treatment.

From Figure 4, it is obvious that the scale layer on the walls of the metal pipe shown in Figures 5a is much thicker than that shown in Figures 5b. This makes it possible to conclude that the use of a device for electromagnetic water treatment helps to reduce the formation of scale on the surfaces of heat exchangers.

The performed studies of the influence of the intake air temperature on the efficiency of the piston compressor allow us to conclude that an increase in the temperature of the air entering the compressor cylinder leads to a decrease in the compressor performance and an increase in the energy costs of compression.

For example, for reciprocating compressors with a capacity of $100 \text{ m}^3 / \text{min}$ and a drive power of 630 kW, an increase in air temperature for every 1°C leads to a decrease in the efficiency by 0.15-0.17%.

The implementation of our proposed technical solutions at the compressor units of mining enterprises helps to reduce the energy costs of the air compression process in the cylinder by an average of 4-5%, and rise the compressor performance by up to 8%, depending on the operating conditions. And also to exclude emergency situations and to increase operational indicators of working units of the compressor, as a result reducing the cost of production of compressed air.

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MAIN CAUSES OF DIGGING MACHINE FAILURES AND WAYS OF THEIR ELIMINATION**Nuritdin Shukurov**

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ОСНОВНЫЕ ПРИЧИНЫ ОТКАЗОВ ЗЕМЛЕРОЙНЫХ МАШИН И ПУТИ ИХ УСТРАНЕНИЯ**Шукуров Нуритдин Рахимович**

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ABSTRACT

As you know, failure is understood as an event consisting in complete or partial loss of system performance. Failures can be structural, which are due to miscalculations and mistakes made at the design stage of the machine; technological, resulting from a violation of the manufacturing technology of the machine; operational, caused by violation of the rules for the operation of the machine.

The article analyzes the violation of the performance potential of earth-moving machines in terms of corrosion parameters. The types of corrosive effects that are most susceptible to structural materials used in the manufacture of earth-moving machines are considered.

АННОТАЦИЯ

Как известно, под отказом понимается событие, заключающееся в полной или частичной утрате работоспособности системы. Отказы могут быть конструкционными, которые обусловлены просчетами и ошибками, допущенными на стадии проектирования машины; технологическими, являющимися результатом нарушения технологии изготовления машины; эксплуатационными, вызванными нарушением правил эксплуатации машины.

В статье анализируется нарушение потенциала работоспособности землеройных машин по параметрам коррозии. Рассмотрены виды коррозионных воздействий, которым наиболее подвержены конструкционные материалы, используемые при изготовлении землеройных машин.

Keywords: structural failure, technological failure, hardening method, working body of the machine, wear, resource, reliability.

Ключевые слова: конструкционный отказ, технологический отказ, метод упрочнения, рабочий орган машины, износ, ресурс, надежность.

As you know, the share of failures caused by wear of parts accounts for about 80% of the total number of machine breakdowns. The working bodies of earth-moving machines are subjected to especially intense

abrasive wear. The creation of a more wear-resistant cutting body for earthmoving machines and its protection from wear, as well as the development of ways to in-

crease its resource, are among the priority tasks of manufacturers and operators every year becoming more and more relevant [1].

Failures can be structural, which are due to miscalculations and mistakes made at the design stage of the machine; technological, resulting from a violation of the manufacturing technology of the machine; operational, caused by violation of the rules for the operation of the machine.

As we know, technological methods are divided into methods of volumetric and surface hardening. The methods of volumetric hardening of parts involves carrying out any technological operations, as a result of which the material in all working sections acquires increased antiwear properties [2].

The main reasons for failures of earth-moving machines are overloads, as a result of which the actual stresses arising in the parts of the machine exceed the permissible values (wrong choice of safety margins); destruction of welded joints due to fatigue stresses (incorrect design of welded joints, poor-quality performance); Corrosion-mechanical and abrasive wear of bearings, gear wheels, chain joints, working bodies of the machine, parts of hydraulic equipment (poor choice of materials, anti-corrosion coatings, lubricants, cleanliness class of rubbing surfaces and fit of parts, hardness of the surface layer of parts; design of sealing elements and the like).

A major challenge for wheeled earthmoving machines is extending the life of tires, which cost about 20% of the total cost of running the machine and double the cost of running the engine. At the same time, with an increase in the carrying capacity and dimensions of the machine, the cost of operating tires increases by 40 ... 50%.

A characteristic feature of the tires of many earth-moving machines is heavy loads and relatively low travel speeds (compared to the speeds of transport vehicles). Such tires must have a high abrasion resistance.

The wear of cutting bodies in soils depends on their properties, abrasiveness, density, moisture and chemical activity, as well as the particle size. A certain role in the wear of cutting bodies is played by the load and speed during wear by the physical and mechanical properties of materials and geometric shapes [3].

It is important to improve the reliability of the hydraulic drives of earth-moving machines. It is believed that at a pressure of the working fluid above 30 MPa, the 85% γ -resource of hydraulic pumps should not be less than 5000 hours. To ensure this, it is necessary to use wear-resistant materials, means of reliable sealing of the hydraulic system, and reliable filters.

The typical mode of operation of the gear drives of earthmoving machines is to frequently reverse the machine's travel and shift gears under load. To ensure the service life of gears of 5000 ... 8000 h, high-quality heat treatment and carburizing of the gear teeth, the use of reliable seals in gearboxes is required.

At the design stage, the reliability of the machine is ensured by its rational layout solution, the correct choice of construction materials, the shape and profiles of parts and elements of the metal structure; the use of modern calculation methods when determining loads, strength parameters and service life of parts and assembly units [4].

There are still no generally accepted methods for calculating parts for wear. However, based on practical experience and research into the processes of wear and tear of parts, we can recommend very effective means of hardening machine parts.

For example, molecular-mechanical processes that cause the seizure of metals during friction, tearing of metal particles from the surface of one part and enveloping them onto another, lead to the appearance of scratches and scoring on the working surfaces (seizing). At the same time, as a means of hardening, it is required to increase the surface hardness of the rubbing pairs and create such temperature operating conditions under which the surface hardness does not decrease, as well as to prevent the rubbing pairs from working without lubrication.

And in case of corrosive processes accompanied by mechanical processes (corrosion-mechanical wear), it is necessary to apply a layer of metal of high hardness and weakly oxidized to the working surfaces of the parts. It also requires an increase in the class of surface cleanliness, elimination of uneven residual stresses, especially in a thin near-surface layer.

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FOOD TECHNOLOGY

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REDUCTION OF FREE FATTY ACIDS IN COTTON OIL WITH IMMOBILIZED LIPASE

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ABSTRACT

It has been shown that the use of sorbents based on silica gel, polyamide and fofatidylethanolamine in lipase immobilization promotes an increase in the stability of the enzyme 2-2.5 times and the retention of activity in media with ethanol and acetone. It was found that the content of free fatty acids in cottonseed oil with immobilized lipase can be reduced by 60-70%.

АННОТАЦИЯ

Показано, что использования сорбентов на основе силикагеля, полиамида и фофатидилэтаноламина при иммобилизации липазы способствует повышению стабильности фермента 2-2,5 раза и сохранению активности в средах с этанолом и ацетоном. Установлено, что содержание свободных жирных кислот хлопкового масла с иммобилизованной липазой можно снизить на 60-70%.

Keywords: lipase, fungus, *Rhizopus microspores*, immobilization, stability, use, neutralization, cottonseed oil.**Ключевые слова:** липаза, грибная, *Rhizopus microspores*, иммобилизация, стабильность, применение, нейтразация, хлопковое масло.

Recently, in many countries, the production and use of enzyme preparations in the oil and fat industry has been expanding. Enzymes are used both at the stage of processing oil seeds [1] and at the stage of refining and modification of oils [2].

In the production of vegetable oils, one of the most critical technological processes is oil refining.

Refining combines processes, the main purpose of which is to remove substances from oils, accompanying it, and some foreign impurities. Related substances include substances contained in seeds and passing into oil in a minimally altered state and substances that have changed during extraction under the influence of external factors [3].

Recently, many authors have shown that the use of enzymes is promising for the hydration and neutralization of vegetable oils using various enzymes [4].

Enzymatic hydration of vegetable oils using proteolytic and lipolytic enzymes has been successfully carried out by many researchers [1]. Research is also being conducted on the use of lipolytic enzymes to neutralize free fatty acids in the refining of vegetable oils [5]. The essence of the method lies in the fact that lipase is used to attach free fatty acids to mono- and diglyceride molecules. It is known that lipases in systems with a low water content catalyze the synthesis of glycerol esters with fatty acids and a number of other reactions.

Especially, much attention is paid to the use of immobilized enzymes, since the free lipases used for this process turned out to be less stable and lost activity due to the heterogeneity of the system [6]. Therefore, immobilized enzymes with high catalytic activity and stability are widely used.

The aim of this work is to study the decrease in the content of free fatty acids in cottonseed oil with immobilized lipolytic enzymes on hydrophobic sorbents obtained on the basis of silica gel, polyamide and phosphatidylethanolamine.

Methodology

Reagents. We used a lipase preparation from the fungus *Rhizopus microsporus* (Institute of Microbiology of the Academy of Sciences of the Republic of Uzbekistan), purified according to a previously published method [7].

To prepare buffer solutions, we used one- and two-substituted potassium phosphate (chemically pure "Reakhim"), rhodamine 6Zh (chemically pure "Reakhim"), acetic acid (chemically pure "Reakhim"), rectified alcohol (JSC "Biokimyo") and hexane (reagent grade "Reakhim"), silica gel KSK (reagent grade "Reakhim").

Determination of lipolytic activity. Lipolytic activity was measured by photocolometric method using rhodamine 6G as a chromophore agent [8]. Specific activity was expressed in μmol of fatty acids released in 1 hour per 1 mg of protein.

Refined cottonseed oil emulsified with an equal volume of 1% polyvinyl alcohol was used as a substrate. The reaction mixture with a volume of 2 ml, containing 0.2 ml of the substrate in 0.1 M phosphate buffer, pH 7.5, and 20 mM CaCl_2 , was incubated at 37 $^\circ\text{C}$ in the enzyme solution for 1 h. 0.25 ml of the reaction mixture

was taken and added 1 ml 0.1 M HCl in ethanol to stop the reactions. The rest of the operations were performed according to the method [8].

Synthesis of sorbents for immobilization of lipolytic enzymes. To 100 g of SiO_2 with a particle size of 160-250 μm was poured 10 g of polyamide dissolved in concentrated HCl (200 ml), the mixture was kept under stirring for 1.5-2.0 hours, then 200 ml of 40% aqueous acetone was added ... The supernatant was removed by decantation, and the sorbent was washed with distilled water until neutral pH of the medium. Then the resulting sorbent was activated with 2 n HCl at a temperature of 45 $^\circ\text{C}$ for 1.5-2.0 hours, after which it was washed with distilled water and modified with a 1% solution of glutaric dialdehyde in 0.1 M phosphate buffer pH 8.0 for 2 hours ...

The unbound portion of glutaric dialdehyde was removed by washing with distilled water and 0.1 M phosphate buffer, pH 8.0. Then, a solution of cephalin (phosphatidylethanolamine) with a concentration of 40 mg / ml in a 0.1 M buffer, pH 8.0, containing 50% ethyl alcohol was added to the sorbent. The mixture was kept under constant stirring for 24 h, then washed with ethanol and dried in air.

The immobilization of lipases on such sorbents was carried out by incubating the enzyme solution in 0.1 M phosphate buffer pH 7.4-8.0 with the carrier for 3-5 hours at a temperature of 4-10 $^\circ\text{C}$. The ratio of carrier and enzyme preparation was 10: 0.5. The unbound part of the enzyme was removed by washing with 0.1 M buffer solution pH 8.0 [9].

Hydration of cottonseed oil. 200 g of the test oil was heated to 45-50 $^\circ\text{C}$ with stirring, then the stirrer speed was increased and the specified amount of o was slowly introduced into water and kept stirring for 60 minutes. The total water content was 6% by weight of the oil. Then the temperature of the mixture was raised to 85 $^\circ\text{C}$ and kept at this temperature for 20 minutes. At this temperature, the mixture was stirred for 60 minutes. The hydrated oil was decanted, filtered and dried at a temperature of 100-110 $^\circ\text{C}$.

Treatment of hydrated cottonseed oil with immobilized lipases. 150 g of the test oil, heated to 45-50 $^\circ\text{C}$ with stirring, then the stirrer speed was increased and a predetermined amount of immobilized enzyme, 5% by weight of the oil, was slowly introduced. Then it was kept at this temperature for 12 hours.

Chemical analysis of refined oil was carried out according to the generally accepted method [3].

Results and discussion

The oil extracted from oilseeds is a mixture of free fatty acids (FFA), mono-, di- and triglycerides, phosphatides, pigments, sterols and tocopherols. Traces of metals, flavonoids, tannins and glycolipids may also be present [3,10].

FFA in raw cottonseed oil varies depending on harvesting methods, storage conditions, up to processing in oil and fat factories.

It should be noted that FFAs are more susceptible to oxidation than the glycerol esters of these fatty acids; and this lipid oxidation leads to oxidative rancidity in

edible oils. Therefore, any increase in the acidity of the oil must be absolutely ruled out.

The resulting immobilized lipase from the fungus *Rhizopus microsporus* on a hydrophobic carrier to reduce the acid number of cottonseed oil had a number of advantages over free lipase.

Figure 1 shows the thermal stability of free and immobilized lipase. From the data presented, Fig. 1 shows that after immobilization, the thermal stability of the enzyme increases significantly. For example, when the enzyme was incubated at 50 °C for 40 minutes, the decrease in the activity of the free enzyme was 50%, for the immobilized lipase it was 20%.

Figure 1. Thermal stability of free and mobilized lipase from the fungus *Rh.microsporus* at 50 °C

When obtaining immobilized enzymes, the main goal is not only to increase resistance to high temperatures, but also to reduce the inactivating ability of various denaturing agents, which occurs when the enzyme is used in various technological processes.

It is known that adsorbed lipases on hydrophobized surfaces retain a higher catalytic activity [6]. Lipase activation during adsorption on hydrophobic surfaces is

associated with the provision of optimal orientation of the active site of enzymes in relation to the substrate. It can be assumed that in such systems, when the enzyme is located between the lipid layers (the substrate phase and the hydrophobic cavity of the carrier), due to the protective effect of the substrate, the high catalytic activity and stability of the enzymes are retained.

Figure 2. Effect of ethanol (a) and acetone (b) on the activity of free (1) and immobilized lipase from the fungus *Rh.microsporus* (2)

In fig. 2 shows the effect of ethanol and acetone on the activity of free lipase and immobilized on silica gel

modified with polyamide, cephalin or palmitic acid. It can be seen that the activity of free lipase decreases with

an increase in the concentration of ethanol and acetone in the reaction medium. Free lipase completely lost its catalytic activity in the presence of 30% ethanol, while the decrease in the activity of immobilized lipase was insignificant. The rate of lipid hydrolysis by immobilized lipase increased with an increase in the acetone content in the reaction medium to 25–40 vol. %. In this case, 1.5–1.9 times more free fatty acids were formed than in the absence of acetone (Fig. 2b).

Immobilized lipase was effective in the treatment of cottonseed oil to reduce the content of free fatty acids.

In fig. 3 shows the effect of enzymatic treatment of cottonseed oil on the content of free fatty acids with free and immobilized lipase. The presented data show that the treatment of cottonseed oil with free lipase does not lead to a decrease in FFA (Fig. 3, curve 1).

1- free lipase, 2 = immobilized lipase

Figure 3. Decrease in the acid number of cottonseed oil with free and immobilized lipase

Immobilized lipase is able to carry out the reaction of addition of FFA to mono- and diglyceride molecules with the formation of triglycerides, which leads to a decrease in the acid number of cottonseed oil. In this case, a decrease in the acid number of the oil begins after 90–100 minutes of incubation with immobilized lipases. the content of free fatty acids of cottonseed oil with immobilized lipase decreases the acid number of the oil by 60–70%.

Thus, the data obtained allow us to conclude that by processing cottonseed oil with immobilized lipases, it is possible to carry out the process of neutralizing cottonseed oil. This will lead to a decrease in the acid number of cottonseed oil. In this case, the state of the enzyme plays a significant role. Lipases immobilized on hydrophobic surfaces have higher activity and stability due to better orientation of the active center of the enzyme and substrate.

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CHEMICAL ENGINEERING

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ACTIVE CATALYSTS FOR PRODUCING VINYL ACETATE MONOMERS

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АКТИВНЫЕ КАТАЛИЗАТОРЫ ДЛЯ ПОЛУЧЕНИЯ ВИНИЛАЦЕТАТНЫХ МОНОМЕРОВ

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АННОТАЦИЯ

В статье исследуется влияние γ - Al_2O_3 , высококремнистого цеолита (ЮКЦ), бензонита, керамзита, природы бентонита, пористой структуры, способов приготовления и режимов на активность катализатора, состоящего из ацетата палладия, меди и калия, для парофазный синтез этиленвинилацетата.

ABSTRACT

The article investigates the effect of γ - Al_2O_3 , high-silica zeolite (SCZ), benzonite, expanded clay, the nature of bentonite, porous structure, preparation methods and modes on the activity of a catalyst consisting of palladium, copper and potassium acetate for the vapor-phase synthesis of ethylene vinyl acetate.

Ключевые слова: этилен, уксусная кислота, ацетоксилирование, винилацетат, носитель, селективность.

Keywords: ethylene, acetic acid, acetoxylation, vinyl acetate, carrier, selectivity.

Polyvinyl alcohol, after polyvinyl acetate in size, vinyl acetate is used for the production of paints, coatings and water-soluble packaging.

Polyvinyl acetal directly from polyvinyl acetate plays an important role in the production of a safe intermediate layer of glass, insulation of washed soils, coatings and magnetic wires.

Ethylene vinyl alcohol is the fastest growing application of vinyl acetate due to its use as barrier resins for plastic butyls, food packages, tanks for gasoline and technical polymers.

Ethylene vinyl acetate, which, thanks to the packaging industry, continues to grow continuously on the market, and is also used for the production of vapors and shower shoes. In addition, polyvinyl butyral and ethylene vinyl acetate are produced from vinyl acetyl monomer. Polyvinyl butyral helps produce safety raw materials used in the construction and automotive

industry, and vinyl acetate ethylene is widely used to wipe architectural coatings due to low environmental impact. [1.2]

The tasks of the work are:

- Study of methods of vinyl acetate production;
- Study of physicochemical bases of vinyl acetate production from ethylene and acetic acid by bugphase method;
- Consideration of main features of process raw materials, as well as product requirements
- Specifics of bifunctional catalysts
- Search for catalysts and technologies and patents for their implementation
- Optimize vinyl acetate production process
- Process Flow Diagram Description
- Accounting of material and heat balances of the reactor

Methods of producing vinyl acetate

The first production process, the reaction of acetic acid and acetylene takes place at a temperature of 170-250 in the gas phase. At the same time conversion of acetylene varies from 60% to 70%, the level of selectivity of acetylene and acetic acid is more than 93%.

Reaction of this method:

Table 1 shows the physical properties of each component.

Table 1.

Physical properties

Component	Molecular Formula	Status	Boiling Point	Liquid Temperature
Acetic acid	CH_3COOH	Colorless liquid	117°C	16,6°C
Acetylene	$\text{HC}\equiv\text{CH}$	Acetylene	-	80,8°C

Component Molecular Formula Boiling Point State Liquid Temperature

Acetic acid colorless liquid 117 16.6

Acetylene Colorless gas - 80.8

Ruh acetate is an acceptable reaction catalyst, but two auxiliary materials are widely used: carbon and clay beads. The spirit dominates acetate, so it is found less poisonous, cheap and light. Charcoal is a modern retaining material, but the best in terms of mechanical strength, distribution of trunks in size, surface surface is proposed. These are tubular carbon balls. However, in the world this process is used to a lesser extent for economic reasons. Acetylene as a raw material is much higher. This is generally less economically advantageous than using ethylene instead of acetylene.

Synthesis gas

Synthesis gas is a mixture of carbon monoxide, carbon dioxide and hydrogen. It was produced by converting a carbonaceous fuel into a gaseous product.

This product is capable of producing some kind of heat. As an example of synthesis-gas production, coal waste gasification and coke reforming can be mentioned. In this report, esterification with ketene is considered as an example of a synthesis gas method. Acetaldehyde and acetic anhydride are reagents. EDA (ethylenediamine), which has less thermodynamic advantage. Double reaction, it comes back. The reactions are carried out at a temperature of 800 with the participation of the Brensted acid catalyst, in which case acetaldehyde is a synthesis gas. The physical properties of the components for the synthesis gas method are shown in Table 2.

Reactions of this method:

Table 2.

Physical characteristics of reaction products

Component	Molecular Formula	Ҳолати	Boiling Point State	Liquid Temperature
Acetaldehyde	CH_3CHO	Colorless liquid	20,2°C	-123,37°C
Circus anhydride	$(\text{CH}_3\text{CO})_2\text{O}$	Colorless liquid	139,8°C	-73,1°C
Ethylidene diacetate	$\text{CH}_3\text{CH}(\text{CH}_3\text{CO})_2$	Colorless liquid	167°C	18,9°C
Acetic acid	CH_3COOH	Colorless liquid	118°C	16°C

Ethylidenediacetate is involved in both reactions. Since ethyl diacetate is less volatile than acetaldehyde, acetic acid, circus anhydride and vinyl acetate, heating of ethyl diacetate leads to the isolation of acetaldehyde, acetic acid, acetic anhydride and vinyl acetate. To prevent loss of components due to volatility, pressure is increased at high temperatures. These aldol condensations and oligomerization have led to other similar reactions that result in the formation of impractical resin materials. In addition, compared to the third method proposed, material and household costs were higher, however, commodity prices are beneficial.

Process Catalysts

The catalyst plays a crucial role in the technology. Previously, the catalysts were based on palladium absorbed by alkali metal acetates in an amount of 1 to 5 wt. Modern catalysts are used as enhancers of rare earth metals, mainly gold. A typical Bayer type catalyst at spherical frequencies of silica with a diameter of 5 mm consists of 0.15-1.5 wt% Pd, 0.2-1.5 wt% Au, 4-10 wt% COAC. The reaction takes place very quickly and on a partial surface mainly inside the thin layer.

The normal catalyst life is 1-2 years. Optimum operating conditions are temperature around 150-160 and

pressure from 8 to 10 atm. Heated points above 200 lead to constant activation of the catalyst. The mutual ratio of reactants should provide an excess of ethylene in acetic acid of 2:1 to 3:1. Due to the threat of explosion, the oxygen concentration in the reaction mixture should be delayed by 8% less often than in a mixture containing no acetic acid. The above figures describe structural constraints. In addition, less water in the primary mixture may be required to activate the catalyst. [4]

Due to the strong exothermic effect, it is necessary to maintain this temperature increase in order to cool the reaction mixture with some kind of inert gas. Due to selectivity and heat emission limitations, the reactor is designed for one time, usually with a low conversion for 15-35% acetic acid and 8-10% ethylene.

Analysis of the mechanism of the catalytic chemical reaction reveals the main factors that can affect the reactor consultation. At the beginning of 1970, a large similarity of the reaction mechanism in the gas phase with the liquid phase reaction was demonstrated. In this context, a fairly general concept supporting a liquid phase catalyst is adopted, in which the same reaction mechanism can be used to explain both homogeneous and heterogeneous processes. The class of selective

oxidation reactions is a prime example of the presence of acetoethylation.

Under conventional conditions, the adsorption of acetic acid and water in the catalyst may be noticeable, with sulfuric acid forming about three monolayers. Promoters generally play an important role in metal acetate. For example, potassium acetate gives water and a salt with a liquid temperature of 148. [4]

As a result, the reaction kinetics are not sensitive to acetic acid concentration from the viewpoint of the reactor structure, but some water is needed to activate the catalyst. In contrast, the complex mechanism of adsorption of ethylene and oxygen is involved in the kinetics of the correspondence reaction. This is confirmed by academic and industrial research. [3]

To obtain vinyl acetate, a vapor-gas method of oxidizing ethylene in a solid catalyst (palladium salt in film) is carried out. In this process, the functions of catalysts and promoters are performed by an inert holder. However, it is necessary to add a business metal cation. The catalyst for the process is palladium acetate formed by reacting palladium with acetic acid.

The reaction mechanism is described in Figure 1.

Figure 1. Reaction mechanism

Due to the dispersion of palladium on the surface of the retainer, direct contact of oxygen with the palladium atom occurs.

In order to develop an active and selective catalyst for the synthesis of BA from ethylene and acetic acid, to control the catalytic properties of the introduced components, the influence of the amount and ratio of individual catalyst components was investigated.

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MATHEMATICAL MODEL OF THE EFFICIENCY OF THE CATALYST IN THE SYNTHESIS OF VINYL ACETATE

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МАТЕМАТИЧЕСКАЯ МОДЕЛЬ ЭФФЕКТИВНОСТИ КАТАЛИЗАТОРА В СИНТЕЗЕ ВИНИЛАЦЕТАТА

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АННОТАЦИЯ

Изучены кинетические законы и кинетика и механизм реакции этилена в паровой фазе. Установлено, что общая скорость реакции пропорциональна размеру неинформированных и модифицированных активных центров палладия (а не кластеров). Доказано, что избыточное количество модификатора (как ацетат калия, так и мис) может снижать эффективность катализатора и блокировать активные центры.

ABSTRACT

The kinetic laws and kinetics and mechanism of the vapor phase reaction of ethylene have been studied differently. It was found that the total rate of the reaction was proportional to the amount of unmodified and modified active centers of palladium (not clusters). Excess amounts of the modifier (both potassium acetate and copper) have been shown to block active sites by reducing catalyst efficiency.

Ключевые слова: этилен, кислород, уксусная кислота, винилацетат, кинетическое уравнение, механизм.

Keywords: ethylene, oxygen, acetic acid, vinyl acetate, kinetic equation, mechanism

Production of vinyl acetate in heterogeneous catalysts began in Germany in the late 1930s, a method that has not lost its relevance today: the reaction is carried out in a catalytic system of zinc acetate in a temperature range of 160-240 °C and a carrier $Zn(OAc)_2$ (activated carbon) at a pressure close to atmospheric pressure, is carried out [1-2-3]. To reduce the yield of ethylidendiacetate, the reaction is carried out in excess acetylene (ratio of acetylene to acetic acid = 4-10: 1) and the process is carried out either in tubular reactors, or in fake dilute layer reactors of the catalyst.

The volumetric load is 100-500 h⁻¹, the conversion of acetic acid is about 50%, the yield of vinyl acetate is 40-80 kg/m³ per hour. Due to the accumulation of polymer and resin on the zinc acetate catalyst, it loses its activity over time, forcing the process temperature to gradually increase from 160-180 °C to 220-240 °C [4-5-6-7].

Mathematical model of catalyst efficiency.

In order to create a general mathematical model showing the dependence of the efficiency of the catalyst on its composition, we present the experimental dependencies in Table 1[8-9-10].

Table 1.

Conditions for conducting a series of experiments and the mathematical models obtained in them

Test Series Number	Number of components in catalyst (%)			W (vinyl acetate), mol/hr	W (CO ₂), mol/hr
	Pd	CH ₃ COOK	Cu		
I	0,3-3,0	0	0	$(0,35 \cdot [\text{Pd}]) / (1 + 0,05[\text{Pd}]^4)$	$(0,08 \cdot [\text{Pd}]) / (1 + 0,065[\text{Pd}]^3)$
II	0,2	2,0-20,0	0	$(0,1 \cdot (1 + [\text{CH}_3\text{COOK}])) / (1,0 + 0,013 \cdot [\text{CH}_3\text{COOK}]^2)$	$0,04 + 0,0043 \cdot [\text{CH}_3\text{COOK}]$
III	0,15	5	0,05-3,0	$\frac{0,24 + 0,47 \cdot [\text{Au}]}{1 + 1,75[\text{Au}]}$	$0,075 + 0,018 \cdot [\text{Au}]$

The total rate of reaction is proportional to the amount of unmodified and modified active centers of palladium (not clusters). Excess amounts of the modifier (both potassium acetate and copper) block the active sites, reducing the efficiency of the catalyst. The physical meaning of the partial mathematical models obtained here consists of fractional-linear functions. The difference in the equations of the rates of formation of vinyl acetate and CO₂ indicates that these reactions occur at different active sites of the catalyst.

Taking into account the above considerations, we have the following functional dependencies:

$$W_{\text{BA}} = [\text{Pd}] \cdot (C_1 + C_2[\text{CH}_3\text{COOK}] + C_3[\text{Cu}]) / (1 + C_4[\text{Pd}]^4 + C_5[\text{CH}_3\text{COOK}]^2 + C_6[\text{Cu}])$$

$$W_{\text{CO}_2} = [\text{Pd}] \cdot (C_1' + C_2'[\text{CH}_3\text{COOK}] + C_3'[\text{Cu}]) / (1 + C_4'[\text{Pd}]^4)$$

The numerical values of the coefficients C₁-C₆ and C₁'-C₄' were obtained by comparing the data of the equations with the partial model of the reaction rates obtained earlier and using a number of regression methods. Thus, the generalized mathematical models of catalyst activity, which are defined as the rates of reactions for the formation of vinyl acetate and CO₂, are as follows:

$$W_{\text{BA}} = ([\text{Pd}] \cdot (0,35 + 0,38[\text{CH}_3\text{COOK}] + 4,2[\text{Cu}])) / ((1 + 0,05(1 + 80[\text{Pd}]^4 + 0,01[\text{CH}_3\text{COOK}]^2 + 1,1[\text{Cu}])))$$

$$W_{\text{CO}_2} = ([\text{Pd}] \cdot (0,09 + 0,0244[\text{CH}_3\text{COOK}] + 0,1[\text{Cu}])) / ((1 + 0,07(1 + 20[\text{Pd}]^4)))$$

Among all the experiments, the rates of the formation of vinyl acetate and the values calculated by mathematical models are well matched.

The correlation between the experimental and calculated values for the rates of carbon dioxide formation is two parallel straight lines - for a series of experiments on the effect of [Cu] (curve 1 to the right of Fig. 1). and [Pd] for a series of experiments on the effect of quantity (curve 2 to the right of Fig. 1). The significant increase in the experimental values of the W_{CO₂} velocities for a series of reactions to study the effects of copper is explained by the use of the above-mentioned reason - the use of catalyst samples prepared in violation of the technology. Thus, the velocities of W_{CO₂} differ from those calculated from the experimental values by a constant magnitude, indicating that additional reactions of ethylene combustion occur in the holder rather than in the active palladium centers. The latter value used mathematical models to optimize the catalyst composition in order to find the most efficient samples.[11-12-13]

Figure 1. Correlation between experimental and calculated values of reaction rates

Using mathematical models of the dependence of catalyst activity on the components stored in it (Pd, CH₃COOK and Cu), we determined their optimal composition to achieve both high rates and selectivity of vinylacetate formation: 0.4% Rd + 4% Cu + 7% CH₃COOK / VKTs.[3-4-5-7]

Effect of steam-gas mixture volume rate on vinyl acetate yield. BGA volumetric velocity range: 2000 to 10000 h⁻¹ in the middle zone of the reactor at a temperature of 165°C, a pressure of 4 atm, a ratio of

ethylene to acetic acid 4: 1 and an oxygen content of 7%. The results of the experiments are presented in Table 2.

The dependence of the reagent conversion on the time the reaction mass remains in the reactor is linear, indicating that the reaction rate is constant during this time due to the insignificant value of the reagent conversion. This is confirmed by maintaining the linearity of the time dependence of vinyl acetate output and CO₂ formation.[11-12]

Table 2.

The effect of the volumetric velocity of a vapor-gas mixture on the yield of vinyl acetate

Reaction time, hour	Eat vinyl acetate, gr mol	Education CO ₂ gr mol	Selectivity and conversion (CH ₃ COOH) (C ₂ H ₄)
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Volumetric speed ПГС=2000 hour⁻¹

8	280	3,26	31,17	0,708	0,902 (26,5) (7,36)
16	568	6,61	63,19	1,436	
24	872	10,14	96,95	2,203	
32	1152	13,39	128,02	2,909	
40	1416	16,46	157,37	3,576	
48	1672	19,44	185,86	4,224	

Volumetric speed ПГС=4000 hour⁻¹

8	299,2	3,48	32,52	0,739	0,904(12,04) (3,33)
16	619,2	7,20	67,28	1,529	
24	923,2	10,73	100,27	2,279	
32	1211,2	14,08	131,58	2,991	
40	1504,2	17,53	163,82	3,723	
48	1795,2	20,87	195,03	4,433	

Volumetric speed ПГС=6000 hour⁻¹

8	304	3,53	22,66	0,515	0,932(8,76) (2,35)
16	624	7,20	46,23	1,051	
24	936	10,88	69,86	1,588	
32	1232	14,33	92,007	2,091	
40	1520	17,67	113,45	2,578	
48	1816	21,12	135,61	3,082	

Volumetric speed ПГС=7500 hour⁻¹

8	328	3,81	21,41	0,486	0,94 (7,07) (1,88)
16	672	7,81	43,87	0,997	
24	1000	11,63	65,33	1,485	
32	1312	15,26	85,72	1,980	
40	1632	18,98	106,62	2,423	
48	1960	22,79	128,01	2,909	

Conclusion

The process of obtaining ethylene by catalytic oxidation in the vapor phase to obtain vinyl acetate was studied in detail in a catalyst of the order 0.4% Rd + 4% Cu + 7% CH₃COOK / VKTs. The overall rate of the reaction was found to be proportional to the amount of unmodified and modified active centers of palladium (not clusters). Excessive amounts of the modifier (both

potassium acetate and copper) have been shown to reduce the efficiency of the catalyst and block the active sites. The study selected the following optimal conditions for the reaction: in the middle zone of the reactor at a temperature of 165°C volumetric speed - 2000 h⁻¹, 4 atm, the ratio of ethylene to acetic acid is 4: 1 and the oxygen content is 7%. A mechanism for the formation of vinyl acetate from ethylene and acetic acid in the presence of a palladium catalyst has been proposed.

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ANALYSIS OF NI (II) ION AND DIMETHYLGLOXIME COMPLEX IN USED ADSORBENT

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АНАЛИЗ ИОНА NI (II) И ДИМЕТИЛГЛИОКСИМНОГО КОМПЛЕКСА
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ABSTRACT

This paper presents the results of the analysis of the complex of nickel (II) ion with dimethylglyoxime from the adsorbent composition used in the purification of MDEA. The spectral characteristics of the complex on the SF 46 spectrophotometer, the determination of the composition of the complex using the method of isomolar series, the determination of the actual molar extinction coefficient of the complex and the equilibrium constant by Tolmachyov's graphical method are presented on the basis of tables.

АННОТАЦИЯ

В данной работе представлены результаты анализа комплекса иона никеля (II) с диметилглиоксимом из состава адсорбента, используемого при очистке МДЭА. Спектральные характеристики комплекса на спектрофотометре СФ 46, определение состава комплекса методом изомольных рядов, определение фактического коэффициента молярной экстинкции комплекса и константы равновесия графическим методом Толмачева представлены на графике. основа таблиц.

Keywords: used adsorbent, Ni (II) ion, dimethylglyoxime reagent, sandel sensitivity, quenching coefficient, Tolmachyev graph, pH, buffer solution.

Ключевые слова: использованный адсорбент, ион Ni (II), диметилглиоксимовый реагент, чувствительность по Санделу, коэффициент тушения, график Толмачева, pH, буферный раствор.

Currently, the production has a significant negative impact on the environment due to the toxic content of the adsorbents used as waste in industrial zones. The methods of analysis of the isolated complex of toxic Ni (II) ion formed with dimethylglyoxime in the adsorbent used in this paper are described [4]. Absolute loss of this ion from the adsorbent was achieved, and the spectral characteristics of the complex, the method of isomolar series of the composition of the complex, the equilibrium constant were studied [3].

Spectral description

Light absorption spectra were obtained under selected optimal conditions of the complex formed with dimethylglyoxime reagent and Ni (II).

Process: 2.6 ml of aqueous solution of 0.01% dimethylglyoxime reagent and 5.0 ml of buffer with pH = 8.0 in a 25 ml volumetric flask, 3.5 ml of a solution of Ni (II) of 30.0 µg / ml. from the solution and diluted with distilled water to the mark of the flask. The absorption spectrum of the resulting complex was measured in a

quartz cuvette with a light absorption thickness of $l = 1.0$ cm relative to the reference solution, with a spectrophotometer SF-46. The absorption spectrum of the reagent was obtained with respect to distilled water. The results showed that the maximum absorption area of dimethylglyoxime reagent complex with Ni (II) was located at $\lambda_{\text{comp}} = 550$ nm, the maximum light absorption area of dimethylglyoxime reagent was observed in the region of shorter spectral waves, $\lambda_{\text{reagent}} = 470$ nm.

Using the value of the maximum optical density of the complex compound (in the area $l = 550$ nm), the apparent molar extinction coefficient (E_{off}) [1] was determined by the following formula:

$$E_{\text{off}} = \frac{A}{c} \cdot l \quad (1)$$

The spectral characteristics of the complex and the reagent are given in Table 1. The Sendel sensitivity of the method is 0.001 mcg / cm². The light absorption is calculated by the following formula [2]:

$$S.b.s = \frac{Q \cdot L \cdot 0.0001}{A \cdot 25} \quad (2)$$

Table 1.

Results of the study of the composition of a complex compound using the method of isomolar series
($C_{\text{Ni}^{2+}} = 30$ mkg/ml $C_{\text{HR}} = 2,0446 \cdot 10^{-5}$ M, $l = 1,0$ sm, $n = 3$)

Color of complex	pH	C_{MeR} , nm	C_{HR} , nm	$\Delta\lambda$	$C_{\text{Ni}^{2+}}$, mkg	$C_{\text{Ni}^{2+}}$, Mol/l	$\bar{A}$	Sendel sensitivity Mkg / sm ²
Red-pink	8.0	550	480	70	30	$2.0446 \cdot 10^{-5}$	0.435	0,0027586mkg/sm ²

$$S.b.s. = Q \cdot l \cdot 0,001 / A \cdot 25 = 30,0 \cdot 1,0 \cdot 0,0010,435 \cdot 25,0 = 0,0027586 \text{ mkg/sm}^2$$

The results show that the reaction has a high contrast (at $l_{\text{comp}} = 550$ nm) and sensitivity ($S.b.s. = 0.0027586$).

Determination of the proportion of constituent moles of the complex formed by nickel (II) with dimethylglyoxime reagent. Determination of complex composition using the method of isomolar series.

The molar ratios of the components in the complex formed by nickel (II) with the dimethylglyoxime reagent were determined by the isomolar series method. Equilibrium solutions of nickel (II) and dimethylglyoxime reagents were used to determine the ratio of moles in the complex formed by nickel (II) with dimethylglyoxime

reagent by the method of isomolar series:
 $C_{\text{Ni}^{2+}} = C_{\text{HR}} = 2,0446 \cdot 10^{-5}$ mol/l

Process: A series of solutions were prepared in 25 ml volumetric flasks. To do this, add to each of a variable amount of nickel (II) solution (up to 9.0-1.0 ml) and add a variable amount of dimethylglyoxime reagent solution (up to 1.0 ml-9.0 ml). and 5.0 ml of a universal buffer solution with a pH of 8 were diluted and mixed with distilled water to the mark of the tube.

The optical density of the prepared solutions was measured at KFK-2 at a light filter at 550nm and relative to the reference solution in cuvettes with a light absorption thickness of $l = 1.0$ cm. The results obtained are given in Table 2.

Table 2.

Results of the study of the composition of a complex compound using the method of isomolar series

№	Obtained Ni(II), ml	Obtained V _{HR} , ml	Buffer solution	$\bar{A}$
1.	9.5	1.5	5.0	0.007
2.	8.5	2.5	5.0	0.08
3.	7.5	3.5	5.0	0.165
4.	6.5	4.5	5.0	0.30
5.	5.5	5.5	5.0	0.34
6.	4.5	6.5	5.0	0.39
7.	3.5	7.5	5.0	0.45
8.	2.5	7.0	5.0	0.50
9.	2.0	8.0	5.0	0.43
10.	1.0	9.0	5.0	0.33

It can be seen from this table that the composition of the complex formed by the dimethylglyoxime reagent with Nickel (II) corresponded to the molar ratio of Ni: R = 1: 2.

Determination of the real molar extinction coefficient and equilibrium constant of the complex of nickel (II) with dimethylglyoxime reagent by Tolmachev's graphical method

For a more detailed study of the complex formation reaction of nickel (II) in the dimethylglyoxime reagent and the adsorbent used, the equilibrium constant of the complex formation was determined by Tolmachev's graphical method. All the above results (Ni: R = 1: 2) were taken into account when working with this method. The reaction equation for Ni (II) with dimethylglyoxime reagent can be described as follows.

Process: A 25-ml volumetric flask was filled with a stoichiometrically reactive reagent and nickel (II) solution and a 5.0 ml buffer mixture with a pH of 8.0 and diluted to the mark with distilled water. The optical density was measured at KFK-2 at 6 nf, relative to the specific solution in cuvettes with a light absorption thickness of $l = 1.0$ cm. The results are presented in Table 3.

Table 3.

Results of determination of real molar extinction coefficient and equilibrium constant of the complex by Tolmachev's graphical method

№	V _{Ni2+, мл}	V _{HR, мл}	C _{Ni 2+ · 10⁻⁵}	Ä	$\sqrt{\text{Ä}}$	$\sqrt[3]{\text{Ä}}$	E	1/ε
1.	0.25	0.5	0.075	0.774	3.649	1.022	7338.5	1.36
2.	0.50	1.5	0.100	0.316	3.164	2.044	4892.36	2.04
3.	0.75	2.5	0.128	0.358	2.793	3.066	4174.48	2.40
4.	1.00	3.5	0.157	0.394	2.538	4.088	3791.58	2.64
5.	1.25	4.5	0.160	0.400	2.590	5.11	2622.95	3.13
6.	1.50	5.5	0.180	0.424	2.350	6.13	2517.48	3.40

Tolmachev's graphical formula for the real molar extinction coefficient and equilibrium constant of a complex [2]:

$$[1/\varepsilon = f(1/\sqrt{A})] \quad (3)$$

The following formulas were used in the calculations:

$$\varepsilon_{\text{real}} = 1/1/\varepsilon \cdot 10^{-n} = 1/0,136 \cdot 10^{-4} = 7,52 \cdot 10^{-4} \quad (4)$$

$\varepsilon_{\text{real}}$ - real molar extinction coefficient of the complex;

Compared to the calculated numerical values, the developed method showed a much higher sensitivity, and the complex compound had an average stability.

According to the results obtained, the solution of dimethylglyoxime, used as a reagent in the complete complex precipitation of nickel ions in the adsorbent used, gave good results. According to the spectral characteristics of this complex, the absorption spectrum was measured in a quartz cuvette with a light absorption thickness $l = 1.0$ cm relative to the reference solution, with a spectrophotometer SF-46.

The absorption spectrum of the reagent was obtained with respect to distilled water. The results showed that the maximum absorption area of dimethylglyoxime reagent complex with Ni (II) was located at $\lambda_{\text{comp}} = 550$ nm, the maximum light absorption area of dimethylglyoxime reagent was observed in the region of shorter spectral waves, $\lambda_{\text{reagent}} = 470$ nm, real molar extinction coefficient of the complex is $7,52 \cdot 10^{-4}$.

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ELECTRONICS

DEVELOPMENT OF A PULSE OXIMETER MEASURING BLOOD OXYGEN
AND HEART RATE WITH DATA DISPLAY ON LCD DISPLAY*Irina Baymuratova**Master's student**Tashkent State Technical University named after Islam Karimov
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Uzbekistan, Tashkent**E-mail: xerson2681@gmail.com*РАЗРАБОТКА ПУЛЬСОКСИМЕТРА, ИЗМЕРЯЮЩЕГО СОДЕРЖАНИЕ КИСЛОРОДА
В КРОВИ И ЧАСТОТУ СЕРДЕЧНЫХ СОКРАЩЕНИЙ С ОТОБРАЖЕНИЕМ
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ABSTRACT

The article provides data on the developments that are underway in Uzbekistan for the production of a pulse oximeter device corresponding to local climatic conditions, describes its characteristics and methods of use, electrical circuits, as well as measured parameters.

АННОТАЦИЯ

В статье приводятся данные, о разработках, которые ведутся в Узбекистане по выпуску устройства пульсоксиметр, соответствующего местным климатическим условиям, описывается его характеристики и способы пользования, электрические схемы, а также измеряемые параметры.

Keywords: TIDA-010029, climatic conditions, PPG probe, switching circuit and LED driver, AFE4420 chip.

Ключевые слова: TIDA-010029, климатические условия, пробник PPG, схема переключения и драйвера светодиода, AFE4420 чип.

Life is the most expensive and valuable currency that any state can be proud of. And the health of its people is an integral part of the well-being of any nation.

On the medical equipment market in Uzbekistan, you can currently see many devices designed to measure the level of oxygen in the blood and monitor oxygen saturation of the whole body.

But all companies that provide this equipment do not take into account the specifics of the climatic zone of this state.

Due to the fact that according to international statistics in Uzbekistan during the summer months the temperature in some areas reaches + 40- + 50 degrees, the devices may fail, and the case may heat up and malfunction, at the Islam Karimov Technical State University a special case for the pulse oximeter is being developed, which will correspond to the climatic conditions of this state.

The elements of the TIDA-010029 project (Fig. 1) by Texas Instruments are taken as a basis, which implements many types and types of pulse sensors measuring

the oxygen content in the blood with various functionalities.

Figure 1. TIDA-010029 - development of a wireless non-contact pulse oximeter with BLE interface

The AFE4420 chip is the main hardware part. The wireless interface of the handheld sensor is one of the most preferred option for the end user, this feature allows the user to monitor the sensor readings in real time and monitor the readings.

This is a single-chip photoplethysmography (PPG) measurement device. The 16 different light-corrected measurement combinations are possible with the AFE4420, as the AFE4420 supports up to four LEDs and photodiodes. CC2640R2F is a crystal-based system that wirelessly transmits measured data for further processing. This type of device is powered by a CR3032 battery.

On the example of this company, research is underway to increase the number of LEDs and photodiodes to six, which will allow up to 64 different combinations with backlight correction.

In this structure, the dominant parameter is the correct placement and connection of photodiodes and LEDs on the microcircuit.

Having considered the two main connections of more than one LED and a photodiode, you can make the correct connection-series, in such an aspect as the main parameter of the LED is its operating current, which determines the power of the LED (Fig.2).

Figure 2. Series connection of LEDs

Exceeding the parameters of the maximum current can lead to burnout of the LED, since the temperature of the crystal will be maximized, which will lead to overheating.

Therefore, the problem in these studies is the development of a microcircuit that will correspond in power

to a given number of LEDs and photodiodes. At the same time, it should be compact, since the pulse oximeter should be as compact as possible and should be easy to handle.

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INVESTIGATION OF SCHOTTKY DIODES BASED ON GALLIUM NITRIDE

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ИССЛЕДОВАНИЕ ДИОДОВ ШОТТКИ НА ОСНОВЕ НИТРИДА ГАЛЛИЯ

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ABSTRACT

The influence of the type of metallization and the technology of creating a contact system on the current-voltage characteristics of Schottky diodes made on the basis of epitaxial layers of gallium nitride is studied. The forward voltage drop on the diode reaches 2.5 V at a forward current density of 50 A / cm², the leakage current density does not exceed 10-2 A/cm² at a reverse voltage of 200 V.

АННОТАЦИЯ

Исследовано влияние вида металлизации и технологии создания контактной системы на вольт-амперные характеристики диодов Шоттки, изготовленных на основе эпитаксиальных слоев нитрида галлия. Прямое падение напряжения на диоде достигает 2,5 В при плотности прямого тока 50 А/см², плотность тока утечки не превышает 10–2 А/см² при обратном напряжении 200 В.

Keywords: gallium nitride, Schottky diode, ohmic contact, specific contact resistance, forward voltage drop, current density.

Ключевые слова: нитрид галлия, диод Шоттки, омический контакт, удельное контактное сопротивление, прямое падение напряжения, плотность тока.

Recently, much attention has been paid to the wide-band semiconductors gallium nitride (GaN), silicon carbide (SiC) and diamond as promising materials for creating efficient devices for power and high-temperature electronics. The technology of devices based on gallium nitride is developing most intensively, thanks to its use for the production of LEDs. At the same time, this semiconductor is also attractive for use in power electronics due to its sufficient speed and high breakdown voltage. To date, several types of diodes have been developed, which differ fundamentally in the structure and geometry of the contact arrangement. In particular, Schottky diodes with horizontal and vertical geometry of regions and contacts are intensively studied [1]. Diodes with a vertical structure are characterized by large forward currents, but so far they are characterized by low breakdown voltages and large leakage currents compared to

diodes with a horizontal configuration. This is due to the insufficient quality of GAN substrates containing a sufficiently large number of defects for this technology and the design of diodes.

The aim of this work is to develop and study horizontal Schottky diodes based on epitaxial layers of gallium nitride. In this paper, possible variants of the formation of ohmic contacts are considered, and the forward and reverse current-voltage characteristics are investigated.

The Schottky diodes under study were made on the basis of epitaxial layers of gallium nitride grown on sapphire substrates. An active layer of n-type gallium nitride with a thickness of 2.5 microns was added to the initial sapphire substrate with a high-resistance buffer layer of gallium nitride with a thickness of 1.5 microns (the so-

called template substrate) by chemical deposition from the gas phase using organometallic compounds.

The technological process of manufacturing diodes consisted of four stages, including ion-beam etching of the mesastructure, the creation of ohmic contact with the active layer, the formation of a Schottky barrier at the border with the n-layer, passivation and protection of the crystal surface with a dielectric film. Ion-beam etching with Ar^+ ions was used to form mesa insulation. Titanium obtained by magnetron sputtering was used as a mask. The etching rate of gallium nitride with this method is about 6 nm / min, and the selectivity with respect to the mask is 6:1.

Two methods were used to create low-resistance ohmic contacts. The first is a local increase in the doping level by ion implantation of the impurity in gallium nitride [2]. Silicon ion doping was performed at the Vesuvius-1 facility with an energy of 50 keV and a dose of 10^{15} cm^{-2} . In order to eliminate the effect of ion channeling, doping was carried out at a sample tilt of 7° . The impurity was activated by annealing in a nitrogen atmosphere at 900°C for an hour. Under such doping conditions, a profile with a maximum concentration of $2 \cdot 10^{17} \text{ cm}^{-3}$ was obtained at a depth of 0.2 microns. Then the contacts were formed on the basis of the Ti/Al/Ni/Au metallization system.

The second method is based on the introduction of a tantalum layer into the traditionally used metallization system [3]. Using a tantalum layer allows you to improve the quality of the ohmic contact formed to the high-resistance layer of gallium nitride [4]. The contacts

in both cases were made using contact "explosive" photolithography followed by annealing in a nitrogen atmosphere. Schottky contacts with an area of $9 \cdot 10^{-4} \text{ cm}^2$ were formed on the basis of a Ni/Au system with a thickness of 20 nm and 150 nm, respectively. At the final stage, the crystal surface was passivated with a film SiO_2 obtained by plasma chemical deposition. In the course of the work, experimental samples of diode crystals with a size of 600×600 microns were made and studied. The measurements were carried out on a semi-automatic probe station Cascade Microtech 12000S. The Agilent B1500A semiconductor device performance meter was used to monitor the DC parameters.

The quality of three different variants of ohmic contacts was evaluated. First of all, traditional metallization based on the Ti/Al/Ni/Au system, formed on a high-resistance layer of gallium nitride, was used. In another variant, the same system was used, but with additional sub-editing of the contact areas. In the third option a tantalum sublayer was applied, resulting in five layers of Ta/Ti/Al/Ni/Au. The current-voltage characteristics of the listed contact systems are shown in Fig.1. As can be seen from Figure 1, the Ta/Ti/Al/Ni/Au metallization system has the lowest resistance. The contact resistance was estimated using the Transmission Length Method. The result is the following values of the specific contact resistance: Ti/Al/Ni/Au system (without sub — alloying) — $9.9 \cdot 10^{-3} \text{ Ohm} \cdot \text{cm}^2$; Ti/Al/Ni/Au (with sub — alloying) — $4.5 \cdot 10^{-6} \text{ Ohm} \cdot \text{cm}^2$; Ta/Ti/Al/Ni/Au — $1.6 \cdot 10^{-6} \text{ Ohm} \cdot \text{cm}^2$.

Figure 1. Current-voltage characteristics of ohmic contacts of Ta/Ti/Al/Ni/Au (a) and Ti/Al/Ni/Au (b) metallization systems

The results obtained demonstrate the prospects of using metallization with the addition of tantalum, as well as the technology of sub-alloying. The higher value of the specific contact resistance of metallization with sub-alloying is explained by an insufficient increase in the

level of doping of the active layer due to incomplete activation of the impurity. The current-voltage characteristics of the instrument structures are shown in Fig. 2 and 3.

Figure 2. Direct current-voltage characteristic of the studied diode structures

As can be seen from Fig. 2, the forward voltage drop of a structure with ohmic contacts based on Ta/Ti/Al/Ni/Au metallization is noticeably lower than

that of other structures. This is due to the lower value of the contact resistance of the ohmic contacts.

Figure 3. Inverse current-voltage characteristic of the studied diode structures

The inverse current-voltage characteristics do not have such a strong difference, since they are determined by the quality of the Schottky barrier, which was formed for all structures simultaneously. All structures have a breakdown voltage of about 700 V.

The characteristics of Schottky diodes based on epitaxial layers of gallium nitride with horizontal contacts are studied. Three possible variants of forming ohmic contacts for improving the direct characteristics of diode

structures are considered. A tantalum-based metallization system is obtained, which makes it possible to obtain low-resistance ohmic contacts. The technology of ion doping of the sub-contact areas to reduce the contact resistance was tested. The diode structures are obtained and their current-voltage characteristics are investigated, the forward voltage drop reaches 2.5 V at a current density of 50 A / cm², the leakage current density does not exceed 10⁻² A/cm² at a reverse voltage of 200 V.

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