



**PROBLEMS AND PROSPECTS
IN THE INTERNATIONAL TRANSFER
OF INNOVATIVE TECHNOLOGIES**

**Collection of articles
based on the results of
International scientific and practical conference
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The scientific publication is intended for doctors and candidates of sciences of various specialties, university teachers, doctoral students, graduate students, undergraduates, practicing specialists, students of educational institutions, as well as everyone who shows interest in the issues under consideration for the purpose of using them in scientific work, pedagogical and educational activities.

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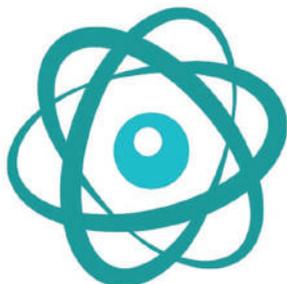
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**ФИЗИКО-
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НАУКИ**



**PHYSICS AND
MATHEMATICS**

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STUDY OF THE EFFECT OF CYCLIC CHANGES IN THE STRESS - STRAIN STATE IN UGS RESERVOIRS ON THE CHARACTERISTICS OF ROCKS**Annotation**

The article describes the researches devoted to the modeling of physical processes in reservoir rocks of underground gas storages (UGS) and the study of rock characteristics under cyclic changes of the stress - strain state in the reservoir. The conclusion about the importance of taking into account changes in reservoir pressure during the operation of UGS facilities in the analysis of the stress - strain state of the reservoir is made.

Keywords

Stress - strain state, physical properties of rocks, reservoir pressure, underground gas storage, permeability.

The system of underground gas storages makes it possible to securely supply territories with natural gas regardless of seasons, temperature fluctuations and emergencies. Today, most UGS facilities are created either in depleted gas, gas - oil or gas - condensate fields or in water - bearing formations, where gas injected into the pore environment displaces the water present in the formation. Gas storages are less common in salt deposits as well as in mine workings of hard coal and other mineral deposits. However, with any design of UGS facilities, their safe and effective functioning requires constant monitoring, as well as maintaining the correct mode of operation [1].

A distinctive feature of underground gas storages in depleted fields as compared with operating hydrocarbon fields is the periodicity of gas injection / extraction cycles, which results in periodic changes of pressure in the well and reservoir. High porosity and permeability of reservoirs are necessary conditions for creation of UGS facilities on the basis of depleted fields. Rocks of such reservoirs, as a rule, have low durability. At the same time, in spite of small values of operational depressions and repressions (up to 20 atm), filtration speeds and, accordingly, mass forces acting on the reservoir rock are very high. On the one hand, at most UGSFs gas injection and withdrawal should be done very quickly, on the other hand, there are great risks of wellbore damage due to changes in the stress - strain state in its vicinity. There is also a problem of sand carry - over, which destroys the well itself and the production equipment.

In the opinion of the authors [2], rock particles movement caused by redistribution of stresses in the rock and gas flow forces leads to a change and redistribution of permeability, increases the heterogeneity of the reservoir. The change of stresses in the reservoir rocks during cyclic operations on the well may also directly affect the change in pore space and rock permeability. The study [3] examines the reduction of capacitive - filtration properties of sand and silty rocks as a result of changes in their porosity during prolonged operation of underground gas storages. The work shows that cyclic loading and unloading during long - term operation of underground gas storages can significantly reduce the capacity and filtration parameters of reservoirs created in depleted gas condensate fields. Tests carried out on sands, under conditions close to operational ones, have

shown that during cyclically changing effective pressure their permeability is gradually decreasing. However, if the magnitude of change in pore pressure during injection / recovery cycles is small, structural changes and irreversible decreases in porosity and permeability were not observed, and deformation remained elastic during testing. This points to the need for proper selection of UGS operation mode, in particular the regulation of the depressions and repressions created in the well.

The study [4] confirms the impact of cyclic operation of UGS wells, especially the changing effective stresses when changing pressure in the reservoir, on the strength and permeability of rocks. Separately, a conclusion is made about the necessity of correct choice of the duration of injection / extraction cycles, since increasing the time of effective stresses in the rock led to a decrease in strength and permeability, as well as contributed to the migration of fine particles.

Thus, the change in the stress - strain state in UGS reservoirs associated with cyclic changes in reservoir pressure during the operation of facilities has a significant impact on the physical characteristics of reservoir rocks. This effect should be taken into account when modeling the processes taking place in UGSF reservoirs.

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PHYSICAL MODELING OF THE STRESS - STRAIN STATE ARISING IN THE VICINITY OF WELLS DURING DOWNHOLE PRESSURE LOWERING USING A TRUE TRIAXIAL LOADING UNIT

Annotation

This paper describes a method for modeling on the true triaxial unit the conditions occurring in the rock in the vicinity of a horizontal well during uniform all - round initial compression of rocks

in the formation to determine the effect of the stress state on the strain, filtration, and rheological characteristics of rocks during downhole pressure lowering. A brief description of the Triaxial Independent Load Test System (TILTS), a unique apparatus created at the Institute for Problems in Mechanics of the Russian Academy of Sciences, is presented.

Keywords

Physical properties of rocks, filtration, stress - state, true triaxial tests, physical modeling.

To develop optimal drilling, development and operation modes, it is important to know how stresses in the rock affect the permeability of the payzone, and what pressures must be maintained at the bottomhole to prevent negative deformational processes in the formation. This article describes a way to simulate, on the TILTS apparatus, the conditions arising in the rock in the vicinity of a horizontal well during uniform all - round initial compression of rocks in the formation, in order to determine the effect of stress state on the filtration, deformational permeability of rocks when the pressure at the bottomhole is lowered.

The Triaxial Independent Load Test System (TILTS) allows to realize any trajectory of loading (deformation) of the sample, including the fracture process. This is a unique scientific installation created in the Institute for Problems in Mechanics of the Russian Academy of Sciences and intended for studying deformation, strength and filtration characteristics of rocks of oil - and - gas, ore and coal deposits. Its distinctive feature is the possibility to load rock samples, which are cubes with faces of 40 or 50 mm, independently along three axes [1]. This makes it possible to recreate in the course of experiments any stress states arising in the formation during drilling, well development and operation, and to study the effect of stresses on the filtration properties of the rock.

The stresses that act in the vicinity of the open borehole are determined by the known solution of the Lamé problem for a cylindrical cavity under the action of all - round compression by external pressure and internal pressure of the fluid filling it [2].

Below is a sample loading program corresponding to the stresses acting on the contour of an uncased well when the pressure at its bottomhole is lowered under a uniform initial reservoir stress field (fig. 1).

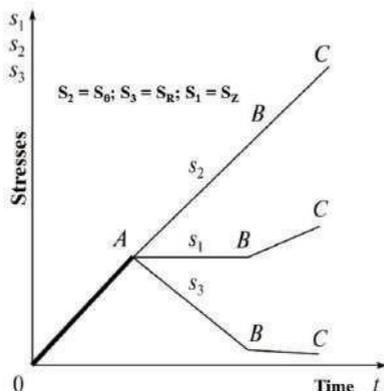


Fig. 1. Program of specimen loading

Here, S_i are the stresses applied in the machine to the faces of the sample. These stresses correspond to the effective principal stresses acting on the soil skeleton in the vicinity of the well: $S_2 - S_0$ (tangential); $S_3 - S_R$ (radial); $S_1 - S_Z$ (vertical).

The program includes three stages.

Stage 1: The sample is pressed uniformly on all sides up to stress equal to the difference between the value of rock pressure and the value of formation pressure, corresponding to the effective initial stress acting on the soil skeleton of the rock (segment OA in Fig. 1). Point A corresponds to the state with stresses acting in the soil skeleton before drilling the well under condition of equality of vertical and lateral rock pressure.

Stage 2. In this loading stage (segment AB) the stress component ($S_1 = S_0$) continues to grow, the second component ($S_1 = S_Z$) remains constant and the third one ($S_2 = S_R$) decreases, and the load changes so that the volume compression in every point of the formation is kept $S = (S_1 + S_2 + S_3) / 3$. The end point of the stage (point B) corresponds to the state when the well is drilled and the bottomhole pressure is equal to the formation pressure.

Stage 3: At the third stage, the process of drawdown creation is simulated, i.e. pressure reduction at the bottom hole (segment BC). At the same time, the radial stress S_R in the soil skeleton as the drawdown increases remains almost equal to zero, while the annular and vertical stresses S_0 and S_Z increase.

In this way it is possible to determine the dependences of deformation, rheological and filtration characteristics of reservoir rocks in oil and gas fields on the stress - strain state in conditions of real stresses, occurring on the walls of uncased vertical and horizontal wells. This is necessary, among other things, to create geomechanical and hydrodynamic models of the field, on the basis of which the project of its development is created.

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PHYSICAL MODELING OF THE STRESS - STRAIN STATE ARISING IN THE VICINITY OF THE WELLS DURING DOWNHOLE PRESSURE REDUCTION IN THE PRESENCE OF LATERAL THRUST

Annotation

This paper describes a way of modeling the conditions arising in the reservoir in the vicinity of the horizontal well to determine the effect of the stress state on the deformation, filtration and

rheological characteristics of rocks when reducing the pressure at the bottomhole bottom in the case of lateral thrust less than unity. The unique true triaxial apparatus created in IPMech RAS, Triaxial Independent Load Test System (TILTS), is briefly described.

Keywords

Physical properties of rocks, filtration, stress - state, true triaxial tests, physical modelin, lateral thrust.

The study of the strength and filtration characteristics of the productive formation is required to create a geomechanical model of the field. Knowing the properties of the reservoir rocks is important both for creating methods to improve well productivity and oil recovery, and for ensuring wellbore stability [1]. When drilling the well, the stress state in its vicinity changes - it becomes significantly uneven and tangential stresses arise. Later, during the development and operation of the well, the pressure at its bottomhole is further reduced in order to ensure the flow of oil or gas. In the initial state, oil and gas reservoirs are in a state of compression by rock pressure. However, lateral pressure can be different from vertical pressure. The ratio of the horizontal component of rock pressure to the vertical component is called the lateral thrust coefficient. This article describes a way to simulate on the true triaxial unit the stress conditions that arise in the rock in the vicinity of a horizontal well in the presence of lateral thrust in the formation, in order to determine the effect of stress state on rock characteristics when the pressure at the bottomhole is lowered.

The Triaxial Independent Load Test System (TILTS) allows to simulate any types of loading (deformation) of the sample, including the fracture process. This is a unique scientific installation created in the Institute for Problems in Mechanics of the Russian Academy of Sciences and intended for studying deformation, strength and filtration characteristics of rocks of oil - and - gas, ore and coal deposits. Its distinctive feature is the possibility to load rock samples, which are cubes with faces of 40 or 50 mm, independently along three axes [1]. This makes it possible to recreate in the course of experiments any stress states arising in the formation during drilling, well development and operation, and to study the effect of stresses on the filtration properties of the rock.

The presence of lateral thrust results in different stresses acting on the wellbore contour after drilling than those acting on the wellbore contour when the initial stress field is uniform. Therefore, the sample loading program, which simulates pressure reduction in the borehole, will change.

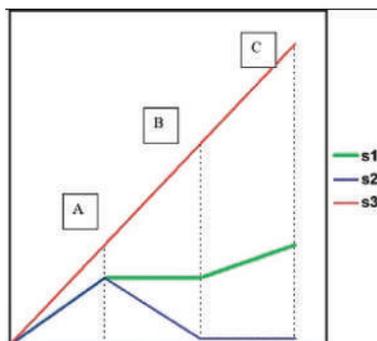


Fig. 1. Program of specimen loading with consideration of lateral thrust

The problem under consideration can be represented as a superposition of two problems: the Lamé problem and the Kirsch type problem [2]. Stresses on the well contour will be equal to the sum of stresses obtained from the solutions of these problems. When the horizontal rock pressure is less than vertical (the most common case), it follows from the solution of the Kirsch problem that the maximum stress will be achieved at lateral points on the borehole contour relative to the axis. A modeling technique is proposed for these points (fig. 1). S_i are the stresses applied in the machine to the faces of the sample. These stresses correspond to the effective principal stresses acting on the soil matrix in the vicinity of the well: $S_3 - S_0$ (tangential); $S_2 - S_R$ (radial); $S_1 - S_Z$ (vertical). The program includes three stages.

Stage 1: In the first step, the specimen is crimped along axis 3 with stress q_v and along axes 1 and 2 with stresses q_h (OA segments in Figure 1). Point A corresponds to the stresses acting in the soil matrix before the borehole was drilled in the presence of lateral thrust.

Stage 2: In the second stage of loading AB, the annular stress component S_3 continues to increase, the second S_1 remains constant, and the third S_2 decreases. The end point of the stage (point B) corresponds to the state when the well is drilled and the bottomhole pressure is equal to the formation pressure.

Stage 3: At the third stage, the process of drawdown creation is simulated, i.e. pressure reduction at the bottom hole (segment BC). At the same time, the radial stress S_R in the soil skeleton as the drawdown increases remains almost equal to zero, while the annular and vertical stresses S_0 and S_Z increase.

With the help of the described methodology, it becomes possible to study the properties of rocks on the installation TILTS and other true triaxial apparatuses in conditions of real stresses arising on the walls of horizontal wells in the presence of the coefficient of lateral thrust in the formation.

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ПЕДАГОГИЧЕСКИЕ НАУКИ



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SPEECH CULTURE AS AN INDICATOR OF PROFESSIONAL AND PERSONAL DEVELOPMENT OF STUDENTS

Annotation: This article examines the problem of the formation of speech culture in the modern educational process. The problem is viewed as interdisciplinary and requires an integrated approach. The author suggests ways to increase motivation to follow the rules of both native and foreign languages. The importance of the role of the teacher as a mentor and a tutor in this process is emphasized.

Key words: speech culture, cognitive activity, professional development, foreign language, joint activity, motivation.

One of the professional characteristics of a specialist in modern society as a participant in communication and organizer of his professional life, and having a significant impact on his professional success is his language culture. In a world where national boundaries in the professional community are being erased, the demand for a modern specialist largely depends on the availability of competent oral and written speech in a foreign language, knowledge of speech methods, persuasion and the ability to communicate effectively, that is, on the level of his linguistic competence.[1] One of the general cultural competencies sounds like this: the ability for business communication, professional communication in one of the foreign languages. The problem is that a modern student, especially a technical university, unfortunately for teachers, has poor communication skills in his native language, which greatly complicates the task.

Abbreviations, incorrect accents, jargon (and even obscene expressions), violation of the grammatical structure of the language are the main, but not all, problems that modern teachers of all disciplines face. A weak language culture is becoming the norm, which is unacceptable. The problem is interdisciplinary and must be addressed in a comprehensive manner. It can be considered at the level of a student - teacher relations and at the level of a student - university.

The communicative - activity approach can become the main one in solving this problem. Under the condition of purposeful and meaningful communication between the teacher and the student, built on mutual trust and respect for each other, results should be expected. Implementing this approach, the teacher chooses forms of activity focused on dialogues, communication, interactive forms of communication, creative tasks that allow developing the student's communicative capabilities, speech initiative, thereby motivating and stimulating the language culture. [2]

Most experts agree that discussions stimulate the ability to independently analyze the information received, increase the student self - estimation, and teach to defend their point of view. [3]

Entering into a dialogue with the teacher, the student himself sets an invisible bar in terms of the culture of speech, tries to express his point of view in competent language, in order to adequately oppose the teacher. The task of the teacher is to help and support the student, not to criticize, but to interact, becoming full partners in the process of teaching and upbringing. It is necessary to prove

that correctness of speech is fashionable and modern, and incorrectness is old - fashioned and irrelevant.

In foreign language classes, the tasks are more specific:

- 1) expanding the base of students' speech activity;
- 2) improving speech culture, namely, the ability to write and speak correctly in the native and foreign languages;
- 3) the formation of skills and abilities of rational speech behavior in various situations of professional communication;
- 4) correct management of the flow of information, understanding of the explicit and hidden meanings of speech, the creation of business and social texts;
- 5) courage in expressing one's thoughts, developing the effectiveness of a speech message.

The educational process should be accompanied by educational, and ideally, be one whole. For each misuse of both native and foreign languages, a "punishment" can be worked out. For example, learn additional words, compose an additional dialogue, and find additional information on the topic under study. The main thing is not to show indifference, and not to allow "profanity" vocabulary to turn into the norm. It is possible to increase motivation only by personal example or by the example of successful people, specialists in their field. Simulated language communication in class can be an excellent example to follow in real life.

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EVALUATION OF THE EFFECTIVENESS OF THE KALMAN FILTER IN SATELLITE RADIO MONITORING

Annotation

The article discusses the effectiveness of the Kalman filter for satellite radio monitoring. The calculations have shown that this method of detecting a harmonic signal can make the right decisions with very high accuracy. Calculations also showed that even with a negative value of S/W , the signal level at the input of the on-board measuring receiver will be more than 90 %. Therefore, when the S/W ratio is greater than 0, the signal level at the input of the on-board measuring receiver will be greater than 90 %. The probability that the signal exists and this signal will be received by the on-board measuring receiver is more than 90 % with a zero S/W ratio and higher.

Keywords

Kalman filter, satellite radio monitoring, radio emission source, radio frequency spectrum, signal - to - noise ratio.

In recent years, wireless technologies have been increasingly used in various fields of radio engineering and telecommunications. However, as wireless systems and networks become more widespread, the problems associated with the shortage of the radio frequency spectrum (RFS) become more complicated. In such conditions, it is necessary to improve the functions and mechanisms of regulation and management of RFS [1 - 3]. Currently, new approaches to RFS management have been developed, such as: dynamic / opportunistic spectrum access, spectrum sharing and aggregation of licensed / unlicensed spectrum, cognitive radio and software - defined networks. All these methods are aimed at achieving a better and more reasonable use of the RFS [4 - 7]. Monitoring of the RFS in this case is one of the ways to assess its load to solve the problems of long - term management of the radio frequency spectrum in the interests of the development of new wireless technologies.

However, currently radio monitoring is carried out on the basis of ground - based radio monitoring facilities. In addition, it is necessary to take into account the fact that the shortage of RFS is observed mainly in large cities, where it is very difficult to control the employment and workload of the RFS with the help of ground - based means of radio monitoring. With the help of ground - based radio monitoring facilities, providing complete, operational and reliable information about the real state of the radio frequency spectrum in a megalopolis is a difficult task, and managing the radio frequency spectrum on a national scale is even more difficult. In this regard, it is necessary to improve the functions and mechanisms of radio monitoring [8 - 9].

In [9, p. 948], an analysis of the energy budget of radio lines was performed, which showed the possibility of using low - orbit small spacecraft for radio monitoring. However, in order to improve the quality of radio monitoring, effective methods are needed to increase the reliability of detection and recognition of IRI radio signals. One of the solutions to this problem is the use of Kalman filters [10 - 11]. This work is devoted to evaluating the effectiveness of the Kalman filter in satellite radio monitoring.

In the absence of a useful deterministic signal in a noisy signal, the Kalman filter determines the absence of the original signal in a stochastic oscillation with zero mean (Figure 1). This means that the Kalman coefficient can be successfully used when monitoring IRI in order to determine the presence of a useful signal. For this purpose, the concept of the similarity coefficient of the filtered signal using Kalman to the original signal is introduced.

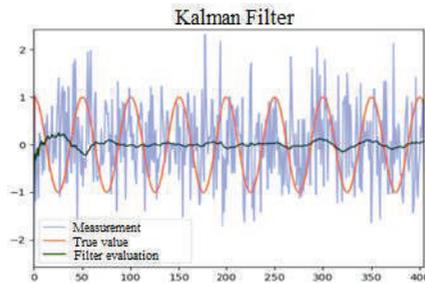


Figure 1. Representation of signals in the time domain based on the results of the Kalman filter with a noise dispersion of 0.1 in the absence of the desired signal

The similarity coefficient is calculated as follows:

- the difference of two signals (filtered and searched) is calculated;
- the RMS value of the difference signal is calculated;
- the RMS value of the difference signal is subtracted from the amplitude of the desired signal.

Figures 2 - 4 show graphs of the dependence of the similarity coefficient on the noise level. As can be seen from Figure 2, the similarity coefficient has a value greater than 0.9 for any positive values of signal - to - noise (SNR). Accordingly, this value of 0.9 can be taken as a threshold value for deciding on the presence of the desired signal in the measured signal, i.e. if, as a result of calculations, the similarity coefficient turns out to be greater than 0.9, then a decision is made that the desired signal is present.

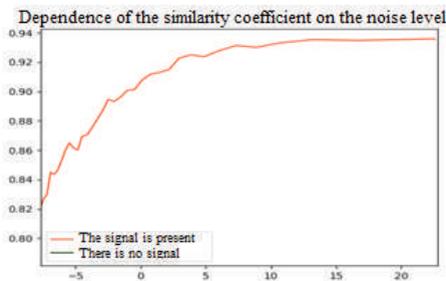


Figure 2. The dependence of the similarity coefficient on the SNR ratio in the presence of the desired signal in the measured signal

As can be seen from Figure 3, the similarity coefficient has a value of no more than 0.3 for any positive values of SNR. Accordingly, this value of 0.3 can be taken as a threshold value for making a decision about the absence of the desired signal in the measured signal, i.e. if, as a result of calculations, the similarity coefficient turns out to be less than 0.3, then a decision is made that the desired signal is missing.

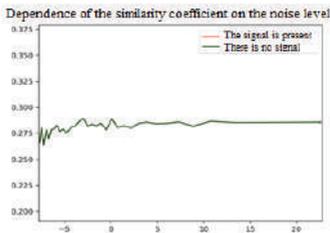


Figure 3. The dependence of the similarity coefficient on the SNR ratio in the absence of the desired signal in the measured signal

The advantage of this method is that the similarity coefficient in the presence of the desired signal has a value greater than the threshold (0.9) even with negative values of the SNR ratio. Figure 4 is a combination of the two above - mentioned graphs of the similarity coefficient, which allows us to successfully demonstrate a method for verifying the presence of a useful signal, where it is possible to enter upper and lower decision thresholds when monitoring IRI.

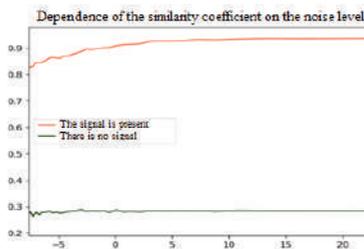


Figure 4. The dependence of the similarity coefficient on the SNR ratio in the presence and absence of the desired signal in the measured signal

The lower threshold is used to exclude a false alarm. The upper threshold is used to exclude skipping a goal. Thus, with a similarity coefficient of more than 90 % , we can confidently confirm the presence of a useful signal, with an indicator of the SNR ratio greater than zero.

From the above results, it is possible to introduce the concept of reliability of the method for application. The reliability of the method is determined as follows:

- for each noise level, the similarity coefficients for both cases are calculated repeatedly (in this case 500 times), i.e. in the presence and absence of the desired signal in the measured signal;
- for cases where the desired signal is present, the value of the similarity coefficient is analyzed, if it is less than the threshold value (in this case 0.9), then this decision is taken as erroneous, otherwise as correct;

- also, in the absence of the desired signal, the value of the similarity coefficient is analyzed, if it is greater than the threshold value (in this case 0.3), then this decision is taken as erroneous, otherwise as correct;

- the relative proportion of correctly made decisions is calculated, which is an indicator of the reliability of decisions made by the method.

Figures 5 and 6 show the dependences of the reliability indicator of the method on the SNR ratio for both cases: in the presence and absence of the desired signal in the measured signal.

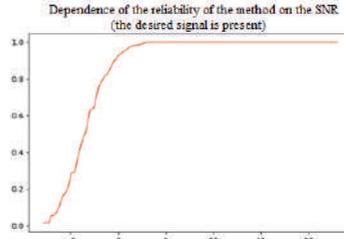


Figure 5. Dependence of the reliability of the method on the noise level in the presence of the desired signal in the measured signal

It is obvious that the reliability index of the method calculated in this way takes values from 0 to 1. It is obvious that the reliability index of the method calculated in this way takes values from 0 to 1. The higher the value of this indicator, the higher the level of reliability and reliability of the proposed method for detecting a harmonic signal.

As we can see from Figure 5, the reliability indicator of the method has a very high value, actually equal to 1, with all positive values of the SNR. But with negative values of the SNR, the indicator sharply tends to zero and already at - 6 dB reaches its possible minimum value.

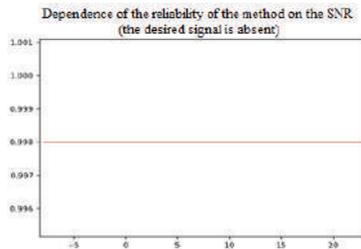


Figure 6. Dependence of the method on the noise level in the absence of the desired signal in the measured signal

Figure 6 shows that the reliability indicator of the method in the absence of the desired signal practically has the maximum possible value, which means that this method works extremely reliably for this case.

Conclusions. The use of Kalman filters will improve the reliability of satellite radio monitoring systems. Even with a negative SNR value, the use of the Kalman filter allows detecting the signal at the input of the on - board measuring receiver with a reliability greater than 0.9 (85 %). If the SNR

ratio is greater than 0, then this indicator will be greater than 0.9 (90 %). Thus, it can be concluded that the probability that the signal is detected and this signal will be received by the on-board measuring receiver is more than 0.9 (90 %) with a zero SNR ratio and higher.

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FORKLIFT WITH COMBINED GRIPPING

Abstract

Warehouse operations are an integral part of the industrial sphere of our country, but without the appropriate modernized equipment, the productivity of an enterprise in any industry declines over time. In order to prevent such a development of events, it is proposed to improve the forklift. This article contains information about the design of the loader, types of grippers, and also fully describes the universal mechanism with which the machine has the ability to combine gripping. At the end of the article, a constructive version of the updated loader is demonstrated, the principle of operation of the machine is described and the corresponding areas of application of the new technology are given.

Scientific research methods: analysis, synthesis, comparison, abstraction.

Results and conclusions: as a result of a scientific study, a new improved forklift was proposed, with which it is possible to increase the productivity of warehouse operations several times, while the machine can be used in warehouses of any class, regardless of the width of the aisles and the size of the shelves.

Key words

Rotary mechanism, forklift, combined gripper, warehouse work, lifting and transport equipment.

Forklift trucks have been indispensable machines in warehouses for nearly a century. Small overall dimensions and the ability to transport goods weighing at least 1.5 tons, while maintaining good maneuverability and speed of movement, make the loader unique - there are no analogues of such a machine. But modern technologies do not stand still, for this reason most manufacturers decide to modernize their machines in order to increase the productivity of warehouse operations.

A forklift is a machine with a working body in the form of a load - gripping fork, which directly grips the pallet and lifts / lowers it onto the shelves of storage facilities. The forks are attached to the mast by means of a carriage, which in turn is equipped with a protective grid that protects the mast from unexpected tangential movements of the load from the side of the forks. The above units are the main elements responsible for the operation of the machine. The units are controlled by means of hydraulic cylinders, the control levers of which are located in the cab. Also, the counterweight, engine compartment and the presence of lighting equipment can be distinguished as structural elements of the machine. A detailed diagram of assemblies and parts is shown in Figure 1 [1 - 3].

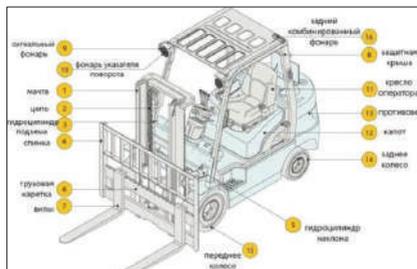


Figure 1. Structural scheme of a forklift

By themselves, loaders come in two types of loading - direct and side. In the first case, the forks are installed in line with the machine, i.e. at an angle of 0 degrees relative to the horizontal line of travel of the machine. This arrangement of the working body is standard and is used on most models [4 - 5].

Another type of loading, side loading, is used less often than the first and is most often found in the operation of reach trucks. Side loading offers advantages over straight loading in narrow width warehouse aisles. A conventional machine needs to turn 90 degrees to fully grip the required pallet. Side loading replaces unnecessary maneuvers of the machine and makes it possible to save time spent on the working cycle of the machine.

But at the moment there is no such modification of the machine that would include a mixed type of pallet gripper. For this purpose, it is proposed to improve the machine, which would have a combined type of loading and unloading of goods.

The main working units of the machine remain unchanged, but the fastening of the mast to the loader body will undergo modernization. If earlier the body was attached directly to the mast itself without the presence of additional equipment, now this will be a worm gearbox. With the help of this device, it becomes possible to achieve the desired result - turning the working body by 90 degrees to one and the other relative to the central horizontal axis of the machine. At the same time, the design of the machine itself will not be complicated. A schematic of the advanced forklift truck is shown in Figure 2.

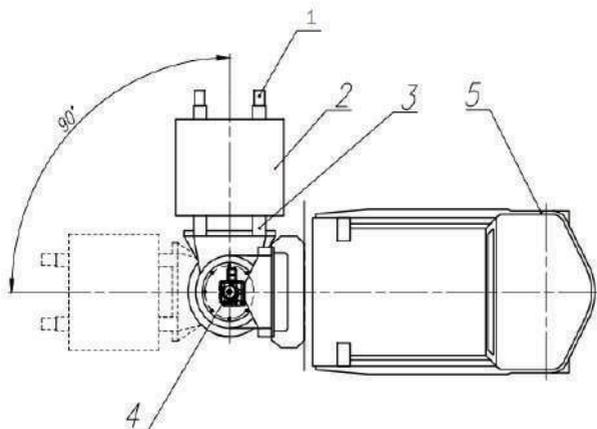


Figure 2. Advanced Combined Grip Forklift: 1 - lifting forks, 2 - pallet, 3 - matches with carriage, 4 - worm gear, 5 - counterweight.

The principle of operation of such a machine will be modified only partially, a hydraulic motor will be added to the hydraulic system, which will be responsible for the operation of the worm gear. The rest of the hydraulic circuit will remain unchanged. It should be noted that the loader will be able to rotate not only in a static position, but also in the process of movement. On the other hand, from the point of view of safe operation, it is undesirable to perform such actions.

Despite the rather diverse classification of forklifts, this upgrade can be performed on any machine, regardless of the lifting capacity and power plant, in other words, this improvement technology is universal.

The updated forklift will be able to work in any warehouse environment and will eliminate the possibility of unnecessary maneuvers of the machine, which will reduce the machine cycle and increase the productivity of warehouse operations.

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ЭКОНОМИЧЕСКИЕ НАУКИ



ECONOMIC SCIENCES

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DIGITALIZATION OF THE CHEMICAL INDUSTRY ON THE EXAMPLE OF "SIBUR" HOLDING

ANNOTATION

One of the most important trends in the development of the national economy today is the digitalization of the chemical industry. The article shows some digital directions being developed by one of the largest chemical holding "Sibur".

Keywords: digitalization, fourth industrial revolution, competitiveness, predictive service

The chemical complex plays a significant role in the implementation of the most important social and economic programs of the country. Transformation of the world economy, development of new production and information technologies, changes in the natural environment, current trends in world politics and demography have a serious impact on the functioning of the chemical industry.

The "Fourth Industrial Revolution", which began in the first half of the 2010s, is expected to significantly change the way the chemical industry operates. Between 2020 and 2025, the application of digital technologies of the Industry 4.0 class is likely to become crucial to ensure the competitiveness of both the individual enterprise and the industry as a whole. By that time, we should expect to see the formation of a global "Industrial Internet" network that will include chemical manufacturing facilities and other facilities involved in the process of producing and selling chemical products. [1]

The World Economic Forum initiated the forecasting of the main trends in the development of digital trends in the chemical industry back in 2017. These are automation and robotics, sensors, Data Science, AI (artificial intelligence), 3D printing, application of information technologies in industry, cloud technologies, specific software.

Digitalization covers many industries, including the petrochemical industry. Digital transformation means even higher productivity, faster changes, more opportunities for company employees (advanced training, analytical support for operators, increased process safety).

Several years ago, Sibur, which produces polymers, rubbers and other petrochemical products for construction, housing and public utilities, medicine, automotive and other industries, began implementing digital technologies in its production and business processes.

Sibur has already implemented projects to create digital twins, Data Science, simulators in VR (artificial reality), reliability management systems and projects with AI. Several dozens of production and business processes have been implemented, the effect of which has already exceeded RUB 8 billion.

We experimented with large databases, automatic devices for process control and management, and process optimization. Now more than twenty digital pilot projects are being developed in Sibur's digital direction at the company's key enterprises. The professions that create digital chemistry include data scientists, UX designers, front and backend developers, testers, engineers and data architects. Introducing new technologies into the industry is difficult, due to industry

specifics it can take years from idea to implementation. At Sibur, prototypes have moved into the operational stage and are already changing production.

Let's take a look at several of Sibur's digitalization projects. The first project is predictive machine maintenance. In the production of polypropylene, which is used to make many things, from packaging films to pipes, an extrusion system is in operation. The goal was to eliminate equipment failures (extruder, pelletizer shaft) that lead to transient product grades instead of target grades.

Predictive maintenance helps the extruder run smoothly. If the system realizes that the current mode of operation is similar to the one that preceded the failure in the past, the operator will receive an alert: it is necessary to urgently change the parameters and recommendations on which ones. The system helps to eliminate unscheduled equipment shutdowns: instead of restarting the equipment, it is possible to predict the abnormal situation and change the technological mode in advance. In addition, each shutdown means additional costs for replacement of consumables and downtime of equipment that could have produced the product.

With the help of the technology it is possible to foresee 85 % of equipment failures. In the future, the company plans to create a predictive maintenance platform that will assess the condition of almost all machines at the holding company's production facilities. In 2017, the extruder was stopped 19 times. Since the model's launch, not once. [2]

The second project is called "Remote Expert". Sometimes the knowledge of employees in production is not enough to repair complex equipment, and in such cases, it is necessary to bring in an expert from another company or a representative of a supplier from another country. To avoid bringing him to the site, Sibur uses AR glasses: the employee looks through them at the machine and sees diagrams, text clues and comments on the order in which to fix it.

Hints can be directed by an expert who, thanks to his glasses, not only sees what the worker sees, but also the sensor readings with the documentation.

A computer that can recognize equipment can also help. Instructions are given in the form of text, diagrams and drawings - the production is noisy, so voice communication is not always suitable. It takes at least 72 hours to bring an expert to the site - all this time the equipment is idle. With AR, however, you can get a consultation within a few hours.

For example, in May 2018, one of the plants needed a survey to restore operations and Sibur employees needed advice from colleagues in Germany. It took one hour instead of two days to continue work on the plant. For the large - scale integration of the Remote Expert, information security needs to be built in, as internal data must not leave the company. To do this, Sibur is building its infrastructure and developing data transfer protocols. [2]

Industry 4.0 technologies make it possible to rapidly adapt equipment to the parameters of working conditions (temperature fluctuations in the room, the presence of impurities in the raw material, etc.), to predict the process, calculate the "weak spots" in the structure of assets, predict equipment failures before they occur and much more.

These technologies help to increase resource and energy efficiency of production, reduce equipment downtime and repair costs, increase production safety, and facilitate operators' work.

For a radical transformation of the chemical complex in the coming years, significant changes in basic chemical science must be achieved and are planned. They will be based on the deep penetration into research of digital methods of data collection and processing and conducting

experiments, first of all, Big data technology, complex mathematical modeling of studied processes. [1,3]

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THE PROCEDURE AND ORGANIZATION OF A CAMERAL CUSTOMS INSPECTION ON THE CUSTOMS TERRITORY OF THE EURASIAN ECONOMIC UNION

Abstract: The Federal Customs Service of Russia provides a system of customs control in many aspects of its activities. Customs control after the release of goods is no exception. Customs authorities must create conditions under which illegal movement of goods across the customs border of the Eurasian Economic Union (EAEU) and their further circulation on the territory of the Russian Federation will become economically unviable.

Keywords: Eurasian Economic Union, cameral customs inspection, customs control after the release of goods, post - customs control.

In the post - release customs control system, customs examination plays a huge role. It is worth noting that the main documental control is carried out in the course of cameral customs inspection.

The relevance of this research work is the uniqueness of such institution of post - control as cameral customs examination, where the least effort is required to control the audited persons and there is no overburdening of documentary checks on participants of foreign economic activity.

Customs inspection as a form of customs control is regulated by Customs Code of the Eurasian Economic Union. Application of it consists in comparing information declared in the customs declaration and the information included in the documents presented to the customs authorities with the accountancy data and other information received in accordance with the procedure established by customs laws.

The subdivisions of customs control after the release of goods in 2020 have continued the realization of the following measures [2]:

- 1) Developing a national goods traceability system;
- 2) Improving regulatory and legal support;
- 3) Introducing goods marking by identification marks;

4) Improving the efficiency of customs inspections in the entirety of the payment of customs duties to the federal budget.

The first step is to analyze the dynamics of customs inspections for the period 2017 - 2020, as shown in Figure 1.

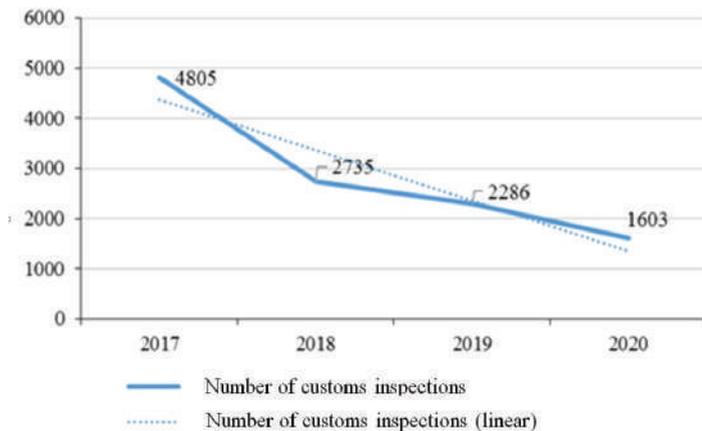


Figure 1: Number of customs examinations carried out for the period 2017 – 2020

It can be demonstrated that the number of customs inspections conducted by customs authorities has been decreasing for four years. From 2017 to 2018 the number of inspections carried out by customs authorities decreased by 43 % , from 2018 to 2019 by 16 % , and by 30 % from 2019 to 2020.

Additions, departments of customs control after the release of goods are guided by the following characteristics:

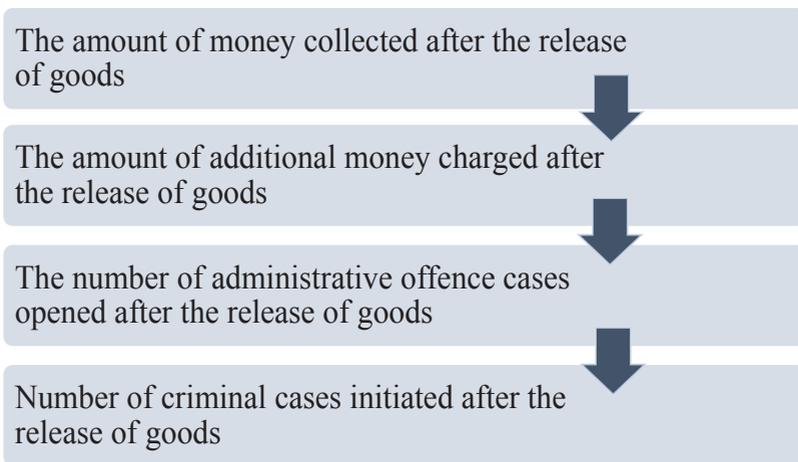


Table 1. Main indicators of the FCS of Russia
in customs inspections for the period 2017 - 2020[3]

Parameter of customs control after the release of goods	2017	2018	2019	2020
Number of additional charges, billion rubles	7,0	11,9	17,2	24
Number of collected payments, billion rubles	6,8	6,4	9,9	11,8
Number of cases opened Cases of administrative offences, pcs.	5224	5731	6862	7300
Number of initiated criminal cases, pcs.	303	287	362	348

Looking at the above - mentioned indicators in more detail, almost all of them recorded an increase in values except for criminal proceedings of cases based on the results of customs inspections. At the same time, the collection of collected funds decreased in 2018, after which it showed a strong increase for two years (by 55 % and 19 %) [4]. As for criminal cases, they were prosecuted based on the results of customs inspections in a wave - like manner. So, there was a 26 % increase in 2019, and a drop in 2018 and 2020 by 5 % and 4 % , respectively (figure 2).

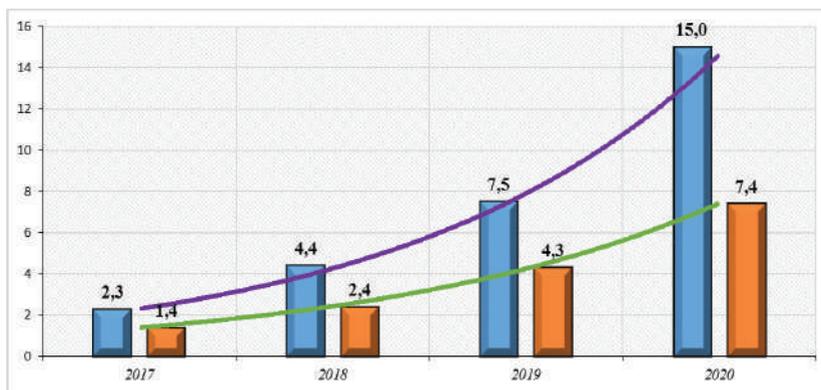


Figure 2: Effectiveness of customs inspections for the period 2017 - 2020 [5]

The interagency cooperation mechanism has a huge role to fulfill during customs inspections. Most of the integration for customs law enforcement of the Eurasian Economic Union is carried out between customs and tax authorities. At the same time, in 2019 and 2020, 967 inspections were carried out in cooperation with the Federal Tax Service of Russia. In this context, coordination between the customs and tax services made it possible to additionally assess customs and other payments, penalties and fines in 2019 and 2020 totaling 10.53 billion rubles and 10.26 billion rubles.

The efficiency of organization and application of post - control is the most important task of the Russian customs service. At the same time, the transition from global customs control to selective

control is one of the reasons for the emergence and active practice of customs control after the release of goods.

The customs authorities of the Russian Federation have the most important tasks to ensure the country's economic security. In addition, the fulfillment of control indicators of the activities of customs control after the release of goods allows to reflect the quality of activities carried out as a part of the realization of customs examinations. The growing values of the activities of these departments do not stop, as new criteria and approaches are demanded in the development of the implementation of customs inspections

Improving the performance of a cameral customs audit is also based on the mechanism of interagency cooperation, where a special place is given to the tax authorities. At the same time approaches to their collaborative control are legally and systematically defined, as well as procedures and tools for the implementation of tasks that are set by competence to each of these departmental authorities.

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