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CONTENT

AGRICULTURAL SCIENCES

ECONOMIC SCIENCES

MATHEMATICAL SCIENCES

MEDICAL SCIENCES

PHILOLOGICAL SCIENCES

PHYSICAL SCIENCES

TECHNICAL SCIENCES

AGRICULTURAL SCIENCES

THE BOTANICAL COMPOSITION OF THE GRASS MIXTURE DEPENDS ON THE LEVEL OF MINERAL NUTRITION

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БОТАНІЧНИЙ СКЛАД ТРАВОСУМІШКИ ЗАЛЕЖНО ВІД РІВНЯ МІНЕРАЛЬНОГО ЖИВЛЕННЯ

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Abstract

The article presents the results of the study of the influence of the level of mineral nutrition on the botanical composition of the herbal mixture. It was established that the fertilizer has a significant effect on the botanical composition of the leguminous-cereal grass mixture. The introduction of complete mineral fertilizer N45P60K60 leads to a decrease in the content of herbaceous forbs and contributes to an increase in the proportion of sown grasses.

Анотація

У статті наведені результати досліджень впливу рівня мінерального живлення на ботанічний склад травосумішки. Встановлено, що удобрення має значний вплив на ботанічний склад бобово-злакової

травосумішки. Внесення повного мінерального добрива $N_{45}P_{60}K_{60}$ призводить до зменшення вмісту в травостої різнотрав'я та сприяє збільшенню частки сіяних трав.

Keywords: botanical composition of the grass stand, fertilizer, grass mixture.
Ключові слова: ботанічний склад травостою, удобрення, травосумішка.

Тваринництво – важлива галузь сільського господарства, значення якої визначається високою часткою у виробництві валової продукції. Від його розвитку залежить наповнення ринку м'ясом, молоком тощо. Тваринництво забезпечує сировиною промисловість та постачає органічні добрива, які підвищують родючість ґрунту та врожайність сільськогосподарських культур.

Розвиток тваринництва залежить від раціональної організації міцної кормової бази. Провідна роль у її створенні належить кормовиробництву [7]. Стратегія розвитку цієї галузі базується на інноваційних, наукоємних технологіях, збереженні довкілля, сталому розвитку сільських територій. Одним із ключових елементів формування кормової бази є створення кормових угідь на основі багаторічних бобових та злакових трав. Корми з бобово-злакових травосумішок найкраще задовольняють фізіологічні потреби тварин [4]. Їх зелена маса і сіно характеризуються високими кормовими якостями. За умістом поживних і біологічно активних речовин зелена маса є неперевершеною серед інших кормових засобів. Сіно, у свою чергу, містить вітамін D, який регулює мінеральний обмін в організмі тварин. Крім того, багаторічні злакові і бобові *трави* використовують для приготування сінажу, силосу, брикетів, гранул та ін. [6].

Одним із факторів підвищення їх продуктивності, є раціональна система удобрення. Унесення науково-обґрунтованих норм мінеральних та органічних добрив може забезпечити бездефіцитний баланс поживних речовин і гумусу [8].

Встановлено, що потенційна продуктивність, тобто здатність травостою повніше використовувати поживні речовини ґрунту, добрив залежить від ботанічного складу травостою [1,3].

Серед багатьох чинників, які впливають на ботанічний склад та структурно-функціональну організацію рослинного покриву важливе місце посідає забезпеченість рослин основними поживними елементами [5].

Таким чином, важливість проведення досліджень щодо впливу мінерального живлення на ботанічний склад травостою надзвичайно висока.

Об'єктом дослідження є процес росту і розвитку багаторічних трав при застосуванні мінеральних добрив.

Предметом дослідження є багаторічні трави: люцерна посівна, грястиця збірна, стоколос безостий, азотні, фосфорні та калійні добрива.

Схема досліду включала такі варіанти: 1. Без добрив (контроль); 2. $P_{60}K_{60}$; 3.$N_{45}P_{60}K_{60}$ кг/га д.р.

Варіанти удобрення закладені в трьохразовому повторенні. Між удобренням розташовували захисні смуги шириною 1,0 м. Використання травостою двохукісне. Всі спостереження і визначення проводилися згідно методики проведення дослідних робіт на луках [2].

Ботанічний склад травостою визначали розбираючи середню пробу масою 1 кг на окремі групи (злакові, бобові, різнотрав'я), а всередині кожної групи – на види рослин.

За результатами наших досліджень, частка сіяних трав була досить високою, і змінювалась в залежності від рівня мінерального живлення (рис.1).

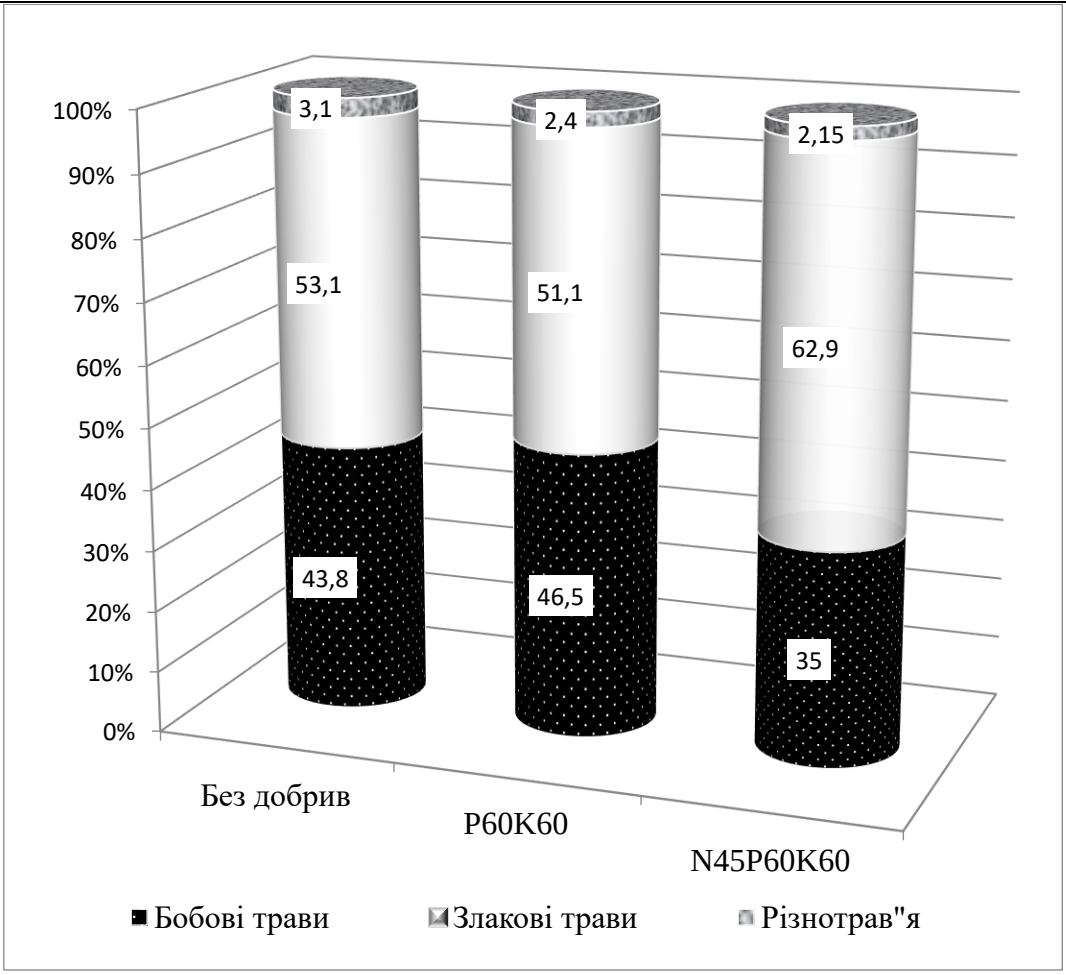

Рис.1. Ботанічний склад травосумішки залежно від удобрення (середнє за 2022-2023 рр.)

Удобрення травосумішки повним мінеральним добривом $N_{45}P_{60}K_{60}$ забезпечило найвищу частку злакових трав у структурі урожаю (62,9%). Це пов'язано з високою ефективністю використання азотних добрив злаковими травами. Застосування лише фосфорно-калійних добрив ($P_{60}K_{60}$) призвело до зростання кількості бобових трав у травосумішці (46,5%). Внесення $P_{60}K_{60}$ підвищувало вміст люцерни посівної в бобово-злакових травостоях на 2,7% та знижувало частку різнотрав'я на 0,7% *порівняно* з *контролем*. *Завдяки* симбіозу з *бульбочковими бактеріями* бобові трави забезпечили себе *азотом. В*несення лише фосфорних і калійних добрив сприяло росту чисельності бобових та збереженню їх у агроценозах.

Група різнотрав'я у новоствореному травостої характеризувалася присутністю в ній однорічних рослин, серед яких переважала лобода біла, грицики звичайні, мишій сизий.

Таким чином, мінеральне удобрення має позитивний вплив на ботанічний склад травосумішки. Внесення добрив призводить до зменшення вмісту в травостої несіяних злаків і, відповідно, збільшення частки сіяних трав. Це сприяє підвищенню кормової цінності як зеленої, так і повітряно-сухої маси корму.

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YIELD OF WINTER RAPESEED SEEDS UNDER DIFFERENT SOWING RATES

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УРОЖАЙНІСТЬ НАСІННЯ РІПАКУ ОЗИМОГО ЗА РІЗНИХ НОРМ ВИСІВУ

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Abstract

The article presents research results on the impact of different sowing rates of winter rapeseed seeds on yield. It is demonstrated that a sowing rate of 0.8 million similar seeds per hectare resulted in the highest rapeseed seed yield compared to sowing rates of 0.6 and 1.0 million similar seeds per hectare.

Анотація

У статті наведені результати досліджень щодо впливу різних норм висіву насіння ріпаку озимого на урожайність. Показано, що за норми висіву 0,8 млн схож. нас./га спостерігався найвищий урожай насіння ріпаку, порівняно із нормами висіву 0,6 і 1,0 млн схож. нас./га.

Keywords: winter rapeseed, sowing rate, yield
Ключові слова: насіння ріпаку озимого, норма висіву, урожай

На норму висіву ріпаку озимого впливає багато чинників, зокрема: умови вирощування, термін посіву, сорт, передпосівний обробіток ґрунту, погода. Від густоти стояння залежить винесення культурою точки росту восени і розвиток кореневої системи, що суттєво впливає на зимостійкість та урожайність [4].

Оптимальна густота посівів, незважаючи на проведені дослідження, для більшості рослин не визначена. Для оптимального росту і розвитку культур необхідна така площа живлення, при якій вони матимуть відповідну кількість поживних речовин і вологи, оскільки як зріджений, так і загущений посів веде до зниження продуктивності [2].

У загущених посівах, через нестачу світла, велика частина пагонів і навіть цілі рослини відмирають, а у тих які вижили сповільнюється розвиток, вони стають менш стійкими до хвороб та шкідників, рослини витягуються, що збільшує ризик вилягання, при якому спостерігається запізніле цвітіння і не дозрівання насіння, а це веде до втрат врожаю. У загущених посівах точка росту зміщується вгору, а це є головною причиною їх

ушкодження морозами та може призвести до загибелі. Крім цього, в загущених посівах створюються добрі умови для розвитку грибкових захворювань.

На загущених посівах значно важче вирощувати культури на насіння, тому для розмноження перспективних сортів часто використовують зріджені і широкорядні посіви. Проте, у таких випадках необхідно здійснювати міжрядний обробіток, а насіння дозріває нерівномірно, через що його збирають роздільним методом.

В густих посівах через високу конкуренцію погіршується розвиток рослин, що негативно впливає на число стручків та кількість насінин в стручку. Це особливо помітно у гібридів які мають більшу здатність до галуження.

У зріджених посівах зниження урожаю пояснюється нераціональним використанням площі живлення. Крім цього, у таких посівах підвищується забур'яненість, час цвітіння збільшується, через що під час збирання на рослині зростає кількість недозрілих насінин, що веде до втрат врожаю і погіршення його якості [3].

Норма висіву сортів ріпаку озимого становить 4-6 кг/га, тоді як для гібридів норма висіву становить 3,0-3,6 кг/га. На територіях з високим ризиком вимерзання норму бажано зменшувати, що сприяє кращому розвитку органів вегетації за меншої довжини стебла.

За сприятливої погоди при посіві та за оптимальної техніки норму посіву зменшують, а при безплужній обробці ґрунту – збільшують.

При ранній сівбі норму висіву зменшують, тоді як при пізній – підвищують.

Рекомендованою нормою посіву ріпаку озимого є 80-100 схожих насінин на 1 м^2.

На норму висіву суттєво впливає сорт. Для гібридів, порівняно з вільно квітучими сортами, норму висіву можна знижувати на 20–30 % [1].

Тому, визначаючи норми висіву насіння ріпаку озимого треба брати до уваги конкретні умови регіону вирощування, тривалість вегетаційного періоду і сортові особливості культури.

Метою проведених досліджень було визначити урожайність насіння ріпаку озимого за різних норм висіву.

У дослідах використовували ріпак озимий сорту Легіон. На контрольній ділянці висівали ріпак за норми висіву 0,6 млн схож. нас./га, на дослідних - 0,8 млн схож. нас./га і 1,0 млн схож. нас./га.

З даних таблиці видно, що найвища урожайність насіння ріпаку озимого спостерігалася за норми висіву 0,8 млн схож. нас./га і становила 27,4 ц/га, що було вище за контроль на 2,7 ц/га (10,9%). За норми висіву 1,0 млн схож. нас./га урожайність становила 26,3 ц/га, що на 1,6 ц/га (6,5%) більше за контроль, проте на 1,1 ц/га (4%) менше за норму висіву 0,8 млн схож. нас./га.

Таблиця

Вплив норм висіву на врожайність насіння ріпаку озимого

Норма висіву, млн. схож. нас./га	Урожай, ц/га	До контролю	
		ц/га	%
0,6 (к)	24,7	–	100,0
0,8	27,4	2,7	110,9
1,0	26,3	1,6	106,5

Отже, посів ріпаку озимого за норми висіву 0,8 млн схож. нас./га забезпечив найвищу врожайність насіння.

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ECONOMIC SCIENCES

THE USE OF DIGITAL TECHNOLOGIES IN THE ACTIVITIES OF DEPOSITARY AND REGISTRAR INSTITUTIONS ON THE WORLD MARKETS AND THE SPECIFICS OF LEGISLATIVE REGULATION

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ИСПОЛЬЗОВАНИЕ ЦИФРОВЫХ ТЕХНОЛОГИЙ В ДЕЯТЕЛЬНОСТИ ИНСТИТУТОВ УЧЕТНОЙ СИСТЕМЫ НА МИРОВЫХ РЫНКАХ И ОСОБЕННОСТИ ЗАКОНОДАТЕЛЬНОГО РЕГУЛИРОВАНИЯ

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Abstract

The process of digitalization of the global economy affects all areas of the global financial market, its trading and post-trading infrastructure, and significantly affects and even forms the main trends in the national financial markets of developed and developing countries. Digitalization is the main driver of the modern development of financial markets and contributes to the expansion of investment tools and changes in approaches and technologies of trading and accounting. At the same time, there is a need to ensure the reliability of transactions and ensure the openness of financial markets, facilitate access to national capital markets, unify rules and regulations for transactions, regulate and supervise the financial sector, standardize requirements for transactions and payment and settlement services for participants in transactions.

Аннотация

Процесс цифровизации мировой экономики затрагивает все сферы мирового финансового рынка, его трейдинговую и пост-трейдинговую инфраструктуры, и значительно влияет и даже формирует основные тенденции на национальных финансовых рынках развитых и развивающихся стран. Цифровизация является основным драйвером современного развития финансовых рынков и способствует расширению инструментов инвестийб изменению подходов и технологий торговли и учета. При этом возникает необходимость обеспечения надежности транзакций и обеспечения открытости финансовых рынков, облегчения доступа к национальным рынкам капиталов, унификации норм и правил осуществления операций, регулирования и надзора за финансовой сферой, стандартизации требований к транзакциям и платежно-расчетному обслуживанию участников операций.

Keywords: digital assets, tokenization, distributed registries, smart contracts, stocks, blockchain, NASDAQ, European Union

Ключевые слова: цифровые активы, токенизация, распределенные реестры, смарт-контракты, акции, блокчейн, NASDAQ, Европейский союз

Digital technologies are currently actively developing abroad and information about the main ideas is being published. Most often, digital transformation is associated with the tokenization[1] of digital assets and other technologies that simplify the accounting and transfer of information about digital assets. All rights to digital assets are accounted for accordingly in the institutions of the depositary and registrar system.

A radical transformation in the financial world can be achieved through modernization, which will completely change the approach to managing, using and monetizing investments. Tokenization opens up new opportunities for creating a variety of financial products and allows everyone to invest globally, regardless of their income or portfolio size. In a militarized form, physical assets can be represented digitally and secured by distributed registries. It is also possible to issue traditional assets in a paramilitary form.

Tokenization in blockchain technology is the process of converting something of value into a digital token that can be used in a blockchain application. The token is a share of ownership of the underlying asset and can be created for both tangible assets, including gold, real estate, bonds, debts and works of art, as well

[1] Tokenization is the process of replacing valuables (such as money, stocks, credit card numbers, medical records) with tokens reflecting these values, which makes trading them easier and safer.

as intangible assets, including ownership rights and product licensing. Moreover, indivisible assets can be divided into token forms.

The importance of tokenization goes far beyond access to investments; it could also facilitate the introduction of new investment models. Currently, most investments use shareholder capital in an effort to optimize profits and share price. For example, when you buy shares of a company, you provide money in exchange for a share, but the way the company is run and largely beyond your direct control. Because an organization uses smart contracts[2], it can manage both financial investments and facilitate voting rights and/or ownership rights related to investments. There is the possibility of incorporating the stakeholder capitalism model, a popular management theory in the 1950s and 60s that promoted benefits provided to the wider community, not just to shareholders.

Is it possible to invest in a company through the use of tokenization with the condition that the CEO does not receive more than 100 times the average earnings of employees, or otherwise the investment will be automatically refunded? The actual figure of the United States is 274 times higher than the average worker's earnings. Alternatively, you can invest in advanced technologies, for example, in the field of computer vision, and link the investment to the fact that the owner will never sell the intellectual property of a company in the defense industry.

The tokenization method allows you to store and transfer native digital assets in a digital blockchain registry, which guarantees a global standard of authenticity. The use of smart contracts ensures fast and consistent execution of transactions, which reduces the amount of administrative work and intermediaries, which, in turn, reduces costs. At the same time, there are problems that need to be solved if we want to use tokenization to transform the market.

Comprehensive work is needed to regulate tokenization, which should include a global taxonomy and token definition. In order to implement such a system more effectively, a stable legal framework and the development of a regulatory framework for defining roles and procedures in the process of creating value for digital assets are required. In addition, it is important to identify the supervisory framework and persons responsible for monitoring and supervision in this area. The combination of these problems with the chaotic nature of the blockchain creates significant obstacles to the large-scale implementation of tokenization.

There are several barriers to industrial-level decision-making and scaling, which makes tokenization less valuable. The technology has a network effect, i.e. its usefulness reaches its maximum when scaled and distributed, which is not sufficiently stimulated at present. As a result, large market players cannot work synchronously, which leads to market fragmentation and reduced liquidity. Despite the consortia's attempts to solve this problem, they face implementation difficulties, including IP ownership, limited advantages for large players, and difficulties in providing access to new technology companies in the market and fintech companies.

Security issues are growing in blockchain applications, which are being put in a difficult position due to cybersecurity and attacks. However, the creation, management and protection of tokenization still remain technologies in rough development. Therefore, there is a need for a certain infrastructure that would facilitate asset management and make it possible to connect tokenization with legacy systems during its smooth adaptation.

Tokenization, despite possible difficulties, can provide a number of important development factors, bring accessibility through fragmentation and speed up calculations, creating greater liquidity. It is also possible to use the software in different time zones. Fast calculations and high liquidity allow financial institutions to switch from the current T+2 standard to almost real-time calculations. Assets can be sold, settled and used as collateral on the same day, which significantly speeds up the circulation of money and is used for a wide range of economic benefits.

Smart contracts can significantly facilitate and change traditional financial processes, which will increase efficiency and reduce costs for all participants. In blockchain, assets can move almost instantly without restrictions and problems, which makes them more mobile and accessible to everyone. This is a huge potential for investors and issuers who can benefit from all this.

Despite the many opportunities provided by tokenization, the next step is to work on consistent global regulation and the development of production-level solutions that are needed for wider adoption. Financial institutions should start considering the necessary infrastructure to support tokenization, such as adaptation, management and integration with legacy systems, to be ready for the future financial sector, as investments in tokenization technologies continue to grow and the benefits of new assets become more apparent.

In recent years, distributed ledger technology (DLT) has attracted a lot of attention from the financial industry and regulators. DLT is a blockchain technology that arose in connection with the advent of cryptocurrencies, when users issue and verify them, rather than the central government. Tokenization is one of the main DLT-related technologies in which multiple users collaborate to reach consensus on the correct state of data.

Since the moment virtual currencies were born, financial giants have begun to explore the possibility of using DLT in securities trading and performing post-trading operations such as clearing and settlements. The goal is to create safer and more efficient markets, because this issue is currently one of the most pressing. For an in-depth understanding of how trading platforms

[2] A smart contract is a computer program that executes agreements concluded between two or more parties, as a result of which certain actions occur when certain conditions are met.

function and how the post-trading market infrastructure is built, it is necessary to study this issue more deeply.

In recent years, financial institutions have experimented with several proofs of concept in certain niches of the trading and post-trading environment. For example, the Australian Stock Exchange and Digital Assets are creating a DLT system for clearing and settlement of shares, which is scheduled to launch in 2023. NASDAQ and Skandinaviska Enskilda Banken AB then created a mutual fund trading platform that uses blockchain technology. Since 2019, the French central securities depository ID2S has started using blockchain technology to issue French commercial securities. In addition, the Canadian Securities Exchange is developing a platform using DLT for clearing and settlement of securities. This platform would allow firms to issue shares and fixed income securities through the placement of security tokens. In 2021, Deutsche Börse, in collaboration with Deutsche Bundesbank and the German Financial Agency, developed and tested a settlement interface for electronic securities that allows payments with central bank money. During testing, the German Financial Agency issued ten-year federal bonds (Bund) in the DLT system, where transactions in the primary and secondary markets were also carried out using DLT.[1]

An important goal of the European Commission is to ensure consumers' access to innovative financial products, taking into account both their protection and financial stability. This forms part of the digital action plan, which has four priority areas:

a) unification of the Single Digital Market,

b) adaptation of the legal framework legislation of the European Union, taking into account digital innovations,

c) promotion of data-based financing,

d) mitigation of risks associated with digital transformation, such as increasing the sustainability of the financial system in the digital the environment.

Certain goals have been set to regulate the DLT pilot mode. First of all, the European Commission thought about legal certainty and compliance of the regulatory framework with the intended use of technology. Stimulating innovation is the second goal, and this can only be done by removing legal obstacles to the use of DLT. However, the use of this technology is still limited due to the lack of consideration of legislation, which also acts as a barrier. Previously existing regulations have tried to be technologically neutral, but legal interpretations can be a big obstacle to the development of this innovative technology. It is necessary to adopt new regulations that will take into account the specifics of DLT.

Article 3 of the CSDR [2], for example, may be considered an obstacle, since it requires transferable securities that are traded on the trading floor to be recorded in the form of an entry in CSD or on before the expected settlement date. Thus, a DLT system without the issuer's central depository providing a notarial function may be unacceptable from the issuer's point of view. In addition, Article 38 of the CSDR requires that the Central Securities Depository and its participants in all storage chains separate their clients' securities in their accounts from those of any other client and, if applicable, from their clients. However, a security account with which a debit or credit operation is possible may not exist in the DLT environment. The European Commission is currently of the opinion that the pilot regime is useful, allowing for the release of some existing market infrastructure requirements for trading and settlement of transferable securities. In this way, these infrastructures can experiment with the technology and assess when and how its full potential will be realized. It will also provide valuable knowledge to legislators to assess whether more extensive changes should be made to existing financial legislation.

The DLT pilot mode focuses on requirements for multilateral trading mechanisms (MTFs) and securities settlement systems (DLT SSS). DLT MTFs are defined as multilateral trading platforms operated by an investment firm or market operator that only allow trading in transferable DLT securities and that can be authorized on the basis of transparent, non-discretionary, uniform rules and procedures to:

a) ensure initial accounting of transferable DLT securities,

b) settle transactions in transferable DLT securities against payment,

c) provide custody services in relation to DLT transferable securities or, where applicable, related payments and collateral provided using DLT MTF.

The securities settlement system, managed by the central securities depository and called DLTS, is designed to settle transactions with securities that will be transferred to DLT. Payment for transactions with securities is carried out by contrasting payments. According to CSDR, the completion of the transaction with the made party occurs when transferring cash, securities or combinations thereof.

The proposal defines «market infrastructures» in a broad sense, as it considers multilateral trading mechanisms (MTFs) as market infrastructures. In contrast, the Committee on Payments and Market Infrastructure (CPMI) and the International Organization of Securities Commissions (IOSCO), which published the Principles of Financial Market Infrastructure [3] on April 16, 2012, consider only payment systems, central securities depositories, central counterparties, securities settlement systems and trading vaults as market infrastructure, but not MTFs. The CSDR then established that central banks can be authorized if they offer at least a securities settlement service, making CSD and SSS rather equivalent. While the financial industry recognizes the role that DLT can play in clearing and settlement activities, it was initially thought that trading platforms or other trading means were less likely to be affected by the technology.

The argument was that trading platforms or an electronic copy available to other trading tools still need to find counterparties, which will not change when using DLT. Rather, the European Commission is of the opinion that DLT can provide settlements in almost real time, thereby making trading and settlements almost instantaneous. Thus, DLT MTFS will be allowed to also provide settlement services, a service that was originally reserved for CSD. Consequently, in the

pilot mode, the requirement that trade and settlements should be carried out by two different institutions is thus no longer imposed. Paradoxically, DLT SSSS are only allowed to settle DLT transferable securities against payment, which means they cannot offer trading services. This can cause problems with equal playing conditions, as DLT MTFS can offer settlement services, while DLT SSS cannot offer trading services. Thus, DLT MTF will be allowed to perform basic notarial and settlement services that are otherwise performed by central depositories, while they only need to comply with a few equivalent Central Depository rules. By performing the same activity, DLT MTF could thus provide CSD services subject to lower regulatory standards than DLT SSS.

With regard to MTF DLT, the proposal provides that they are subject to all the requirements applicable to MTF in accordance with MiFID II and MiFIR [4], except in cases where its operator requests exceptions from its competent authority, which can provide them. Before a DLT market infrastructure operator wants to become active, they must go through the same authorization procedure as a traditional MTF or CSD, but in this way they can specify the exceptions they seek. However, the competent authority may require the operator to comply with additional conditions to ensure investor protection, market integrity and/or financial stability.[5]

The complexity of implementing digital technologies is recognized by many analysts and managers of key banks. Robin Vince, President and Chief Executive Officer of BNY Mellon, commented on this issue: «A comprehensive regulatory framework is needed, but most of its foundations already exist and can be expanded by regulating traditional assets». [6]

To fully realize the potential of the digital asset ecosystem of the future, public and private leaders must work together to create a smart regulatory framework that combines traditional and digital asset systems. Cryptocurrencies may dictate terms in the headlines, but in fact they are only a small part of the world of digital assets. The basis of such a base should be based on two principles. First, regulation should allow the financial industry to use innovations and new technologies wisely. This is a recognition that the old approaches are already becoming irrelevant and it is necessary to bring to life a new approach that will help the industry not to remain in the past.

A fairly long period has already been passed, where many generations of effective financial principles have been observed. With respect to traditional assets, such as cash, stocks and bonds, its presentation in a digital registry can be considered a breakthrough, especially since the original computer registries and real-time payments were paper before them. This development can improve the accuracy of accounting, make it easier to process certain types of assets, such as, for example, real estate and loans, as well as reduce labor intensity and improve the efficiency of calculations.

The new market infrastructure that benefits the financial system can be maintained using distributed ledger technology, which is the basis for crypto assets. There are several examples of taking advantage of this new technology, such as tokenized bonds and central bank digital currencies, which are being studied by major jurisdictions.

In the fall of 2022, the Federal Reserve Bank of New York and the Monetary Authority of Singapore announced a joint effort to explore how the central bank's wholesale digital currencies can improve the efficiency of cross-border wholesale payments using multiple currencies. [7] Therefore, research and innovation related to digital ledger technology should be encouraged rather than penalized in future regulatory frameworks.

Regardless of the type of organization, asset class, or new technologies, maintaining the basic principles of customer protection, orderly markets, and clear regulatory guidance is the second principle. The financial system as a whole can be undermined if digital assets do not comply with these principles. We should keep in mind that while the characters and products in the financial market may change, the scenario of confusion remains familiar due to the effects of mixed customer assets, poor transparency of information and lack of internal controls.

Despite the active development of technologies, it is necessary to use existing and relevant concepts for all market participants and assets, regardless of their technological state. Among such concepts, it is important to pay attention to adequate management, delineation of customer assets, accurate accounting, compliance with security and technology standards, capital and liquidity, certain limits for credit risks, ensuring protection against money laundering, effective risk management and compliance with regulatory restrictions.

Without rules and a regulatory perimeter, banking institutions will not be able to function and provide their services. Today, thanks to this perimeter, they not only fulfill their obligations, but also receive privileges. An important component of this perimeter is trust, the most valuable currency in the global financial system.

The trust of investors and the public sector is a key factor that determines the success of the financial system as a whole. That is why it is so important to know that there are clear rules in the game. Without trust, our financial system will not be able to provide anything useful and honest.

In addition, it is necessary to understand that the lack of confidence in the financial system can lead to the suppression of the use of new technologies that can help the development of the industry. Thus, the creation and maintenance of rules and regulatory perimeters is a necessity that allows our financial system to exist and develop in a world of constant changes and challenges.

Distributed ledger technology (DLT) is increasingly of interest to institutional investors, and this opens up new prospects in the financial sector. However, the digital asset space is at risk from disruptive innovations to disruptive behavior in general. This may result in limited access to the technology for all interested parties.

To prevent this, a comprehensive regulatory framework is needed, which must be adapted to meet the requirements of the DLT. Many of the principles and rules applied to traditional assets can be extended

to digital assets as well.

It is important to understand that these regulations already exist, and expanding their scope to digital assets will ensure consumer protection, prevent market manipulation and increase transparency in the turnover of digital assets. It is precisely such measures, combined with bold innovations and respect for the rights of all participants, that can make DLT the next financial frontier.

In the search for a way to improve the financial system, it becomes clear that it is necessary to use innovations in the field of digital assets. However, without establishing rules and sound regulatory principles, the risks to customers and the system as a whole may be too high.

In order to achieve a balance between innovation and security, special attention must be paid to protecting trust in the financial system. It is the most valuable asset.

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DIRECTIONS OF DEVELOPMENT OF DIPLOMATIC RELATIONS BETWEEN RUSSIA AND YEMEN

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Abstract

This scientific article is devoted to the study of the directions of development of diplomatic relations between Russia and Yemen. The article analyzes the history of diplomatic relations between the two countries, the main problems and challenges facing them, as well as prospects for strengthening cooperation. The study analyzed the potential for the development of cooperation in such areas as economics, energy, culture and education. The key factors contributing to the development of relations, as well as possible obstacles to cooperation were identified. In conclusion, the article draws conclusions about the prospects for the development of diplomatic relations between Russia and Yemen, and identifies areas for further research in this area.

Keywords*:* directions of development, diplomatic relations, Russia, Yemen, economy, energy, culture, education, potential, problems, challenges, prospects, cooperation.

Introduction. Russia and Yemen have long-standing historical ties, but in recent years, economic and political difficulties have led to a weakening of relations between these states. Russia is the largest arms exporter to Yemen, but at the same time, the trade turnover between the two countries leaves much to be desired. In 2020, the trade turnover between Russia and Yemen amounted to only 11.7 million US dollars, while between Russia and Saudi Arabia - 1.7 billion US dollars.

The problems between Russia and Yemen are not only related to trade, but also to the military conflict in the region. Yemen has been in a state of civil war since 2015, and Russia is one of the participants in the international coalition that supports the Yemeni government. In addition, Russia and Yemen have a common problem with terrorism and extremism. In light of these problems, it is necessary to consider the possibilities of further development of interstate cooperation between Russia and Yemen, including the economic, political and military spheres, in order to strengthen relations and resolve the conflict in the region.

The main part. Today, against the background of the difficult geopolitical situation in the Middle East, the issues of diplomatic relations between Russia and Yemen are becoming increasingly important. In addition, Russia and Yemen have significant potential for developing economic cooperation, especially in the field of energy and other industries.

Diplomatic relations between Russia and Yemen have a long history that dates back to the Soviet period. In 1967, after the separation of South Yemen from the British Empire, the Soviet Union established diplomatic relations with the new state.

In 1986, after the unification of South and North Yemen into a single state, Russia continued to maintain diplomatic relations with Yemen. In 1990, after the unification of the GDR and the FRG, Russia was one of the first states to recognize the Republic of Yemen.

In recent years, relations between Russia and Yemen have become more intense. In 2009, as part of Yemeni President Ali Abdullah Saleh's visit to Moscow, an agreement on cooperation between Russia and Yemen was signed. In 2013, Russian President Vladimir Vladimirovich Putin and Yemeni President Abd Rabbu Mansour Hadi signed an agreement on friendship, cooperation and partnership between the Russian Federation and the Republic of Yemen. However, in light of recent events such as the war in Yemen, relations between Russia and Yemen have begun to change. Russia stands for a peaceful settlement of the conflict in Yemen and supports the idea of a national dialogue between the conflicting parties. In addition, Russia also provides humanitarian assistance to Yemen. [1] At the moment, relations between Russia and Yemen are developing in several directions:

1. Military-technical cooperation. Russia is the largest supplier of weapons to Yemen, especially in terms of heavy weapons, including tanks, self-propelled artillery and other military equipment. Recently, Russia and Yemen have been actively discussing the possibility of expanding military-technical cooperation, including the supply of new types of weapons and training of military personnel.

2. Economic cooperation. Russia and Yemen are striving to develop economic ties, although the volume of trade between these countries is still small. Recently, Russia and Yemen have been actively discussing the possibilities of expanding cooperation in trade, energy and agriculture.

3. Political cooperation. Russia and Yemen maintain dialogue at the political level and actively cooperate within the framework of international organizations, including the United Nations and the League of Arab States.

4. Humanitarian cooperation. Russia provides humanitarian assistance to Yemen within the framework of international programs aimed at combating hunger

and poverty, as well as supports medical care and educational projects.

Despite the existing diplomatic relations, Russia and Yemen face a number of problems and challenges that can have a negative impact on bilateral relations. Some of these issues and challenges include:

1. The war in Yemen: The conflict in Yemen, which began in 2015, has become a major problem for relations between Russia and Yemen. Russia supports a peaceful settlement of the conflict and a national dialogue between the conflicting parties, while the Republic of Yemen is at war, which makes it difficult to develop cooperation between the two countries.

2. Economic problems: Economic difficulties in Yemen may hinder the development of bilateral relations, as Yemen is one of the poorest countries in the world. In addition, economic sanctions against Russia may also have a negative impact on trade and investment between the two countries.

3. Security: Security issues are also a challenge for relations between Russia and Yemen. Yemen is located at the intersection of the routes between Africa and Asia, and is located near the Blue and Red Seas, which makes it a strategically important place. However, problems with terrorism and piracy in this region may pose threats to the security of the two countries.

4. Humanitarian situation: Yemen is facing a serious humanitarian crisis caused by the conflict, which has affected many sectors of the economy and social sphere. Russia provides humanitarian aid to Yemen, but the scale of the problem requires more attention that is serious and cooperation between the two countries. [2]

Thus, solving these problems and challenges can be a key step in the development of diplomatic relations between Russia and Yemen. In addition, the development of economic cooperation can contribute to strengthening relations between the two countries, especially if we take into account the prospects for oil and gas trade, as well as the development of other industries such as agriculture and fisheries. [3]

In order to determine the potential for strengthening cooperation between Russia and Yemen, it is necessary to analyze opportunities for expanding cooperation in various fields.

1. Economic cooperation: Russia and Yemen have the potential to expand economic cooperation, especially in the oil and gas industry, in which both countries have significant resources. Russian companies are already working in the oil and gas sector of Yemen, and this cooperation can be further expanded. In addition, agriculture and fisheries may also present opportunities for cooperation, given the traditional development of these industries in Yemen.

2. Trade: is an important area of cooperation between Russia and Yemen. The volume of trade turnover between the two countries has not been very high in recent years, but it still has potential for growth. The main goods that Russia exports to Yemen are petroleum products, metals and food products, as well as many other goods. Yemen, in turn, exports goods such as coffee, textiles, fruits and nuts to Russia. A possible area of cooperation in the field of trade between Russia and Yemen may be the expansion of the range of goods that can be exported and imported between the two countries, as well as an increase in trade turnover. To do this, work can be carried out to improve the infrastructure for the transportation of goods and to assist entrepreneurs and businesspersons from both countries in establishing contacts and establishing business relations. In addition, work can be carried out to attract investments in trade projects between Russia and Yemen, which can accelerate the development of trade relations between the two countries.

3. Energy: Russia is one of the largest oil and gas producers in the world, and Yemen has significant reserves of oil and natural gas. The development of cooperation in the energy sector can be mutually beneficial for both countries.

4. Science and technology: represent a promising area of cooperation between Russia and Yemen. Russia is one of the world's leading scientific and technological centers and has a well-developed system of scientific research in various fields. Yemen, in turn, has the potential to develop the scientific and technical sector, which can be used to solve various problems faced by Yemeni companies and organizations. A possible area of cooperation in the field of science and technology between Russia and Yemen may be the organization of joint research projects that can lead to the development of new technologies and products that can improve the lives of people in both countries. In addition, Russia can provide assistance to Yemen in developing its scientific and technical infrastructure by training Yemeni scientists and researchers in advanced research methods and helping them gain access to new technologies and equipment.

5. Education and culture: Russia can become an important partner for Yemen in the field of education and culture by providing educational programs and experience in the field of cultural exchange. The countries have common cultural ties, and this can be used to strengthen diplomatic relations between the two countries. Russia can offer Yemen assistance in preserving and restoring historical monuments such as Shibam, a city of high-rise buildings that has been recognized as a UNESCO World Heritage Site.

6. Diplomatic dialogue: Russia and Yemen can cooperate within the framework of diplomatic dialogue on various issues, such as combating international terrorism, resolving conflicts in the region and resolving humanitarian issues. This can be achieved through strengthening the exchange of information and opinions between the two countries, as well as through regular meetings of senior diplomats.

Thus, there is a huge potential for expanding cooperation between Russia and Yemen in various fields. Russia and Yemen can strengthen economic, cultural and security relations, as well as develop diplomatic dialogue and cooperation in the economic, social and humanitarian spheres.

The analysis of the prospects for the development of diplomatic relations between Russia and Yemen should take into account the current situation in the country, the region and the world as a whole, as well as the interests and needs of both countries.

On the one hand, Yemen remains a fragmented and unstable State in which armed conflicts, terrorist acts and a humanitarian crisis continue. In these circumstances, the development of diplomatic relations with Yemen may be a challenge for Russia. However, Russia has experience working in difficult regions and can offer its services in resolving conflicts and restoring peace in Yemen. [4] On the other hand, Russia and Yemen have common interests in the region, including the fight against terrorism, energy security and the development of trade and economic cooperation. In this regard, Russia can use its experience in these areas to strengthen relations with Yemen.

In general, the prospects for the development of diplomatic relations between Russia and Yemen depend on many factors, including political stability in Yemen, the interests and needs of both countries, as well as global changes in the world.

Conclusion. Thus, cooperation between Russia and Yemen has the potential to strengthen in various fields such as economics, trade, science and technology, education and culture, energy and tourism. Both countries have their own strengths and achievements in various fields, which can be a starting point for the development of cooperation. Russia and Yemen already have a certain level of cooperation, but much more can be done to strengthen relations between the two countries. It is important to continue working to expand the exchange of experience and knowledge, strengthen cultural ties, develop economic cooperation and trade, as well as establish contacts between representatives of the business communities and investors of both countries. Successful cooperation between Russia and Yemen can not only improve economic and cultural relations between the two countries, but also contribute to solving common global problems such as the fight against terrorism and stabilization of the situation in the Middle East.

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MATHEMATICAL SCIENCES

MODELING THE INFLUENCE OF THE PRESSURE OF THE FLUSHING LIQUID ON THE STRESS STATE OF THE BOTTOM HOLE ZONE OF THE WELL

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МОДЕЛИРОВАНИЕ ВЛИЯНИЯ ДАВЛЕНИЯ ПРОМЫВОЧНОЙ ЖИДКОСТИ НА НАПРЯЖЕННОЕ СОСТОЯНИЕ ПРИЗАБОЙНОЙ ЗОНЫ СКВАЖИНЫ

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Abstract

The article considers the mathematical modeling of the effect of hydrodynamic pressure and filtration of flushing fluid on the stress state of rocks in oil and gas well drilling. Using the finite difference method, the effect of pressure and filtration of the flushing liquid on the stress state of rocks in the bottomhole zone of the well is theoretically investigated.

Аннотация

В статье рассматривается математическое моделирование влияния давления и фильтрации промывочной жидкости на напряженное состояние горных пород в бурении нефтяных и газовых скважин. Используя метод конечных разностей, теоретически исследуется влияние давления и фильтрации промывочной жидкости на напряженное состояние горных пород призабойной зоны скважины.

Keywords: drilling of wells, filtration of washing liquid, radial and angular stress components, finite difference.

Ключевые слова: бурение скважин, фильтрация промывочной жидкости, радиальная и угловая компоненты напряжения, конечная разность.

Введение

Вопросам исследования напряженного состояния призабойной зоны при фильтрации жидкости или газа посвящены многочисленные работы, из которых можно отметить [1-8]. В этих работах указано на существенную роль фильтрационного давления на разрушение горных пород, освоение продуктивных горизонтов и гидравлический разрыв пласта. Лабораторными исследованиями и промысловыми экспериментами установлено, что на эффективность разрушения горных пород определяющее влияние оказывает проницаемость пород[6-7]. Фильтрация бурового раствора в разрушаемую породу разгружает скелет и тем самым облегчает разрушение. При бурении проницаемых пород жид-

кость в поровом пространстве сжимается под воздействием ударной силы струи, что уменьшает дифференциальное давление в скважине и приводит к увеличению механической скорости проходки.

Так как большая часть разбуриваемого разреза скважин представлена проницаемыми породами, существенное место в изучении механизма разрушения горных пород струями жидкости занимает изучение напряженно-деформированного состояния и разрушения породы под действием фильтрационного потока жидкости. В [1, 4, 6, 7] изучены эпюры порового давления в зависимости от свойств горной породы и фильтрующейся жидкости при различных перемещениях струи. При этом, ограничивались решением фильтрационной задачи и не рассматривалось напряженное состояние горной породы под действием фильтрационного давления. В данной работе рассматривается математическое моделирование влияния гидродинамического давления промывочной жидкости на напряженное состояние горных пород призабойной зоны в бурении нефтяных и газовых скважин.

1. Основные уравнения

Основные уравнения напряженно-деформированного состояния горных пород с учетом фильтрационного потока жидкости рассмотрено в работах [9,10]. Уравнения движения имеет вид

$$\sum_i \frac{\partial \sigma_{ik}}{\partial k} = \rho \frac{\partial^2 u_{ik}}{\partial t^2}, \qquad (i,k = x,y,z),, \tag{1.1}$$

где σ_{ik} - компоненты напряжения; u_i - перемещения; $\rho -$ плотность породы. Ограничимся случаем, когда перемещения и их производные малы. Тогда компоненты тензора деформации имеют вид

$$2\varepsilon_{ki} = 2\varepsilon_{ik} = \frac{\partial u_k}{\partial i} + \frac{\partial u_i}{\partial k}, \quad (i,k = x,y,z).$$

Уравнения закона Гука можно представить в виде

$$\sigma_{ik} = 2G\left(\varepsilon_{ik} + \frac{\mu}{1-2\mu} e\delta_{ik} + \frac{1+\mu}{1-\mu}\varepsilon_* p\sigma_{ik} \right), \quad (i,k = x,y,z), \tag{1.2}$$

где $\varepsilon_{ki} -$ компоненты тензора деформации; $u_i -$ перемещения; $e -$ объемное расширение:

$e = \varepsilon_{xx} + \varepsilon_{yy} + \varepsilon_{zz}$; $G -$ модуль сдвига породы; $\mu -$ коэффициент Пуассона; $\delta_{ki} -$ символы Кронекера: $\delta_{ki} = 0$, если $i \neq k$, $\delta_{ki} = 1$, если $i = k$; $\varepsilon_* = \beta_1 K -$ параметр сцементированности породы, $\beta_1 -$ сжимаемость, $K(1-m_0) -$ модуль всестороннего сжатия породы, $m_0 -$ пористость.

В бурении нефтяных и газовых скважин, призабойную зону определенным приближением можно моделировать в виде сферической полости («сферический забой»). Предполагается, что в сферических координатах имеет место симметрия относительно начала координат. Тогда отличной от нуля будет только компонента перемещения в радиальном направлении $u(r,t)$. Напряжения $\sigma_{r\varphi}, \sigma_{\varphi\theta}, \sigma_{\theta r}$ обращаются в нуль, а все остальные величины не зависят от углов φ и θ. Уравнения движения имеют вид.

$$\frac{\partial \sigma_{rr}}{\partial r} + \frac{2}{r}(\sigma_{rr} - \sigma_{\varphi\varphi}) = \rho \frac{\partial^2 u}{\partial t^2}, \; \sigma_{\varphi\varphi} = \sigma_{\theta\theta}. \tag{1.3}$$

Здесь

$$\sigma_{rr} = \frac{2G}{1-2\mu}\left[(1-\mu)\frac{\partial u}{\partial r} + 2\mu\frac{u}{r} + \varepsilon_*(1+\mu)p \right], \tag{1.4}$$

$$\sigma_{\varphi\varphi} = \sigma_{\theta\theta} = \frac{2G}{1-2\mu}\left[\mu\frac{\partial u}{\partial r} + \frac{u}{r} + \varepsilon_*(1+\mu)p \right]. \tag{1.5}$$

$$\varepsilon_{rr} = \frac{\partial u}{\partial r}, \;\; \varepsilon_{\varphi\varphi} = \varepsilon_{\theta\theta} = \frac{u}{r}, \;\; e = \frac{\partial u}{\partial r} + 2\frac{u}{r}, \;\; \frac{\partial \varepsilon_{\varphi\varphi}}{\partial r} + \frac{1}{r}(\varepsilon_{\varphi\varphi} - \varepsilon_{rr}) = 0, \tag{1.6}$$

$$\Delta u - \frac{2}{r^2}u + \varepsilon_* \frac{(1+\mu)}{1-\mu}\frac{\partial p}{\partial r} = \frac{1-2\mu}{2(1-\mu)} \cdot \frac{\rho}{G} \cdot \frac{\partial^2 u}{\partial t^2}, \tag{1.7}$$

где

$$\Delta = \frac{\partial^2}{\partial r^2} + \frac{2}{r}\frac{\partial}{\partial r} = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 \frac{\partial}{\partial r} \right)$$

- оператор Лапласа в сферической системе координат.

2. Фильтрация промывочной жидкости в призабойной зоне скважины

Исследования гидромеханического способа бурения нефтяных и газовых скважин основано на математическом моделировании напряженного состояния горных пород под действием сжимающего воздействия фильтрационного потока промывочной жидкости. Оно требует в первую очередь, определение перераспределения давления в зоне разрушения проницаемой породы на забое и по пласту, обусловленных фильтратом бурового раствора, поступающего под давлением из скважины.

Рассмотрим бесконечную упруго-пористую среду, содержащей сферическую полость радиуса r_0. При $t > 0$ на поверхность полости начинает действовать динамическое давление струй промывочной жидкости $p_j(t)$. Определим распределение порового давления в области $r_0 < r < +\infty$. В данном случае искомое давление описывается уравнением пъезопроводности в сферической системе координат:

$$\frac{\partial p}{\partial t} = \chi \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 \frac{\partial p}{\partial r}\right), \quad (r_0 < r < +\infty),, \tag{2.1}$$

где $p(r,t) -$ поровое давление; $\chi -$ коэффициент пьезопроводности; $t -$ время; $r -$ радиальная координата.

Предполагается, что первоначально пласт находится в невозмущенном состоянии с пластовым давлением. Поэтому давление в среде (в порах) в начальный момент считаем равным пластовому давлению $p_{пл}$. Тогда начальное и граничные условия для уравнения (2.1) можно представить в виде:

$$p(r,0) = p_{пл}, \quad (r_0 \le r < +\infty); \tag{2.2}$$

$$p(r,t) = p_j(t), \quad p(+\infty,t) = p_{пл} \quad (t > 0), \tag{2.3}$$

Введем новые безразмерные величины

$$\bar{r} = \frac{r}{r_0}, \bar{t} = \frac{t}{t_x}, \bar{p} = \frac{p}{p_0}, \ \bar{p}_{пл} = \frac{p_{пл}}{p_0}, \ \bar{p}_j = \frac{p_j}{p_0}, \quad \bar{\chi} = \frac{t_x}{r_0^2}\chi, \tag{*}$$

и перепишем (2.1)-(2.3) в безразмерных величинах:

$$\frac{\partial \bar{p}}{\partial \bar{t}} = \bar{\chi}\frac{1}{\bar{r}^2}\frac{\partial}{\partial \bar{r}}\left(\bar{r}^2 \frac{\partial \bar{p}}{\partial \bar{r}}\right), \quad (1 < \bar{r} < +\infty), \tag{2.4}$$

$$\bar{p}(\bar{r},0) = \bar{p}_{пл}, \quad (1 \le \bar{r} < +\infty); \tag{2.5}$$

$$\bar{p}(1,\bar{t}) = \bar{p}_j(\bar{t}) \quad \bar{p}(+\infty,\bar{t}) = \bar{p}_{пл}, (\bar{t} > 0), \tag{2.6}$$

где $t_x \ p_0 -$ некоторые характерные значения времени и давления (в расчетах за t_x мы принимаем конечное время счета *T*, а за $p_0 -$ максимальное осевое давление струи).

Решение задачи (2.4)-(2.6) нетрудно получить в аналитическом виде. Для случая, когда

$$p_j(t) = p_0(a_0 + a_1 \cos \omega t), \text{ т.е. } \bar{p}_j(\bar{t}) = a_0 + a_1 \cos \bar{\omega}\bar{t}),$$

оно имеет вид

$$\bar{p}(\bar{r},\bar{t}) = \frac{a_0}{2\bar{r}} erfc\,\frac{\bar{r}-1}{2\sqrt{\bar{t}}} + \frac{a_1}{2\bar{r}} e^{-\sqrt{\frac{\bar{\omega}}{2}}\bar{r}} \cos\left(\bar{\omega}\bar{t} - \sqrt{\frac{\bar{\omega}}{2}}\bar{r}\right),$$

где $\omega -$ частота колебаний, $\bar{\omega} = \omega t_x;$ $a_0 = 1, a_1 = 0 -$ соответствует «ударному», $a_0 = 0, a_1 = 1 -$ периодическому, $a_0 = 1, a_1 = 1 -$ пульсирующему воздействию жидкости.

3. Расчет перемещений и компонент напряжения

В рассматриваемом случае сферической симметрии отлично от нуля только радиальная компонента перемещения $u(r,t),$ через которой компоненты напряжения и деформации выражаются формулами

$$\sigma_{rr} = \frac{2G}{1-2\mu}\left[(1-\mu)\frac{\partial u}{\partial r} + 2\mu\frac{u}{r} + \varepsilon_*(1+\mu)p\right], \ \sigma_{\varphi\varphi} = \sigma_{\theta\theta} = \frac{2G}{1-2\mu}\left[\mu\frac{\partial u}{\partial r} + \frac{u}{r} + \varepsilon_*(1+\mu)p\right].$$

$$\sigma_m = \sqrt{\sigma_{rr}^2 + \sigma_{\varphi\varphi}^2 + \sigma_{\theta\theta}^2},$$

где $\sigma_m -$ модуль напряжения.

С учетом уравнения движения (1.3), получим следующее дифференциальное уравнение относительно перемещения:

$$\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial u}{\partial r}\right)-\frac{2}{r^2}u+\alpha\frac{\partial p}{\partial r}=\frac{1}{b^2}\frac{\partial^2 u}{\partial t^2}, \tag{3.1}$$

где

$$\alpha=\varepsilon_*\frac{1+\mu}{1-\mu},\quad b^2=\frac{G}{\rho}\cdot\frac{2(1-\mu)}{1-2\mu}.$$

Считаем, что в начальный момент среда находится в невозмущенном состоянии, поэтому начальными условиями для уравнения (3.1) будут:

$$u(r,0)=0,\quad \frac{\partial u(r,0)}{\partial t}=0,\quad (r_0<r<+\infty). \tag{3.2}$$

На поверхность забоя (сферической полости) при $t>0$ начинает воздействовать давление струй промывочной жидкости $p_j(t)$, т.е.

$$\sigma_{rr}(r_0,t)=-p_j(t). \tag{3.3}$$

Считаем, что при достаточно большом расстоянии от забоя скважины перемещение практически отсутствует, т.е.

$$u(r,t)=0.\ \text{при}\ r\to+\infty. \tag{3.4}$$

При численном решении задачи условие (3.4), для достаточно большого относительно r_0 числа R заменим условием

$$u(R,t)=0,\quad (t>0,\ R>>r_0). \tag{3.5}$$

В уравнении (3.1) и краевых условиях (3.2)-(3.5) переходим к безразмерным величинам. Для этого наряду с (*), введенными в предыдущем разделе, введем следующие безразмерные величины:

$$\bar{u}=\frac{u}{r_0};\ \ \bar{\sigma}_{tt}=\frac{\sigma_{ii}}{\sigma_0},\ (i=r,\varphi,\theta);\ \ c^2=b^2\frac{t_x^2}{r_0^2};\ \ \bar{\alpha}=\alpha\sigma_0;\ \ \lambda=\frac{\mu}{1-\mu}, \tag{3.6}$$

где

$$\sigma_0=p_0=\frac{2G(1-\mu)}{1-2\mu}.$$

В безразмерных величинах получим уравнение

$$\frac{1}{\bar{r}^2}\frac{\partial}{\partial\bar{r}}\left(\bar{r}^2\frac{\partial}{\partial\bar{r}}\right)-\frac{2}{\bar{r}^2}\bar{u}+\bar{\alpha}\frac{\partial\bar{p}}{\partial\bar{r}}=\frac{1}{c^2}\frac{\partial^2\bar{u}}{\partial\bar{t}^2}, \tag{3.7}$$

с краевыми условиями

$$\bar{u}(\bar{r},0)=0,\ \frac{\partial\bar{u}(\bar{r},0)}{\partial\bar{t}}=0,\quad (1\le\bar{r}\le\bar{R});; \tag{3.8}$$

$$\bar{\sigma}_{rr}(1,\bar{t})=-\bar{p}_j(\bar{t})\ \text{или}\ \left[\frac{\partial\bar{u}}{\partial\bar{r}}+2\lambda\frac{\bar{u}}{\bar{r}}\right]\Bigg|_{r=1}=-(1+\bar{\alpha})\bar{p}_j(\bar{t}); \tag{3.9}$$

$$\bar{u}(\bar{R},\bar{t})=0. \tag{3.10}$$

Безразмерные компоненты напряжения имеют вид:

$$\bar{\sigma}_{rr}=\frac{\partial\bar{u}}{\partial\bar{r}}+2\lambda\frac{\bar{u}}{\bar{r}}+\bar{\alpha}\bar{p},\ \bar{\sigma}_{\varphi\varphi}=\bar{\sigma}_{\theta\theta}=\lambda\frac{\partial\bar{u}}{\partial\bar{r}}+(1+\lambda)\frac{\bar{u}}{\bar{r}}+\bar{\alpha}\bar{p}. \tag{3.11}$$

Для решения задачи (3.7) – (3.11) применим метод конечных разностей. С этой целью, учитывая, что наибольшее изменение искомых величин происходит непосредственно около забоя скважины, используем неравномерную сетку [11]

$$\varpi=\left\{(r_i,t_j):r_i=1+h_r i^2,\ i=\overline{0,N},\ h_r=\frac{\bar{R}-1}{N^2};\ t_j=h_t j,\ j=\overline{1,M},\ h_t=\frac{\bar{T}}{M}\right\},$$

и непрерывную область $1\le\bar{r}\le\bar{R},\ 0\le\bar{t}\le\bar{T},\ (\bar{T}=T/t_x)$ покроем сеточной областью (r_i,t_j), где $\bar{r}=r_i,\ \bar{t}=t_j,\ T-$ конечное время счета.

Заменяя производные, входящие в (3.7) с конечными разностями, используя разностную схему с весом σ, получим следующее разностное уравнение

$$\frac{1}{r^2\hbar_i}\left[r^2_{i+\frac{1}{2}}\left(\sigma\frac{\hat{u}_{i+1}-\hat{u}_i}{h_{i+1}}+(1-2\sigma)\frac{u_{i+1}-u_i}{h_{i+1}}+\sigma\frac{\breve{u}_{i+1}-\breve{u}_i}{h_{i+1}}\right)\right]-$$

$$-\frac{1}{r^2\hbar_i}\left[r^2_{i-\frac{1}{2}}\left(\sigma\frac{\hat{u}_i-\hat{u}_{i-1}}{h_i}+(1-2\sigma)\frac{u_i-u_{i-1}}{h_i}+\sigma\frac{\breve{u}_i-\breve{u}_{i-1}}{h_i}\right)\right]-\frac{2}{r_i^2}(\sigma\hat{u}_i+(1-2\sigma)u_i+\sigma\breve{u}_i)+$$

$$+\frac{\overline{\alpha}}{h_i+h_{i+1}}\left[\sigma(\hat{p}_{i+1}-\hat{p}_{i-1})+(1-2\sigma)(p_{i+1}-p_{i-1})+\sigma(\breve{p}_{i+1}-\breve{p}_{i-1})\right]=\frac{\hat{u}_i-2u_i+\breve{u}_i}{c^2h_t^2},\quad(3.12)$$

где

$$\hat{u}_i=u_i^{j+1}=\overline{u}(\overline{r}_i,\overline{t}_{j+1}),\ u_i=u_i^j=\overline{u}(\overline{r}_i,\overline{t}_j),\ \breve{u}_i=u_i^{j-1}=\overline{u}(\overline{r}_i,\overline{t}_{j-1}),$$

$$h_i=r_i-r_{i-1},\ \hbar_i=r_{i+\frac{1}{2}}-r_{i-\frac{1}{2}},\ r_{i\pm\frac{1}{2}}=1+h_r\left(i\pm\frac{1}{2}\right)^2;\quad i=\overline{1,N};\ \ j=\overline{1,M}\cdot$$

Вводя обозначения:

$$\overline{A}_i=\frac{c^2h_t^2}{\hbar_i h_i}\frac{r^2_{i-\frac{1}{2}}}{r_i^2},\ \overline{B}_i=\frac{c^2h_t^2}{\hbar_i h_{i+1}}\frac{r^2_{i+\frac{1}{2}}}{r_i^2},\ \overline{C}_i=\overline{A}_i+\overline{B}_i+\frac{2\sigma c^2h_t^2}{r_i^2};$$

$$F_i=2u_i-\breve{u}_i+(1-2\sigma)(\overline{A}_iu_{i-1}-\overline{C}_iu_i+\overline{B}_iu_{i+1})+\sigma(\overline{A}_i\overline{u}_{i-1}-\overline{C}_i\breve{u}_i+\overline{B}_i\breve{u}_{i+1})+$$

$$+\frac{\overline{\alpha}c^2h_t^2}{h_i+h_{i+1}}[\sigma(\hat{p}_{i+1}-\hat{p}_{i-1})+(1-2\sigma)(p_{i+1}-p_{i-1})+\sigma(\breve{p}_{i+1}-\breve{p}_{i-1})],$$

$$A_i=\sigma\overline{A}_i,\ B_i=\sigma\overline{B}_i,\ C_i=1+\sigma\overline{C}_i,$$

Систему уравнений (3.12) можно представить в виде

$$A_i\hat{u}_{i-1}-C_i\hat{u}_i+B_i\hat{u}_{i+1}=-F_i\quad(i=\overline{1,N-1}).\quad(3.13)$$

Аппроксимация начальных условий (3.8) и граничного условия (3.10) имеет следующий вид:

$$u_i^0=0,\quad\breve{u}_0^0=0.\quad(3.14)$$

$$\hat{u}_N=0;\quad(3.15)$$

Для аппроксимации граничного условия (3.9) проинтегрируем уравнение (3.7) на промежутке $[1,\ r_{\frac{1}{2}}]$, осредняя интегралы и используя соотношение (3.9) получим следующее равенство

$$C_0\hat{u}_0=B_0\hat{u}_1+F_0,\quad(3.16)$$

где

$$\overline{B}_0=\frac{c^2h_t^2r_{0.5}^2}{h_1(r_{0.5}-1)},\ \overline{C}_0=\overline{B}_0+2c^2h_t^2-\frac{2\lambda c^2h_t^2}{r_{0.5-1}},\ B_0=\sigma\overline{B}_0,\ C_0=1+\sigma\overline{C}_0,$$

$$F_0=2u_0-\breve{u}_0+(1-2\sigma)(\overline{B}_0u_1-\overline{C}_0u_0)+\sigma(\overline{B}_0\overline{u}_1-\overline{C}_0\breve{u}_0)+$$

$$+\frac{(1+\overline{\alpha})c^2h_t^2}{r_{0.5}-1}[\sigma\overline{p}_j^{\,j+1}+(1-2\sigma)\overline{p}_j^{\,j}+\sigma\overline{p}_j^{\,j-1}]+\frac{\overline{\alpha}c^2h_t^2}{r_{0.5}-1}\cdot$$

$$\cdot[0.5r_{0.5}^2(\sigma\,\hat{p}_0+(1-2\sigma)p_0+\sigma\,\breve{p}_0)+(1+0.5r_{0.5}^2-2r_{0.5})(\sigma\,\overline{p}_j^{\,j+1}+(1-2\sigma)\overline{p}_j^{\,j}+\sigma\,\overline{p}_j^{\,j-1})].$$

Уравнение (4.13) с условиями (4.14)-(4.16) решается методом прогонки:

$$\hat{u}_i=\alpha_{i+1}\hat{u}_{i+1}+\beta_{i+1},\quad(i=\overline{1,N-1}),\quad(3.17)$$

где

$$\alpha_i=\frac{B_i}{C_i-\alpha_iA_i},\ \beta_i=\frac{A_i\beta_i+F_i}{C_i-\alpha_iA_i},\quad(i=1,N-1).\quad(3.18)$$

Последовательность расчетов следующая:

- из (3.16) следует, что

$$\alpha_1=\frac{B_0}{C_0},\ \beta_1=\frac{F_0}{C_0};$$

- по формулам (3.18) вычисляются коэффициенты прогонки для $i=1,\ldots,N-1$;

- используя, что $\hat{u}_N=0$, для $i=N-1,N-2\ldots,0$ вычисляются значения $\hat{u}_i$;

- используя найденные значения перемещения для каждого временного слоя по формулам

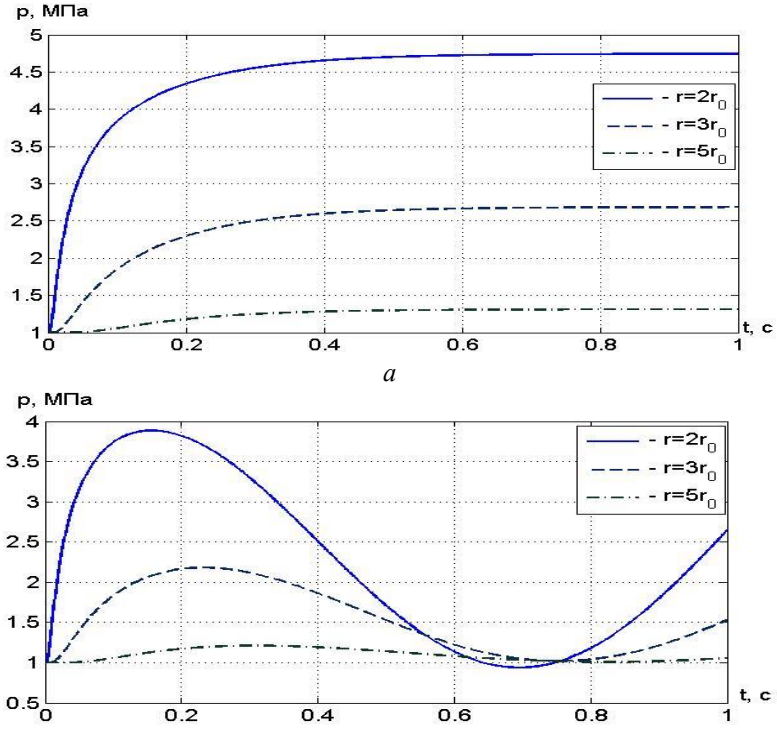
$$\hat{\bar{\sigma}}_{rri} = \frac{\hat{\bar{u}}_{i+1} - \hat{\bar{u}}_{i-1}}{h_{i+1} + h_i} + 2\lambda \frac{\bar{u}_i}{r_i} + \overline{\alpha}\hat{\bar{p}}_i, \quad \hat{\bar{\sigma}}_{\varphi\varphi i} = \hat{\bar{\sigma}}_{\theta\theta i} = \lambda \frac{\hat{\bar{u}}_{i+1} - \hat{\bar{u}}_{i-1}}{h_{i+1} + h_i} + (1+\lambda)\frac{\bar{u}_i}{r_i} + \overline{\alpha}\hat{\bar{p}}_i,$$

$$\hat{\bar{\sigma}}_{mi} = \sqrt{\hat{\bar{\sigma}}_{rri}^2 + \hat{\bar{\sigma}}_{\varphi\varphi i}^2 + \hat{\bar{\sigma}}_{\theta\theta i}^2} \qquad (3.19)$$

вычисляются безразмерные компоненты и модуль напряжения.

4. Результаты и обсуждения

С помощью полученных формул проведены численные расчеты по следующим исходным данным: $r_0 = 0.1\ м;\ \ p_{пл} = 10^6\ Па;\ \ p_0 = p_j = 1.5 \cdot 10^7\ Па;\ \ \chi = 1\ м^2/с.$ Графики зависимости давления жидкости от времени для значений радиальной координаты для $r = 2r_0; 3r_0; 5r_0$. *а.* $\omega = 0;$ *б.* $\omega = 5\ c^{-1}$ показаны на рис. 1.



а

а

Рис. 1. Графики зависимости от времени давления промывочной жидкости для значений радиальной координаты $r = 2r_0; 3r_0; 5r_0$ *а.* $\omega = 0;$ *б.* $\omega = 5\ c^{-1}.$

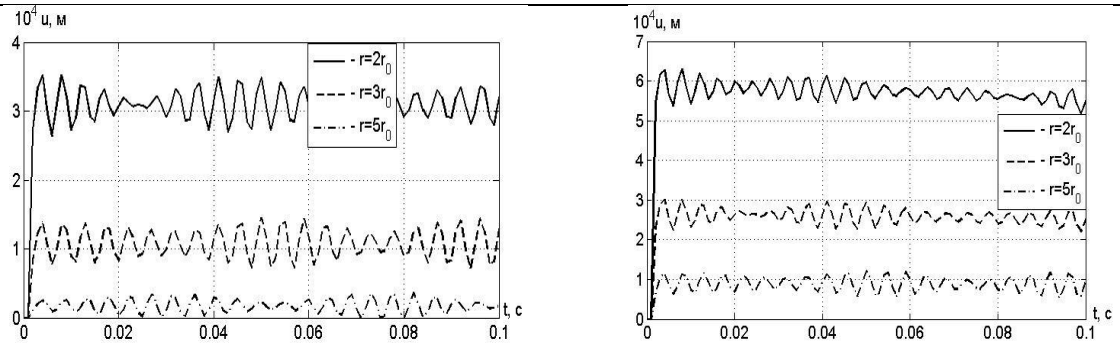
При расчетах компонент напряжения для значений параметров приняты следующие:

$r_0 = 0.1\ м;\quad \chi = 1 м^2/с;\ \rho = 2500\ кг/м^3;\ \ p_{пл} = 10^6\ Па;\ p_j = 1.5 \cdot 10^7\ Па;\ \mu = 0.2;$

$G = 2.86 \cdot 10^8\ Па;\ \ \varepsilon_* = 0.25;\ \ \omega = 0,\ 5;\ 15\ 1/с;\ \ R = 10.1\ м.$

Изменение по координате радиальной компоненты напряжения в моментах времени t=0.01, 0.5, 1 с. a. $\varepsilon_* = 0, \omega = 5\,1/с$. b. $\varepsilon_* = 0.25, \omega = 5\,1/с$ показаны на рис. 2. Видно, что при отсутствии фильтрации жидкости ($\varepsilon_* = 0, \omega = 0$) профили радиального напряжения для «ударного» и пульсирующего давлений существенно не отличаются друг от друга.

В случае $\varepsilon_* = 0, \omega = 5\,1/с$, значения радиальной компоненты напряжения с удалением от забоя, сначала резко уменьшаются, особенно в начале процесса, а затем начинает возрастать оставаясь отрицательной и стремится в нуль (рис. 2a). Фильтрационное воздействие промывочной жидкости (при $\varepsilon_* = 0.25, \omega = 5\,1/с$) приводит к увеличению абсолютного значения радиальной компоненты напряжения только в начале процесса. Под действием колебания, графики для значений t=0.5 с и t=1 почти сменяются (рис. 2b).



а *б*

Рис. 2. Изменение по координате радиальной компоненты напряжения в моментах времени t=0.01, 0.5, 1 с. a. $\varepsilon_* = 0, \omega = 5\,1/c$ *. b.* $\varepsilon_* = 0.25, \omega = 5\,1/c$ *.*

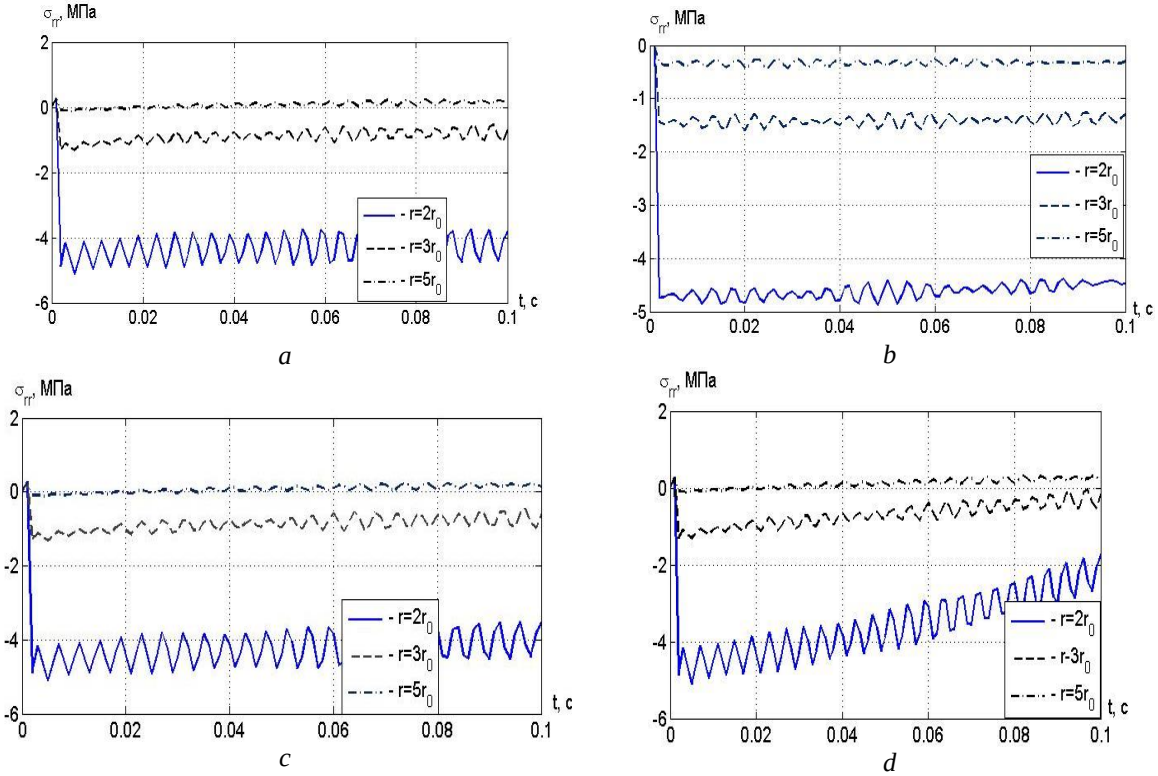
На рис. 3 приведены зависимость от времени радиальной компоненты напряжения по времени для $r = 2r_0, 3r_0, 5r_0$ в промежутке времени $0 < t \le 0.1\,c$ при:

a. $\varepsilon_* = 0.25, \omega = 0$; b. $\varepsilon_* = 0, \omega = 5\,1/c$; c. $\varepsilon_* = 0.25, \omega = 5\,1/c$; d. $\varepsilon_* = 0.25, \omega = 15\,1/c$.

Рис. 3а показывает, что вблизи забоя скважины (например, при $r = 2r_0$) напряжение резко возрастает, затем, со временем медленно возрастает и стремится к некоторому среднему значению. При $r = 3r_0, r = 5r_0$ такой характер изменения сохраняется, но упомянутое среднее значение возрастая переходит в положительную область. Влияние пульсации промывочной жидкости (без учета фильтрации, $\varepsilon_* = 0, \omega = 5\,1/c$) на изменение радиального напряжения показано на рис. 3b. Здесь графики имеет такой же колебательный характер, как в предыдущем случае, но за рассматриваемый промежуток времени среднее значение радиальной компоненты напряжения не переходит в положительную область.

Для изучения совместного влияния фильтрации и пульсаций промывочной жидкости на радиальное напряжение рассматривались случаи $\varepsilon_* = 0.25, \omega = 5\,1/c$ (рис. 3c) и $\varepsilon_* = 0.25, \omega = 15\,1/c$ (рис. 3d).

Рис. 3c существенно не отличается от рис. 3a, это связано с тем, что при малых частотах колебаний и времени $\cos\omega t$ мало отличается 1. При относительно больших частотах колебаний влияние пульсаций станет заметным, при $\omega = 15\ 1/c$, оно приведет к быстрому убыванию абсолютного значения напряжения вблизи забоя скважины (рис. 6d).



a *b*

c *d*

Рис. 3. Зависимость от времени радиальной компоненты напряжения для $r = 2r_0, 3r_0, 5r_0$ *в промежутке времени* $0 < t \le 0.1\,c$ *. a.* $\varepsilon_* = 0.25, \omega = 0$ *; b.* $\varepsilon_* = 0, \omega = 5\,1/c$ *; c.* $\varepsilon_* = 0.25, \omega = 5\,1/c$ *; d.* $\varepsilon_* = 0.25, \omega = 15\,1/c$ *.*

Графики изменения угловой компоненты напряжения по радиальной координате для значений времени t=0.01; 0.5; 1 с показаны на рис. 4. Влияние частоты колебаний на угловое напряжение без учета изменения порового давления (при $\varepsilon_* = 0, \omega = 5\,1/c$, 4a) и (при $\varepsilon_* = 0, \omega = 15\,1/c$, рис. 4b), показывает, что при относительно малых значениях времени ($t = 0.01c$) профили напряжений существенно не отличаются.

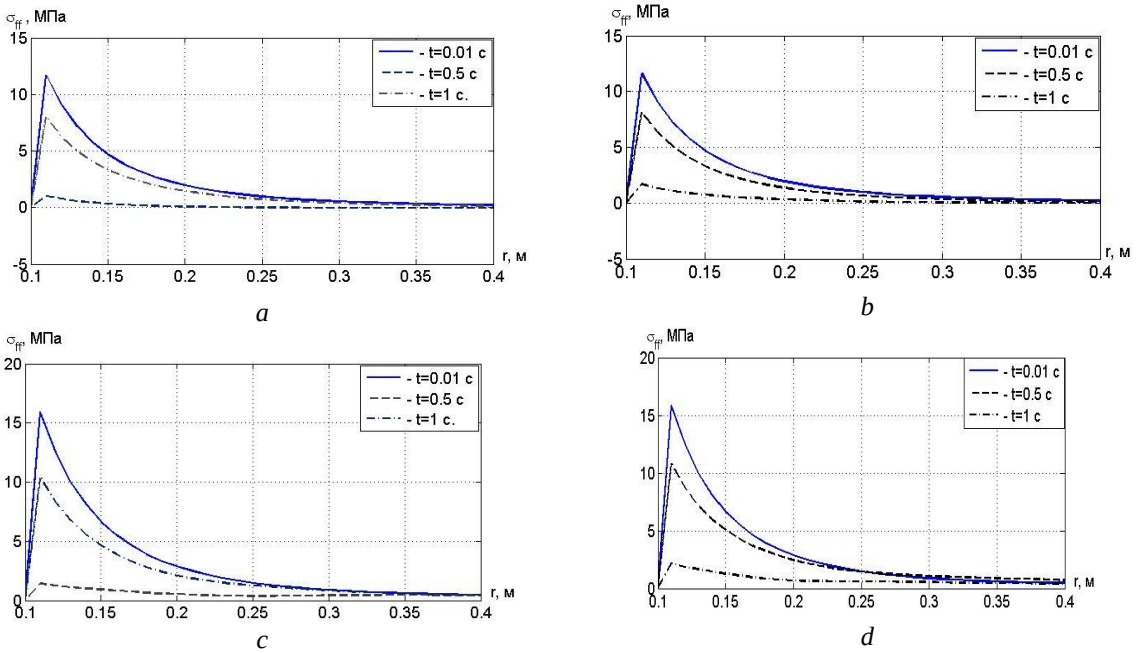


Рис. 4. Распределение угловой компоненты напряжения по координате при t=0.01, 0.5, 1 с. a. $\varepsilon_* = 0, \omega = 5\,1/c$ *; b.* $\varepsilon_* = 0, \omega = 15\,1/c$ *; c.* $\varepsilon_* = 0.25, \omega = 5\,1/c$ *; d.* $\varepsilon_* = 0.25, \omega = 15\,1/c$.

Поровое давление при значении параметра сцементированности, $\varepsilon_* = 0.25$, при тех же значениях частоты колебания, приводит к увеличению значений углового напряжения, характер распределения (формы графиков) не изменится (рис. 4.7c, 4.7d). Во всех случаях, с течением времени и удалением от забоя значение напряжения стремится в нуль (порода разгружается).

На рис. 5 приведены графики изменения угловой компоненты напряжения по времени для $r = 2r_0, 3r_0, 5r_0$ в промежутке времени $0 < t \le 0.1\,c$. Видно, что при $\varepsilon_* = 0, \omega = 0$ ее значения вначале скачком увеличивается, особенно около забоя скважины (на рисунке при $r = 2r_0$), с удалением от забоя уменьшается (на рисунке при $r = 3r_0, 5r_0$). С течением времени средние значения стремятся к определенному предельному значению. Это среднее значение с удалением от забоя уменьшается истремится в нуль (рис. 5a). Под влиянием фильтрации значения углового напряжения увеличивается ($\varepsilon_* = 0.25, \omega = 0$), но характер изменения (форма кривых) существенно не изменится (рис. 5b) $\varepsilon_* = 0.25, \omega = 0$.

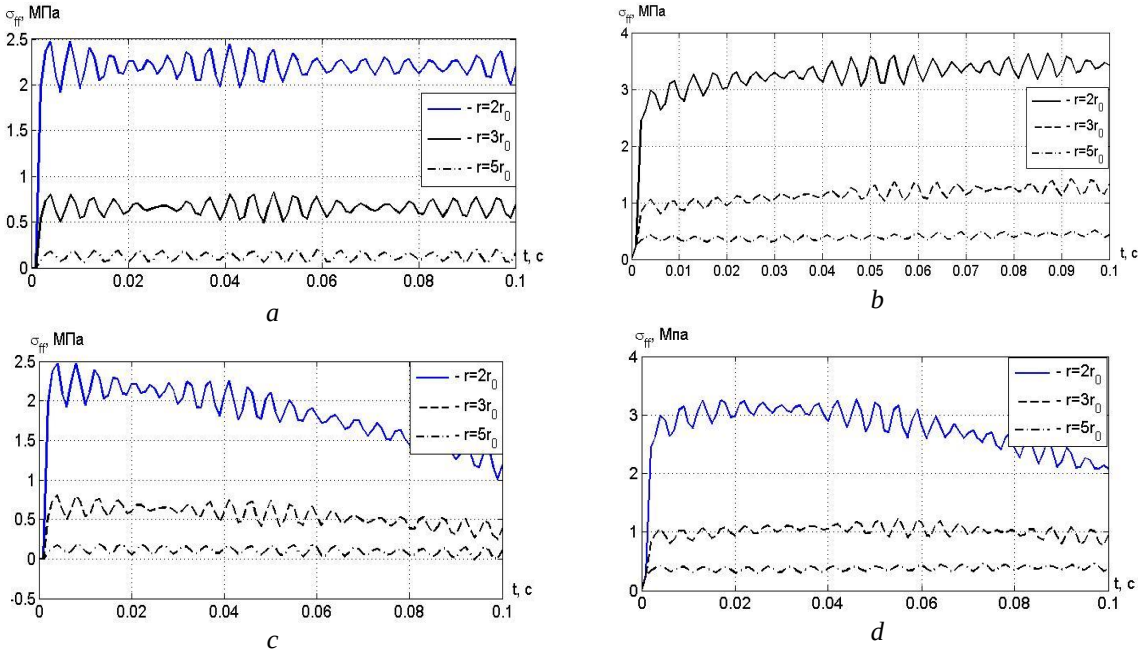


Рис. 5. Изменение угловой компоненты напряжения по времени для $r = 2r_0, 3r_0, 5r_0$ *в промежутке времени* $0 < t \le 0.1\,c$. *a.* $\varepsilon_* = 0, \omega = 0$ *b.* $\varepsilon_* = 0.25, \omega = 0.$ *c.* $\varepsilon_* = 0, \omega = 15\,1/c.$ *d.* $\varepsilon_* = 0.25, \omega = 15\,1/c.$

На рис. 5c ($\varepsilon_* = 0, \omega = 15\,1/c.$) и рис. 5d ($\varepsilon_* = 0.25, \omega = 15\,1/c.$) показаны влияние изменения порового давления на угловое напряжение при одной и той же частоты колебания. Из графиков видно, что фильтрация жидкости приводит к увеличению углового напряжения и к стабилизации его значений со временем.

5. Заключение

При пульсирующем воздействии промывочной жидкости при отсутствии фильтрации значения радиального напряжения сначала резко уменьшается, затем начинает возрастать и стремится в нуль. Фильтрационное воздействие промывочной жидкости приводит к увеличению абсолютного значения компонент напряжения, особенно, в начале процесса. Увеличение порового давления при одних и тех же значениях частоты колебаний, приводит к увеличению значений углового напряжения. Таким образом, пульсирующее давление струй промывочной жидкости может привести к увеличению разрушения горных пород, тем самым увеличению механической скорости бурения.

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MEDICAL SCIENCES

CLINICAL CHARACTERISTICS OF ACUTE DIARRHEA DISEASES IN CHILDREN

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Abstract

Due to the fact that acute diarrheal diseases, under the influence of many climatic and social factors, sometimes have an unsatisfactory course with the formation of invasive diarrhea syndrome, and also cause various complications and often turn into chronic forms, and today it continues to be an urgent problem for pediatricians and children's infectious disease specialists. Diarrhea is a syndrome that is estimated as a violation of intestinal function accompanied by acceleration of defecation when the intestine is damaged by toxins, bacteria and viruses. Currently, acute intestinal infections (AII), accompanied by diarrhea, occupy second place in the structure of infectious diseases after respiratory viral infections. According to WHO statistics, more than 1 billion people fall ill every year in the world, and 65-70% of them are children under 5 years of age. It has already been established that diarrhea is the second leading cause of child mortality. According to statistics, in 2017, 1.8 million children under the age of 5 years died from diarrheal diseases [1,6,8]. 40% of hospitalized patients with infectious diseases make up OKI. In recent years, despite the introduction into medical practice of the most modern laboratory-diagnostic methods and the use of a wide spectrum of action of drugs in the treatment of these diseases, doctors working in the system of practical health care still face many difficulties in the diagnosis and treatment of AII of bacterial origin (in connection with the resistance of pathogens) [2,9].

Keywords: child, diarrhea, acute intestinal infection, dysbacteriosis, intestinal microflora.

Goal of the work: Comparative assessment of the clinical features of acute diarrheal diseases in children of different ages.

Material and methods: studies were conducted on 86 young children: 54 patients with acute diarrheal diseases of established etiology (n=54), 32 patients with acute diarrheal diseases of unknown etiology (n=32). 30 healthy children (n=30) were selected as a control group. Among 86 children with diarrhea under observation, 52 (60.5%) were boys, 34 (39.5%) were girls. The patients were divided into 3 age groups: Group I 4-12 months 35 (40.7%); Group II 1-2 years 37 (43.0%); Group III 14 (16.3%) patients aged 2-3 years. The vast majority of children with acute onset of the disease were hospitalized 73 (84.9%). These patients, along with anamnestic data, underwent general clinical and bacteriological studies.

Results. The clinical characteristics of diseases accompanied by acute diarrheal syndrome were studied taking into account the child's age, diet and etiology of the disease. When assessing the severity of the condition, it was found that between children with acute diarrhea of unknown etiology (n=54) and acute diarrhea of unknown etiology (n=32), moderate and severe diarrhea was more common. (61% and 74%, respectively), and relapses of the disease are significantly higher (38.6%) in children under 1 year of age. In other words, there is a direct relationship between the severity of the disease and the age of the child. The etiology of acute diarrhea was established in 71 (82.6%) patients using a bacteriological research method, PCR diagnosis was carried out in 52 (60.5%) patients. During examination of 42 patients, the etiological factor of diarrhea was revealed to be of bacterial origin: salmonellosis - in 17 (31.5% - mainly in children under 1 year of age), dysentery - in 18 (33.3%) patients, in 7 (16.7%) patients - *E. Coli.* When analyzing the dependence of the frequency of acute diarrhea on the etiological factor, it was found that in children under 1 year of age, despite the predominance of salmonellosis (Salmonella typhimurium in our survey) compared to dysentery, with increasing age the proportion of dysentery in the etiology of acute diarrhea remains consistently high, and the frequency acute diarrheal diseases in children over 1 year of age are generally 3 times higher than in children under 1 year of age. This trend is also evident for certain diseases. Since the proportion of Escherichia infection in children under 1 year of age is 14.3%, then among children aged 1-3 years this figure almost doubles (22.9%). Among children under 1 year of age, acute diarrheal diseases of unknown etiology account for about 31.3%, which requires further improvement of laboratory diagnostic methods. When studying the dependence of cases of acute diarrhea on the type of diet, it was found that 37 (43%) children were mixed-fed, 24 (27.9%) children were naturally fed, and 26 (30.2%) children were bottle-fed. Among these children, diarrhea most often occurred in children fed too much mixed food. Cases of relapse and severe course of the disease, diarrhea was observed mainly in formula-fed children (61.7%). In our studies, diarrheal diseases,

which occurred mainly in the form of gastroenterocolitis (43.2%) and gastroenteritis (34.8%), did not reveal a significant difference between the compared groups in the localization of lesions in the gastrointestinal tract.

During the study, we also analyzed the clinical characteristics of symptom complexes of acute diarrhea in children under 1 year of age (n=35) and 1-3 years of age (n=51) with symptoms of acute diarrhea (Table 1).

Table 1

Comparative clinical characteristics of symptoms of acute diarrhea in children under 1 year and 1-3 years

Signs		Up to 1 year (n=35)		1-3 years (n=51)	
		abs	%	abs	%
onset of the disease	acute	24	68,6	38	74,5
	gradually	10	28,6	11	21,6
body temperature	norm	5	14,3	7	13,7
	>38	21	60	28	54,9
	<38	9	25,7	16	31,4
general weakness		35	100	51	100
slackness		35	100	51	100
pale skin		34	97,1	51	100
dry mucous membranes		35	100	51	100
coated tongue		34	97,1	51	100
sleep disorder		19	54,3	26	50,9
decreased appetite		33	94,3	49	96,1
Nausea		19	54,3	32	62,7
vomit	one by one	20	57,1	31	60,8
	numerous	6	17,1	7	13,7
abdominal pain		32	91,4	42	82,4
flatulence		23	65,7	30	58,8
pain in the sigmoid colon		12	34,3	22	43,1
tenesmus		8	22,8	18	35,3
stool character	liquid with slime	25	71,4	35	68,6
	with mucus and admixture of blood	7	20,0	12	23,5
	abundant watery	2	5,7	5	9,8
amount of stool	3-5	12	34,2	15	29,4
	5-10	19	54,3	25	49,0
	10-15	4	11,4	9	17,6
	>15	0	0	4	7,8
hepatomegaly		12	34,3	17	33,3

As can be seen from the table, the disease in both groups usually has an acute onset and is 68.6% and 74.5%, respectively. In both groups, the severity of the condition was determined primarily by impaired water-electrolyte metabolism and the development of intestinal toxicosis, and the manifestation of clinical signs was varied. However, among these signs in all children, general symptoms of intoxication were considered more characteristic: increased body temperature (60.0 and 54.9%, respectively), general weakness, lethargy, peeling of the skin, dry mucous membranes, dry tongue, sleep disturbances (54.3 %). and 50.9%), decreased appetite (94.3 and 96.1%). The severity of both the general toxic syndrome and local manifestations varies depending on age. Thus, if single cases of vomiting were recorded more often in children aged 1-3 years (60.8%) compared to children under 1 year of age (57.1%), then multiple vomiting was more often observed in children under 1 year of age (17, 1%). In both groups, there was a significant increase in the frequency of abdominal pain (91.4 and 82.4%, respectively) and bloating syndromes (65.7 and 58.8%). Pain in the sigmoid colon, attacks of tenesmus or their equivalents were more pronounced in children 1-3 years old (22.8 and 35.3, respectively). In addition to the indicated main clinical signs of the disease, all patients had diarrhea, among whom more transparent mucous stools were observed (71.4 and 68.6%, respectively) and bloody mucous stools (20.0 and 23.5%, respectively). In acute diarrheal diseases in 54.3% of children under 1 year and in 49.0% of children 1-3 years old, a 5-10-fold increase in the daily amount of stool lasting 12-14 days as the main symptom again confirms the leading role of diarrhea An objective examination revealed hepatomegaly in 67.6% of patients, splenomegaly in 36.4%, pathological heart murmurs and wheezing in the lungs in 28.6%. For children under 1 year of age, mild dehydration and a toxic-dystrophic state are more typical, manifested by such symptoms as sharpness of facial features, large drooping and sunken eyes, decreased tissue turgor, dry mucous membranes and a burning sensation ($p>0.01$),acute diarrhea in children 1-3 years old was accompanied by dehydration and exicosis of the first degree. In acute diarrheal diseases, due to an increase in the daily number of bowel movements and persistence of stool disorders, even after the cessation of antibacterial therapy and the end of the inflam-

matory process in order to study the intestinal microbiota, a microbiological study of stool was carried out in all children. Taking into account the acceleration of defecation and the persistence of stool abnormalities even after the cessation of antibacterial therapy and the end of the course of treatment for acute diarrheal diseases in order to study the intestinal microbiosis was carried out a microbiological study of stool in all children. During these examinations, the presence of dysbacteriosis of varying degrees was confirmed in all (100%) children: in 16 (18.6%) patients - degree I, in 46 (53.5%) patients - degree II, in 14 (16, 3%) - Patients with grade III dysbacteriosis. In 64.2% of patients, a deficiency of bifidobacteria, 66.8% of lactobacilli and 37.4% of *Escherichia coli* was determined. At the same time, fungi of the genus Candida, Klebsiella and Proteus were detected in significant titers in some children. One of the issues that drew attention was that despite the disappearance of clinical symptoms during therapy, the recovery of the body in all children occurs very slowly. This situation was once again confirmed by the identification of the pathogen in 1/3 of the children at the 3-4th week of the disease and the persistence of varying degrees of intestinal dysbiosis during repeated microbiological studies.

Conclusion. Thus, we can conclude that in modern times, during acute diarrheal diseases, a number of different changes are observed, which manifests itself in the fact that diarrheal diseases in most patients become moderate and severe forms, the recovery process lasts up to 3-4 weeks, and pathogens acquire multiresistance to antibiotics. In our study, a severe course of the disease with an unsatisfactory outcome in some children was more often associated with a severe intoxication syndrome, clearly defined disturbances of water-electrolyte metabolism and immunodeficiency, and in rare cases with congenital background diseases.

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PHILOLOGICAL SCIENCES

THE ROLE OF AI IN EFL TEACHING AND LEARNING

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Abstract
This article explores the use of Artificial Intelligence (AI) in teaching English as a Foreign Language (EFL) and provides an overview of two innovative technologies: ChatGPT and Wordtune. ChatGPT offers an interactive environment for students to practice speaking in English through virtual dialogues, while Wordtune provides AI-assisted text rewriting. The article discusses the advantages and disadvantages of using technology in education, specifically AI, and its impact on learning. It emphasises the importance of balancing innovation with caution, ensuring human control and the development of critical thinking.

Keywords: Artificial Intelligence (AI), EFL Teaching (English as a Foreign Language), ChatGPT, Wordtune, Language Learning Technologies, Educational Innovation, Language Proficiency Enhancement, AI Writing Tools, Pedagogical Applications, Ethical Implications

Education is becoming the primary location for experimentation and innovation due to the rapid evolution of technology. In particular, the field of teaching English as a foreign language (EFL) is at the forefront, utilizing cutting-edge technology, such as artificial intelligence (AI), to enhance learning outcomes. This paper delves into the role of AI in EFL instruction, focusing on two advanced technologies: Wordtune and ChatGPT. ChatGPT, a Generative-Transformative Networks (GPT) based technology, offers textual feedback through virtual dialogues, providing a unique learning experience. On the other hand, Wordtune, an AI-powered tool, offers text revision, alternative phrasing, and writing advice, boosting language competency and English writing skills. In this essay, we explore the practical applications of these technologies and their impact on teaching English to non-native speakers, improving language proficiency, and creating an engaging learning environment conducive to efficient language acquisition.

The use of AI-powered writing tools in English as a foreign language (EFL) classrooms is on the rise. In addition to grammar checks and writing aids, there are programs that will create a written work like an essay without requiring any human assistance. Their ease of use and effectiveness save students and educators both time and energy. Furthermore, AI writing tools have been used specifically for English as a foreign language learners with lower English proficiency. Students can obtain rapid feedback and support through the use of these tools, allowing them to detect and correct errors more quickly. Recently, there has been an increase in the number of viewpoints about how artificial intelligence affects pupils' writing skills. Others suggest that employing AI can assist students improve their writing skills, while others are concerned about the potential negative consequences of these tools. These include reliance on technology, safety concerns, a lack of empathy, and a lack of inventiveness.The Chat Bot is one example of innovation that is fast gaining popularity. Artificial intelligence (AI) has taken over the globe, and its powers have been recognized by everyone from academics to ordinary Internet users. It is a component of artificial intelligence, which many people find fascinating. However, some educators are concerned about them. They've heard stories of cheating and bad behavior involving chat bots. Concerned about the usage of ChatGPT, educational institutions have declared a ban on its use one following another. Teachers and school administrators believe ChatGPT jeopardizes pupils' critical thinking and writing abilities. ChatGPT is a computer application that communicates with people in a way that feels natural. ChatGPT can converse with users in a natural and responsive manner. The language model's neural network, which employs vast data sets to construct varying strengths of connections, ensures that ChatGPT can generate textual responses similar to human speech, answer follow-up inquiries, admit mistakes, and so on. ChatGPT can additionally produce text in a wide range of formats such as essays, humor, and poetry. It's performance on similar tasks (e.g., answering similar questions) can be improved with continuing user interaction.

Essentially, contrary to widely held and frequently idealized notions, ChatGPT analyzes the available data to determine the most likely (i.e., most frequent and pertinent) answers to users' queries rather than reasoning or reacting emotionally. As a result, end-user feedback is critical to its eventual accuracy. ChatGPT is unable to "understand" the language it creates or the context of the information because of its underlying methodology, resulting in plausible-sounding yet inaccurate or nonsensical answers. . Scientists and media outlets have previously expressed worries regarding the correctness of material offered by ChatGPT, with some claiming that ChatGPT invents content in the face of a dearth of expertise and even fabricates phony sources. Experts discovered that, notwithstanding their apparent capability, chatbots do not understand the meaning of the words being proposed. To be more specific, ChatGPT is a new text-generating search tool that lacks the ability to search the Internet for pertinent content,

but it does an amazing job of simulating human interaction and filtering out superfluous information to propose what the user is looking for. It is, without a doubt, a really powerful search tool, but there is where it ends, reminding us of the same wonder we felt when we first used Google search or Google scholar. The prevalent uneasiness is largely the result of a lack of comprehension of technology, which leads to an anxiety of the unfamiliar. Texts generated by a chatbot using a big language model are easy to recognize at this stage because the writing style follows a pattern. This imagined level of capacity has prompted severe ethical issues concerning the use of GPT4's future generation. According to Business Insider (2023), OpenAI CEO Sam Altman has stated that the next generation of GPT will not be distributed until they figure out how to utilize it securely and ethically. As long as then, second/foreign language educators have a bit of time to work over the issue of ethical and responsible usage of chatbots with students, discussing their benefits, challenges, and risks, which is a far better method than avoiding the matter totally.

ChatGPT provides numerous educational advantages and prospects. Some argue that experiential learning can assist learners since ChatGPT can generate various problem-solving scenarios. ChatGPT also offers individualized tutoring to students. AI labeling may alleviate educators of a hefty workload, permitting them to devote more time to lesson preparation. ChatGTP has a number of major advantages for students.

Because ChatGPT perfectly simulates human contact, students can quickly initiate an actual dialogue with the chatbot. The benefit of this is that students are usually asking genuine questions, especially when in search of projects to consider. As a result, all of the aspects required for an honest discussion will be present, such as summarizing, asking subsequent inquiries, clarifying, sharing information, and so on. Unlike most classroom sessions, students receive chance to work on many areas of language use. Above all else, ChatGPT is unique in that it provides users with a plethora of academic resources and materials. Many of the platforms or programs previously utilized by students, such as Grammarly, Wikipedia, Google Translate, Quillbot, and so on, are used in tandem by ChatGPT. As a result, he is able to recognize language and organizational issues in pupils' writing, as well as suggest writing ideas and make adjustments. He can also explain and provide examples of how to use terminology. Most significantly, advice is instantaneous, as opposed to instructor feedback, which takes time and might have completely lost whatever was previously written by the time students receive feedback.

Due to ChatGPT is unavoidable, educators and institutions should seize the chance to innovate traditional teaching and evaluation approaches. To begin, SL/FL teachers should minimize the quantity of take-home tasks, which they ought to be doing, because long-standing market tools like Google Translate and Quillbot have eroded the genuineness and reliability of numerous of these assignments. Where take-home projects need to be provided, teachers could offer activities that AI chatbots cannot readily do, such as composing daily diary entries, summarizing lecture content, or other forms of written assignments. Although ChatGPT offers various opportunities for significant changes in education, there are numerous unknown consequences and prospective repercussions that require additional exploration. [1]

Wordtune is a second popular AI writing tool. Wordtune is an artificial intelligence-powered digital writing helper that can alter the chosen content through modifying the structure of sentences or replacement words with synonyms while retaining the original meaning. Machine learning is used in this technology to train a machine to interpret and build natural text from enormous amounts of written material. Wordtune, which is powered by artificial intelligence, recognizes trends in a huge dataset and provides possibilities for creating unique phrases rather than stealing text from other web sources.

Wordtune can be accessed via its own online writer or as a browser extension. As a browser extension, the program works with a variety of online services, including Gmail, Google Docs, Facebook, Twitter, LinkedIn, WhatsApp (web version), Slack, and others. Once installed to the browser, users can write in any compatible web application. Let's go over the way to use Wordtune. Above the selected text, a purple circle with a "W" will emerge. Users can get a list of choices for altering the highlighted text by clicking on this icon. Wordtune offers a variety of rewriting options, such as basic rewriting, informal tone, formal tone, reduced text, and extended text. (Figure 1).

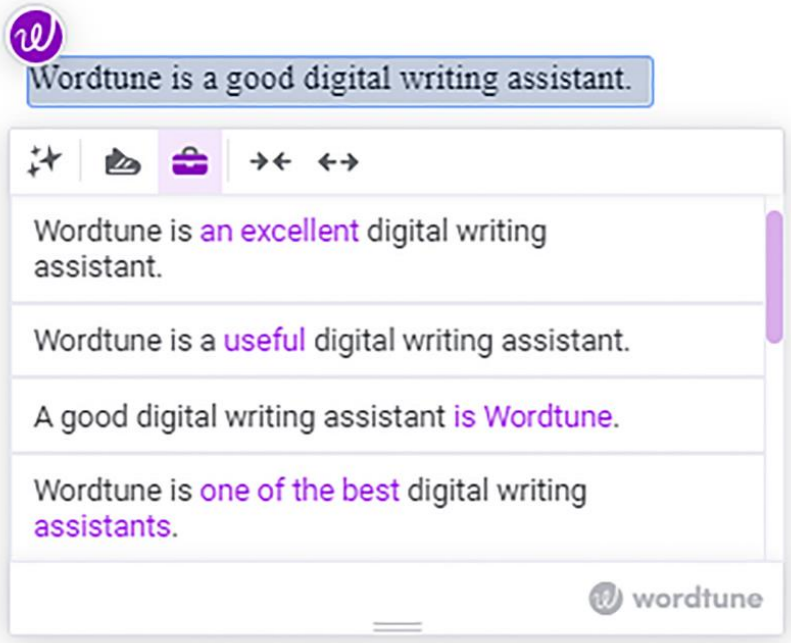

Figure 1. *An example of a rewrite suggestion via Wordtune (formal tone).*

Wordtune is only accessible for English writing at the moment, although it is capable of translating content from various languages into English (Figure 2). This translation option is very helpful for EFL authors who type an expression or section of a phrase in a different language and then choose the content to receive English rephrasing possibilities. The translation feature is available in Spanish, Mandarin, Arabic, Hindi, Korean, Hebrew, and Russian.

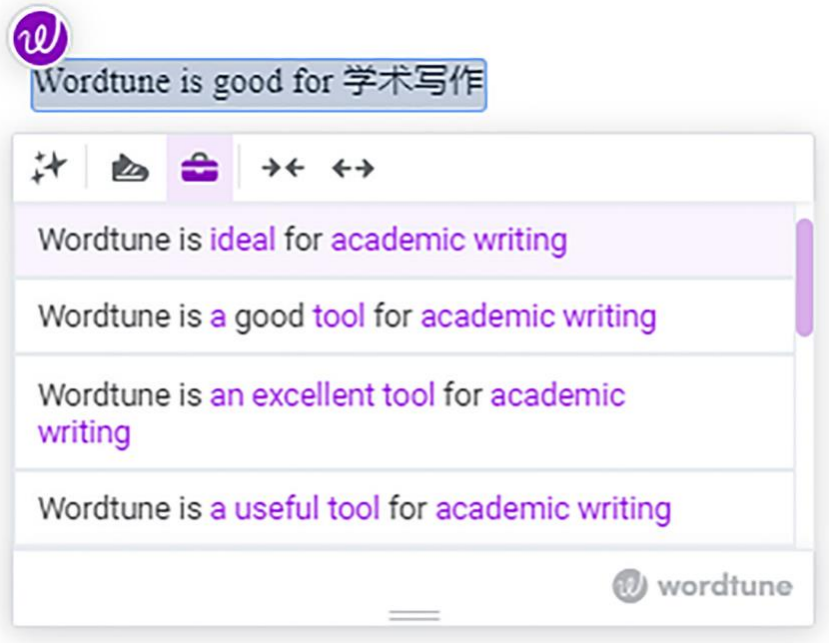

Figure 2. *An example of the translation feature of Wordtune.*

Wordtune is a handy tool for improving the level of quality of what you write in real time. It is appropriate for users with varying levels of knowledge of English. In this regard, the interpreting function is especially valuable for English novices who face a language barrier. Such users may also produce rewriting or paraphrasing choices in English based on an English sentence composed of many terms from their original language (Figure 3). Instead of being caught on a single phrase or expression, the technology will assist them in maintaining a continual flow of English texts. Artificial intelligence-generated rewriting choices will assist users improve their English by proposing relevant synonyms, deleting wrong words, and selecting a desired tone for advanced English writers who want to write at a more sophisticated level. Users can also use the text shortening and lengthening functions to make content more compact or to produce more thoughts. Wordtune provides options for self-directed learning for EFL writers, but it can also be valuable from a pedagogical

standpoint. Teachers, for example, might organize web-based writing assignments and encourage students to utilize Wordtune during the writing process. Teachers should also encourage participants to recollect on what they have learned from participating in the revisions, such as new words, synonyms, clauses, and professional form of sentences that they would not have been able to utilize in their writing otherwise.

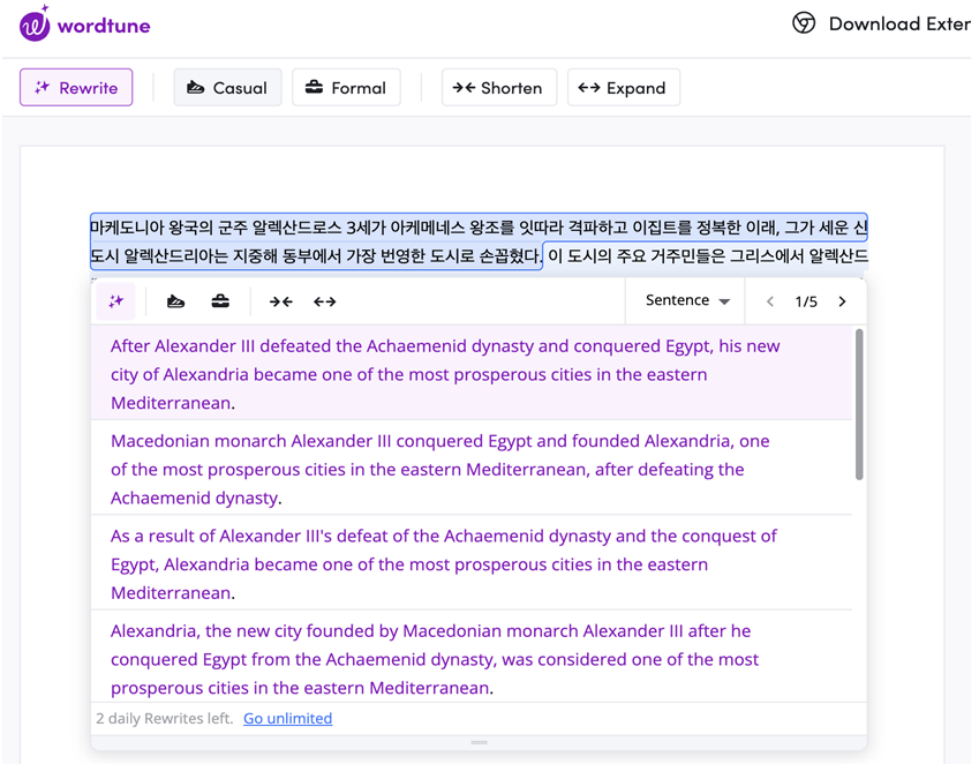

***Figure 3**. An example of the translation feature of Wordtune.*

Wordtune and ChatGPT are two examples of artificial intelligence technologies that are becoming more and more recognized as significant assistants in the writing process. Wordtune acts as an effective writing aid, suggesting various ways to improve and enhance what we write. It is a helpful tool, especially when it comes to developing thoughts or selecting the most relevant words or phrases. ChatGPT, on the other hand, is renowned for its ability to emulate mental processes and conversational abilities, despite being incredibly sophisticated. Teachers frequently expose students to ChatGPT, recognizing its utility but cautioning them about its faults, such as its lack of human interaction and logic. By reconsidering old ways to learning, the development of machine learning in education has resulted in about dramatic change. Despite reservations regarding the utilization of artificial intelligence for knowledge and the risk of misunderstandings, there is an urgent need to strike a balance. It is vital to capitalize on technology improvements while exercising caution in their deployment. The use of AI technologies like ChatGPT and Wordtune deserves to be addressed with caution, emphasizing the significance of control from humans and critical thinking skills in conjunction with dependence on technology. This well-rounded strategy is required to maximize the positive effects of AI-based learning while minimizing its inherent hazards. [2]

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PHYSICAL SCIENCES

SOME QUESTIONS OF THE THEORY OF SOLUTION VISCOSITY

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Abstract
The article has a review on the viscosity models of liquids, starting with the viscosity models of past centuries, then models of viscosity of the XX century and, finally, the rheological models of the XX and XXI centuries. In the field of liquid rheology, there is no satisfactory quantitative theory that connects the rheological properties of the media with the parameters of their structure. The viscosity model of liquids is proposed, in which the liquid is considered as a system of non -current -appropriate molecules, immersed in a thermostat, which is the entire volume of fluid. Quantum transitions due to the interaction of molecules with a thermostat will be dissipative (with a probability P), in contrast to interaction with an external (for example, electric) field (with probability F). Dissipative processes lead to the fact that the secondary field Z_2 is always less than the primary Z_1. Since the subsystem of molecules exchanges only energy with the thermostat, the corresponding ensemble of particles will be canonical. Theoretically calculated response function and a model is built. The fluid viscosity model that we proposed takes into account the thermodynamic properties of the liquid, its structure and response to external fields.

Keywords: visibility, liquid, molecule, model, dissipation, thermostat, Gibbs energy, thermodynamics.

Introduction

Today, solutions are distinguished as: Newtonian; Bingham viscoplastic; pseudoplastic; dilatant liquid. The classification of rheological models of liquids is carried out according to the dependence of the strain rate $\partial\tau/\partial t = \dot{\tau}$ on the shear rate (velocity gradient) $\dot{\tau} = \partial\upsilon/\partial z$. For a Newtonian fluid - a linear law: . For a non-Newtonian fluid: $\sigma = \alpha\dot{\tau}^n$. Pseudoplastic – n < 1, with slow movements the viscosity is high, then decreases. Dilatant liquid – n > 1, viscosity increases with increasing speed. Bingham plastic - the Bingham model is similar to the dry friction model:

$$\sigma = \begin{cases} \sigma_0 + \alpha\dot{\tau}, & \dot{\tau} > 0, \\ -\sigma_0 + \alpha\dot{\tau}, & \dot{\tau} < 0. \end{cases}$$

The most well-known pseudoplastic liquids are paints, emulsions and some suspensions. Although dilatant liquids are not so common, there are quite a lot of them, including most deflocculants: clay suspensions, sand/water systems. An example of a Bingham fluid is paint, in which, due to the action of binders (in particular carboxymethylcellulose), a threshold for shear stress arises, and it is capable of forming fixed layers on vertical surfaces. A separate case of non-Newtonian fluids are thixotropic and rheopex fluids, the viscosity of which changes over time. If the viscosity decreases over time, then the liquid is called thixotropic, and if, on the contrary, it increases, then it is called rheopex.

In this article we will review models of liquid viscosity and propose our own model.

Viscosity models from past centuries

Newton's model

For the first time, internal friction (viscosity) between layers of liquid was noted by I. Newton in 1687. As I. Newton showed (1642-1727) [1], the force of internal friction is proportional to the velocity gradient and area of the contacting layers of the flowing liquid:

$$F = \eta \cdot \frac{\Delta\upsilon}{\Delta Z} \cdot S, \qquad (1)$$

where η is the coefficient of dynamic viscosity.

This result is described in all encyclopedias, monographs and textbooks. However, Newton's errors are known when describing the rotational motion of a viscous fluid, which were later corrected by D. Bernoulli (1700-1782) and Stokes (1819-1903) [2]. A recent paper [3] states "that the viscosity of Newtonian fluids cannot depend on the shear rate." However, formula (1) has been used everywhere for more than 300 years (Fig. 1a).

Navier-Stokes and Poiseuille models

The equations of this model were derived by the French scientist Navier (1785-1836) in 1822 and the English scientist Stokes in 1845 and are called the Navier-Stokes equations (Fig. 1 b) [4]. The equations of motion of a viscous incompressible fluid will be written as follows:

$$\frac{dV_x}{dt} = X - \frac{1}{\rho}\frac{\partial p}{\partial x} + \nu\left(\frac{\partial^2 V_x}{\partial x^2} + \frac{\partial^2 V_x}{\partial y^2} + \frac{\partial^2 V_x}{\partial z^2}\right)$$
$$\frac{dV_y}{dt} = Y - \frac{1}{\rho}\frac{\partial p}{\partial y} + \nu\left(\frac{\partial^2 V_y}{\partial x^2} + \frac{\partial^2 V_y}{\partial y^2} + \frac{\partial^2 V_y}{\partial z^2}\right) \quad (2)$$
$$\frac{dV_z}{dt} = Z - \frac{1}{\rho}\frac{\partial p}{\partial z} + \nu\left(\frac{\partial^2 V_z}{\partial x^2} + \frac{\partial^2 V_z}{\partial y^2} + \frac{\partial^2 V_z}{\partial z^2}\right)$$

where $\nu = \eta/\rho$ - kinematic viscosity of the liquid.

a) *b)*

Figure 1. Viscosity models: according to Newton [1] (a); according to Navier-Stokes (b) [4]

Equations (2) are second order partial differential equations. In these equations, the density ρ, kinematic viscosity ν and projections of external mass forces X, Y, Z are known. Unknown quantities: pressure p and three projections of velocity V_x, V_y, V_z - a total of four unknowns. The number of unknowns exceeds the number of equations. The system of equations is not closed. One more equation is added to this system - the continuity equation. If we set the boundary conditions, then the system of equations (2) will have a unique solution, which, in the case of translational flow of an incompressible fluid in a channel with parallel walls in a gravity field (Fig. 1b), for the pressure loss Δp has the form:

$$p_1 - p_2 = \Delta p = \frac{3\eta \cdot \overline{V} \cdot l}{h^2} \quad (3)$$

The energy loss is proportional to the first degrees of viscosity η, the average speed V and the length l of the channel section under consideration. A similar method is used to solve the problem of laminar fluid flow in a round pipe with diameter d. For pressure loss we obtain Poiseuille's formula (1797-1869):

$$\Delta p = \frac{32\eta \cdot \overline{V} \cdot l}{d^2} \quad (4)$$

Maxwell's model

Initially, Maxwell's model (1831-1879) was proposed to describe the movement of highly viscous liquids, the periods of which are long compared to molecular times [5]. Maxwell's model can be represented by a purely viscous piston and a purely elastic spring connected in series, as shown in Fig. 2a. The model can be represented by the following equation:

$$\sigma + \frac{\eta}{E}\dot{\sigma} = \eta\dot{\varepsilon} \quad (5)$$

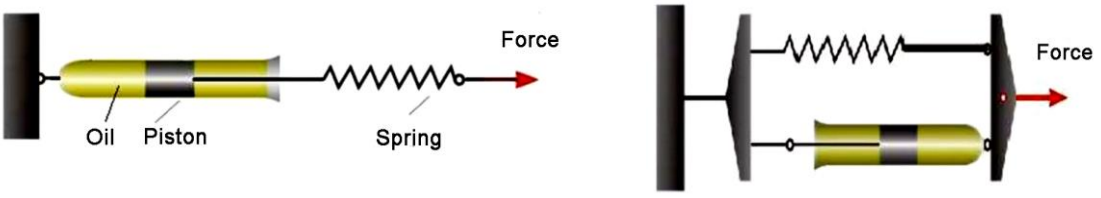
Maxwell's model predicts that the stress σ decreases exponentially with time. This model can be applied to soft solids: thermoplastic polymers near their melting point, fresh concrete (ignoring its aging), and numerous metals near their melting point.

Kelvin-Voigt model

This model is named after the British physicist and engineer Lord Kelfin (1824-1907) and the German physicist Woldemar Voigt (1850-1919). The defining relation is expressed in the form of a first order linear differential equation [5]:

$$\sigma = E\varepsilon + \eta\dot{\varepsilon} \quad (6)$$

This model represents a solid body subject to reversible viscoelastic deformation (Fig. 2b). At constant stress (creep), the model is realistic; it predicts that the strain will tend to σ/E over time to infinity.



a) *b)*

Figure 2. Viscosity models: Maxwell (a); according to Kelvin-Voigt (b) [5]

20th century viscosity models

Let's start with the review [6], which presents models proposed before 1940.

Frenkel model

As is known, Ya.I. Frenkel (1894-1952), when deriving the viscosity formula, proceeded from the idea of a liquid as a "spoiled" crystal lattice, in which atoms, having broken away from their places, moved into the "interlattice space" and oscillate around new unstable

equilibrium positions (Fig. 3a) [7]. The elementary flow process consists of the spontaneous movement of a particle from one temporary equilibrium position to another. Using the Stokes formula (assuming spherical particles, f = 6πηa), he obtains an equation for determining the viscosity coefficient η, namely:

$$\eta = \frac{1}{6\pi a} \cdot f = \frac{\tau_0}{a\delta^2} \cdot \frac{kT}{2\pi} \cdot e^{\frac{E_\eta}{kT}} \quad (7)$$

In the second version of the theory, the diffusion coefficient D is expressed according to the formula of Smoluchowski-Einstein and Ya.I. Frenkel receives:

$$\eta = B \cdot T \cdot e^{\frac{E_\eta}{kT}} \quad (8)$$

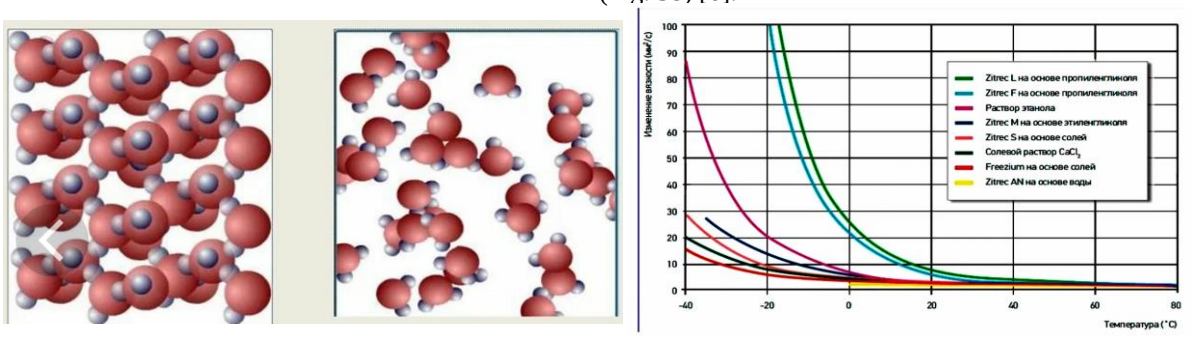
This formula, as indicated by Ya.I. Frenkel, agrees worse with experiment than the exponential dependence of the form η = A exp(Eη/kT), which does not include the absolute temperature as a factor.

Andrade model

Andrade's formula (1887-1971) for the temperature dependence of viscosity is presented in general form:

$$\eta \cdot \upsilon^{\frac{1}{3}} = A \cdot e^{\frac{C}{\upsilon T}} \quad (9)$$

Formula (9) contains an exponential factor characterizing the energy relations of the process, as well as the specific volume. Testing this formula for different liquids gives very good agreement with experiment (Fig. 3b) [6].



a) *b)*

Figure 3. Viscosity models: according to Frenkel, solid molecules (on the left), and liquid molecules (on the right) [7] (a); according to Andrade [6] (b).

Khaikin model

In his theory of liquid viscosity S.E. Khaikin (1901-1968) uses Stewart's idea of the structure of liquids. Stewart (1828-1887) assumes that the liquid consists of small submicroscopic aggregates that retain a crystalline structure. The interaction of these aggregates, located in different layers of liquid, between which there is a velocity difference, leads to the emergence of a viscous force. Khaikin obtains, using Newton's formula, the following expression:

$$\eta = \frac{f_0 \cdot \sqrt{\rho} \cdot \Delta l^{\frac{5}{2}}}{8\sqrt{kT}} \quad (10)$$

Here Δ1 is the size of the aggregate, ρ is the density of the liquid, f0 is the force acting on a unit surface, k and T are, as usual, Boltzmann's constant and absolute temperature.

Assuming then that the sizes of aggregates Δ1 are proportional to $(T-T_0)^{-1}$, and denoting all temperature-independent coefficients through A, he obtains the following temperature dependence of viscosity for oils, alcohol, etc. [8] (Fig. 4a):

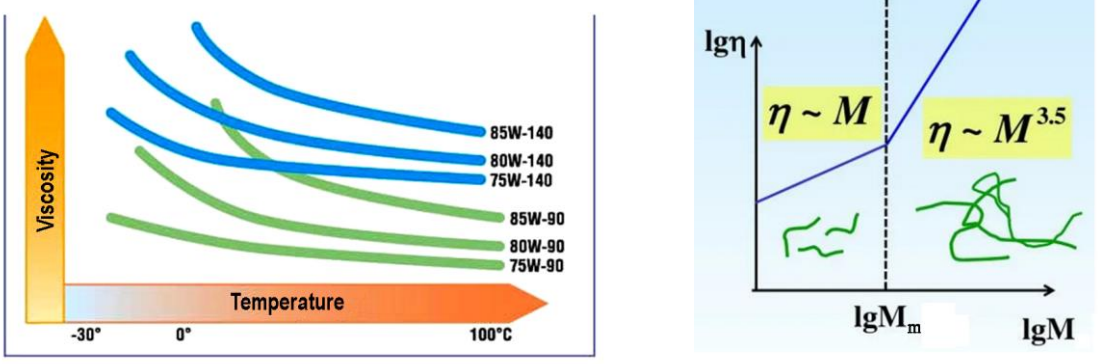
$$\eta = \frac{A}{\sqrt{T \cdot (T - T_0)^5}} \quad (11)$$

Bernal model

Bernal (1901-1971) derives an expression for viscosity:

$$\eta = A \cdot e^{\frac{B}{RT}} \quad (12)$$

In general, A and B are functions of temperature. The activation energy B, in addition, must also depend on pressure, since it significantly depends on the coordination of liquid molecules. Bernal divides all liquids into ionic, homeopolar, metallic and molecular (polymers) (Fig. 4b). In formula (12), parameter A is related to the molar mass of the polymer M [9].



a) *b)*

Figure 4. Viscosity models: according to Khaikin [8] (a); according to Bernal [9] (b).

Eyring-Ewell model

The theory of liquid viscosity, developed by Eyring (1901-1981) and co-workers [6], like Bernal's theory, is based on certain ideas about the nature of the liquid state. Eyring approaches the question of the nature of liquids from the perspective of real gases and uses the methods of static mechanics. Eyring obtains the following formula for calculating viscosity at any temperature and pressure [6]:

$$\eta = 1.090 \cdot 10^{-3} \frac{M^{1/2} \cdot T^{2/3}}{\upsilon^{5/3} \cdot \left(\frac{\partial P}{\partial T}\right)_\eta} \cdot e^{\frac{\upsilon \cdot \left(\frac{\partial P}{\partial T}\right)_\eta}{nRT}} \quad (13)$$

The work of Mott and Gurney [10] is devoted to criticism of Eyring's theory of liquids, or more precisely to the derivation of the distribution function and entropy of melting according to Eyring, who, adhering to the main provisions of Bernal's theory, consider liquid as the limiting state of a polycrystalline body in which the difference between individual crystals disappears.

McLeod model

McLeod (1891-1977) gives an empirical formula for unassociated liquids:

$$\frac{\eta \upsilon^{1/3}}{\sqrt{T}} = \frac{B}{\upsilon - b}, \quad (14)$$

where B is a constant, and for associated liquids:

$$\frac{\eta \upsilon^{1/3}}{\sqrt{T}} = \frac{B}{(\upsilon - b)^n}, \quad (15)$$

These formulas were tested by McLeod for organic liquids, and the agreement with experiment was no worse than Andrade's.

Einstein-Brinkman model

A special place in theoretical and applied rheology is occupied by Einstein's formula (1879-1955) for the viscosity η of dilute, unstructured colloidal solutions:

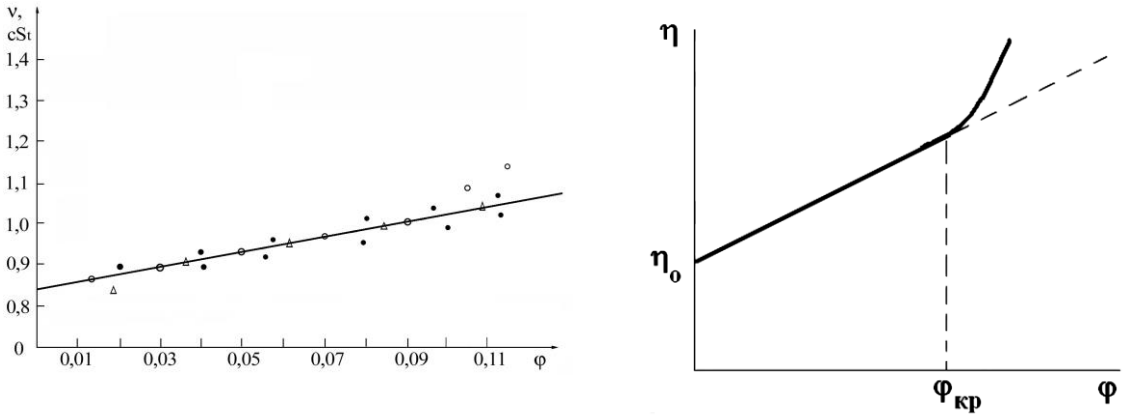
$$\eta = \eta_0 (1 + \alpha\varphi). \quad (16)$$

Here η_0 is the solvent viscosity, φ is the volume fraction of the dispersed phase in the suspension and α is a numerical coefficient equal to 2.5 for spherical particles. The formula gives results that are acceptable in terms of accuracy at a concentration φ of no more than 0.1 (Fig. 5a). In this case, it must be ensured that particles do not stick together.

Of the other forms, the Brinkman equation (1950-2011) is attractive for its simplicity:

$$\eta = \frac{\eta_0}{(1 - \varphi)^\alpha}, \quad (17)$$

which is derived based on Einstein's equation (16) and gives an obvious result: η = ∞ at φ = 1 (Fig. 5b), i.e. when transitioning to a monolithic solid.



a) *b)*

Figure 5. Dependence of the kinematic viscosity of an aqueous solution on the content of the solid fraction [11] (a); viscosity of colloidal solutions [12] (b).

Rheological models of the 20th and 21st centuries

In the field of rheology of liquids, there is not yet a satisfactory quantitative theory connecting the rheological properties of media with the parameters of their structure (see above). A huge number of rheological equations are mentioned in the literature; for example, in works [13-17] you can find information about more than 50 of their types.

Over the past 10 years, rheological models have been covered in doctoral and candidate dissertations [18-31]: viscoelastic properties of magnetic and electrical fluids; non-isothermal flows of two-phase non-Newtonian media over permeable surfaces; dynamics and disintegration of jets of complex liquids; dynamics of an ultrathin layer of liquid; rheometric flows of polymer liquids taking into account shear stratification of the flow; rheokinetics of phase transformations of petroleum systems and gel-forming compositions; nonlinear behavior of concentrated polymer solutions under large periodic deformations; the influence of inertial forces on residual stresses and rheology of polymers and composites based on them; the influence of phase viscosity on the hydrodynamic characteristics of flows of immiscible liquids in microchannels of rectangular cross-section and much more. The same works provide a review of rheological models for all of the above problems.

Liquids, melts, dense plasma and a number of other connected systems that do not have an ordered structure are characterized by an unpleasant property

for constructing their theory - the average kinetic energy E per particle is equal in order of magnitude to the potential energy U [32]. Due to the lack of a small parameter for which it would be convenient to carry out decomposition, there is no strict theory as applied to liquids and melts, such as, for example, to a solid (E/U << 1) or gas (E/U >> 1). In the 20th and 21st centuries, computer models replaced rigorous results [33, 34]. For example, Patent RU 2015611658 dated 02.20.2015 says: "The program is designed to calculate the activation energy of viscous flow and the pre-exponential of the Frenkel-Eyring-Arrhenius equation from two points, as well as to construct viscosity-temperature curves. The program is applicable for any liquids, solutions and dispersed media: polymers and their solutions, petroleum products, food media, etc." And quite a lot of such programs have appeared: Flow3D is a unique program for solving hydrodynamics problems. Developer: Flow Science, USA Developer website: www.flow3d.com; the GazKondNeft software system (PS GKN) performs the functions of computational modeling of phase transformations, thermophysical properties of gas and liquid mixtures, technological processes and schemes; "STARS" is a powerful modern software system that calculates the thermophysical properties and phase state of liquid and gaseous phases, oil fractions, mixtures, including mixtures of hydrocarbons with oil fractions, both at a single point and in a given range of temperatures and pressures; publications in the field of modeling the rheological properties of pulps showed that the most widespread among modern solutions are the following software systems: COMSOL Multiphysics, ANSYS Fluent, OpenFOAM, STAR-CCM+, NeiNastran; The leading positions in the market of oil and gas simulation software products are currently occupied by the products of three foreign companies - Invensys Process Systems (which includes SimSci - Esscor, the owner of the PRO/II trademark), Aspen Technologies (with Hyprotech, the owner). brands HYSIM, HYSYS, Aspen) and ChemStations (which owns the CHEMCAD trademark).

Scientists from the Institute of Metallurgy of the Ural Branch of the Russian Academy of Sciences and the Ural Federal University developed in 2022 a method for theoretical high-precision determination of the viscosity of liquid metals using a trained artificial neural network. The practical application of artificial neural networks has become a symbol of the 21st century [35]. For example, in [36], a neural network approach was used to predict the viscosity and density of lubricating oils when gases are dissolved in them.

Our model

Our model is based on works [37-39], where solid bodies were considered. Let us now consider the liquid from this position. To measure any physical property of a liquid, you need to influence it with some primary field (magnetic, electric, etc.) and measure the secondary field (system response), the value of which carries information about the object. Since the process of interaction of an object with a field usually proceeds quite quickly (single-particle relaxation time is ~ 10^{-12} s), it is clear that this process is far from equilibrium. On the other hand, the characteristics of the secondary field carry information about an object that is in certain thermodynamic conditions and has thermodynamic parameters that are directly related to its structural, chemical and physical properties.

Thus, with the help of nonequilibrium statistical thermodynamics, it is possible to find a connection between the microscopic (quantum) processes of interaction of primary fields (the parameters of which can be controlled and varied within wide limits) with the macroscopic characteristics of the liquid.

Let us consider a liquid as a system of non-interacting molecules immersed in a thermostat, which represents the entire volume of the liquid. Quantum transitions caused by the interaction of molecules with a thermostat will be dissipative (with probability P) in contrast to interaction with an external (for example, electric) field (with probability F). Dissipative processes lead to the fact that the secondary field Z_2 is always less than the primary field Z_1. Since the subsystem of molecules exchanges only energy with the thermostat, the corresponding ensemble of particles will be canonical [40]. Then the expression for statistical entropy has the form:

$$S = -k\sum_i f_i \ln f_i, \qquad (18)$$

where f_i is the distribution function; k is Boltzmann's constant.

Differentiating (18) with respect to time and transforming, we obtain:

$$\frac{dS}{dt} = \frac{k}{2}\sum_{i,j}\left(lhf_i - \ln f_j\right)\left(P_{ij} f_i - P_{ji} f_j\right), \qquad (19)$$

where P_{ij} is the probability of transition from initial i (with energy E_i) to excited state j (with energy E_j). For dissipative processes, the detailed equilibrium principle has the form:

$$\frac{g_i P_{ij}}{g_j P_{ji}} = e^{\frac{E_j - E_i}{kT}}, \qquad (20)$$

where g_i, g_j are statistical weights for levels E_i and E_j. Then (19) will take the form:

$$\frac{dS}{dt} = \frac{k}{2} P_{ij}\left(\ln f_i - \ln f_j\right)\left(f_i - \frac{g_i}{g_j} f_j e^{-\frac{E_i - E_j}{kT}}\right), \qquad (21)$$

Canonical distribution function [40]:

$$f_{ij} = \frac{1}{Z} e^{-E_{ij}/kT}, \qquad (22)$$

where is the partition function:

$$Z = e^{-G/kT}, \qquad (23)$$

where G is the Gibbs potential (free energy) of the thermostat + system of molecules.

Let us assume that the non-configurational part of the Gibbs potential depends linearly on the concentration N of molecules:

$$e^{-G/kT} = \sum_N h(N), \qquad (24)$$

where $h(N) = \omega(N)\cdot e^{-G/kT}$; (25)

ω(N) - statistical weight.

After cumbersome but simple calculations, it is not difficult to show that the function h(N) is a Gaussian distribution around the equilibrium value with small variance, i.e.:

$$h(N) = h(\overline{N})e^{-\Delta\overline{N}^2/N}. \quad (26)$$

Substituting (26) into (24), we have:

$$e^{-G/kT} = h(\overline{N})\sum_{\Delta N} e^{-\Delta\overline{N}^2/\overline{N}}. \quad (27)$$

To estimate the sum in (27), we replace it with the integral:

$$\sum_{\Delta N} e^{-\Delta\overline{N}^2/\overline{N}} = \int_{-\infty}^{+\infty} e^{-x^2/\overline{N}}\,dx = \sqrt{\pi x}.$$

Then (27) takes the form:

$$e^{-G/kT} = h(\overline{N})(\pi\overline{N})^{1/2}. \quad (28)$$

Using (24) and taking the logarithm of (28), we find:

$$G/kT = -\ln\omega(\overline{N}) + \frac{G(\overline{N})}{kT} + \frac{1}{2}\ln(\pi\overline{N}), \quad (29)$$

where $G(\overline{N})$ is the part of the total Gibbs potential associated with the concentration of molecules. From the estimate of the first logarithmic term it follows:

$$\ln\omega(\overline{N}) = N\ln\left(1+\frac{\overline{N}}{N}\right) + \overline{N}\ln\frac{N+\overline{N}}{N}. \quad (30)$$

Approximating the logarithm in the first term on the right side of (30) by the first term of its series expansion, and expressing the second term in terms of the Gibbs potential of the system of molecules G^f, we obtain:

$$\ln\omega(\overline{N}) = \overline{N} + \overline{N}G^f/kT. \quad (31)$$

Substituting (31) into (29) and neglecting the term $1/2\ln(\pi\overline{N})$ compared to $\overline{N}$, we obtain:

$$G = G(\overline{N}) - \overline{N}G^f - \overline{N}kT. \quad (32)$$

As above, assuming that the thermodynamic potential depends on the equilibrium number of molecules C^f in a linear manner, i.e.:

$$G = G^0 + \overline{N}G^f, \quad (33)$$

where G^0 is the thermodynamic potential of the thermostat, we find:

$$G = G^0 - \overline{N}kT. \quad (34)$$

Using (34), expression (23) is transformed to the form:

$$Z = e^{-G^0/kT}e^{\overline{N}}. \quad (35)$$

Substituting (34) into (21), we find:

$$\frac{dS}{dt} = \frac{k}{2}\sum_{i,j} P_{ij}e^{G^0/kT}e^{-\overline{N}}e^{-E_i/kT}\left(\frac{E_j - E_i}{kT}\right)\left(1 - \frac{g_i}{g_j}e^{2\frac{E_i - E_j}{kT}}\right). \quad (36)$$

Neglecting small terms and replacing the sum in (36) with an integral (which is true for a continuous spectrum of molecular energy values), we obtain:

$$P = \frac{2\Delta S}{k\tau}\exp\left\{-\frac{E_m - G^0/N}{kT}\right\}, \quad (37)$$

where ΔS is the change in entropy in the dissipative process; E_m is the average value of the energy of the ground state of molecules; τ – relaxation time.

For the response function Φ of the system to an external field we have:

$$\Phi = \frac{F}{F+P}, \quad (38)$$

where F = 1/τ.

After transformations, we finally get:

$$\Phi = \frac{kT}{c}\cdot\frac{W}{G^0}\cdot\overline{N}. \quad (39)$$

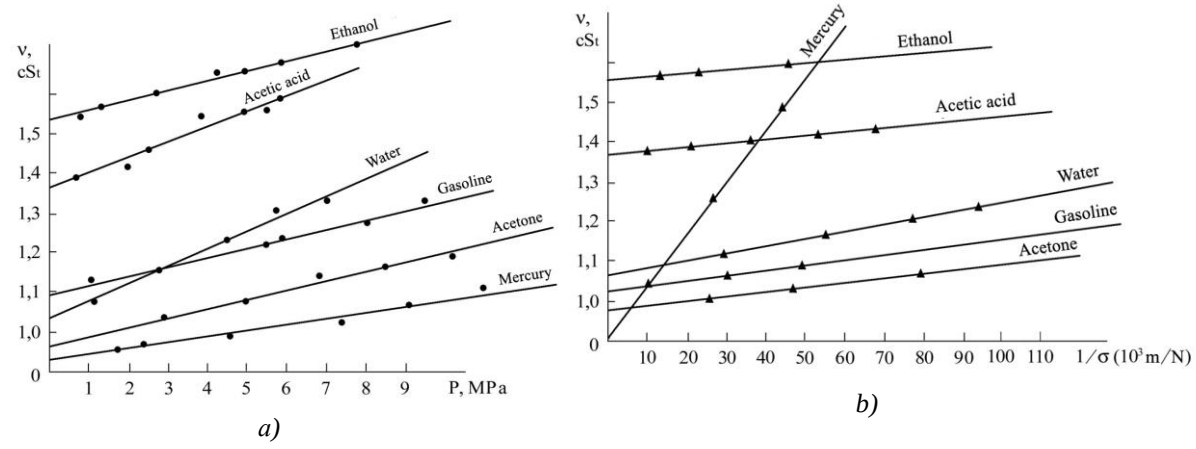
As a response function in [39], we take the kinematic viscosity ν, NkT=PV=(V=1) = P - pressure in the liquid; W – kinetic energy of particles (molecules) of liquid $W=mv^2/2$; G^0 - Gibbs energy; c = const, m is the mass of particles, v is their speed. Equation (39) will take the form (Fig. 6a):

$$\nu = \frac{1}{c}\cdot\frac{p}{2G^0}\cdot mv^2. \quad (40)$$

Taking into account that $G^0 = \gamma S$, S is the area, we obtain the following equation for the relationship between the viscosity of a solution and its surface tension γ (Fig. 6b):

$$\nu = \frac{J}{\gamma}, \quad (41)$$

J – fluid constant under given thermodynamic conditions.

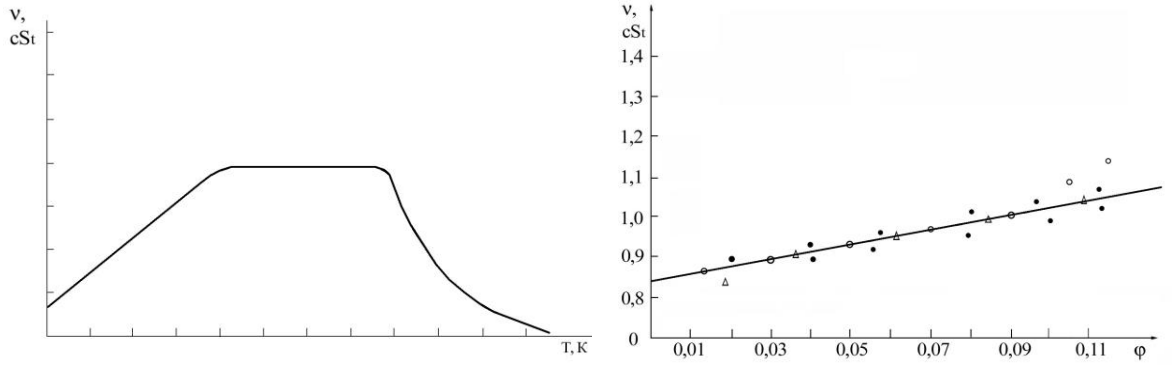


a) *b)*

Figure 6.
Theoretical dependences of kinematic viscosity on pressure for some liquids (a), illustration of formula (41).

If the Gibbs energy is represented in the traditional form $G^0 = A+BT+CT^2$, then formula (40) takes the form (Fig. 7a):

$$\nu = \frac{1}{c} \cdot \frac{p}{2(A + BT + CT^2)} \cdot mv^2. \qquad (42)$$



a) *b)*

Figure 7. Theoretical dependence of the kinematic viscosity of a liquid on temperature (a), on the content of the solid fraction (b).

Figure 7b represents Einstein's formula (16) for the viscosity ν of dilute, unstructured colloidal solutions.

The kinematic viscosity coefficient ν is the ratio of the dynamic coefficient η to the density of the substance, i.e. $\nu = \eta/\rho$. All previous formulas are valid.

Our proposed model of liquid viscosity in the form (39) – (42) takes into account the thermodynamic properties of the liquid, its structure and response to external fields. For example, if a liquid is exposed to an electric field, then for most liquids it leads to a decrease in its surface tension γ. And this leads to an increase in the kinematic and dynamic coefficient of viscosity of the liquid according to formula (41), i.e. internal friction increases.

Conclusion

In this message, we touched upon the issue of liquid viscosity, which plays an important role in various industries, for example, chemical, petrochemical, food, glass, paint and varnish and others, where the initial and final products are subject to fluctuations in viscosity. Having an acceptable model of liquid viscosity, one can theoretically predict the synthesis of a particular final product. It is to this aspect that this article is intended.

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TECHNICAL SCIENCES

CORPORATE MANAGEMENT OF PRODUCTION AND ECONOMIC ACTIVITIES COTTON PROCESSING ENTERPRISE

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Abstract
Based on a system analysis of the facility as a complex production and economic system, a multi-level hierarchical structure of an integrated management system for the main production of a cotton processing enterprise has been developed as the main task of corporate management.

Keywords: Corporate governance, hierarchical management, primary processing of cotton, production, technological process, data bank, governing body, feedback.

Introduction

It is generally accepted that effective enterprise management is possible only by planning all processes and relationships of an economic entity. The main target function of planning is to ensure long-term competitiveness, which determines the strength and stability of the management object in the market.

In a dynamically changing situation in the external environment, it is necessary to improve models and technologies for managing enterprises and their groups in order to increase the efficiency of economic activities, maintain competitiveness and maximize profits. The prerequisites for the economic development of many industries indicate the need to develop new concepts of corporate management and planning, the solution of which is impossible without modern flexible approaches to enterprise development. This is due to the fact that in modern conditions of rapidly changing technologies, information support, the external environment and the rational use of limited resources, the corporate form of entrepreneurship is one of the most effective.

In the context of the functioning of corporations and the planning of their assets, it becomes possible to use the potential of integrated structures (the possibility of transferring financial resources, reducing transaction costs, the possibility of self-financing of individual business units, government orders). The main goal of corporate planning is to build a system for effective management of a group of enterprises based on the timely identification of threats and business opportunities, a system of planning and resource management within the group, as well as on the basis of the formation of competitive business units [1].

The main task of corporate governance is to protect participants in corporate relations from the potential arbitrariness (ineffective activities) of hired managers.

Corporate governance can be reduced to three main areas:

- management of property or shareholding;
- management of production and economic activities;
- financial flow management.

The main function of corporate governance is to prevent and resolve conflicts within the company, which is the key to its survival in an aggressive competitive environment.

One of the most important tasks of the state is to ensure favorable conditions for the functioning and development of the main spheres of society, including the creation and maintenance of economic or production infrastructure, i.e. such basic industries as energy, metallurgical and fuel and energy industries, agriculture, food industry, transport, communications, telecommunications, etc. [1-8].

Problem analysis

The modern economic world is very changeable, dynamic and complex, and therefore many scientists see a solution in project management. The success of a modern manager today depends entirely on the ability to manage complex (often involving many operations) and time-limited activities aimed at creating original products.

Organizations operating in certain and uncertain external environments will be regulated differently, depending on their structure and the type of management system used. It is also important that the structure or management system of the organization corresponds to the external environment in which it is located [2]. Particular attention when studying the features of managing business entities in conditions of uncertainty in the external environment requires studying the state of the organizational culture of the enterprise in such conditions. Work [2] offers recommendations on the issue of maintaining the stability of enterprises in crisis conditions.

Management of corporations and enterprises under conditions of uncertainty is usually considered as an open, non-linear, disproportionate process that has systemic properties. In work [3], the project mode with its corresponding elements is substantiated for effective corporate management: problem, goal, objectives, activities, stakeholders, schedule, risks, and also proves that analysis is an important condition for successful management informational and temporal (temporal features) uncertainty.

Article [4] presents an analysis of risk management models, their advantages and disadvantages, which showed the need to introduce new tools into corporate risk management models in order to ensure the adequacy of risk management systems to new challenges. These tools include: reframing, the introduction of real options, the use of smart contracts based on blockchain technology, the introduction of benchmarking and the approach to creating shared value. These tools primarily provide a reduction in the corporation's relational risks, but can also help reduce business risks. In addition, these tools cover various areas of the corporation's activities from contract management to assessing the effectiveness of risk management for different groups of stakeholders. The introduction of modern tools into corporate risk management models will help improve the adaptability and efficiency of corporate risk management.

In the research [5] of N.N. Trofimova, the features of modern corporate governance are considered, factors are highlighted that increase the relevance of improving corporate governance and the weaknesses of modern corporate governance. Using the proposed author's approach, based on system analysis, the basic principles, key problems are identified and the basic models of modern corporate governance are analyzed. The scientific novelty and practical value of the article lies in the fact that the author has identified the main factors for increasing the efficiency of corporate governance of Russian enterprises in the real sector of the economy.

A.D.Khairullina, A.V. Pavlova in his [6] studies proposes the integration of the risk management system and strategic management by determining the corresponding key risk indicators for each indicator of the BSC (system of strategic indicators) of the corporation. It is also proposed to improve the economic and mathematical methods used for the analysis and assessment of risks, namely: to use fuzzy logic methods (specifically the fuzzy number method), since this method allows you to assess the probability of risk occurrence under conditions of uncertainty, which is especially important for the economic environment when input the data is stochastic. Thus, the article describes the pitfalls encountered at each stage of the risk management procedure in corporate management and proposes approaches to improving the corporate risk management system.

An analysis of numerous works shows that the development of automated control systems, process control systems, organizational management systems, organizational and production systems, as well as integrated management of industrial enterprises and others is often carried out, as a rule, in isolation. At the same time, inconsistency of goals, criteria, models and management algorithms, lack of compatibility, integration of organizational, functional, production, technical, information and software, which are organic parts of a unified management system, significantly complicate the development and implementation of these systems and do not allow achieving the required systemic effect . In this regard, the stage under consideration in the development of production management systems is characterized by the integration of individual automated subsystems using a local or corporate computer network, software and information interfaces and a distributed data bank - into a single integrated system for complex automation of production and economic activities of an enterprise. Solving the issues of integration of functional, technical, software and information support forms the basis for the creation of such systems [1-8].

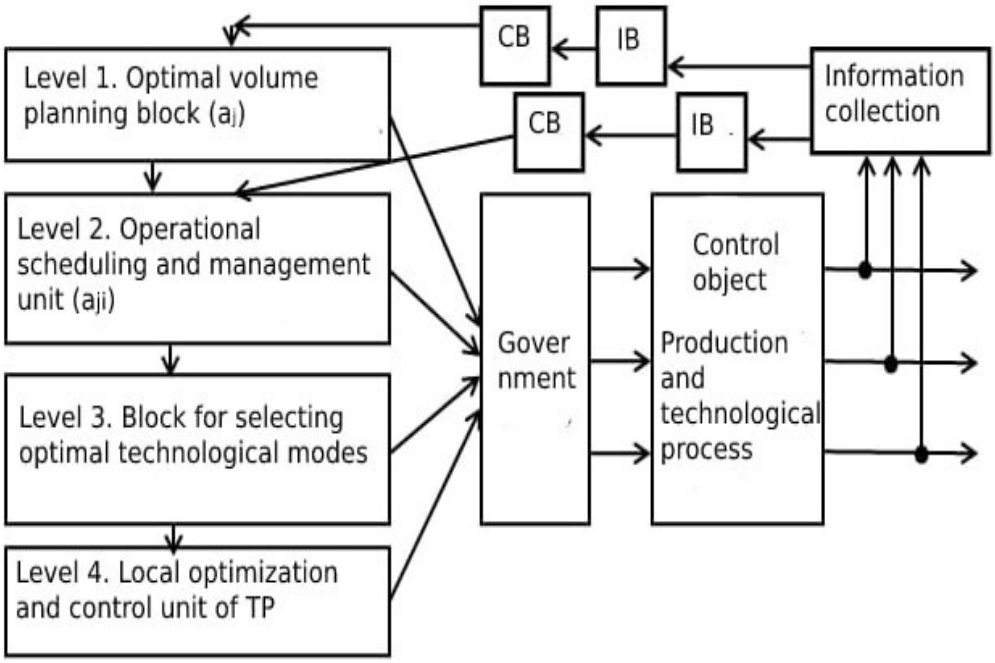
Methodology and discussions

Our research has substantiated the need to develop a coherent theory of management of a modern industrial enterprise, including means of describing the control object and the tasks of forming management decisions based on the principles of system optimization with the widespread use of optimization methods and various heuristics, a mechanism for expert assessments and techniques for forming decisions under conditions of uncertainty [9-12].

Representing a management object, a cotton processing enterprise, as a hierarchical structure has a number of advantages, the main of which are: the possibility of dividing the system under consideration; ensuring integration of the problems being solved; increasing the adaptability and reliability of the system as a whole; the ability to select and standardize modules focused on solving simplified problems and coordinating such tasks in a single system.

The synthesized management system for the main production, using the example of cotton processing production (Fig.) is a four-level hierarchical system, the individual levels of which are separated by the following management functions: volumetric (current) planning - operational scheduling - selection of optimal technological modes - process regulation.

The time decomposition of the production process control problem is carried out on the basis of the frequency characteristics of disturbances acting on the production process of obtaining final cotton products. Each level of the hierarchical production process control system of a cotton processing enterprise monitors disturbances in a certain frequency spectrum.



At level I, a set of problems of volumetric planning of inputs and output is solved. This complex includes: the main task is to calculate the optimal production program of a cotton processing enterprise, broken down by quarters and months; auxiliary tasks - formalization of dependencies between the parameters of the production process and variables characterizing the behavior of the technological process; justification of planned norms for the yield of final cotton products, as well as planned norms for waste (production irrecoverable losses); forecasting the receipt of raw materials for cotton modification (raw cotton assortment); optimal distribution of production resources between types of products.

At level 2, a set of tasks of operational scheduling and management is solved: the task of assigning subsets of manufactured modifications of the final product to TP; the problem of distributing available resources between subsets of modifications of the final product; schedule task, i.e. determination of the moments of the start of work (batch launches) of fixed modifications of the feedstock for cotton processing; the task of choosing the optimal sequence for launching fixed modifications of cotton; the task of promptly adjusting some technical and economic indicators of the plan in connection with changes in individual indicators of the plan, cotton assortment, equipment operating time fund, etc. A set of tasks for operational calendar planning makes it possible to increase the likelihood of meeting the planned indicators formed at level I [9,10].

At level 3, the optimal operational decisions determined at level II are implemented by selecting the optimal parameters of discrete technological modes based on the current analysis of disturbances of the processes themselves.

At level 4, the problem of direct regulation of processes (local control) and ensuring stable and accurate maintenance of the operating parameters of technological processes defined at level 3 is solved. The main function of level 4 is polling of sensors of operating variables and direct digital control of technological processes.

Conclusion.

Based on the analysis of the issues raised, we can say that compliance with corporate governance standards helps improve the decision-making process that can have a significant impact on the efficiency of the financial and economic activities of the enterprise at all levels. High-quality corporate governance streamlines all business processes occurring in the enterprise, which contributes to the growth of turnover and profits while simultaneously reducing the volume of required capital investments.

Corporate planning allows you to focus on external factors of the company's development, since internal ones are amenable to greater managerial influence. Risk management methods used within the integrated group make it possible to reduce the level of uncertainty in predicting the course of the corporation's business processes.

Finding ways to overcome uncertainty and manage changes in the external environment remains a relevant area of management and requires close research. Thus, management under conditions of uncertainty is a systemic process focused on the classical properties of integrated management systems of corporations, associations, and enterprises.

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