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AGRICULTURAL SCIENCES

INFLUENCE OF THE HUMIC PREPARATION "ROSTOK" ON THE GERMINATION OF VEGETABLE SEEDS IN THE CONDITIONS OF THE REPUBLIC OF KAZAKHSTAN

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Abstract

This article presents the results of a study on the effectiveness of processing vegetable seeds with a humic preparation. In the region of the Republic of Kazakhstan, the influence of the humic preparation "Rostok" on the germination and productivity of vegetable crops was studied.

Seed treatment with a humic preparation "Rostok" involves the improvement of production technologies not only in terms of quantitative and qualitative improvement, but also in terms of maintaining environmental safety and balance of agro ecosystems.

Presowing seed treatment with a humic preparation "Rostok" contributed to an increase in the field germination of seeds of the "Rubin" radish - by 15% and increased the yield by 1.3 kg / m^2.

Presowing treatment with a humic preparation "Rostok" allows to increase the germination energy of vegetable seeds, allows unconditioned seeds to be brought to sowing conditions in terms of germination, which makes it possible to save seed material, increase the yield of vegetable crops.

Keywords: humin, preparation, yield, vegetable, germination, control, growth.

Introduction: The modern scientific system of agriculture involves the transition to greening and biologization, aimed at producing environmentally friendly products with minimal use of chemicals [1].

Ensuring food security of the Republic of Kazakhstan is a priority task. Vegetable crops are of great importance among the plant growing products. Carrot, radish and beet varieties are among the most responsive crops to mineral nutrition and the use of growth stimulants.

The difficult economic conditions prevailing at the present time set the task of vegetable producers to obtain high, stable yields and high quality products using resource-saving and economical technologies. This problem can be solved by directly managing the growth and development of plants using new agricultural techniques. A modern direction is the search and development of such techniques that could increase the yield of crops with minimal use of chemicals. One of these areas is the use of hemic preparations produced on the basis of natural organicsources, incl. peat. Due to the structural features and physicochemical properties, they are characterized by high physiological activity, activate the metabolism of beneficial micro flora, increase the defense mechanism of plants against the action of unfavorable climatic factors, and contribute to the formation of a high yield of vegetable crops. The studies of the authors (V.S. Vinogradov, Yu.V. Smirnov) revealed a positive ecological effect of treatments with humic stimulants on vegetable crops [2].

Seed treatment with a humic preparation "Rostok" involves the improvement of production technologies not only in terms of quantitative and qualitative improvement, but also in terms of maintaining environmental safety and equilibrium of agroecosystems [3]. In modern technologies for the cultivation of vegetable crops, great importance is attached to the methods of pre-sowing seed treatment with new environmentally friendly preparations that improve the sowing quality of seeds, stimulate the growth and development of plants, increase productivity, as well as foliar dressing, which increase both the yield and the quality of products [4].

According to a number of researchers, the use of plant growth regulators (PPP) is one of the most promising ways to increase plant productivity. Their effectiveness is largely determined by the potential capabilities of the plants themselves, as well as the growing conditions [5].

Both natural and synthetic compounds can be used as exogenous plant growth regulators. Their use makes it possible to enhance or weaken the signs and properties of plants within the normal range set by the genotype, to increase the resistance of plants to adverse conditions, to compensate for the shortcomings of varieties and hybrids Due to their high efficiency in small doses,

these drugs usually meet the current increasingly stringent requirements for environmental safety [6].

The use of growth stimulants provides an increase in the yield and quality of grown products, an increase in resistance to diseases and other stressful influences, an improvement in fruit set, an acceleration of ripening, a decrease in the content of nitrates, radionuclides, etc. Plant growth regulators are classified from various positions: by chemical composition, crops, influence on the physiological processes of plants, etc. [7].

The goal is to develop a technology for the use of a humic preparation "Rostok" for obtaining environmentally friendly vegetable products. Presowing treatment with a humic preparation "Rostok" allows to increase the germination energy of vegetable seeds, allows unconditioned seeds to be brought to sowing conditions in terms of germination, which makes it possible to save seed material, increase the yield of vegetable crops.

Research method: The high efficiency of the use of humic preparations has been proven many times. To develop a technology for the use of a humic preparation "Rostok" for obtaining ecologically safe vegetable products.

The influence of the method of extraction, composition and concentration of the reagent, stages of purification from impurities on the chemical composition of humic preparations from peat was studied.

On the basis of technological experience and the results of field tests, since 2001, the research and production center "Eureka", created as part of the department, began to carry out experimental production of a modified highly purified humic preparation "Rostok". It is obtained by chemical modification of humic acids extracted from peat. As a result of changes in the structure and properties of humic acids, their biological activity and ability to penetrate through cell membranes increase [8].

The preparation contains complex compounds of humic acids. It is recommended for use in agriculture, communal, forestry and personal subsidiary plots in the form of aqueous solutions for treating seeds (tubers, bulbs, seedlings, cuttings, etc.) and plants of all types of crops at various phenological stages of development in 2-4 terms after 10 -15 days. The drug can be used in the form of pre-sowing treatment (0.5 l / t 1% of the drug, solution consumption 10 l / t) and foliar treatment (100 ml of 1% drug per 100 l of solution, solution consumption 200-400 l / ha; with low volume spraying with 200 ml / ha of 1% preparation).

The drug has a significant effect on the redox processes in the plant cell, activates protein synthesis and carbohydrate metabolism, has stimulating and antistress properties. The energy of seed germination, root formation, growth and development of the aerial part, product quality, plant resistance to diseases increase, and the passage of phonological phases is accelerated [9].

Germination (laboratory and field) - the ability of seeds to form normally developed seedlings. Field germination is lower than laboratory germination, since it is impossible to create optimal conditions in the field, as in the laboratory.

It is possible to increase the germination energy and germination capacity by pre-sowing treatment with the Rostock preparation (0.5 l / t), adding it to the dressing agent. In addition, plants develop a more powerful root system.

According to the results of our research, the humic preparation "Rostok" increased the germination energy of vegetable seeds (table 1). So the germination of seeds treated with a humic preparation on table beets of the "Bordeaux 237" variety and the radish of the "Rubin" variety was one hundred percent. Germination of seeds of carrot varieties "Nantskaya" was very high 93%, while in the control the level of germination of carrot seeds was 71%.

Figure 1 shows that the use of the humic preparation "Rostok" made it possible to improve the germination of beet seeds and provided a 16% increase to the control.

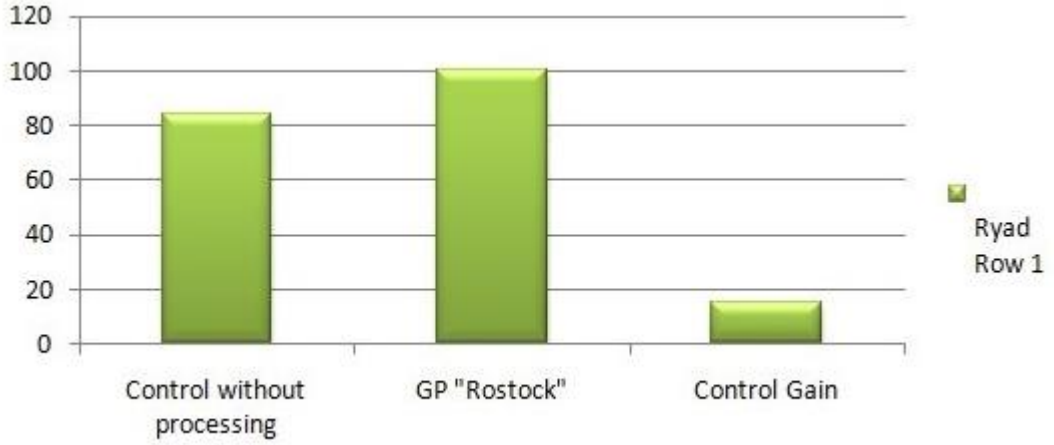

Figure 1. Germination of seeds of Beetroot "Bordeaux 237" treated with SE "Rostok" and increase to control%.

The positive effect of the treatment of carrot seeds with the humic preparation "Rostok" is evidenced by the excellent result of field germination of 93%. Which exceeded the control option by 22%, the data is shown in

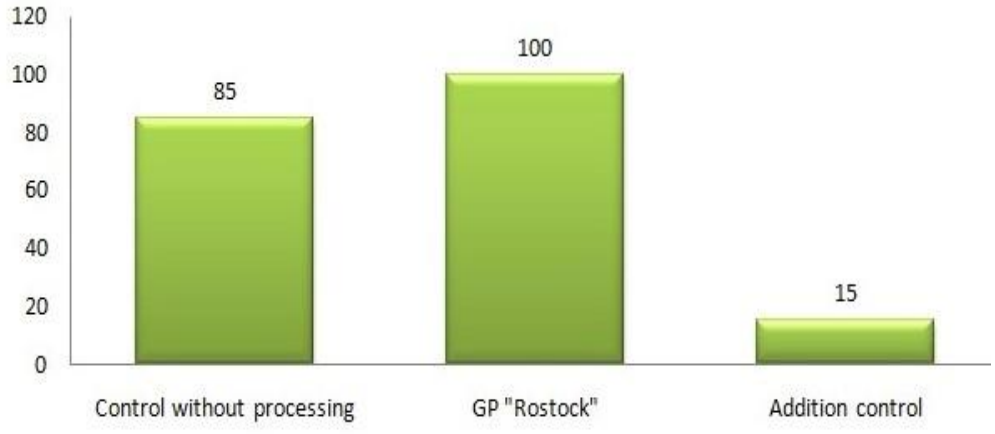

Figure 2. Germination of seeds of "Rubin" radish treated with SE "Rostok" and% increase to control.

Our observations are confirmed by long-term field and production tests of the humic preparation "Rostok" on vegetable crops. I would like to note that, at present, it is used in the farms of many regions of Russia and Kazakhstan.

The sprout helps to increase the field germination of seeds, the energy of germination, and affects the growth and development of vegetable crops. Experiments on vegetable crops confirm the studies of the effect of the humic preparation "Rostok" on the germination energy of spring wheat, barley and oil flax, when using which the germination energy increased by 23.5%, 37.1%, 8.2%, respectively. In studies of the use of the humic preparation "Rostok" in a tank mixture with herbicides, it was possible to increase the field germination of wheat - 81.2%, barley - 78.8%, and flax - 91.2.

The drug activates metabolic processes, resulting in an increased consumption of minerals from the soil. Seedlings on the plots did not appear all at once, they are stretched to one degree or another. This can be explained by the fact that not only the pre-sowing treatment but also the quality of the seeds, the conditions of moistening the upper layer of the soil, its temperature, the uniformity of the depth of seeding, the quality of soil preparation and other factors affect the amicability of the seedlings.

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CHEMICAL SCIENCES

PHASE EQUILIBRIUM IN THE $CaInTe_2$-$CaIn_2Te_4$ SYSTEM AND ELECTROPHYSICAL PROPERTIES OF THE $CaInTe_2$ COMPONENT

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Abstract

The physicochemical properties of alloys of the $CaInTe_2$-$CaIn_2Te_4$ system and the electrical properties of the $CaInTe_2$ compound were studied by complex methods of physicochemical analysis: differential thermal analysis (DTA), X-ray phase analysis (XRD), microstructural analysis (MSA), as well as the determination of microhardness and density, the phase diagram of the system was built. The phase diagram of the $CaInTe_2$-$CaIn_2Te_4$ system is partially quasi-binary. Eutectic equilibrium and peritectic transformation occur in the system. In the $CaInTe_2$-$CaIn_2Te_4$ system, only on the side of the $CaIn_2Te_4$ compound, solid solutions reach 8 mol. % $CaInTe_2$, solid solutions based on $CaInTe_2$ are practically not found. The electro-physical properties of the $CaInTe_2$ compound have been studied.

Keywords: system, density, microhardness, phase, solid solution

Introduction

The components of the $CaInTe_2$-$CaIn_2Te_4$ system were synthesized by the ampoule method from CaTe, InTe and In_2Te_3 compounds. The properties of the elements of the main II subgroup are given in detail by the author of [1]. In systems with the presence of calcium, semiconductor materials with luminescent properties were studied in [2, 3]. Indium chalcogenides and the ternary and quaternary phases and solid solutions derived from them are semiconductor materials with functional properties. Indium sulfide and selenide compounds are photoelectric [4–8], and telluride compounds are semiconductors with thermoelectric properties [9,10]. From this point of view, the study of the $CaInTe_2$-$CaIn_2Te_4$ system is of scientific and practical importance.

The purpose of the work is to study the phase equilibrium in the $CaInTe_2$-$CaIn_2Te_4$ system, build its phase diagram and study the electrical properties of the $CaInTe_2$ compound.

Experimental part

Alloys of the $CaInTe_2$-$CaIn_2Te_4$ system were synthesized from $CaInTe_2$ and $CaIn_2Te_4$ components in evacuated quartz ampoules up to a pressure of 0.133 Pa. The alloys were synthesized in the temperature range 1100–1400 K. For homogenization, the alloys were subjected to heat treatment at 610 K for 240 hours. Then the samples were studied by the methods of physicochemical analysis (DTA, XRF, MSA, measurements of density and microhardness).

Differential thermal analysis (DTA) of the alloys was carried out on an NTR-73 low-frequency pyrometer. Chromel-alumel was taken as a thermocouple, the heating rate was 10 K/min.

X-ray phase analysis (XPA) was performed on a D2 PASER X-ray diffractometer. At that time, CuKα radiation and a Ni filter were used. The microstructure of the samples was analyzed using a MIM-8 microscope.

The microhardness of the alloys was measured using a PMT-3 metallographic microscope. The density of the samples was determined by the pycnometric method; toluene was taken as the working solution. The electrical properties of the $CaInTe_2$ compound were carried out in vacuum by the compensation method [11,12].

Results and its discussion

Of great interest are the physicochemical and physical properties of ternary and more complex compounds of calcium with other metals. Therefore, the study of the chemical interaction of $CaInTe_2$-$CaIn_2Te_4$in the internal section of the Ca-In-Te ternary

system is one of the important issues. Synthesis of alloys of the system was carried out from the $CaInTe_2$ and $CaIn_2Te_4$ components by the ampoule method under a vacuum of 0.133 Pa. The resulting alloys are compact black substances. The alloys were subjected to heat treatment for 300 hours at 400°C to homogenize them.

Components $CaInTe_2$ and $CaIn_2Te_4$ are gradually triturated during prolonged exposure to the open air. The reason for this is that when exposed to air, they gradually absorb moisture from the air and undergo changes. Alloys of the system dissolve very well in strong mineral acids (HCl, HNO_3). Homogenized samples were studied by the methods of physicochemical analysis.

During the differential thermal analysis of alloys of the $CaInTe_2$ - $CaIn_2Te_4$ system, it was found that more than two endothermic effects are observed on their thermograms. A large number of effects on thermograms indicates that a complex interaction occurs in the system. The results of the microstructure analysis show that the alloys of the system in the solid state are single-phase and two-phase. Since the $CaInTe_2$ compound is peritectic in the system and as a result of the decomposition of this compound at high temperatures, three-phase fields are also present.

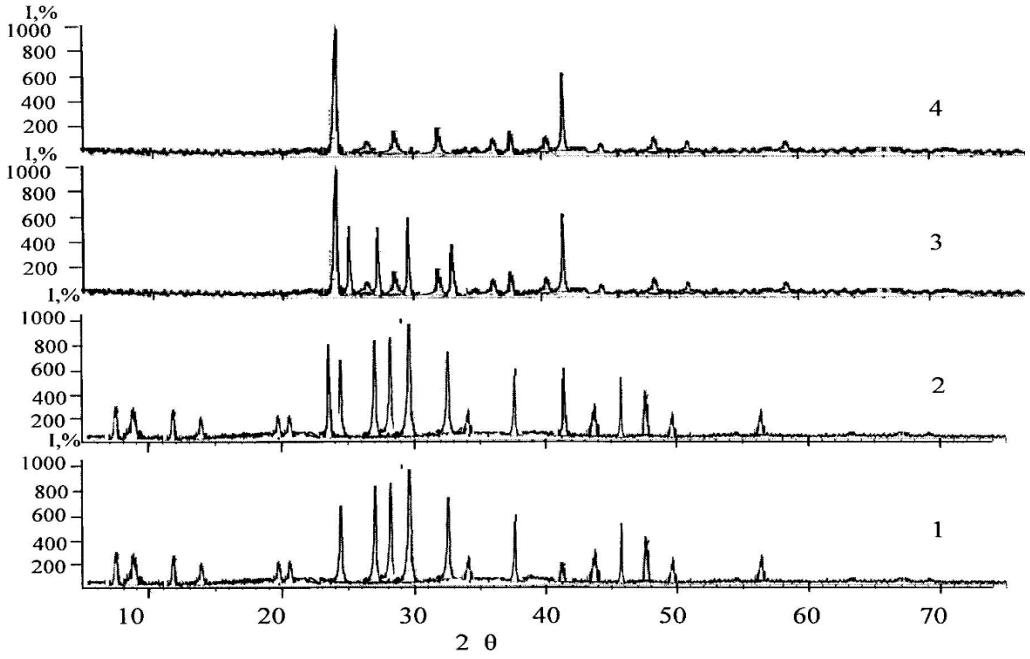

Fig. 1. X-raypatterns of alloys of the $CaInTe_2$-$CaIn_2Te_4$system. 1- $CaInTe_2$, 2-40 mol %, 3-70 mol %, 4- 100 mol.% $CaIn_2Te_4$.

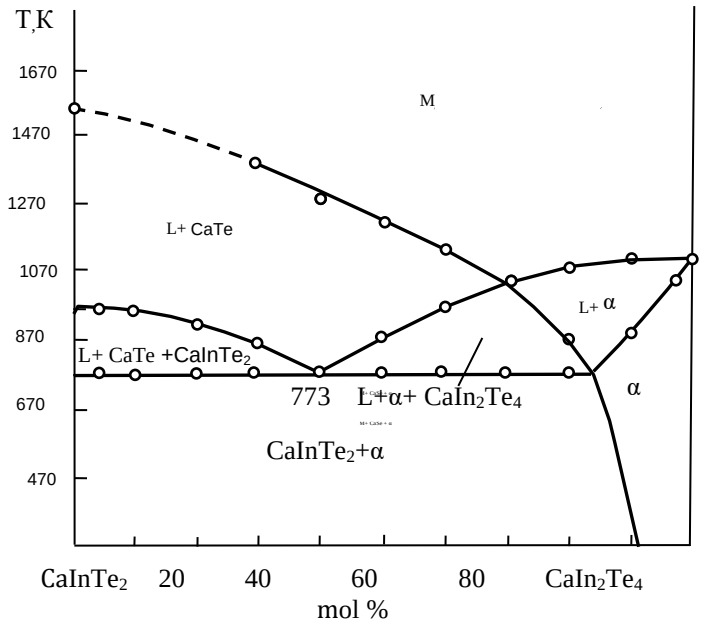

Fig.2. Phase diagram of the $CaInTe_2$ - $CaIn_2Te_4$ system.

Based on the $CaIn_2Te_4$ compound, a sufficient area of the solid solution is formed. To refine the region of the solid solution, alloys containing 3, 5, 7, and 8 mol % $CaInTe_2$, which were kept at 200 and 400 °C for 150 hours, were subjected to heat treatment and cooling by placing them in ice water at these temperatures. After that, microstructural analysis of samples containing 3, 5, 7 and 8 mol. % $CaInTe_2$. As a result, it was found that the solubility region at room temperature based on the $CaIn_2Te_4$ compound is 8 mol % $CaInTe_2$. At the eutectic temperature, the region of the solid solution based on $CaIn_2Te_4$ corresponds to an interval of 15 mol % $CaInTe_2$.

In order to confirm the results of differential thermal and microstructural analyzes, an X-ray phase analysis of alloys with 40 and 70 mol % $CaIn_2Te_4$ of the $CaInTe_2$ - $CaIn_2Te_4$ system (Fiq.1). According to the results of X-ray analysis, it was found that the diffraction lines obtained on the diffraction patterns of the alloys consist of a mixture of diffraction lines of the primary components. That is, the $CaInTe_2$ - $CaIn_2Te_4$ system has a quasi-binary character in the solid state. At higher temperatures, the system is partially quasi-binary. As a result, the results of the analyzes complement each other.

By measuring the microhardness of the phases of the $CaInTe_2$ - $CaIn_2Te_4$ system, a comparison was made of the components that make up the system. As a result of measuring the microhardness in the system, two types of values were determined. The microhardness value (1650-1750) MPa corresponds to the microhardness of the $CaInTe_2$ compound, and the value (1900-1990) MPa corresponds to the microhardness value of the α-solid solution based on the $CaIn_2Te_4$ compound.

Based on the results of physicochemical analysis, a phase diagram of the system was constructed (Fig. 2). The state diagram of the system is partially quasi-binary, accompanied by eutectic equilibrium and peritectic transformations.

The liquidus of the system is limited by the monovariant equilibrium curves of the α-solid solution formed on the basis of the $CaIn_2Te_4$ and $CaInTe_2$ compound, which is in equilibrium with the liquid. In the range of 0-70 mol % $CaIn_2Te_4$, as a result of the decomposition of the $CaInTe_2$ compound, two-phase regions consisting of M + CaTe are observed below the liquidus curve. Another two-phase region consists of (M+ α) below the liquidus curve in the region of 70-100 mol % $CaIn_2Te_4$. As a result of reprecipitation, three-phase fields arise in the concentration range of 0-85 mol % $CaIn_2Te_4$ from (M+ CaTe +$CaInTe_2$) and M+α+ $CaIn_2Te_4$. The region of the α-solid solution formed on the basis of the $CaIn_2Te_4$ compound is 8 mol % $CaInTe_2$.

Temperature dependence of electrical conductivity (σ), thermo-EMF. (α), current strength (I) and resistivity (ρ) of the $CaInTe_2$ compound were studied in the temperature range of 300-350 K. The dimensions of the samples were 1.5x0.5x0.4 cm.

The temperature dependence of the electrical conductivity (σ) of the $CaInTe_2$ compound is shown in fig. 3. It can be seen from the graph that the electrical conductivity increases with temperature. Additional conductivity occurs in the temperature range of 300-350 K, the specific conductivity is formed with a subsequent increase in temperature. The electrical conductivity of the $CaInTe_2$ compound at room temperature is $\sigma = 2.96\ 10^{-5}\ \Omega^{-1}\cdot cm^{-1}$, and at 350 K it is $\sigma = 4.2\ 10^{-4}\ \Omega^{-1}\cdot cm^{-1}$. The $CaInTe_2$ compound also has a relatively high resistivity.

The thermo-EMF of this compound is also given in fig. 3. The thermo-EMF of the $CaInTe_2$ compound decreases with temperature. The value of its thermo-emf at room temperature $\alpha = 620$ μV/deg, and at 350 K its value is $\alpha = 350$ μV/deg.

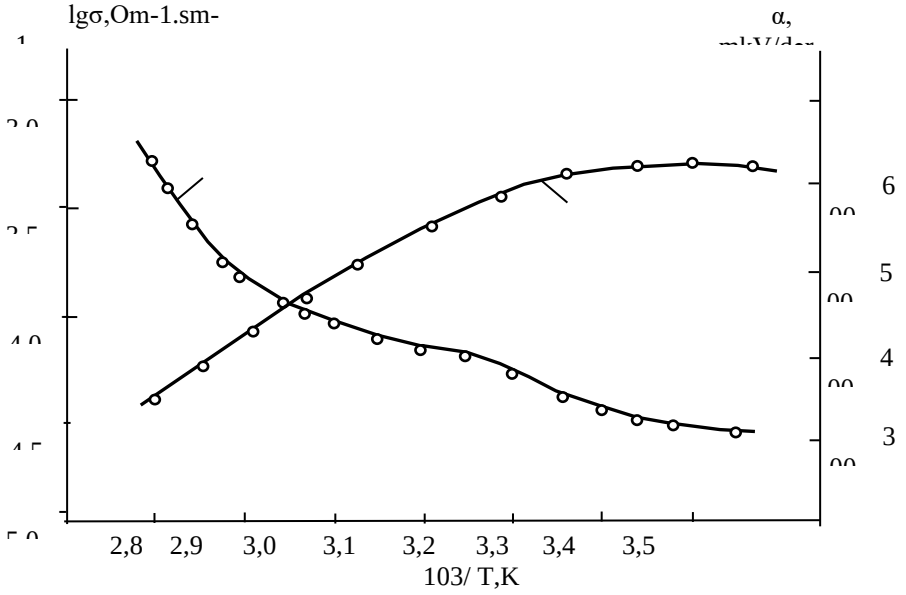

Fig.3.Temperature dependence of electrical conductivity and thermo-EMF of the $CaInTe_2$

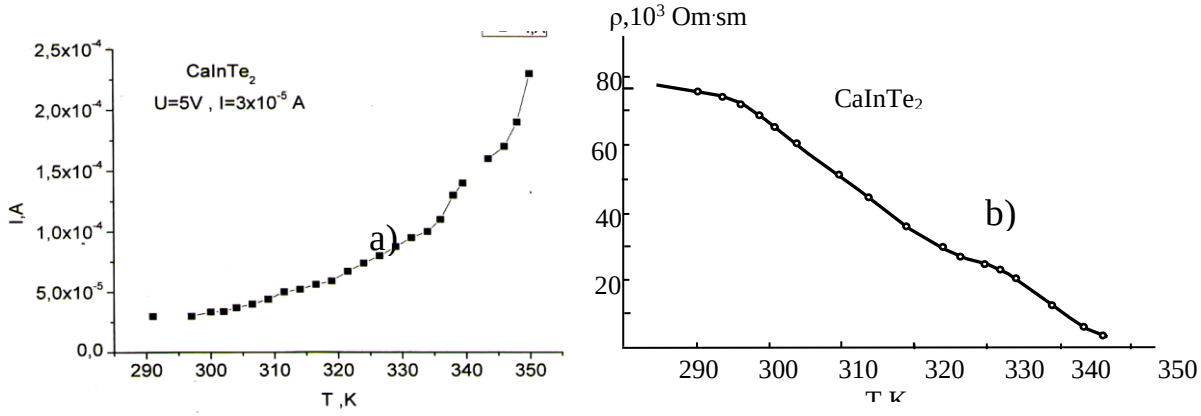

Fig.4. Temperature dependence of the electric current (a) and resistivity (b) of the $CaInTe_2$ compound.

On fig. 4 a shows the temperature dependence of the current strength of the $CaInTe_2$ compound. The $CaInTe_2$ compound has a lower resistance, so the temperature dependent increase in current flowing through the $CaInTe_2$ is large. The value of the current strength at room temperature is $I = 3 \cdot 10^{-5}$ A, and at 350 K $I = 2.5 \cdot 10^{-4}$ A. An increase in the current strength depending on temperature indicates that the $CaInTe_2$ compound has a semiconductor property.

The temperature dependence of the resistivity of the $CaInTe_2$ compound is shown in fig. 4 b. As can be seen from the temperature dependence of resistivity, the temperature dependence is linear and decreases with temperature. The resistivity of the $CaInTe_2$ compound is significantly lower than the resistivity of the $CaInSe_2$ compound. The reason for this is related to the increase in the proportion of metallic bonds in the series Se→Te. The resistivity of the $CaInSe_2$ and $CaInTe_2$ compounds is $\rho = 75.10^8$ Ω·cm and $\rho = 3.10^7$ Ω·cm, respectively.

Conclusion

The chemical interaction in the $CaInTe_2$-$CaIn_2Te_4$ system was studied by the methods of physicochemical analysis and its phase diagram was constructed. As a result of the decomposition of the $CaInTe_2$ compound, the state diagram of the system becomes partially quasi-binary. The process of eutectic equilibrium and peritectic transformation takes place in the system. In the $CaInTe_2$-$CaIn_2Te_4$ system at room temperature, solid solutions based on $CaIn_2Te_4$ reach up to 8 mol % $CaInTe_2$ and on the basis of the $CaInTe_2$ compound, the solid solution region is practically not defined. The temperature dependence of the electrical conductivity (σ), thermo-EMF (α), current strength (I), and resistivity (ρ) of the $CaInTe_2$ compound has been studied in the temperature range of 20–150°C.

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EARTH SCIENCES

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THE ROLE OF GROUNDWATER OVEREXPLOITATION IN THE DESERTIFICATION OF ARID TERRITORIES

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РОЛЬ ЧРЕЗМЕРНОЙ ЭКСПЛУАТАЦИИ ПОДЗЕМНЫХ ВОД В ОПУСТЫНИВАНИИ АРИДНЫХ ТЕРРИТОРИЙ

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Abstract
This article assesses the anthropogenic component in a complex system of factors, which negatively affect the ecology of the arid territory of the eastern part of the Terek-Kuma artesian basin as a whole, including groundwater resources.

Аннотация
В статье производится оценка антропогенной составляющей в системе комплекса факторов, негативно влияющих на экологию аридной территории восточной части Терско-Кумского артезианского бассейна в целом, включая ресурсы подземных вод.

Keywords: artesian waters, depression, underground runoff, desertification
Ключевые слова: артезианские воды, депрессия, подземный сток, опустынивание

В условиях аридного климата и отсутствия поверхностного стока вопросы питьевого и хозяйственного водоснабжения территорий всегда стоят наиболее остро. Поиск и разведка месторождений подземных вод, оценка их естественных и эксплуатационных запасов становятся приоритетными для устойчивого развития народного хозяйства. В этих целях необходимо детально изучать вопросы формирования и размещения подземных вод, прослеживать естественную динамику движения от областей питания до областей разгрузки, оценивать взаимосвязь между водоносными горизонтами, поверхностными, подземными и морскими водами.

Начиная с середины пятидесятых годов на территории восточной части Терско-Кумского артезианского бассейна ежегодно проводились режимные наблюдения над уровнями, температурами и химическим составом подземных вод, что позволило выяснить условия циркуляции и дренажа артезианских вод, их зональность, впервые дать комплексную оценку их запасов и ресурсов. К настоящему времени пробурено более 3000 артезианских скважин, которые эксплуатируют бакинские и апшеронскте водоносные горизонты плиоцен-четвертичного комплекса.

На большей площади Терско-Кумской области Дагестана апшеронские воды имеют гидрокарбонатно-натриевый состав и минерализацию 0,4-0,6 г/л. Лишь по мере приближения к акватории Каспийского моря минерализация апшеронских вод увеличивается за счет хлоридных солей натрия. В целом апшеронский водоносный комплекс содержит пресные и слабоминерализованные воды хорошего качества, пригодные для питья. Дебиты большинства скважин изменялись в начальный момент эксплуатации в пределах 2-15л/сек, лишь в отдельных случаях достигая 50л/сек, при избыточном напоре 16-19 метров. Южнее, с погружением кровли апшерона, значительно возрастают избыточные напоры, составляя в среднем 30-35м и достигая в отдельных населенных пунктах 44м.

Бакинские водоносные горизонты водообильны на всей территории бассейна. Средние дебиты 90% артезианских скважин в начальный момент эксплуатации изменялись в пределах от 2 до 10л/сек. Порядка 10% всех исследуемых в этих районах скважин имели более высокие дебиты, но не превышающие 30л/сек. По гидрохимическому составу артезианские воды бакинских отложений представлены преимущественно двумя химическими типами вод: сульфатно-кальциевыми и натриевыми и гидрокарбонатно-натриевыми. В областях, примыкающих к областям питания, на юго-западе, содержатся в основном сульфатно-натриевые и сульфатно-кальциевые артезианские воды с минерализацией 0,6-1г/л. При движении на север,

северо-запад, северо-восток сульфатные воды в глинисто-песчаных морских осадках бакинского яруса замещаются на гидрокарбонатные, минерализация которых колеблется в пределах 0,4-0,8г/л, увеличиваясь в восточном направлении до 1г/л и достигая 2-3г/л у береговой линии.

Увеличение потребности в воде привело к многократному росту добычи артезианских вод; кроме того эксплуатация подавляющего большинства артезианских скважин в течение десятилетий велась на предельном гидродинамическом режиме, что привело к падению напоров в водоносных горизонтах, истощению запасов пресных артезианских вод, ухудшению их качества. Помимо деградации водных ресурсов, в Терско-Кумской области Дагестана резко ухудшилось состояние пастбищ, активизируется наступление песков, засыпаются населенные пункты. Основной причиной опустынивания Черных земель и Кизлярских пастбищ специалисты считают перевыпас, увеличение допустимых нагрузок на пастбища. Однако необходима оценка и других, не столь очевидных, факторов, обуславливающих опустынивание, среди которых повсеместное снижение уровня грунтовых вод под влиянием депрессии в напорных горизонтах, расположенных наиболее близко к поверхности,

С этой целью был 1) изучен естественный, не нарушенный эксплуатацией, гидродинамический режим подземных вод плиоцен-плейстоценового водоносного комплекса [2]; 2) прослежена динамика изменения напоров в продуктивных водоносных комплексах плиоцен-четвертичных отложений за весь период эксплуатации артезианского бассейна [4]; 3) построена математическая модель процесса эксплуатации водоносных комплексов, с помощью которой воспроизведён механизм формирования, развития и распространения депрессионной зоны [1];4)исследовано влияние образовавшейся региональной депрессии на структуру подземного стока и получена современная гидродинамическая картина подземного потока в плиоцен-четвертичных отложениях Северо-Дагестанского артезианского бассейна [5].

Как отмечено в [2], на территории Терско-Кумского междуречья в доэксплуатационный период, в грунтовые воды разгружалась большая часть артезианских вод. Величина напорного питания, рассчитанная в [3] балансовым методом для Терско-Кумского участка по разности расходов испарения и инфильтрации составляла 489 тыс. $м^3$/сут, площадной модуль разгрузки 0,26 л/с $км^2$. Это означает, что ежегодно уровень грунтовых вод увеличивался за счет притока артезианских вод на 8,2 мм. Для дагестанской части Терско-Кумского бассейна эта цифра выше и составляла в среднем 13 мм/год, на отдельных площадях повышаясь до 30 мм/год и более. Благодаря ежегодному притоку уровень грунтовых вод находился на большей части области на глубине от 1 до 5 метров.

Если сравнить современные карты абсолютных пьезометрических уровней для бакинского и апшеронского водоносных комплексов, построенные по результатам моделирования [6], станет очевидным, что почти для всех точек области напоры в апшеронском водоносном горизонте становятся ниже, чем в бакинском, т.е. вертикальная составляющая скорости фильтрации изменила свое направление на противоположное. Данное обстоятельство свидетельствует о том, что грунтовые воды перестают получать подпитку от напорных вод плиоцен-четвертичного комплекса из-за депрессии в последнем. Даже пренебрегая величиной испарения с зеркала грунтовых вод, только снижение скорости вертикальной фильтрации неизбежно влечет за собой начало процесса понижения уровня грунтовых вод.

Падение избыточных напоров до нуля в ближайших к поверхности водоносных горизонтах наблюдается в некоторых населенных пунктах уже в 70-е годы: это время можно считать точкой отсчета, начиная с которой уровень грунтовых вод неуклонно снижается, причем скорость падения уровня и площадь, на которую это явление распространяется, находится в прямо пропорциональной зависимости от масштабов образовавшейся депрессии в напорных пластах плиоцен-четвертичных отложений.

По результатам расчетов для территории Терско-Кумского междуречья строится схематическая карта абсолютных величин снижения уровня грунтовых вод, которая, будучи совмещена со схемой глубин залегания уровня грунтовых вод ([3]), дает картину изменения уровня грунтовых вод за период эксплуатации бассейна, изображенную на рис.1.

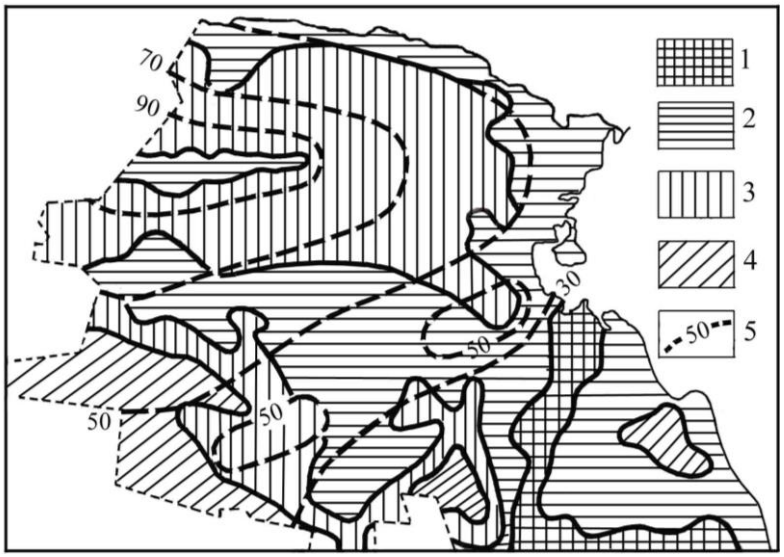

Рис. 1. Схематическая карта снижения уровня грунтовых вод и областей, подверженных антропогенному опустыниванию.
Глубина залегания уровня грунтовых вод:
1 – от 0 до 1м; 2 – от 1 до 3м; 3 – от 3 до 5м; 4 – от 5 до 10м .
5 – расчетная величина снижения уровня грунтовых вод (см).

Таким образом, совершенно очевидно, что процесс снижения уровня грунтовых вод охватил всю территорию Терско-Кумского междуречья Дагестана. Наиболее значительные снижения уровня грунтовых вод на северо-западе, абсолютные значения снижения уровня грунтовых вод здесь достигают 90 и более сантиметров; цифра 70 см охватывает почти весь район Прикумской зоны поднятий, а значение 50 см характерно для всей области, находящейся над депрессией.

На северо-западе рассматриваемой территории, внутри изолинии 90см, лежит область с уровнем грунтовых вод от 1 до 3м, при снижении уровня грунтовых вод на 1м указанная площадь перейдет из разряда высокопродуктивных в разряд средне- и низкопродуктивных. Большая же часть области, где уровень грунтовых вод изменяется от 3 до 5м, относится к разряду низкопродуктивных и при столь значительных снижениях уровня здесь начинается процесс опустынивания. Именно зона, очерченная на карте изолинией 50см – это та площадь, где опустынивание неизбежно из-за неуклонного снижения уровня грунтовых вод.

Еще более ускорить процесс снижения уровня грунтовых вод может применение принудительных откачек в артезианских скважинах, перестающих самоизливаться: в этом случае возможно проникновение или отток грунтовых вод и смешивание их с артезианскими водами близких к поверхности напорных пластов.

Хорошее качество артезианских вод плиоцен-четвертичного водоносного комплекса (исключая хазарский и хвалынский водоносные горизонты) позволяет использовать их для орошения сельскохозяйственных угодий. На тех площадях, где подобное орошение имеет место, может наблюдаться кратковременное повышение уровня грунтовых вод, в том случае, если покровная толща песчанистая. Если же верхняя часть покровной толщи преимущественно глинистая (что характерно для большей части рассматриваемой области), вся дополнительная влага будет потрачена на испарение, так как скорость испарения в нашем случае намного выше скорости фильтрации в глинах.. Орошение сельскохозяйственных земель требует дополнительно больших объемов добычи артезианских вод: если иссякает один водоносный горизонт – разработчики переходят на более глубокие горизонты или ставят насосы. Так, в результате окультуривания одних площадей, обезвоживается вся территория в целом.

Следует отметить, что реальные величины снижения уровня грунтовых вод на оконтуренной территории могут оказаться значительно выше, чем расчётные, по той причине, что фиксированный боковой приток подземных вод на западной и юго-западной границах области на самом деле не является постоянным и его величина снижается из-за наличия множества эксплуатирующихся водозаборов на сопредельной территории.

Таким образом, можно сделать вывод, что опустынивание территорий Северного Дагестана можно напрямую связать с повсеместным снижением уровня грунтовых вод вследствие развития региональной депрессии в напорных водоносных горизонтах плиоцен-четвертичных отложений из-за чрезмерной многолетней эксплуатации артезианских вод Терско-Кумского артезианского бассейна.

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ECONOMIC SCIENCES

SWOT ANALYSIS OF GEORGIAN GASTRONOMIC TOURISM

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Introduction

Georgia has always been the prize stone of great empires. Unfortunately, there were constant attacks, sometimes they captured some part of our homeland, sometimes the whole country. Sometimes this happened for a short time, other times the occupation lasted for hundreds of years. If one can see something good in all this, it is the variety of Georgian cuisine. However, our culinary arts were not only influenced by invaders. Due to its convenient geographical location, Georgia has always been at the crossroads of trade routes. First, it is enough to mention the Great Silk Road. Foreign merchants traveling on these roads also had a great impact on Georgian food culture.

Over the centuries, Georgians took the best of everything that foreigners had, later rejected and forgot something, changed and kept others according to Georgian taste. However, the influence of foreigners is visible in many ways, and a prominent example of this is "Foreign Spice", its name clearly indicating that it was imported from a foreign country. This is how many dishes have come to this day, for example, khinkali or kali, whose roots, as experts claim, are from Asia, but Georgians added their own nuances to their recipes and cooking methods and turned them into real Georgian dishes.

Another important advantage of Georgian cuisine is its diversity. Every corner of this small country is enlivened by its unique culinary art. Not in every corner, sometimes the dishes are different even at the level of the ancient village. "In the villages of Kartli: in Dzegvi and Nichbis, the local population still prepares "garlic khinkal", which may be made elsewhere (eg in Tetratskaro), but the mentioned dish is mainly characteristic of these villages. The same villages are characterized by another peculiarity in terms of traditional cuisine. This is a wild growing "capar", which the locals collect and pickle for the winter. (This member of the caper family is also used in folk medicine)." To the surprise of the participants of a one-week tour in Georgia, they eat khachapuri every day and it is always different. Let's take the Racha-Lechkhum-Kvemo Svaneti region, which is quite small and very few in number. While traveling here, the tourist gets acquainted with three different historical-geographical provinces of Racha, Lechkhumi and Kvemo Svaneti, as if similar but different architecture, life, cuisine, wines, and it is impossible not to bring the visitor into admiration.

One of the important elements for the development of Georgian gastrotourism is Georgian wine and Georgian wine tourism. Wine tourism is considered a sub-species of gastronomic tourism, but for Georgia, wine and wine tourism are so important (Taktakishvili, 2017). that they often become the reason and basis for implementing gastronomic tours.

In addition to the above-mentioned factors, Georgian gastronomic tourism has other positive and negative aspects. We considered that a simple analysis will more clearly present the state of this type of tourism in Georgia. Considering the educational (professional) factors and consumer demand is crucial in this process (Abashidze, 2023; Kvirkvaia et al., 2018).

Overally, the tourism industry in Georgia is still in its early stages of development, but it has the potential to be a major driver of economic growth. The government has taken steps to promote tourism, such as easing visa restrictions and investing in infrastructure (Papava, Charaia, 2021; Gamsakhurdia et al., 2017, Sikharulidze, 2018). Tourism can also play a significant role in small and medium size business development in Georgia, including through fintech technologies also (Lashkhi et al., 2022a; 2022b); Tourism as one of the drivers of the Georgian economy (Kadagidze et al., 2021; Tsutskiridze, Charaia, 2023; Anguridze et al., 2015), makes a significant contribution to the Georgia wellbeing and life standard uprise.

SWOT analysis

At the beginning, I will explain a few important points from each graph of the SWOT analysis in a relatively broad way, and at the end, a summary and detailed list of these issues will be presented in the form of a table.

Strong sides

✓ Positive image of Georgia as a tourist country and permanent increase in the number of foreign tourists and visitors over the last 20 years. Work in this regard began as early as 1998, when the State Department of Tourism and Resorts of Georgia was created, and in terms of image promotion and branding, activities were especially intensified since 2004, which, along with the resolution of other issues (security, unilateral cancellation of the visa regime with tourist generating countries, etc.) A steady and steady increase in tourists and visitors followed. The only exception was the regression caused by the pandemic in 2020-21 (Meladze at al., 2022; Charaia at al., 2021; Papava, Charaia, 2021).

✓ One of the distinctive and authentic elements of Georgian cultural heritage - Georgian cuisine, which is a delicious and amazing mixture of spices, herbs, recipes and cooking methods left here by many ancient civilizations.

✓ A diverse range of authentic local Georgian dishes and Georgian wine (Saferavi, Khvanchkara, Kindzmarauli, Rkatsiteli, Tsolikauri and others) and dishes (Khachapuri, Khinkali, Kubdar, Shkmeruli, Chakafuli, Tsiv, Tkemali and others) brands, which are well known domestically and internationally in the tourist market;

✓ Tasting of local cuisine and wine ranks first among the tourist activities carried out by foreign visitors in Georgia, and satisfaction with Georgian table

and hospitality is quite high. Unfortunately, the same is not true of the quality of tourism services in general;

✓ Establishing a close connection between the local population and tourists through wine and food products, which is a good way for guests to have a full-fledged cultural exchange with the locals. That's why Georgian gastronomy can become one of the factors that bring foreign tourists to the country again and again, the so-called. will facilitate re-visits;

✓ Rich tangible and intangible cultural heritage, modern and creative culture, which makes Georgia a fascinating tourist destination. 3 cultural monuments (Mtskheta, Gelati and Zemo Svaneti), one natural monument (wetlands of Georgia), as well as 4 intangible cultural monuments (Georgian polyphonic song, Georgian way of making wine in a pitcher, Georgian alphabet and Georgian wrestling) are included in the UNESCO list of material culture monuments.

✓ Traditional hospitality of Georgians. "The guest is God's!" This expression shows how much a Georgian appreciates a guest, whom he considers a gift from God. "Wonderful" is another Georgian word that emphasizes the natural hospitality of Georgians. "Superb" is a synonym of the best, the best, excellent, and the content indicates that the Georgian kept and increased the best for a stranger, a guest;

✓ Georgian traditional table, the same bread culture, which in 2020 was awarded the status of an intangible cultural heritage monument of national importance. The Georgian table is very complex, multifaceted and multi-layered, followed by archaic elements and angular features. Its etiquette, tradition, tamada, merikife and toasts are a truly Georgian phenomenon, the like of which cannot be found anywhere else, which makes it very attractive and interesting for tourists;

✓ A Georgian village, where tourists can taste ecologically clean products and authentic dishes (sourdough, dambal-cottage cheese, sulguni, Gudi cheese, churchkhela, honey, etc.) and wine;

✓ Georgia's convenient geographical location, due to which it can play the role of a tourism hub in the South Caucasus in general and, among other things, a gastronomic tourism center;

✓ Convenient geopolitical location of Georgia in the region. Historically, Georgia and Tbilisi have always represented the political center of the South Caucasus. Today, the Great Silk Road, Trasecka and, recently activated, the Middle Corridor remain almost the only routes for freight and passenger traffic between Asia and Europe due to the Russia-Ukraine war. In addition, due to the conflict between Azerbaijan and Armenia, it is impossible to carry out combined gastronomic tours in the South Caucasus without traveling to Georgia;

Weaknesses

✓ I consider the biggest obstacle facing the development of Georgian gastronomic tourism to be the lack of a strategic plan that will be approved by all participants of this sector;

✓ Also, it is a serious challenge that food product manufacturers and restaurant business representatives do not properly realize the great potential and profitability of gastronomic tourism, which is why most of them consider the local population as the main target segment and pay less attention to tourists. While working on this topic, I asked almost all famous restaurants in Tbilisi to fill out a simple questionnaire that did not require any confidential information. I received answers from only 10% of respondents. This speaks for itself about the attitude of the managers of these enterprises towards tourism. Due to such a small number of responses, of course, this study turned out to be statistically unreliable, but it still provides an opportunity to draw certain conclusions. For example, at Odabade restaurant, which positions itself as a place to offer authentic Georgian, in particular Maghreb dishes, 50% of guests are foreigners. A few other restaurants have slightly less but similar statistics.

✓ Lack of complete inventory and register of local authentic food products and dishes remains an important problem. An inventory of food-related tangible and intangible heritage such as utensils, customs, recipes, products, etc. should be carried out. Then it is necessary to identify from them those special products, dishes and drinks of local gastronomy that have the greatest potential to be introduced in the tourist market, in order to create the basis for creating a new gastronomic offer or renewing the existing one.

For the rest of the information on weaknesses, see below in Table N 1.

Opportunities

✓ Development and adoption of a strategic plan for the development of gastronomic tourism, which will make it possible for this type of tourism to move from the tracks of spontaneous development to planned evolution; This, of course, is the most important and difficult task, but at the same time, it is possible to make a stable, thoughtful development of this sector, based on the principles of sustainability, and therefore, the economic, ecological and socio-cultural benefits obtained, will be balanced.

✓ Georgia is not perceived in the international market as a gastronomic tourism destination, which makes it difficult to "sell" it, but this so-called "Underestimation" is a possibility even if the right steps are taken;

✓ Today, in Georgian gastronomic tourism, technological innovations tested in marketing are almost not used, but their use can become the main driving force of this type of tourism; This should be done through a combination of digitization, big data management and artificial intelligence to be able to predict customer behavior and needs. Such activities will primarily facilitate business to facilitate access to customers throughout the value chain.

✓ Improving the scenario, environment, places and system of hosting tourists in order to perfect the gastronomic tourism product - there is an opportunity to create museums, gastronomic interpretation centers, meeting and event halls, etc., which will contribute to the diversity of the tourism product and the satisfaction of tourists.

See the rest of the information about the possibilities below, in Table N 1.

Threats

✓ Greater diversity of gastronomic tourism products and more aggressive marketing among Georgia's competitors in gastronomic tourism. There is quite a lot of competition in this field, so without competitor

analysis and comparative analysis it is impossible to develop this type of tourism correctly. Especially since most of our competitors have a better quality-price ratio, more diverse products and better marketing compared to us.

✓ Failure to consider the changed behavior and needs of tourists as a result of the pandemic, especially in family kitchens and cellars. In the post-pandemic period, people pay more attention to the observance of sanitary-hygienic norms, healthy food, ecologically clean products and general health care. If these issues are not taken into account, it will be difficult to hope for the satisfaction of tourists.

See Table N 1 below for more information on hazards.

Table 1.

SWOT analysis of Georgian gastronomic tourism

Strength	Weakness
1. Positive image of Georgia as a tourist country; 2. Georgian cuisine, as one of the distinctive and authentic elements of Georgian cultural heritage; 3. A diverse assortment of authentic local Georgian dishes; 4. Georgian wine and food brands, whose awareness is high in the international tourist market; 5. The priority of tasting local cuisine and wine from the tourist activities carried out by foreign visitors and high satisfaction with Georgian table and hospitality; 6. Establishing a close connection between the local population and tourists through wine and food products and a full-fledged cultural exchange between them; 7. Rich tangible and intangible cultural heritage, modern and creative culture; 8. Traditional Georgian hospitality and Georgian bread as a unique cultural heritage; 9. Georgian village where tourists can taste ecologically clean products and authentic dishes and wine; 10. Convenient geographical location of Georgia; 11. Convenient geopolitical location of Georgia; 12. The abundance of Georgian restaurants, family kitchens and family wineries; 13. As a result of the increase in the income of the local population, a large part of it has the opportunity to visit Georgian restaurants, get a good gastronomic experience, travel to get new impressions; 14. Popularity of culinary television programs and shows; 15. Permanent increase in the number of foreign tourists and visitors over the last 20 years.	1. Absence of a strategic plan for the development of Georgian gastronomic tourism; 2. Improper image and branding of Georgia as a gastronomic tourism destination; 3. Improper marketing of Georgian cuisine in the global market; 4. Lack of competitive gastronomic tourist product corresponding to international standards and its diversity; 5. Inappropriate hybridization of the gastronomic tourism product with other types of tourism. An exception may be the MICE business, however, there is quite a large reserve here as well. 6. "New Georgian cuisine", if it exists, could not become as important an element for gastronomic tourism as the Spanish Nueva Cocina (New Cuisine) for the Basque Country and Spain. 7. Lack of modern technologies and innovations in the marketing of gastronomic tourism; 8. Absence of complete inventory and register of local authentic food products and dishes; 9. The scarcity of culinary events and the absence of a calendar of gastronomic festivals and celebrations with fixed dates; 10. Absence of an effective distribution system for the existing gastronomic tourism product; 11. Uneven distribution of gastronomic tourism products and events between regions of the country; 12. Absence of an international quality certification system for Georgian food products; 13. Absence of a national quality model of gastronomic tourism enterprises, which is why the risk of tourists getting a low-quality experience is high; 14. Lack or absence of personnel trained in accordance with modern international standards; 15. Lack of experience in receiving foreign tourists and lack of relevant skills, including foreign languages; 16. Absence of training programs aimed at training chefs so that they can properly use more local products, be able to perform the function of a guide and interpret, which will increase the quality of this type of tourism; 17. Inadequate quality of gastronomic tourist services and Georgian tourist services in general; 18. Absence of authoritative national, regional and local associations and networks of gastronomic tourism; 19. Inadequate awareness of the great potential and profitability of gastronomic tourism by food producers and restaurant business representatives. 20. Orientation of the modern Georgian peasant on the quantitative index of production, not on the qualitative one; 21. Unbalance of products and dishes in Georgian gastronomy (e.g. lack of fish dishes); 22. Absence of programs for research and monitoring of gastronomic tourism markets, as well as assessment of the impact of this type of tourism on the territories,

Opportunities	Threats
1. Development and adoption of a strategic plan for the development of gastronomic tourism, which will make it possible for this type of tourism to move from the tracks of spontaneous development to planned evolution; 2. Georgia is not perceived in the international market as a gastronomic tourism destination, which makes it difficult to "sell" it; 3. Today, the technological innovations tested in marketing are almost not used in Georgian gastronomic tourism, but their use can become the main driving force of this type of tourism; 4. Growing interest of local and foreign tourists in Georgian food products and cuisine; 5. The possibility of creating interesting culinary routes through small catering establishments and family kitchens in the regions of Georgia; 6. Planning and holding gastronomic festivals and events on fixed dates, especially in regions, which will make it easier for tour operators to include them in tourism programs; 7. Based on the growing interest in local food products and family cooking, the creation of cooking schools, courses, farmers' markets and others; 8. Creation of communication and cooperation mechanisms, both between the state and private structures, and between the sectors involved in gastronomic tourism. 9. Improving the scenario, environment, places and system of hosting tourists in order to perfect the gastronomic tourism product. 10. Planning events for local communities that encourage them to give a name to their gastronomic traditions, strengthen their sense of pride and help preserve their cultural identity.	1. Greater variety of gastronomic tourism products and more aggressive marketing among Georgian competitors in gastronomic tourism; 2. More and more interest in gastronomic tourism in our neighbors, as well as in our competitor countries in tourism in general, and concern for the development of this sector; 3. The Covid-19 pandemic and the slow pace of tourism recovery in the post-pandemic period; 4. Failure to take into account the changed behavior and needs of tourists as a result of the pandemic, especially in family kitchens and cellars; 5. Due to the lack of effective quality control mechanisms for local products and dishes, unmet expectations and dissatisfaction of tourists 6. Difficulties in lending to gastronomic tourism businesses, especially startups, high interest rates and high collateral fees; 7. Ignoring the requirements of a healthy lifestyle and healthy food and not making appropriate changes in Georgian cuisine; 8. Unstable political situation of the region and the country (Abkhazia and Samachablo occupied by Russia; Russia-Ukraine war, Karabakh conflict) 9. Increased political risks due to the Russia-Ukraine war, disruption and slowdown of global logistics connections, danger of deepening inflationary processes and economic recession in the world; 10. Increased natural disasters due to global warming, climate change, difficulties in the production of agricultural products; 11. Improper condition of water supply, sewage, roads and other communal infrastructure in the regions;

Conclusions

It can be safely said that Georgia has an excellent potential for the development of gastronomic tourism, which, unfortunately, is only partially utilized. The strengths and opportunities of Georgian gastrotourism are so impressive that even in the absence of any well-thought-out strategic plan, the business manages to achieve success in this field independently, without assistance from the state. But this cannot continue indefinitely, especially since our direct competitors constantly take care of the diversity of their gastronomic tourism products, carry out quite aggressive marketing, and there is constant promotion of this industry by the state.

In order for Georgian gastronomic tourism to develop stably and take its proper place in the global tourism market, there are many problems to be solved, but, in my opinion, it is first necessary to develop a strategic plan that will be approved by all participants of this sector.

This strategic plan should define key strategies such as: product strategy, market strategy and target audience and positioning strategy (WTO, 2019).

As the World Food Travel Association points out in its 2020 report, such a well-planned tourism strategy can bring many benefits. In particular:

- Attracting new and repeating visitors;
- Improving visitor experience;
- Positive economic impact;
- Sharing positive impressions;
- Protection of local heritage;
- Education of the local population.

Hopefully, soon Georgia will have such a plan developed, approved and adopted with the participation of all the main stakeholders of the field, and our country will take a proper place in the international market of gastronomic tourism.

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IMPORTANCE OF FUNDAMENTAL CONCEPTS AND REGULARITIES IN BUSINESS MANAGEMENT

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Abstract
The paper discusses fundamental concepts and regularities, knowledge of which is necessary for business process management. A little sociological research was conducted, studying the level of awareness of fundamental concepts and regularities and determining the need to acquire this knowledge.

Keywords: business process, structure, system, elements, parameters.

Introduction

Standards, guidelines, protocols and algorithms are beneficial for practising professionals, reducing the risk of errors and legal liability. Their use provides for the development of technical skills and strengthens them with practice. For growth, it is necessary to refine and improve existing standards, to introduce evidence-based theoretical knowledge into practice, as well as to generalize good practice and transfer it to theoretical knowledge.

It is worth noting that the role of practising professionals is essential in any field, and the number of such professionals is of greater necessity than that of thinking and creative professionals. According to the data of one of the studies, to raise "n" number of thinking professionals (considering small groups), we need to teach "n^2" number of people. According to this, if we train 25 professionals, 5 of them will be thinkers, and 20 will be practitioners.

Theory, if not tested in practice, remains a useless doctrine. Application of theory in practice requires necessary learning and skills. First, it is critical to comprehend theoretical knowledge and access its essence. Knowing basic facts by heart applies to practical tasks but only in standard cases. In reality, the share of non-standard cases is not so insignificant. Therefore, next to template knowledge, thoughtful knowledge plays an important role, especially in terms of developing theoretical knowledge and improving practical activities. This requires a thoughtful knowledge of the most general concepts and regularities (Balanchivadze & Tkebuchava, 2020). Unfortunately, the existing education system cannot provide such knowledge, neither in general education nor in higher education institutions (Kvirkvaia et al., 2018). Graduates of humanitarian specialities are more or less equipped with such knowledge, while in educational programs of natural science and technical direction, less attention is paid to providing above mentioned.

The knowledge of general regularities is crucial for the formation of critical thinking, which is necessary for the creation of a new business or the maintenance and development of the sustainability of the existing one because the business process is subject to the general regularities of the processes in the world, including ones such as a global pandemic or wars (Charaia et al., 2022; Papava, 2021), and being aware of those facts is the tool that is necessary for business development.

Research hypothesis:

- Business is a process subject to the fundamental regularities of the universe;
- Critical thinking is necessary for the correct management of business processes, which is based on the knowledge of fundamental concepts and regularities;
- Critical thinking basics should be included in the business management and administration curriculum.

The objectives of this work are:

- Equipping interested parties (students, businesspeople, managers and others) with such knowledge will enable them to perceive business processes, identify contributing and hindering factors influencing business, and based on the general regularities of the process, conduct correct analysis and make evidence-based, valid and optimal decisions;
- Studying the level of awareness of fundamental concepts and regularities and determining the need to acquire this knowledge.

Goals:

- Finding and studying scientific literature about the general regularities of the world's development;
- Determining the impact of general regularities on business processes;
- Conducting sociological research in order to study the level of awareness of fundamental concepts and regularities and to determine the need to acquire this knowledge;
- Analyze, judge and draw conclusions about the processed material.

The subject of research is fundamental concepts and regularities. As for the **object,** it is the business process.

The work is mainly analytical, and the following research **methods** are used: analysis and synthesis, deduction and induction, systemic, structural-functional, comparative and sociological.

The paper discusses the fundamental concepts and provisions necessary for conscious perception, analysis and optimal decision-making of processes; their definitions and content are obtained from various sources; the author's view is presented; used examples and events are explained based on the logical chain of general statements.

Business – as a process

In a simple sense, the world is a set of **processes** and **conditions**. We can say that the process is a set of infinite states.

Process - (Latin: processus) "Any sequential alternation of events, the path of development." (Chabashvili, 1989). It is a set of real, dynamic, changing events. Each specific process has a beginning and an end. In general, processes in the universe, existed, exist and will exist indefinitely.

Condition:

„1. The state of existence of someone or something, general circumstance, situation.

2. Existence, being, in one form or another". (Linguistic Technology Group, n.d.), (Cambridge Dictionary, n.d.)

Relative, a concept of abstract content, represents a process in instantaneous time. To turn it into a reality, you need to capture the process in some way in instantaneous time (e.g. photography). If the process is really slow and we cannot notice dynamics in a short period, then we are talking about a condition in a given period.

The fact that business is a process and not a state is confirmed by the concepts and definitions in the scientific literature, such as "business process", "production process", and "business management process". For example:

- "The purpose of business process management is to make the organization more flexible and effective towards changes, not only for customers and employees but for other interested parties as well" (Helms, 2021; Lashkhi, 2022; Abashidze, 2023)
- "Management is a continuous process, the basis of which is the preparation, adoption, execution and correction process of decisions" (Lipartia, 2020)
- "In General, management principles can be defined as starting norms, rules and regularities concerning the management process, the observance of which helps to achieve the goals and solve the tasks facing society" (Lipartia, 2020)

Thus, business is a manifestation of the process and is subject to all the regularities characteristic of the process. Therefore, knowledge of these regularities is not only necessary but vital for the conscious management of business processes.

Any process happens in a certain environment, which is called a system. The business process occurs in a business system. It can be holdings, corporations, factories, workshops, brigades etc.

Elements of a business process - civil dictionary defines a system as any combination of regularly arranged and defined interrelated parts. System components are called system **elements**. For example, the workshop system may include workshop building, machines, people working in the workshop and so on.

As it is apparent from the definition, the elements of the system are arranged in a certain regularity. They have a specific role and function in this system. The interconnection of elements implies not only their passive, mechanical connection but also their mutual influence on one another. Any element of the system directly or indirectly affects all the others, and any element is directly or indirectly affected by all the others. Therefore, they are in a dialectical unity with each other. Elements, as well as the results of their interaction, are characterized by distinct features.

Business process parameters

A parameter is:

"The characteristic quantity or quantities of the main properties of an object or event" (Chabashvili, 1989)

"A quantity that allows us to characterize some phenomenon, some property of a device (e.g., electrical conductivity, thermal conductivity etc.)" (Chikovaba, 1960).

"A quantity characteristic to any system, task, behaviour, or event" (Uridia, 2004).

Those are called system **parameters**. Parameters can be **quantitative** and **qualitative**. A quantitative parameter is measured and expressed in numbers, responds to the question - how much? But the qualitative parameter is not measured and expressed in numbers, responds to the question - what kind? Quantity and quality cannot exist independently. Any subject and event is determined by both quantitative and qualitative data. The interaction of elements affects the parameters of the system.

System elements themselves are subsystems of the given system, and they can be called first-order subsystems. Of course, they also have their own elements, which are second-order subsystems of the system, and so infinitely. Furthermore, any system is a subsystem of a higher-level one, and that too endlessly. Therefore, one expression of the infinity of the universe is the perpetuity of division and union. The universe is an infinitely large system that is infinitely divided into an unlimited number of subsystems.

The processes in the system are influenced by certain **factors**.

Factor - [Latin factor maker, creator] "The determinant of any event or driving force of a process". (Chikobava A. , 1962)

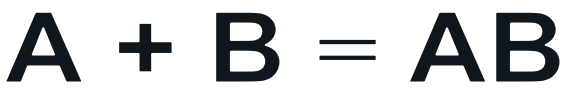
The system, as a part (element) of the supersystem, is influenced by other elements of the supersystem, which are called **external factors of the system**. Also, the elements of the system interact with each other. The influence of both external and internal factors affects the parameters of the system.

If the general parameters do not change as a result of the interaction of factors affecting the system, the system is in **equilibrium**.

Equilibrium - “a state of immobility, created by the simultaneous influence of mutually opposing equal forces”. (Linguistic Technology Group, ო. ჯ.)

Generally, there are two types of equilibrium: static and dynamic. **(Picture 1)**

1. Static equilibrium



2. Dynamic equilibrium

Source: author

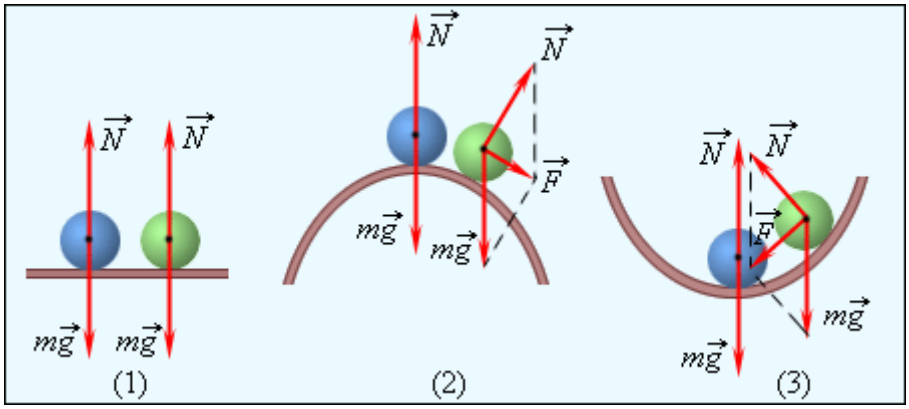
Picture 1 – Static and Dynamic equilibrium

Dynamic equilibrium is the relationship of system elements that determines the stability of system parameters. The system strives for equilibrium. That is, it tries to maintain the existing equilibrium or to restore the disturbed one.

The system maintains dynamic equilibrium if the influence of the factors affecting it compensate for each other.

Balance is characterized by stability. The more firmly a system maintains or easily restores equilibrium, the more stable it is.

A ball on a flat horizontal surface is in a state of indeterminate equilibrium. The ball at the top of the convex surface is in unstable equilibrium, while the ball at the bottom of the concave is in stable equilibrium (Picture 2).



Picture 2 - Different types of equilibrium of a ball on a support
(1) indeterminate equilibrium, (2) stable equilibrium, (3) unstable equilibrium
Source: www.physics.aidio.net

There are open and closed systems. In an open system, the exchange of mass and energy with the environment is actively taking place. A closed system is isolated from the environment and is characterized by strong autonomy, although there is no entirely closed system. The more open the system is, the more the environment influences it and the more tools the system needs to maintain or restore equilibrium.

The concept of a system includes not only the unity of material elements but also certain non-material unities that are used to manage material systems. One of the essential principles of business management is the principle of systematic management, which considers the business organization as "a unified system, considering its internal structural and external interconnections and interdependencies" (Tughushi & Kirimlishvli, 2005).

Le Chatelier's principle for dynamic equilibrium, its general character

Under conditions of constant external and internal factors, the system reaches and maintains equilibrium.

French chemist Henry Le Chatelier developed a principle for reversible chemical reactions that can be generalized for any dynamic equilibrium:

If a dynamic equilibrium system is affected by some new factor, processes that will try to compensate for this impact will be triggered in the system.

For example: if in a market where the supply and demand for a given commodity at a given price are in equilibrium ("equilibrium point"), the supply of the commodity is increased, the price will accordingly decrease in order to increase sales. The price will continue to fall until equilibrium is established between the supply and demand of the good (the new "equilibrium point").

Considering Le Chatelier's principle, in case of changes in the factors affecting the business, it is possible to predict the result of this change. Furthermore, it is possible to determine what kind of change of a specific factor is needed to get the desired result.

Three basic laws of Dialectics

The processes happening in the world are subject to certain general laws and principles. Those apply to business processes as well.

Avtandil Dzamashvili, PhD, explains in his book "Philosophy" – „In the theory of dialectics, i.e. development, there are three principally essential issues: First - this is the question of the driving force of the reality development. What inexhaustible power causes the constant movement-development of reality? A certain kind of answer was formed to this question, it was given the form of a law, and in the theory of Dialectics, it was called the Law of Conflict and Unity of Opposites; The second issue concerns the mechanism of development: - how does development take place, that is, how do qualitatively new things occur, what is the mechanism of transition from the old to the new? - The set of opinions formed as an answer to this question also took the form of a law in the theory of Dialectics and was named - the Law of the Transition of Quantitative Changes to Qualitative Changes; The third question is even more fundamental for the development itself. Development is the transition from the old to the qualitatively new. So, the question is about the relationship between the old and the new. Is the new an improvement on the old? Therefore, does the developing movement have any definite direction? The formulated answer to this question, which was given the form of a law, was called the Law of the Negation of the Negation". (Dzamashvili, 2009)

The Law of Unity and Relationship of Opposites

"All objects, events, and processes are characterized by internal contradictions, the sources, and force of growth and development. Thus, the movement of reality is created not because of external factors but because of causes that arise and are in all objects and in us.

The law emphasizes the possibilities of understanding the universe by understanding any integral system as fragmented and complex, with incompatible elements and tendencies (forming a unity in a battle). This interpretation explains that the fact of development lies in the growth of contradictions, which at a particular stage destroys the old and creates the new" (Brown, 2021)

Based on the content of this law concerning the system, the term "different" implies elements, and for the existence of the system, at least two elements that are different from each other are necessary. Without their coexistence and interaction, the system cannot exist. For example: in the absence of any element of the business system or their inactivity, the business as a system will not be able to fully perform the function that was planned, that is, the desired result will not be achieved.

The Law of the Transition of Quantitative Changes to Qualitative Changes

Quantity refers to the exhaustive parameters of phenomena or objects, and quality is a stable system of certain characteristics. The law of transition of quantitative changes into qualitative changes is based on the following: when the quantity changes, the quality will necessarily change. (Basic laws of dialectics and their application. A New View of the Foundations of Philosophy, 2019).

"The law of transition of quantitative changes to qualitative is a kind of accumulative system. It is said that small, constant quantitative changes, step by step, create a transition to a new quality, like a leap. At this moment, the previous state is eliminated, and a new one is created, depending on the nature of things and the conditions of their development. If such a jump occurs, all the quantitative changes up to this stage are cancelled, and the process begins again, until a new quality is formed" (Brown, 2021)

Quantitative changes mean changes in the quantitative parameters of the system. And in the qualitative change - changes in qualitative (characteristic) parameters. For example: Quantitative parameters for business systems can be: revenues, costs, profits, working hours and others. Qualitative changes - micro, small, medium and large business, VAT payment, legal form and others.

The law states that not all changes in the quantitative parameter(s) lead to a change in the qualitative parameter(s). Still, there is a limit to the shift in the quantitative parameter(s) that will lead to a change in the qualitative parameter(s). For example: let's assume that the income of the LLC was 50 thousand GEL per year (quantitative parameter) and it was a VAT non-paying organization (qualitative parameter). LLC began to develop and grew by 10 thousand GEL every year. Although the quantitative parameter (annual income) changed, the qualitative parameter (non-VAT-paying organization) was unchanged, because according to the legislation, an organization whose annual income exceeds 100 thousand GEL becomes a VAT-payer. Accordingly, the LLC will need 5 years to reach the critical threshold of quantitative change (annual income), beyond which its qualitative change will occur (VAT-paying organization).

A good example of the transition from quantitative changes to qualitative changes is: ice-water-steam. A change in water temperature (quantitative parameter) from 0 to 100^0C does not cause a change in the aggregate state (qualitative parameter) of water, at 0^0C and below water turns into ice, and at 100^0C and above - into steam.

It should be noted that the threshold of transition from quantitative change to qualitative change can shift if certain other parameters change. For example: in conditions of low atmospheric pressure, the temperature of evaporation of water is lower than 100^0C.

The Law of the Negation of the Negation

Negation implies a transition from one qualitative state to another - replacing the old quality with a new one, when the development process is progressive. (Kentchiashvili, 2023) The essence of the law of the negation lies in the fact that the new exists only until it becomes old and is replaced by something new, which in turn exists until it itself turns into the old. (Basic laws

of dialectics and their application. A New View of the Foundations of Philosophy, 2019).

The law of negation is a direction of development based on the negation of previous experiences while preserving the positive content of past stages. Thus, this postulate is a manifesto of upward progress, which destroys the old and creates the new, and the chain of growth has no end. Such continuous negation is characteristic of all processes and phenomena observed in nature, society, and thought. (Brown, 2021).

The law implies the following: nothing in the universe is unchanged and everything (including the system), after certain quantitative changes, undergoes a qualitative change. Depending on the content of the law, the original qualitative condition will be negated by the new qualitative condition, that is, the first qualitative condition is negated, and the second qualitative condition is the negator.

Moreover, the second qualitative state will not be unchanged and after certain quantitative changes it will be rejected by another qualitative state, that is, the negator will be rejected, and so on endlessly. Here it is implied that the first qualitative state was the negator of the qualitative state before it, and so on ad infinitum. This law expresses the infinity of the world in time, that is, the qualitative change of the world has been and will always be.

In business management, it is necessary to conduct processes in such a sequence that our desired result is achieved.

Structure and function, their dialectic unity;

The structure of the system consists of its elements, which, as we mentioned, represent subsystems, respectively, have their own structure (elements) and so on. The relationship of these elements represents a process, that is, a function is performed. Therefore, structure and function are inseparable - there is no function without structure and no structure without a function (The Law of Unity and Relationship of Opposites). Structure determines function and function determines structure i.e. function depends on structure, and structure depends on the function. In such a case, it is said that structure and function are in dialectical unity with each other.

Therefore, any structural change in the business process affects the result of the process, and, if it is in our interest to change the result (function), it is necessary to make appropriate changes in the structure (structure).

Results of sociological research

Within the framework of the article, online sociological research was conducted. The purpose of the research was to study the level of awareness of fundamental concepts and regularities and to determine the need to acquire this knowledge.

There were 144 participants, the number of valid questionnaires - 144, invalid – 0.

Sociological research revealed:

- The research group has some knowledge about the basic laws of dialectics, systems and dynamic equilibrium (Conscious knowledge is present in the following percentage terms: about the 3 basic laws of dialectics -14,8%; about the system - 21,5%; about the dynamic equilibrium - 20,4%; about Le Chatelier's principle - 12,7%).
- The vast majority of the research group is interested in deepening knowledge about fundamental concepts and regularities (77.1%) and believes in the necessity to include a relevant training course in educational programs (79.6%).

Conclusion and recommendations

Thus, based on the analysis of the processed materials and the conducted sociological research, the hypothesis presented in the article is confirmed, namely:

- Business is one of the specific cases of processes in the world;
- The business process is subject to the general regularities, characteristic of other processes;
- The correct management of business processes requires the ability of critical thinking, which is based on the knowledge of fundamental concepts and regularities;
- The level of awareness of fundamental concepts and regularities is noticeably low;
- It is necessary to include a module for teaching the general basics of critical thinking in business management and administration educational programs, as revealed by the results of sociological research;
- Putting theoretical knowledge (given in this paper) into practice will reduce the risk of making wrong business process decisions. This will have a positive impact on the optimal management of business processes and, accordingly, business development.

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THE ROLE OF THE LEADERSHIP STYLE IN IMPLEMENTING ORGANIZATIONAL CHANGES ON THE EXAMPLE OF COMPARING GEORGIAN AND FRENCH ORGANIZATIONS

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Introduction

The 21st century can be called the era of great technologies. A few years ago, we could not have imagined the progress of artificial intelligence (Abashidze, Dabrowski, 2016), when countries would think about stopping it or adding regulatory bodies to existing institutions for regulation. As is known, the Italian Personal Data Protection Authority has banned (temporarily suspended) the use of ChatGPT4 and the French government has decided to mobilize additional measures to study the usefulness of this version of artificial intelligence (www.emarketerz.fr, 2023)

The development of technologies has its positive side and plays a big role in the progress of various scientific and industrial fields. Therefore, the pros and cons of new technologies should be well studied and the expected risks should be determined with great care and foresight.

According to research conducted by the American banking organization Goldman Sachs, new technologies have the potential to make significant changes in the global economy, as well at a local level, including small developing nations (Lashkhi et al., 2022; Charaia et al., 2021). In particular, artificial intelligence, according to their calculations, can increase global GDP by 7% (almost 7 trillion dollars) and productivity by 1.5 percentage points within 10 years.

According to them, the progress of artificial intelligence systems could have a big impact on employment markets. Up to 300 million full-time jobs could be automated and replace humans (GoldmanSachs, 2023).

Especially in the age of technology, a large role is given to the leaders and the strategy they choose and the relationships between the persons/colleagues in the implementation of changes in the organization.

In business management theories, technological innovation and managerial innovation are often separated from each other (Jaouen and Le Roy, 2013). For authors Birkenshaw, Hamel and Moll (Birkinshaw, Hamel and Mol, 2008) Management innovation is the key to success. The term Managerial Innovation was coined for the first time in 1981 by the scientist Kimbarlim, who wanted to distinguish technological innovation from other types of innovation (Kimberly, 1981).

In managerial innovation, the emphasis is not shifted to the introduction of technological innovations, but the main attention is given to the mobilization of human resources and their preparation for relevant innovations.

The innovative management style and innovative vision of the leader is very important to achieve success in today's world. Otherwise, companies will not only be uncompetitive, they may even be destroyed (Gamsakhurdia, 2013). We know many such cases in the industry. For example, the Blockbuster company, which owned about nine thousand stores by 2004 and in 2019, only a few branches remained (Clifford, 2011). The company's management refused to cooperate with Netflix and could not compete with Hollywood videos. Incorrect assessment of market innovations and managers' unrealistic expectations of dominance among competitors led the company to failure.

A similar situation developed in the case of Kodak, a company that employed eighty thousand people by 1980, faced unforeseen events at the beginning of the 21st century. The main reason for its failure was improper evaluation of digital technologies. The leaders of that time failed to adequately assess the trends of the coming era. In 2012, the company was forced to sell its patents to Apple and Google in order to avoid financial crisis.

From these examples it becomes clear how important is the objective assessment of the situation and the adequate attitude to the innovations on the part of the leaders and governing bodies.

When implementing changes, the leaders of the organization are of crucial importance, who act in different ways based on their personal qualities to achieve the set goals. Back in the 80s, psychologist Kirton proposed an interesting theory by studying adaptive-innovative attitudes to events. According to existing theory, every manager (individual) has to choose between adaptation and innovation. Individuals at both ends of the continuum are creative, just in different ways. Individuals with high adaptability prefer to find solutions using established systems, while individuals with high creativity prefer to go beyond current norms to find new answers to unsolved problems.

One of the main factors in the implementation of innovative approaches is the constant updating of acquired knowledge (Kvirkvaia et al., 2018). In successful countries, a lot of attention is paid to permanent training of employees, which is often financed by the organization and the state, in whole or in part (Papava, Charaia, 2021). Various funds and services have been created for such a development approach, which participate in the financing of employees according to certain criteria. In France, there are several funds that are directly interested in financing the training of managers, for example, AGEFICE, FAFCEA, FAFPM, FIFPL, SPP, PCM, VIVEA.

The paper gains from examining in more details how Georgian and French firms approach and manage change. Each of them has unique cultural norms, values and management techniques. This article examines and

contrasts leadership styles in these two different cultural contexts to offer light on the cultural implications leaders must take into account when undertaking digital transformation initiatives. Organizations can modify their change management techniques to optimize effect and prevent cultural pitfalls by recognizing cultural pitfalls.

Georgia's regional dynamics, religious beliefs and historical traditions all influence the country's leadership. France's leadership reflects the country's cultural origins, as well as its historic traditions. French leaders' underlying motives and priorities may be influenced by their cultural emphasis on intellectualism, art and the legacy of the French Revolution.

An important factor in determining a country's leadership style is its political climate. Because Georgia has relatively recent democratic history and political uncertainty, it may have distinct leadership difficulties compared to France, a well-established democratic country with a lengthy political history. In order to gain a better understanding of democratic procedures and political institutions, it can be useful to examine how leaders are elected and maintained in each nation.

It is not uncommon for the economic factors to influence leadership decisions. For instance, Georgia, a developing nation, might place greater emphasis on improving infrastructure, attracting foreign investment and expanding the economy (Sikharulidze, Charaia, 2018; Wang 2018). Considering that France is a developed country, social welfare, economic stability and international trade links might be of higher importance. Analyzing the leadership philosophies of each nation within the context of these economic priorities reveals the techniques used by its leaders.

With the help of these analyses, we can better understand leadership dynamics in different cultural contexts, which will also facilitate the development of international policies and practices to encourage efficient leadership.

Literature review

There are studies researching leadership styles in France and Georgia factors conditioning them. It is worth to note, that national culture seems to be an important factor shaping leadership styles in those countries.

Niforos (2010) shows that the experience French leaders gain in fast-evolving global environments demonstrates the versatility of French management techniques. National identity can be attributed to some shared characteristics (adherence to humanistic values, structured management and respect for individual freedom and choice). Despite the fact that they have taken different paths to reach the same conclusion—that subcultures and supracultures are capable of coexisting underneath or above national boundaries, resulting in hybrid cultural archetypes transcending national borders. Buckermann (2011) demonstrated that French national culture had a profound effect on the corporation's internal organization. Multinational companies that started out as national businesses and developed over time without engaging in significant cross-pollination with foreign companies typically exhibit such a condition. A multinational company's highly uniform cultural approach has both advantages and disadvantages. When cultural frictions are not encountered during communication, internal tensions and frictions can be reduced, which can be advantageous. When there is a uniform cultural structure, it might be difficult to be tolerant of diverse cultures. Due to the emphasis on personal networks, auto-reproduction of elites and suppression of culture-foreign components, such a close-knit society is difficult to alter. Through the analysis of French organizational leadership's power sources, outcomes and triad model, Yang, Tossan & Law (2022) provide an overview of French organizational leadership. As a result of these relationships, which offer great legitimacy to the French leadership process, French leadership is fundamentally based on having connections with influential institutions such as top management and the Grandes écoles. Hierarchical, honor-based and ends-over-means leadership forms are suggested as part of the triangle model for French leadership. French leadership places a high priority on results as outcomes. The general traits of French leadership may be explained by enlightenment ideology since the French Revolution from an historical and cultural perspective.

According to the findings of Jacque Lou & Ferdinand (2020) both transactional and transformational leadership styles were used by the branch manager to effectively manage the manufacturing company. At a moderate level, authoritarian leadership was the least used, while laissez-faire leadership was moderately used. A manufacturing organization under study reported that the leadership styles used had an impact on the effectiveness and productivity of its employees. As a result, the employees gave an exceptional effort to their work. Human resource management involves implementing effective leadership techniques that support the achievement of the organization's goals and objectives, as well as the workforce's desired outputs and productivity. Management should devise plans that encourage workers to be innovative at work, use transformational leadership to make them feel like they belong, give workers a greater sense of responsibility, give them less direction from superiors, and let them express themselves creatively. Khan (2019) states that it is common in France for cultural organizational challenges to be unclear, inconsistent and weak in leadership. The main barriers to change are senior management's aversion to change, stereotypes, a lack of understanding, employees' mistrust of outsiders, nationalism, etc. It is possible that not every province in a huge country like France shares the same culture. In order to navigate this challenging path, the manager can employ transactional or transformational leadership techniques. Thus, not all organizations will accurately reflect the suggested leadership styles.

Gambier and Eclapier (2023) found that French organizations are characterized by commanding leadership. It is known as dissonant leadership, which lacks empathy for the workforce and can negatively impact an organization in many ways. French leadership culture is characterized by a rigid hierarchy that emphasizes respect for authority and hierarchical rigidity.

Naqshbandi and Jasimuddin (2018) found that higher degrees of knowledge-oriented leadership can improve open innovation outcomes. In other words, knowledge-oriented leadership positively impacts open innovation.

According to Evans (2010), women tend to apply greater restraint and prudence to financial management and are constantly concerned about not becoming over-indebted when it comes to financial management. There may be a reason why certain venture capitalists in France are less willing to invest in women-owned businesses if they are seeking a quick return on investment because women are generally more cautious and long-term-oriented. There is less risk for women and they are solidly rooted in the long term.

There are several researches studying leadership styles in Georgia, which provides mixed results.

Tkeshelashvili (2009) in her study demonstrates that Georgians rank their society highly in terms of in-group collectivism, assertiveness and power distance. Study suggests that Georgia is in close proximity to several Eastern European countries. Even though data from culture dimensions indicates that it should be more like authoritarian leadership, employees in Georgia see the predominant leadership style as Middle-of-the-Range Leadership. As a result of the correlation analysis, a high in-group collectivism culture dimension was more influential at work than a high assertiveness culture dimension or a high power distance culture dimension. Employee orientation is higher than expected as a result of these two factors.

Yasar and Chinelo (2015) studied 201 from the 396 employees at Georgian Oil and Gas Corporation (GOCG). They investigated the effects of Georgian Oil and Gas Corporation's leadership style on employee performance experimentally. They found that collaboration affects job quality positively, supportive communication has a positive impact on motivation and delegation affects employee satisfaction positively. Worker loyalty was positively and strongly correlated with the measure of aiding subordinates. Employee involvement in decision-making is recommended in order to foster a sense of community and improve job quality. This study proposes that a Caucasian setting can be used to study leadership style in order to build successful and profitable businesses.

Minadze and Minashvili (2018) found in their research that transactional leaders are considered to be more consistent with supervisory actions. They point out avoidant leadership as the least utilized style in Georgian organizations. The transformational style and the employee engagement showed the strongest linear relationship.

Maridashvili (2015) states that it is important to remember that managers create their leadership style based on intrinsic rewards rather than extrinsic rewards, where business policies, empowerment, success and achievement, as well as praise for a job well done, stand out above others. Depending on the level of management to which these managers belong, their motivations and leadership philosophies vary.

Methodology

In this study, we examine the attitudes of leaders in French and Georgian organizations during organizational changes involving academic, industrial and public sectors. The purpose of this research is to gain insight into the factors that influence leadership approaches during times of change by examining the differences and similarities in attitudes across these two distinct cultural contexts. The research was conducted in French and Georgian organizations. Among others heads of Georgian Technical University, East European University, Georgian startup Atomus took part in the research.

From the French side, representatives of 13 organizations participated in the research. 15 percent were led by the representatives of the industry sector, followed by almost equal percentages of coaches, communication specialists, network marketing and public service officers/supervisors. From Georgian side, leaders of 5 companies took part in the research.

The survey was voluntary and the anonymity of the respondents was strictly protected. Qualitative data was collected through semi-structured interviews. Stratified random sampling was used to ensure that a variety of organizations and leaders are represented. A proportionate number of organizations from each stratum was randomly selected to participate in the study. The population was divided into three strata according to academic, industrial and public administrative sectors. After selecting the organizations, leaders (managers, executives and decision-makers) were interviewed and surveyed.

Results and discussions

New leaders with less than 3 years of experience predominated among the participants. The majority (7 respondents) consider themselves a humanistic leader. 5 respondents of the surveyed managers consider the combination of financial progress, group development, collective goodwill, timely fulfillment of set goals as success. They think that making change requires making employees satisfied with their jobs. To achieve financial success and achieve goals, leaders must prioritize their team's needs and satisfaction during the implementation of change.

Six managers consider experience as their advantage, four managers - education, one - kindness towards colleagues, for the rest two managers - a combination of these criteria. In addition to emphasizing the importance of fostering a supportive and caring workplace, the participant attributes the success of the transformation to a combination of experience and education. Still they iterate that having happy employees is important to make change happen.

Eight respondents consider themselves innovative leaders, two believe that they are not innovators, one hopes that the group perceives itself as a news-loving leader. The rest believe that they do not have time for constant news. They believe that employees value innovation as well and looking forward for innovative leader, consistently introducing new ideas. Change process can go smoothly if employees perceive leaders as

people who promote a culture of change and embraces novelty.

Seven respondents believe that to improve the results, it is necessary to better train the heads of organizations, while two believe that it is necessary to develop digital skills better and the rest think that motivating group members more is a necessary condition for the country's progress. Obtaining better results and promoting good change within an organization require organizational leaders to improve their abilities and knowledge through greater training.

Nine respondents think that digital transformation is a very important factor for the development of the organization, the believe that a good knowledge of technologies is a necessary skill for the development of organizations. Participants highlight how technological skills play an important role in driving the growth and progress of their firm (Zivzivadze et al., 2021). They emphasize the importance of digital transformation and its ability to transform enterprises.

Eight respondents consider women leaders to be innovators. However, the supremacy of Cope Zimmerman's law (protection of parity in management boards) in innovative matters is not strongly expressed by the interviewees and they believe that a lot depends on the situation.

Six leaders consider artificial intelligence as a means of increasing competitiveness in their organizations and part of them think that it is possible to replace humans with this method. Though it is interesting that most of them do not use the assistance offered by the Bank of Entrepreneurs (methods of introducing and diagnosing artificial intelligence in enterprises).

As the research showed, the majority of the heads of the organization like the collaborative style and consider themselves humanistic leaders. For them, success is a combination of financial progress, group development, collective goodwill.

The research revealed that the interviewees consider better training of the employees of the organization as one of the prerequisites for advancement. The most important factor for them is digital transformation of organizations and high level knowledge of technologies.

It is not necessary to consider the unconditional success of the organization as only the involvement of female leaders and protection of parity for the participants in the research. A large part of them consider artificial intelligence as a means of increasing competitiveness in the future and a small part of the interviewees does not rule out replacing humans with them.

Results demonstrated in the survey of French leaders show characteristics of transformational leadership where a leader is humanistic, corporate culture-oriented, open-minded and focused on technical capabilities. It is the quality of leadership that motivates and inspires followers to achieve remarkable outcomes. Transformative leadership is a kind of leadership that motivates and inspires followers. Individuals and organizations are transformed through the adoption of a clear vision, the stimulation of creativity, the creation of a positive and collaborative culture for the team members to reach their full potential.

Through their humanistic and people-centered approach, the leader develops strong relationships, while his or her innovative thinking encourages creativity and innovation. In addition, transformational leaders are characterized by an open mindset, are open to feedback and are willing to consider alternative perspectives. In addition, the emphasis on technical skills corresponds to the transformational leader's desire to embrace change and incorporate applicable technology for improved organizational performance.

In general, the leadership style found in the survey of French executives displays many characteristics of transformational leadership.

From the Georgian side, representatives of 5 organizations participated in the research. They were representing manufacturing, education, business association, retail and public sectors.

Only one of the surveyed leaders stated that his leadership style is humanistic. Two of them stated that they were just goal oriented and two of them said they were good managers with sound knowledge and capabilities.

Only one of them stressed importance of team when talking about success, while others stated that financial success of the company and respect towards leader by the team, together with the team spirit are all important when talking about success.

Three leaders stated that they implement changes in the organization very often, while all of them agreed that digital transformation has an important impact on their organization. Four respondents believe that AI cannot replace human jobs in the nearest three years.

As a result of the company's focus on profitability and sustainability, its financial success was considered critical. Furthermore, the team's regard for the leader was deemed vital, highlighting how important it is for leaders to have credibility and influence within their organizations.

Some Georgian leaders emphasize the humanistic aspect, while others emphasize goal achievement and management expertise, based on the survey results. Success is seen as a combination of financial achievement, team spirit and leadership respect. With a willingness to embrace digital transformation, the leaders do not appear proactive in their approach to change. Even though AI is acknowledged as an important technology, it is widely believed that it will not completely replace human work any time soon.

Based on the qualities exhibited by the leaders surveyed in Georgia, the leadership style presented here combines Transactional and Situational leadership, as well as Task-Oriented and Transformational leadership qualities.

Georgian leaders' leadership styles appear to be a combination of a variety of approaches based on the responses. Transactional elements are used to set goals and manage tasks, situational adjustments are used based on the context, transformational elements are used to inspire the team and a forward-thinking attitude is used to lead digital transformation. This finding is not surprising and Georgia is currently experiencing a period of transition, since it balances its historical legacies with the winds of change that are sweeping the country

today. It is certain that some corporate leaders have been influenced by the country's history, particularly the Soviet era. It was during this period that people developed their visions and demonstrated a feeling of conservatism when it came to changes. Since they have traveled through an era of stability and uniformity, they may be inclined to conserve tried-and-tested techniques.

A new generation of young, energetic leaders embrace change, however. Their drive for growth and innovation motivates them to challenge traditional thinking. In addition, they are transformational leaders and growth catalysts since they are constantly searching for new and better ways to accomplish their goals.

Georgia's corporate scene has a distinct dynamic as a result of the coexistence of these two opposing leadership styles. Although conservative leaders tend to provide stability and continuity, their rivals offer a fresh perspective and energy. In the country's growth and development, this clash of viewpoints creates both opportunities and problems.

Furthermore, this changeover period fosters synergies and learning opportunities between the two groups. As the younger and older leaders connect and exchange ideas, the older leaders can gain insights into new techniques, while the younger leaders can gain wisdom and lessons from their past experience. Together, they contribute to shaping Georgia's economic ecosystem in a way that combines tradition and modernity in the future.

Conclusion

It is imperative that leaders adopt agile and adaptive leadership approaches as the digital landscape changes constantly. It is advised that leaders in both Georgian and French organizations are able to adapt quickly to market changes, customer demands and technological developments. When leaders adopt an agile mindset, they can experiment, fail quickly, learn and adapt their strategies accordingly.

In both Georgian and French contexts, leaders play an important role in implementing digital transformation. To implement a successful transformation, one needs visionary leadership, effective change management, cross-functional collaboration, digital leadership capabilities and agility. Leadership in digital transformation can be optimally adapted and optimized by comparing Georgian and French practices during digital transformation and by understanding the modern trends and findings in digital transformation.

The findings of the research are in line with the literature review, which shows that national culture is an important factor determining leadership style. Georgian leadership style is characterized with mixed qualities of different leadership styles, while study of French organizations showed that the leaders mostly utilize transformational leadership style that is partly aligned to the literature reviewed above. Based on these findings it can be said that the process of the change in French organizations will be more supported and the employees will be in the center of the process. While in Georgian organizations, this process largely depends on the background and philosophy of a leader itself.

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GEORGIA'S BANKING SECTOR TRENDS AND IMPACT ON LOCAL ECONOMY DURING THE PANDEMIC AND POST-PANDEMIC PERIOD

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Abstract

The banking sector is a key driver of economic growth in Georgia. The sector has been resilient during the COVID-19 pandemic, with low levels of non-performing loans and strong capital buffers. However, the pandemic has had a negative impact on the local economy, leading to a decline in economic activity and a slowdown in credit growth. The post-pandemic period is expected to be challenging for the banking sector, as it will need to support the recovery of the local economy. The sector will need to focus on providing credit to businesses and households, as well as on developing new products and services to meet the needs of customers.This paper discusses the current trends in the development of the banking sector in Georgia in 2019-2022, in relation to the issues of economic growth and the problems and challenges that the pandemic and post-pandemic periods have shown us.

Keywords: banking sector, Georgia, pandemic, economic growth, digitalization, competition, customer service, inclusive growth.

Introduction

The development trends of the banking sector and its impact on the local economy include the paradigm of the development of the banking sector (Anguridze et al., 2015) in terms of overall economic development and the impact of the global shock of the Covid pandemic in the pandemic and post-pandemic period, 2019-2022. It should be noted that this is the first complex research of its kind in the direction of the economy and the banking sector in the recent past.

The second thing, which is very interesting, is the connection between the banking system and the economy of Georgia, what is the impact of innovative and digital products on the banking sector, especially in the pandemic and post-pandemic periods, and on the other hand, the impact of the banking system on the economy, as well as the impact of the macroeconomic background (Dilanchiev, Taktakishvili, 2021; Wang et al., 2018) on the development of the banking system in general in crisis and post-crisis periods.

The financial shock caused by the COVID-19 pandemic has put severe pressure on global financial markets and the banking sector. In December 2019, a novel coronavirus (COVID-19) emerged in the city of Wuhan, China, and spread globally (Gautam et al., 2022, Zhou et al., 2021). The World Health Organization (WHO) declared COVID-19 a global pandemic on March 11, 2020, and declared a public health emergency (Gautam et al., 2022). The COVID-19 pandemic suddenly appeared in a world that was not prepared for such an event, which devastated the economies of countries around the world and also seriously and rapidly affected the global economy (Duan et al., 2021, Fernandes, 2020). Its losses exceed the global financial crisis of 2008 (Hanif et al., 2021).

COVID-19 poses a significant threat to public health and economic development (Zhou et al., 2021). This disease has increased uncertainty and risks, drastically reducing global activity (Padhan and Prabheesh, 2021). Notably, studies examining the impact of COVID-19 have rapidly emerged. Researcher Fernandes (Fernandes, 2020) stated that COVID-19 has reduced global demand and supply. Yue, Giselle Korkmaz, and Zhou (Yue et al., 2020) showed a reduction in consumption and investment. Research by Devpura and Narayan (2020) found that COVID-19 cases and deaths exacerbated oil price fluctuations. Gubareva (Gubareva, 2021) and Cholak and Öztekin (Çolak and Öztekin, 2021) analyze credit crunch due to COVID-19. Researchers Akhtaruzzaman, Boubakeri, Luci and Sensoi (Akhtaruzzaman et al., 2021) investigated the role of gold as a hedge during the COVID-19 pandemic crisis, also known as coronomic crisis (Papava, Charaia, 2020). COVID-19 is also negatively affecting the performance of various firms and industries (Fu and Shen, 2020, Gamsakhurdia, Fetelava, 2023; Shen et al., 2020) and the insurance sector (Wang et al., 2020).

The paper discusses the impact of innovative technologies and digitization on the banking sector, digital banking essentially refers to the use of modern technology to deliver banking products. Some believe that digital banking essentially means an online or mobile banking platform, but to truly grow digital, we believe it should go beyond that.

The transition from the existing banking service platform to a digital one implies the use of the latest technologies at all functional levels and on all service delivery platforms, where financial education takes a significant impact (Kvirkvaia et al., 2018; Zivzivadze et al., 2021). Digital banking should similarly be considered not only on the internet or mobile banking platform (Abashidze, Dąbrowski, 2016), but also at the branch, head office, online service delivery platform, ATMs and points of sale. The paper shares a study

published in 2022 on these issues - The Impact of Fintech on Financial Institutions: The Case of Georgia (Charaia et al., 2021; Lashkhi et al., 2022).

Research Methodology

The effectiveness of the banking sector's financial condition is determined by economic performance, commercial and financial performance, and others. Otherwise, the successful implementation of financial plans of commercial banks will have a positive impact on its financial situation. In the opposite case, the cost of production increases, the income from sales decreases, and the financial condition and solvency of the firm are threatened.

The research is based on analytical, synthetic, structural, trend, grouping and comparison methods. The objects of the research are the limited liability enterprises: "Engurhesi" and "Gardabni thermal station". The companies operate in the field of energy. The research was conducted based on the financial statements of commercial banks in 2019-2022.

During the dynamic analysis, a comparison of each indicator of the financial statement with the previous period is used. Through it, the management can analyze the multi-year financial situation of the enterprise to find out what causes specific changes. Base indicators can be used for the analysis, in particular, the data of any past period, which may be presented as a percentage. At this time, each subsequent year is compared to the base year and deviations are determined. Dynamic analysis is also called horizontal analysis.

Structural analysis shows the structural composition of financial indicators as a percentage. At this time, each article and/or group of articles of the financial statement is presented as a percentage with respect to the main (base) indicator of the statement. In contrast to the dynamic analysis, at this time the financial statements of a specific period will be analyzed. Because of this, it is static and non-dynamic.

During the comparative analysis, specific indicators are compared at the intra-enterprise and inter-enterprise levels. If the comparison of individual indicators of enterprises and their subsidiaries is considered at the domestic production level. At the inter-enterprise level, the performance of a particular enterprise is compared with that of a competing enterprise or with the industry average of a given industry. Both comparisons are made with the help of trend analysis, reflecting changes in financial indicators over a specified period of time.

Statistical materials from the database of the National Bank of Georgia, commercial banks, the Ministry of Finance, Saxstat, the International Monetary Fund and the World Bank are widely used in the work.

Banking Sector Trends in Georgia

As already mentioned, according to 2021-2022, the market of banking services was represented by 15 commercial banks, where the level of business concentration is quite high. The correlation of system concentration index and interest rates was also used to evaluate the banking system. The specific share of the 3 largest banks in relation to total assets is taken as the international level of concentration. The banking system of Georgia with the level of concentration of assets (77%) passes by such countries as Montenegro (83%), Moldova (70%) and Iceland (100%), however, if we take into account another parameter, the annual interest rate of basic lending, according to all credit products (meaning both retail lending, mortgage and business loans), Georgia has one of the highest interest rates (11.8%). And with this rate, we have the highest rate in Europe and the region of Azerbaijan (17.18%) and Ukraine (14.24%), together with Somkheti (11.62%).

In the post-crisis period, bank assets increased from 60.5 billion GEL to 70.3 billion GEL, or by 56%. From this, the share of the two largest commercial banks (TBC Bank and Bank of Georgia) in the total assets of the system is 44% and 38% respectively, which is 72% in total, the credit portfolio is 77%, and the share of net profit was 71% of the total profit of the system. If we add one more systemic "Liberty Bank" to these two banks (4.7%), their specific share in total assets, i.e. the level of concentration, is already close to 77%.

Assets (thousand Gel)	2022	2021	2019
TBC Bank	24,135,160,161	20,145,371,858	18,032,113,318
Bank of Georgia	26,625,502,407	21,788,183,848	17,139,080,625
Liberty Bank	3,623,271,954	3,111,348,075	2,144,192,712
Total	54,383,934,522	45,044,903,781	37,315,386,655
Total System Assets	70,350,872,000	60,568,539,000	47,183,367,000
Concentration level	77%	74%	79%

It should be noted that since 2015, according to 2022, the specific share of system-forming banks in total assets has increased from 59% to 77%, i.e. by 22 percentage points. Likewise, the rate of credit investments has increased, up to 55% and 82%.

Credit portfolio	2022	2021	2019
TBC Bank	17 834 148 836	16 739 135 187	12,616,108,774
Bank of Georgia	16 316 961 029	15 385 154 749	11,165,922,704
Liberty Bank	2 501 952 397	1 975 000 866	1,240,836,088
Total Credit Portpholio	36 653 062 262	34 099 290 802	25,022,867,566
The volume of total loans	44 224 210 000	42 189 443 000	31,078,641,000
As a percentage of profit	82,88%	80,82%	81%

The net profit rate has increased even more. In 2021, the net profit of the leading 2 banks alone amounted to 85% of the entire system, and in 2022 it reached a record 90%.

Net Profit	2022	2021	2019
TBC Bank	967,251,772	940,330,426	392,114,132
Bank of Georgia	924,342,950	831,973,935	390,435,262
Net profit	1,891,594,722	1,772,304,361	782,549,394
Total net profit	2,090,774,000.00	2,082,611,000	953,635
As a percentage of profit	90.47%	85.10%	82.00%

The increase in the assets of systemic banks is largely due to the significant increase in the assets of the first two largest banks, at the expense of the increase in retained earnings. It should be noted here that the rate of banking concentration in the listed countries varies between 55-68%. Accordingly, we have a banking concentration rate higher than the European average (71.12%), and we also have a lending rate much higher than the European average (10.4%).

These data also show that in conditions of high banking concentration, high interest rates should also be explained due to relatively low competition. Higher than the European average and with 100% banking concentration, the base lending rate in Iceland (100%) is 5.76%, in Montenegro 5.92% with 72% concentration, and 6.12% with 74% concentration in Albania. The relatively high lending rate in Romania is 6.49%, much lower than our banking concentration of 67%. Credit rates higher than the European average are in Belarus - 9.03% and Moldova - 8.18%, and in the South Caucasus countries: Armenia - 11.62% and Azerbaijan - 17.8%, although the level of banking concentration does not exceed 68% (Chart 7).

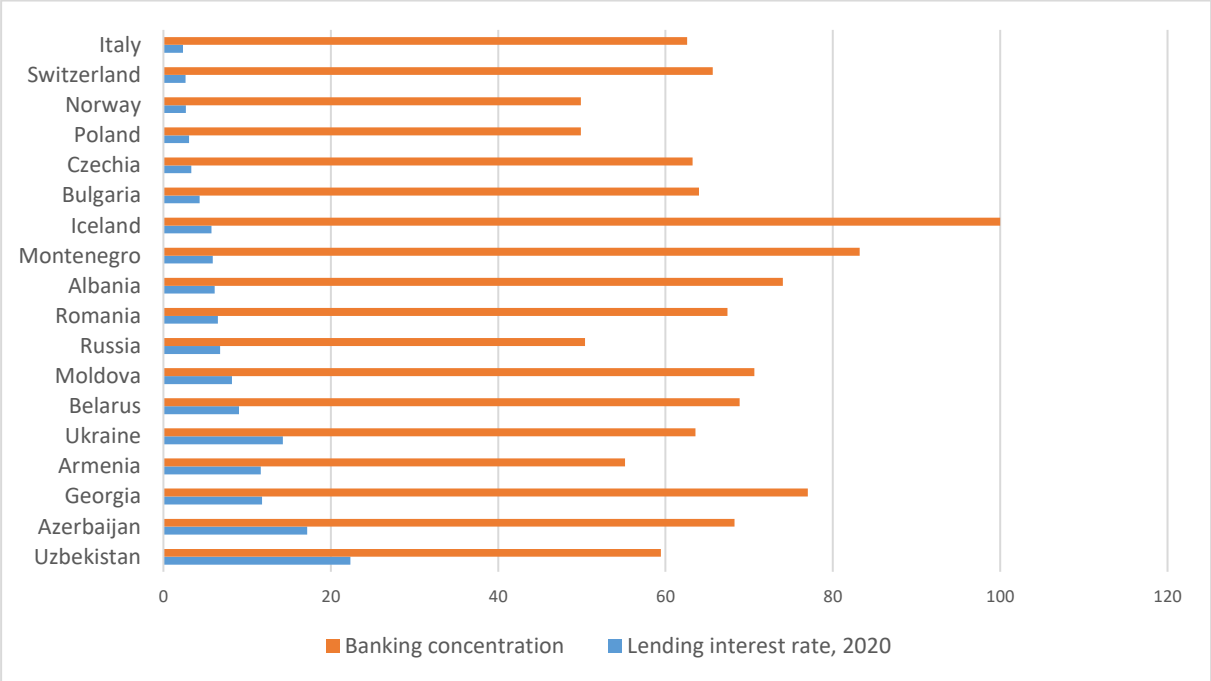

Diagram 1. Banking concentration and lending interest rates, 2020-2021, years %

Source: The World Bank.

The assets of "Bank of Georgia" increased from 9 billion GEL to 26.6 billion GEL from 2015 to 2022, which is equivalent to an increase of 38% from 29% in the system index. The growth of TBC Bank's assets was even higher, increasing from 6.9 billion GEL to 24.3 billion GEL in the same period, which is a systematic increase from 23% to 34%.

At a certain stage of development of the banking services market, high market concentration should not be evaluated negatively. The leading system-forming banks also represent a unique business barometer, both

in terms of attracting investors (Lashkhi, Charaia, 2017; Charaia et al., 2020; 2022; Sikharulidze, Charaia, 2018) in the sector, as well as offering the rules of the game to other market participants, introducing innovative banking products, and pricing banking products. However, on the other hand, high market concentration, due to the enterprise-wide effect, gives certain advantages to leading banks compared to competitors and primarily in dealing with customers, which is then expressed in a positive correlation between concentration and profitability.

In fact, such a high concentration naturally bears the hallmarks of an oligopoly, where there is such a market structure when two. A large bank offers a large part of all products to its clientele. In an oligopoly, enterprises compete in different ways. They care more about product differentiation so that consumers know the difference between the products they manufacture. In an oligopoly, firms are price seekers, although there are few in the market

Profitability of the Georgian Banking Sector

Naturally, with the increase in assets, the profits of the banking sector also increase. The past 2 years ended with a record profit of 2 billion GEL, which is not so much business, but retail lending growth, which contains certain risks and which is discussed in the liquidity analysis.

We believe that despite a number of problems, the banking sector of Georgia is one of the most successful sectors of Georgian business, we also see that according to the statistics of the last five years, the net profit of the banking sector is increasing, if according to the same data of 2019, the net profit was 953 million GEL, at the end of 2022, the profit rate has increased to 2,090 million GEL, or 2.1 times, and the average annual profit is 1.3 billion GEL, without looking at 84 million GEL in 2020 or reduction to profit.

The growing profit of the banking sector in the country can be explained especially by the double-digit economic growth of 2021-2022 and the improved banking supervision and service system in accordance with international standards, but on the other hand by higher lending rates than the size and partially high interest spread, the analysis of which will be offered in the relevant part of the study.

Higher interest income from loans to individuals is due to higher interest rates compared to business loans, on the one hand, due to risk factors, and on the other, to the relatively short term of the loans. It is interesting that the interest income of the banking sector grew by an average of 14% per year, including the increase in the crisis year 2020 by 12% compared to 2019.

Its disproportionate connection with the sharply reduced profit of 2020 is explained by the fact that according to the banking reporting methodology, the system suffered a loss of -943 million in March 2020, due to the increased volume of possible losses on loans, which amounted to - 1,165,198 million GEL and was caused by the uncertainty that led to the shutdown of the economy during that period due to the Covid pandemic.

In the vertical segment of interest income, the specific share of interest income received from lending to individuals was stable in the range of 53%, although in 2022 this indicator decreased to 50%, which is explained by the decrease in the rate of lending, although in the case of legal entities, if in 2019-2021 it was 35% of the total interest income, 20 In 2012, it was slightly reduced to 34%.

The fact that the pace of lending to individuals has been increasing in recent years is related to the development and availability of retail products, including installments, services, both in terms of reducing interest rates and extending maturity. I would also like to point out that this trend is also noticeable in EU member states. Trends and modern integrated banking products and technologies are still identical everywhere.

The total credit portfolio of commercial banks increased from 31 billion GEL to 44.2 billion GEL in 2019-2022, which is 42%, and by 11% in the average annual rate. In addition, in the credit portfolio, loans granted to households, including entrepreneurs, have increased by 49%, with an average annual increase of 12%, including individuals by 47%, while loans granted to legal entities have increased by only 35%, with an average annual increase of 9%. While, loans issued to legal entities in 2022 compared to 2021 decreased by 82 million GEL, which is mainly explained by the effect of the exchange rate, the dollarization of loans on loans issued in foreign currency (70%) is much higher than the base rate and, accordingly, it was also reflected in the volume of loans under the conditions of 16% strengthening of the GEL.

This trend is more noticeable if we consider the credit portfolio in a vertical section (Graph 16). It can be seen from the graph that the ratio of loans to households and legal entities in total loans, %, was almost equal in 2019-2022 and was within 51-49 percent, and in the crisis year 2020, it was at all equal. This proportion changed in 2022, when the share of household loans in total loans increased from 51% to 54%, and on the contrary, it decreased from 49% to 46% in 2022, which confirms the effect of the exchange rate.

We believe that this transformation of the system, which is reflected in the equal proportional development of lending to individuals and legal entities, in contrast to the years 2012-2017, when the specific share of lending to individuals increased to 56%, will be reflected in the expansion of new banking services, increased digitization, increased service quality and new products. All this will contribute to the modernization of the country's economy. As we can see, in 2012-2017, the rate of retail lending by commercial banks was increasing, which was taking place against the background of the decrease in business lending activity, and naturally cannot be evaluated positively. Despite such a high growth of the credit portfolio, its structure gives a very interesting picture in terms of business lending and loans to households.

We believe that the decrease in retail lending rates is still related to the new banking regulations, as for the

growth of business lending, it can be an echo of high economic growth on the one hand, and state programs supporting business on the other hand.

Georgian banks really need to introduce innovative approaches even more actively in business relations, by introducing new business models of digital banking. Recently, banks are increasingly actively moving to new B2B models, which is only welcome, because the bank should become a partner of the entrepreneur in the form of a financial advisor and consultant. It is significant that, according to research commissioned by the European Commission, the growth rate of small businesses is on average 3 times higher if the organization is led by digital technologies. Due to high competition and lack of capital, a small or medium-sized company that wants to raise awareness, stimulate sales or generally position the company is faced with a choice - to use traditional, expensive media or to give preference to Internet communications, spend minimal resources and continuously monitor what customers think about their company, practically switching to a marketing research and sales platform.

The change in the mentioned proportion and the growth of retail lending rates significantly led to an increase in the profitability of the banking sector, because compared to business loans, consumer loans are on average 3-4% more expensive, and the maturity is shorter. This problem creates serious risks for the banking sector, especially as it has already been mentioned that 85% of the profit of the system falls on the share of the three commercial banks forming the system.

Profitability of banks, on assets and capital

Return on assets (ROA) and return on equity (ROE) at the end of 2022 were 3.8% and 30.2%, indicating a fairly large equity multiplier of 7.9. It is true that as of the end of 2022, as of the 4th quarter, the rates of return on both capital and assets have decreased compared to 2021 (4.1% and 37.3%, respectively), when the capital multiplier was 9, although it is still at a high level. For comparison, in the fourth quarter of 2019, the rate of return on assets and capital was 2.4% and 19%, respectively, although with a high (8%) capital multiplier. Naturally, in the crisis year 2020, due to the loss of the system in the first 3 quarters, the indicators of the multiplier were negative, this is especially true for the 1st quarter, when the indicators of returns on assets and capital were -6.9% and -64%, respectively. However, in 2021-2022, following the growth of assets, we see a significant increase in profitability, which also indicates an improvement in the efficiency of scale, in terms of a decrease in the ratio of expenses to income, although, as we mentioned, this indicator is still on a growth trend.

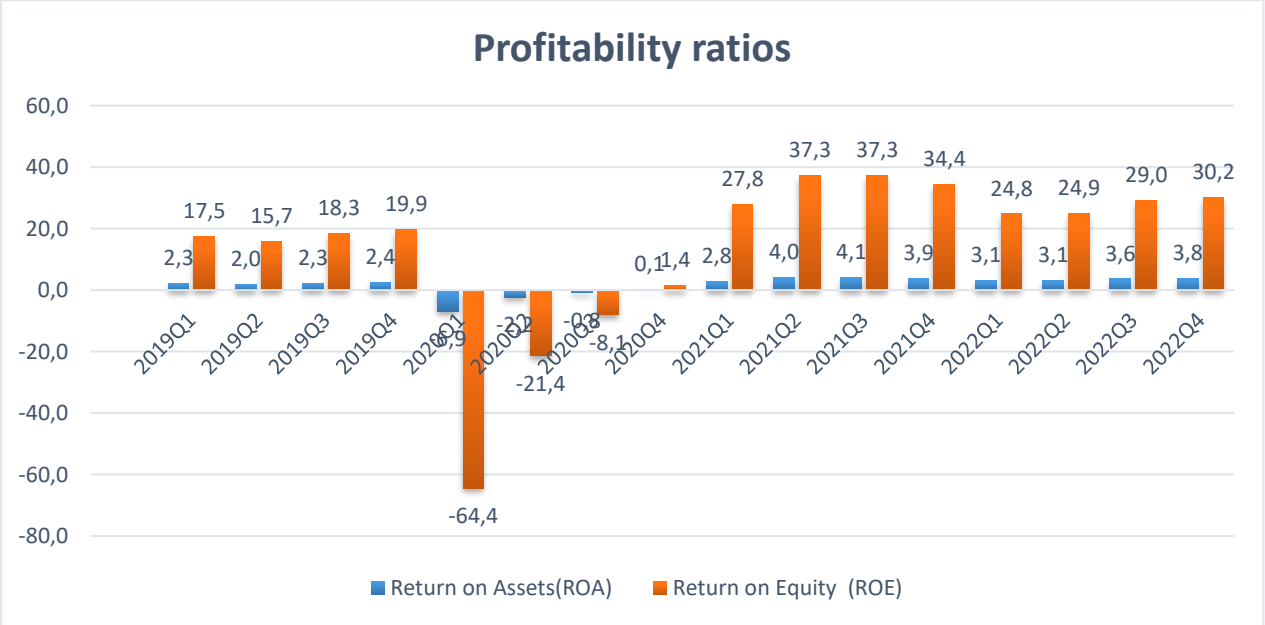

Diagram 2. Rates of return on assets and capital (%)

Source: National Bank of Georgia.

Both ROA and return on equity (ROE) measure how well a company is using its resources. But one of the main differences between the two is how they treat a company's debt. ROA determines how much leverage a company has or how much debt it has (Papava, Charaia, 2021). After all, its total assets include any capital it borrows to run its operations.

On the other hand, ROE measures only the company's return on equity, which does not include its liabilities. Thus, ROA accounts for the company's debt and ROE does not. The more leverage and debt a company takes on, the higher ROE will be relative to ROA. Thus, when a company takes on more debt, its ROE will be higher than its ROA. Assuming that income is constant, assets are now greater than equity and the denominator of the return on assets calculation is also higher. This means that the company's ROA falls while its ROE remains at the previous level.

One of the biggest problems with ROA is that it cannot be applied across industries. This is because

companies in one industry have a different asset base than those in another. So the asset base of companies in the oil and gas industry is not the same as in the retail industry. Some analysts also believe that the basic ROA formula is limited in its applications, which are most suitable for banks. Bank balance sheets are a better representation of the true value of their assets and liabilities because they are recorded at market value based on market accounting of historical value.

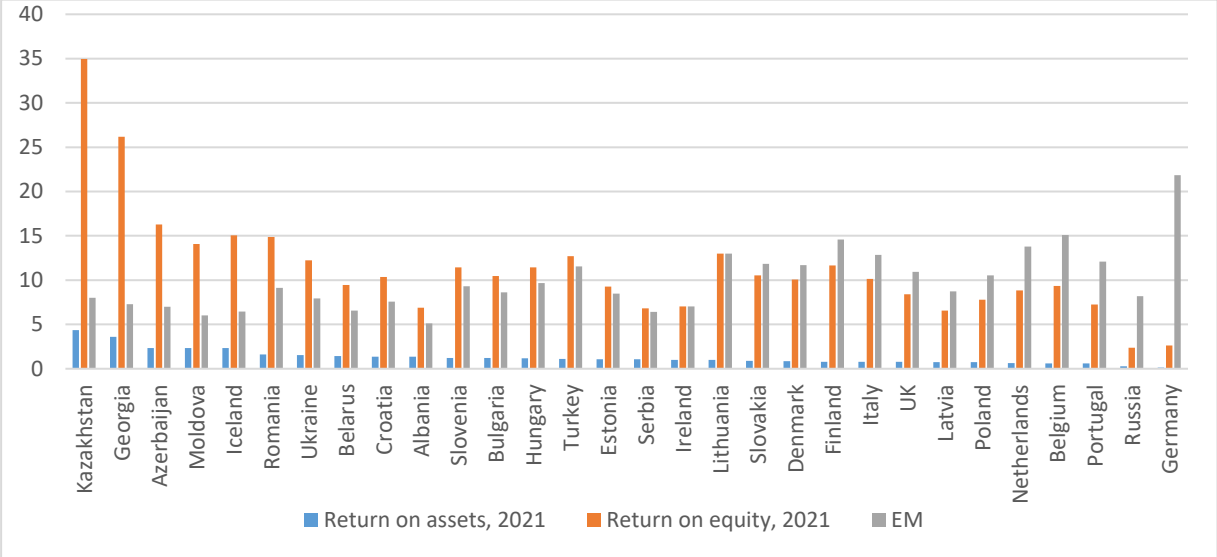

Diagram 3. Equity multiplier, return on assets and return on equity figures, 2021

Source: Bank return on equity, in percent, 2021

The study uses the equity multiplier, which is a risk indicator that measures the portion of a company's assets that is financed by shareholders' equity rather than debt. The equity multiplier is calculated by dividing the value of the company's total assets by the total equity in the company's shares. In our case it is the ROE/ROA ratio. A high equity multiplier indicates that the company is using a large amount of debt to finance its assets. The equity multiplier is also known as the leverage ratio or financial leverage ratio and is one of three ratios used in the DuPont analysis.

A high equity multiplier indicates that the company is using a large amount of debt to finance its assets. Companies with higher debt burdens will have higher debt service costs, meaning they will need to generate more cash flow to maintain a healthy business (Gamsakhurdia et al., 2017). The structural analysis of income also shows that the annual growth of non-interest income in the horizontal segment after a 3% drop during the corona shock period of 2020, which was also reflected in an 11% decrease in commission income, is characterized by a ZTRD trend. If interest income grew steadily by 19% in 2021-2022, on the other hand, non-interest income increased by an average of 44%, including commission income by 33%.

The impact of non-interest income on financial performance has been the subject of several studies. Return on assets (ROA), obtained by dividing net income by total assets, is one of the most widely used metrics of financial success. Return on equity (ROE), calculated by dividing net income by total equity, is another measure of financial performance. According to studies, interest-free income and financial success are positively correlated. Profitability determined by ROA and ROE was determined to be significantly affected, in particular, by non-interest income. It should be noted that the COVID-19 pandemic also had its impact on this particular issue as well. Hasko et al (2021) based on 51 banks in Europe (a study based on the period January-September 2020) showed that a 10% loss in non-interest income compared to the same period in 2019 was mainly due to a decline in trading and fee income. However, the impact on financial performance was minimal as banks were able to rely on government support and liquidity infusions.

After the covid pandemic shock, the specific share of interest income in total income decreased from 82% to 75%, and the share of non-interest income increased from 18% to 25%, which is 4 percentage points higher than in 2019, and should be evaluated positively in terms of the dependence of interest income and therefore the reduction of risks, although from commissions The received incomes remain stable within 8%. In the structure of non-interest income, the leading position is still the income from conversion operations, i.e. from currency purchase and sale operations, the rate of which exceeded the percentage rate of 2019 itself, and the total income has increased from 8% to 12%, from 359.8 million GEL to 886 million GEL, and by 4 percentage points even the income from commissions itself circle (570 million GEL).

Important factors driving the dollarization of deposits are the inflation rate and volatility, as well as currency depreciation, in low-income countries (Charaia, Papava, 2019; 2022). And the asymmetric exchange rate policy encourages depositors to have deposits mostly in foreign currency in order to maintain their purchasing power. From the point of view of de-dollarization of deposits and credits, the development of the liquid capital market in local currency will be

important in the medium term, along with the development of the stock market in the long-term, which with the de-dollarization of deposits, as we can see, the Georgian banking system is distinguished by one of the highest profitability and Net interest margin, equity multiplier and debt service leverage are at the European average. In addition, in countries with dollarized and highly import-dependent economies, interest rates and their differentials are high, resulting from risks arising from currency devaluation. Consequently, price elasticity to monetary and credit shocks is often higher in countries with dollarized economies, because inflation is more responsive to monetary and credit shocks due to weak policy transmission mechanisms.

In the conditions of high concentration and oligopoly market, where the assets of two banks are up to 75% of the total banking assets, which is discussed in detail in the corresponding chapter of this paper, the SEB is obliged to intervene more actively in the market for the sake of macroeconomic stabilization and limit the profits of banks, both in the direction of increasing the refinancing rate, interest margin and interventions in the market.

Conclusions

The Georgian economy has been resilient in the face of global shocks, but the high dollarization of the economy and the current account deficit remain challenges. The banking sector is in a good position, with decreasing dollarization of both loans and deposits.

The economy grew by 10.3% in 2021-2022, but unemployment and poverty remain high. The government should focus on inclusive growth, which means promoting the growth of micro and small businesses and employment.

Digital technologies can help small businesses grow, but they need access to capital and support. The Georgian economy has been resilient in the face of global shocks, but the high dollarization of the economy and the current account deficit remain challenges.

The banking system in Georgia is facing a number of challenges, including a high net interest margin, low non-interest income, and a lack of guarantee mechanisms for small and medium-sized businesses. The development of the stock market could help to reduce the banks' reliance on interest income and increase non-interest income. The future of Georgian commercial banks will depend on their ability to adapt to the new digital era and provide customers with fast and secure services. The main problem of lending to small and medium-sized businesses in Georgia is access to capital and lack of guarantee mechanisms.

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MATHEMATICAL SCIENCES

ON THE POSSIBILITY OF A CONNECTION BETWEEN THE CONSTRUCTION OF A CLASS OF BIGEODETIC BLOCKS AND THE EXISTENCE PROBLEM FOR BIPLANES

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Abstract

Graph theory and enumerative combinatorics are two branches of mathematical sciences that have developed astonishingly over the past one hundred years. It is especially important to point out that graph theory employs combinatorial techniques to solve key problems of characterization, construction, enumeration and classification of an enormous set of different families of graphs. This paper describes the construction of two classes of bigeodetic blocks using balanced incomplete block designs (BIBDs). On the other hand, even though graph theory and combinatorics have a close relationship, the opposite problem, that is, considering certain graph constructions when solving problems of combinatorics is not common, but possible. The construction of the second class of bigeodetic blocks described in this paper represents an example of how graph theory could somehow give a clue to the description of a problem of existence in combinatorics. We refer to the problem of existence for biplanes. A connection between the mentioned construction, the Bruck-Ryser-Chowla theorem and the problem of existence for biplanes is considered.

Keywords: Bigeodetic Blocks, BIBDs, Biplanes.

Introduction

A *balanced incomplete block design* (or simply a block design) on a set S with $|S| = n$, where $|S|$ is the cardinal number of S, is a family of subsets $B_1, B_2, \ldots, B_b$ of S called *blocks* such that:

(a) $|B_i| = k$, $1 \le i \le b$.

(b) If $x \in S$, then x belongs to exactly r blocks B_i.

(c) If x, y are distinct elements of S, then $\{x, y\}$ is contained in exactly λ blocks.

This block design is denoted (b, n, r, k, λ).

Just like any other combinatorial structure, block designs are defined in terms of certain parameters whose values determine the answer to the question of existence, that is, which values of these parameters produce the configuration in question and which do not. Given a (b, n, r, k, λ)-design, there are necessary conditions that its parameters must satisfy, namely, $bk = nr$, $r(k - 1) = \lambda(n - 1)$.

The conditions previously described on the parameters of a block design are necessary, but not sufficient. It means that we can use them to rule out the existence of a block design for certain groups of parameters. However, being given the values of the parameters, which satisfy the conditions previously mentioned, does not guarantee the existence of a block design with those parameters. There are many groups of possible parameters for which the existence problem has not been settled.

A design with $b = n$ is called *symmetric*. In such a design $r = k$ and hence such structure is called (n, k, λ)-design. For symmetric designs, there is an additional restriction for their existence [4, Theorem 3.1].

Theorem 1. (*Bruck-Ryser-Chowla*) Let n, k, λ be integers for which there exists a symmetric (n, k, λ)-design. If n is even, then $k - \lambda$ equals a perfect square. If n is odd, then the equation

$$x^2 = (k - \lambda)y^2 + (-1)^{(n-1)/2}\lambda z^2$$

has a solution in integers x, y, z not all zero. •

The set of vertices and edges of a graph G are denoted $V(G)$ and $E(G)$, respectively. An *undirected graph* is one having edges with no direction. Two vertices of a graph G are *adjacent* if they are connected by an edge. A graph in which every pair of its vertices is adjacent is called *complete*. The complete graph on n vertices is denoted K_n. A *path* in a graph G from vertex v_0 to vertex v_n is a sequence $v_0v_1\ldots v_n$ of different vertices and is denoted $P(v_0, v_n)$. The number of edges of a path P determines the length of this path and is represented by $|P|$. The length of a shortest path connecting vertices u and v in G represents the *distance* between these two vertices. The greatest distance between any pair of vertices of G is called the *diameter* of G, which is denoted $d(G)$. The number of edges incident to v is called the *degree* of vertex v and is denoted *deg* (v). G is said to be *regular of degree k* (or *k-regular*) if every vertex of G has equal degree k and *biregular* with *degree sequence* (k, l) if for any vertex v of G *deg* $(v) = k$ or *deg* $(v) = l$ for fixed values k and l, $k \ne l$. A *subgraph* H of a graph G is a graph whose vertices and edges are subsets of those of G. A *loop* is an edge that connects a vertex to itself. *Multiple edges* are two or more edges that are incident to the same two vertices.

In this research a graph is undirected, without loops or multiple edges. *Bigeodetic graphs* were defined by Srinivasan [5, p.102] as graphs in which each pair of nonadjacent vertices has at most two paths of minimum length between them. *K-geodetic graphs* have been defined in [1, p. 188] as graphs in which each pair of nonadjacent vertices has at most k paths of minimum length between them. Thus, a k-geodetic graph is *geodetic* when $k = 1$, *bigeodetic* when $k = 2$, *trigeodetic*

when $k = 3$, and so on. The minimum number of vertices whose deletion (implies also the deletion of the edges incident to the deleted vertices) disconnects G is called *vertex connectivity* of a graph G. A graph G is called *p-connected* if its vertex connectivity is equal to p. A *block* is a graph whose vertex connectivity p is greater than 1. In [1, pp. 190-201], a general study of k-geodetic graphs has been performed and bigeodetic blocks have been considered there as a particular case of k-geodetic graphs.

A *cover* of a graph G is a set $\{G_1, G_2, ..., G_m\}$ of complete subgraphs of G such that $G_1 \cup G_2 \cup ... \cup G_m = G$. A cover of G is called a Θ-*cover* if any two elements of the cover are edge-disjoint.

Let G be a graph having vertices $v_1, v_2, ..., v_n$. Let $A = \{G_1, G_2, ..., G_m\}$ be a cover of G, where $V(G_i) = \left\{v_{i_1}, v_{i_2}, \ldots, v_{j_i}\right\}$, $1 \le i \le m$. For each i, $1 \le i \le m$, take new vertices $v_{i_1 i}, v_{i_2 i}, \ldots, v_{i_{j_i} i}$ and construct a complete graph $K(G_i)$ on these vertices. Take n new vertices $v_{10}, v_{20}, ..., v_{n0}$ and connect $v_{il\,i}$ to $v_{il\,0}$ for $1 \le l \le j_i$, $1 \le i \le m$. The resulting graph is denoted $G^*(A)$.

Consider a (b, n, r, k, λ)-design on a set $S = \{x_1, x_2, ..., x_n\}$. Let K_n be a complete graph with vertex set $\{x_1, x_2, ..., x_n\}$ and G_i be a complete graph on vertex set of B_i, $1 \le i \le b$. Clearly, $A = \{G_1, G_2, ..., G_b\}$ is a cover of K_n. Construct graph $K_n^*(A)$ and denote it $K_n^*(r, k, \lambda)$. This is a k-connected, biregular block with degree sequence (r, k). It has $n(r + 1)$ vertices and $nr(k + 1)/2$ edges. In Figure 2, $K_7^*(6,3,2)$ is constructed using the blocks of a (14, 7, 6, 3, 2)-design.

The described procedure to generate graph $K_n^*(r, k, \lambda)$ and the following theorem with its respective corollary are taken from [5, pp. 103-107].

Theorem 2. Let $\mu = \max[\max(|B_i \cap B_j| : i, j = 1,...,b, i \ne j), \lambda]$. Any pair of nonadjacent vertices of $K_n^*(r, k, \lambda)$ has at most μ distinct paths of minimum length between them. The diameter of $K_n^*(r, k, \lambda)$ is 4 if $B_i \cap B_j \ne \varnothing$ for every $i, j, i \ne j$ or 5 if $B_i \cap B_j = \varnothing$ for some pair of distinct values i, j. •

Corollary 1. If (b, n, r, k, λ) is a symmetric design, then in $K_n^*(r, k, \lambda)$ there are at most λ paths of minimum length between each pair of vertices. •

Results

Next, we present two constructions of bigeodetic blocks using block designs (Theorem 3 and Claim 1).

The construction described in Claim 1 has a special connotation because even though it describes a simple observation about the existence behavior pattern of the employed symmetric $((n^2+n+2)/2, n+1, 2)$-designs in a very short interval of integer values, the last section of this paper suggests that this simple observation could not be just a coincidence and could give a clue to the description of a more general problem of existence.

Theorem 3. For every $n \equiv 0$ or 1 (mod 3), $n \ge 4$, there exists a bigeodetic block on n^2 vertices with diameter 4 or 5, with vertex connectivity 3 and degree sequence $(n-1, 3)$.

Proof. When $n \equiv 0$ or 1 (mod 3), $n \ge 4$, there exists an $(n(n-1)/3, n, n-1, 3, 2)$-design on a set S [2, Theorem 15.4.5]. Thus, taking G_i to be a complete graph on vertices of B_i, $1 \le i \le n(n-1)/3$, graphs $G_1, ..., G_{n(n-1)/3}$ form a cover of the complete graph K_n on vertex set S. Construct graph $K_n^*(n-1, 3, 2)$. This graph has n^2 vertices. According to Theorem 2, this is a bigeodetic graph of diameter 4 if $B_i \cap B_j \ne \varnothing$ for every $i, j, i \ne j$ or 5 if $B_i \cap B_j = \varnothing$ for some pair of distinct values i, j. It is easy to observe that $K_n^*(n-1, 3, 2)$ has degree sequence $(n-1, 3)$ and is 3-connected for $n \ge 4$. •

Next, we give the blocks of (10, 6, 5, 3, 2) and (14, 7, 6, 3, 2) designs, which are used to construct the bigeodetic blocks shown in Figures 1 and 2.

(i) $\{x_1, x_2, x_4\}$, $\{x_1, x_2, x_3\}$, $\{x_3, x_4, x_5\}$, $\{x_2, x_4, x_5\}$, $\{x_2, x_5, x_6\}$, $\{x_1, x_5, x_6\}$, $\{x_2, x_3, x_6\}$, $\{x_1, x_3, x_5\}$, $\{x_1, x_4, x_6\}$, $\{x_3, x_4, x_6\}$.

(ii) $\{x_1, x_2, x_4\}$, $\{x_1, x_2, x_3\}$, $\{x_3, x_4, x_6\}$, $\{x_3, x_4, x_5\}$, $\{x_2, x_5, x_6\}$, $\{x_3, x_6, x_7\}$, $\{x_1, x_6, x_7\}$, $\{x_1, x_4, x_7\}$, $\{x_2, x_3, x_7\}$, $\{x_1, x_3, x_5\}$, $\{x_2, x_5, x_7\}$, $\{x_2, x_4, x_6\}$, $\{x_1, x_5, x_6\}$, $\{x_4, x_5, x_7\}$.

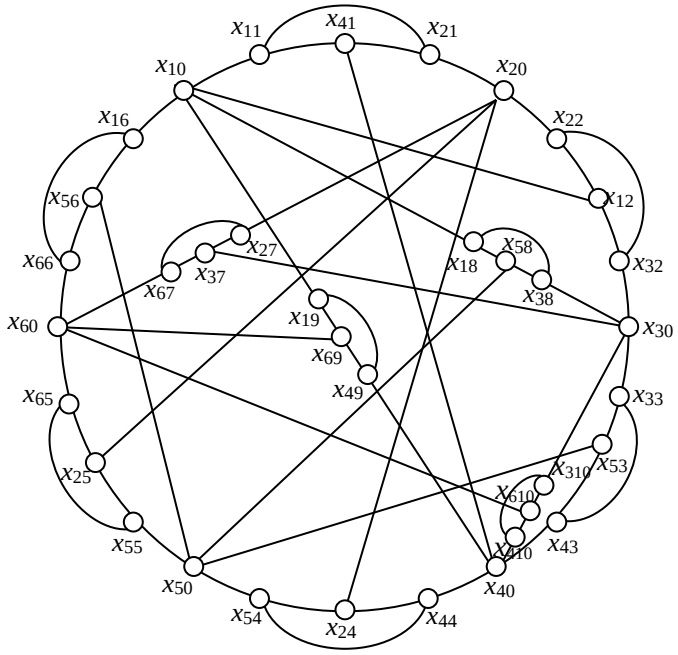

Fig. 1. A Bigeodetic Block generated by a (10, 6, 5, 3, 2)-design.

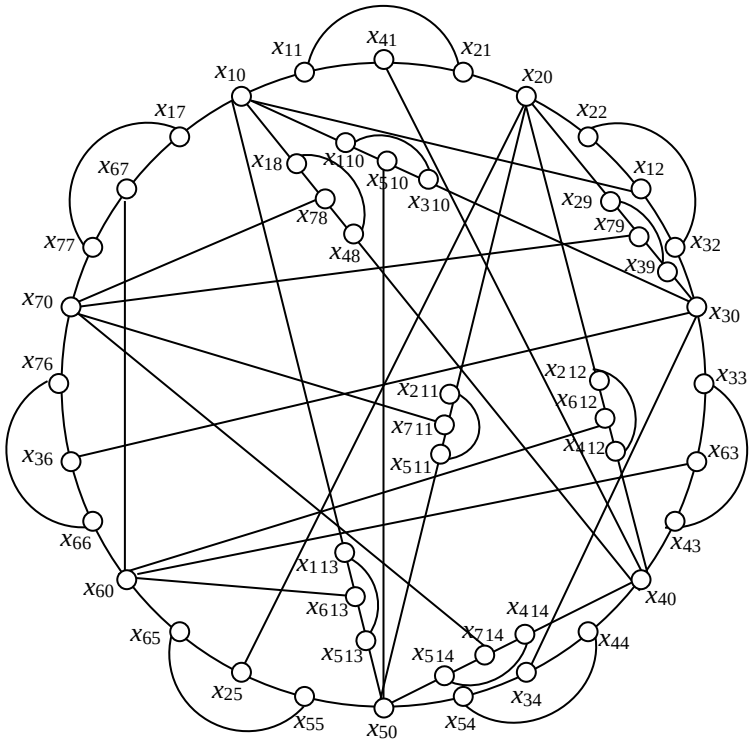

Fig. 2. A Bigeodetic Block generated by a (14, 7, 6, 3, 2)-design.

Claim 1. For every $n \equiv 1$ or 2 (mod 4), $2 \le n \le 10$, such that (n-1) is a perfect square or $n \equiv 0$ or 3 (mod 4), $3 \le n \le 12$, such that (n-1) is a prime power, there exists an (n+1)-regular, (n+1)-connected bigeodetic block of diameter 4. •

Remark. When $n \equiv 1$ or 2 (mod 4), $2 \le n \le 10$, such that (n-1) is a perfect square or $n \equiv 0$ or 3 (mod 4), $3 \le n \le 12$, such that (n-1) is a prime power, there exists a symmetric block design $((n^2+n+2)/2, n+1, 2)$ on a set S with blocks B_i, $1 \le i \le (n^2+n+2)/2$ (the final section of this paper lists all symmetric $((n^2+n+2)/2, n+1, 2)$-designs so far found. Note that they obey the "simple pattern" of existence mentioned in the initial part of this remark). Let G be a complete graph on vertex set S, and G_i be a complete graph on vertex set B_i, $1 \le i \le (n^2+n+2)/2$. G_1, ..., $G_{(n^2+n+2)/2}$ form a cover of G. Construct graph $G^*_{(n^2+n+2)/2}(n+1, n+1, 2)$. This graph is an ($n$+1)-regular, ($n$+1)-connected one and has $(n^2+n+2)(n+2)/2$ vertices. According to Corollary 1, this is a bigeodetic block. Since any two blocks of a

design $((n^2+n+2)/2, n+1, 2)$ have two common elements, the diameter of $G^*_{(n^2+n+2)/2}(n+1, n+1, 2)$ is 4. •

Next, we give the blocks of (4, 4, 3, 3, 2) and (7, 7, 4, 4, 2) designs, which are used to construct the bigeodetic blocks shown in Figures 3 and 4.

(i) $\{x_1, x_2, x_3\}, \{x_1, x_2, x_4\}, \{x_1, x_3, x_4\}, \{x_2, x_3, x_4\}$.

(ii) $\{x_1, x_2, x_3, x_4\}, \{x_1, x_3, x_5, x_7\}, \{x_1, x_4, x_5, x_6\}, \{x_1, x_2, x_6, x_7\}, \{x_2, x_3, x_5, x_6\}, \{x_2, x_4, x_5, x_7\}, \{x_3, x_4, x_6, x_7\}$.

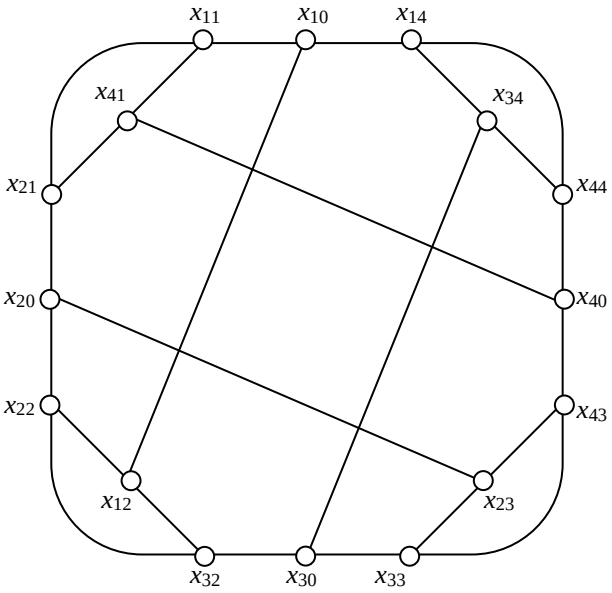

Fig. 3. A Bigeodetic Block generated by a (4, 4, 3, 3, 2)-design

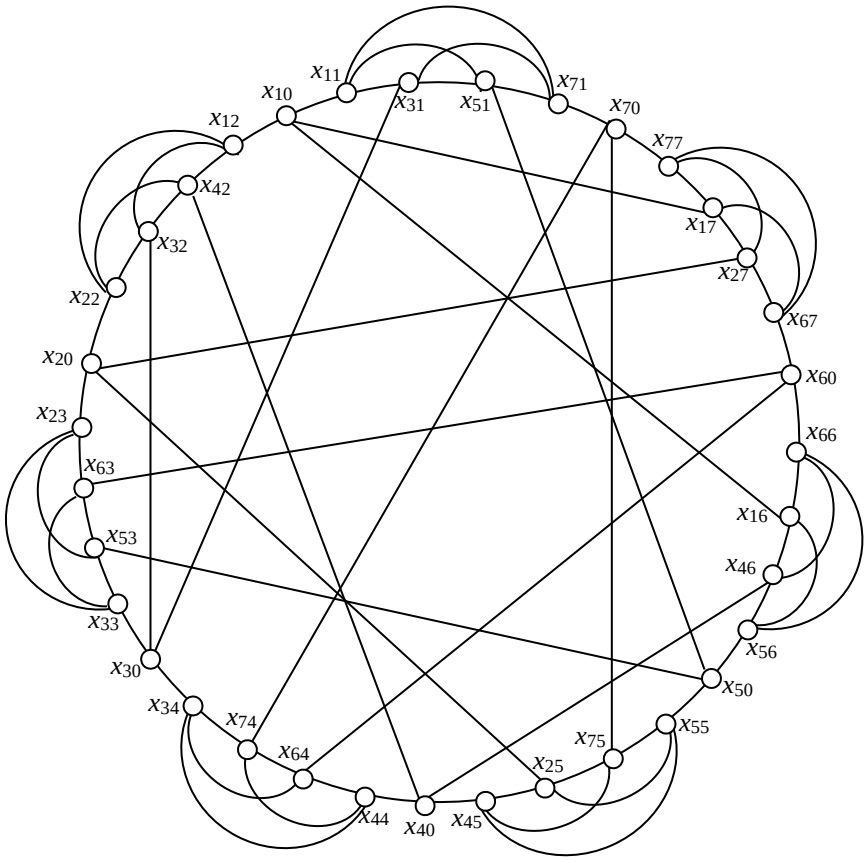

Fig. 4. A Bigeodetic Block generated by a (7, 7, 4, 4, 2)-design.

Corollary 2. If $(b, n, r, k, 2)$ is a block design, then $K_n^*(r, k, 2)$ is a bigeodetic graph of diameter either 4 or 5. •

Srinivasan, Opatrny, and Alagar [5, p. 111] considered that it is possible to construct n-regular, k-connected bigeodetic blocks of diameter d, where $k, n, d \geq 2$, $k \leq n$.

They have denoted this class of blocks $B(k, n, d)$ and have posed the following problem:

Is class $B(k, n, d)$ nonempty for every $k, n, d \geq 2$, $k \leq n$?

Claim 2. For every $n \equiv 1$ or 2 (mod 4), $2 \leq n \leq 10$, such that $(n\text{-}1)$ is a perfect square or $n \equiv 0$ or 3 (mod 4), $3 \leq n \leq 12$, such that $(n\text{-}1)$ is a prime power, class $B(n+1, n+1, 4)$ is nonempty. •

Concluding Remarks

Similar constructions to those ones described in Theorem 3 and Claim 1 for bigeodetic blocks can be formulated for trigeodetic blocks using $(b, n, r, k, 3)$-designs. Thus, when $n \equiv 1$ (mod 2), $n \geq 5$, there exists an $(n(n\text{-}1)/2, n, 3(n\text{-}1)/2, 3, 3)$-design [2, Theorem 15.4.5]. In the same way, when $n \equiv 0$ or 2 (mod 3), $3 \leq n \leq 14$, $n \neq 12$, there exists a symmetric $((n^2+n+3)/3, n+1, 3)$-design, namely: (5, 4, 3), (11, 6, 3), (15, 7, 3), (25, 9, 3), (31, 10, 3) [2, Appendix 1], (45, 12, 3), (71, 15, 3) [3, p. 105], which is called a *triplane*.

For any fixed integer value $\lambda \geq 2$, the question of whether there exists an infinite number of symmetric (n, k, λ)-designs is unresolved. In particular, when $\lambda = 2$, such a design is called a *biplane* and there exists only a few known examples, namely, (4, 3, 2), (7, 4, 2), (11, 5, 2), (16, 6, 2), (37, 9, 2), (56, 11, 2), (79, 13, 2). The first two biplanes are here used to generate two bigeodetic blocks (see Figures 3 and 4). Ryser [4, pp.114-115] proved that if in a symmetric (n, k, λ)-design n is odd and $(k, \lambda) = 1$ where (k, λ) denotes the positive greatest common divisor of k and λ, then $(k - \lambda, \lambda) = 1$ and the equation $x^2 = (k - \lambda)y^2 + (-1)^{(n-1)/2}\lambda z^2$ associated with the Bruck-Ryser-Chowla theorem has a solution in integers x, y, and z, not all zero. It is evident that for $n \equiv 0$ or 3 (mod 4) with $n > 3$ and $(n\text{-}1)$ a prime power, $(n^2+n+2)/2$ is odd and $((n^2+n+2)/2, n+1, 2)$-biplanes satisfy the conditions established by Ryser. As a result, when substituting n, k, and λ into $x^2 = (k - \lambda)y^2 + (-1)^{(n-1)/2}\lambda z^2$ for $(n^2+n+2)/2$, $n+1$, and 2, respectively, an equation with a solution in integers x, y, and z, not all zero is generated. Consequently, for $n \equiv 0$ or 3 (mod 4) with $n > 3$ and $(n\text{-}1)$ a prime power, $(n^2+n+2)/2$ is odd and $((n^2+n+2)/2, n+1, 2)$-biplanes satisfy the necessary condition established in Theorem 1 for their existence.

Due to the fact that some special families of block designs turned out to be finite, it is believed that only finitely many symmetric designs exist for any fixed $\lambda > 1$. Assuming that this is true, one could formulate the question if for a given finite integer interval, biplanes and their existence respond to the same simple pattern of behavior described in the construction of the Claim 1 bigeodetic blocks.

Assume that n belongs to a finite interval of integer values and m is a fixed integer, m ≥ 12. Could it be possible that being n ≡ 1 or 2 (mod 4), 2 ≤ n < m, such that (n-1) is a perfect square or n ≡ 0 or 3 (mod 4), 3 ≤ n ≤ m, such that (n-1) is a prime power, there exists a symmetric block design $((n^2+n+2)/2, n+1, 2)$?

Note that the answer to this question is in the affirmative for $m = 12$.

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PHILOSOPHICAL SCIENCES

AXIOM OF CARING FOR WELL-BEING OF HUMANITY LIES IN SALVATION OF HUMANITY FROM THE SIN

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Abstract
No matter how many reforms, theories, concepts, proofs, arguments, practical examples we should consider, it is undeniable that axiom of caring for well-being of humanity lies in the salvation of humanity from sin.

Keywords: Mankind, well-being, economic, scientific-technical progress

At the turn of the XX-XXI centuries, humanity is facing new challenges and demands.

It is worth noting that the main reason for overcoming all problems is the survival of humanity and care for their well-being. Therefore, the greatest responsibility rests on the correct and rational management and functioning of the "economy".

Unfortunately, in the civilized and economically developed countries of the modern world, in the officially accepted economic theories and practical economic management activities, the Lord, the principles of the Christian faith and moral norms are almost completely neglected.

Mankind (human) is the only subject in the world created for perfection, which God created in His own image and according to His likeness: “and God blessed them, and God said unto them, “Be fruitful and multiply, and replenish the earth, and subdue it; and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth.” (Genesis 1,27-28).

Therefore, taking care of the well-being of the "phenomenon" created for perfection requires great responsibility, caution, intelligence and great spirituality. It is not correct to create only material wealth and best social conditions for the society, maximum satisfaction of their demands and it is enough to say that their well-being is ensured.

Today, when society has reached the highest peak of civilization with its "invaluable" ruduns, taking care of their well-being remains an urgent problem. Reduced costs and increased profits through scientific and technical progress another new question has arisen: In particular, have welfare and trends of caring it increased or decreased? Is it still relevant to search for ways to solve it and to develop overcome methods for humanity, or has it become passive?

We will not be morally correct if we do not mention the great role and importance of the achievements of scientific and technical progress in improving the living conditions of mankind, raising their level and well-being. It can be said with confidence that its result is an increase in the life expectancy of the population, a decrease in mental and physical workload. But the main thing is not how much the process lightens a person's burden, but how the lightening of the burden affects his spiritual mental thinking. Is there a place for a person to realize a clear mind, or does he do everything through conditioned reflexes. “Happy is the man who finds wisdom, And the man who gains understanding; For her proceeds are better than the profits of silver, And her gain than fine gold”. (Proverbs 3:13-14)

As we know, scientific and technical progress is seriously affected by globalization and integration processes, which are the main source of modern public relations. In their background, it seems that living conditions are improving and perfecting, but the general economic situation around the world is becoming difficult. Relations between states and individuals are becoming complicated, the presence of unruly economic elements is observed. The growth of globalization and integration processes in general and scientific-technical progress in particular has accelerated the growth of unsustainable, unmanageable economic processes in the world. It is observed that similar economic models are used by different countries, without considering any traditional interests, which is followed as if by identification of models of economic systems of the state, which intensifies the competitive struggle in the market and causes a desire for monopolistic or oligopolistic tendencies. The latter ends with chaos, the proliferation of the shadow economic elements to capture the market, economic and financial crises that affect the population. The socially vulnerable layer has increased, the number of unemployed has increased, the pressure directed at each other by people has increased (expansion), Because of this, the number of mentally, physically, morally and socially damaged population has increased, in balancing of which only economic laws and regularities are powerless. „Envy captured the uneducated nation“. Therefore, the quantitative side is not of decisive importance for achieving the result, but the qualitative side is given priority. We learn about this from the Holy Scriptures. “Then Elijah said, “I’m the only prophet of GOD left in Israel; and there are 450 prophets of Baal. Let the Baal prophets bring up two oxen; let them pick one, butcher it, and lay it out on an altar on firewood—but don’t ignite it. I’ll take the other ox, cut it up, and

lay it on the wood. But neither will I light the fire... O Baal, answer us! But there was no reply of any kind. Then they danced, hobbling around the altar they had made... altar of the LORD that was broken down. And Elijah took twelve stones, according to the number of the tribes of the sons of Jacob, unto whom the word of the LORD came, saying, Israel shall be thy name... And the water ran round about the altar; and he filled the trench also with water." (B.C. Testament, Third Kings 18,22-45)

Humanity has to wrestle with wolf laws and fight for existence, fight for survival. ɔð Everything they do on earth is done by processes that are considered unnatural. Humanity cannot or does not use the world as it was given. The country was given to man as "food", as a means of life, but life must first of all be a relationship with God. The world and food were created for human so that they could have a connection with God through them. Only food taken for God's sake could be life-giving. The infinite tragedy of Adam (mankind) is that he perceived food as "life in itself". i.e. He believed in food, when the only object of faith and hope is God. "They have mouths but cannot speak, and eyes but cannot see. They have ears but cannot hear, and noses but cannot smell." (Psalms: 113,13,14,15) They forget that the Creator of the universe is God: "The earth is the LORD's, and all its fullness, The world and those who dwell therein." (Psalms: 23,1-2). For the salvation of humanity, the "Bible" written by people enlightened by God's grace is the head of the main source from which all sciences, including economics, should be fed. That the Bible is a book about the world and man, about humanity and its future, about its ultimate destiny, about its daily existence. "Man - the crown of the supreme of all creation" is not just fancy words. The main focus of Scripture is on humanity, God makes connection with him who bears his image and is called to receive the likeness (deification theosis) connection between God and man, between God and people, between God and humanity... connection is always two-sided.

The fact, which is unfortunately real, clearly tells us that a part of humanity is trying to adapt to the management of the world through the use of unnatural rules. Surround anomalous methods to society and make them consider as natural phenomena and regularities. Fast-paced civilization, acceleration of the scientific-technical process, internationalization, intensified migration processes, free movement of foreign capital, acceleration of the pace of globalization, obviously made it more difficult, expensive and dangerous to take care of the well-being of humanity on earth and highlight its positive results, including their safety. So what's going on? Is it only the weakness of economic science, or the result of the imperfection of economic science in general?

Today the world is facing a common dilemma. This dilemma is the big cross that all humanity has to carry, that the Lord gives us this cross, and sometimes its carrying is heavy and sometimes it is lightened (depending on the spiritual condition of the person). However, this does not mean that humanity does not participate in the creation of its cross, the vertical of which is the spiritual connection with the Lord, and the horizontal is the spiritual connection with other people. In this way, humanity should create two spiritual pillars, which include: striving for God and striving for neighbor. The apostle Paul says: Bear one another's burdens and thus you will fulfill the law of Christ." The Lord remind us, humanity: "Come to me, all you who are weary and burdened, and I will give you rest. Take my yoke upon you and learn from me, for I am gentle and humble in heart, and you will find rest for your souls. For my yoke is easy and my burden is light." (Matthew 11,28,29,30)

Globalization is a natural process, how global the economy is, what stage of globalization the earth is in, is also a result of this natural process. "Globalization is an inevitable event and is connected with the development of scientific and technical progress. It can be said that the whole world has become global, but this does not necessarily mean that big countries have to absorb small countries."

Some people think that the spiritual or national values of small nations create conflict and confrontation, which may turn into enmity and strife. In fact, this is not the case at all. These values, their diversity, on the contrary, enrich the world, eliminate conflict and confrontation. However, at the same time, it is necessary to form a moral axis of human values that will promote dialogue between civilizations. The main thing is that in the current of modern processes, we should understand well where the subject is and where the object is. The object is very often nations, and the subject tries to wrap his ideas around that object and remove the national-moral, spiritual achievements, values, which is very dangerous for us. We need to know what is acceptable and what is not, what is pseudoculture.

Today, as political scientists point out, the tragedy that took place in the USA on September 11, 2001 announced to the world the beginning of a new, unprecedented post-modern era in the history of mankind, which requires a fundamental revision of the centuries-old relations between states and peoples. It seems paradoxical, but the stronger the state is from an economic or military point of view, the greater the threat posed by international terrorism, which can attack nuclear power plants, chemical plants, secret laboratories and other important facilities. It is from the point of view of this global common threat and world-scale international cooperation that all problems that prevent the cooperation of states and people's well-being, stability of development should be reviewed. This is the only reasonable alternative to the new reality created in the world. From a geopolitical point of view, the modern system of international relations is based on rivalry not between nation-states, but between nation-empires. This will be one of the most important characteristics of our life, which can be called the most modern. A period where a part of degraded humanity tries to adapt to the world using wrong, unnatural methods and offers it to us in a natural format.

Based on all of the above, we come to one conclusion, which allows us to make a reasonably well-thought-out mix, that:

1. All these problems cannot be solved only by means of economic factors. It is necessary to develop a synergistic social economy.

2. It is not enough and perfect to have a planar perception of the created problem, where the cutoff system is the point of intersection of the axes of the coordinate plane, if this problem is not discussed in the spatial perspective, where the Supreme Lord is, and the cutoff point is the justice.

3. It is not correct to idolize wealth and profit as the main means of satisfying the needs of humanity, unless the main thing is understood that „and also everyone to whom God has given wealth and possessions, and given him power to enjoy them, and to receive his reward and to rejoice in his labor-this is the gift of God.“ (Ecclesiastes: 5,18)

4. It should not be understood that the Christian faith condemns wealth and the rich man. The result of human economic activity is expressed in the creation-accumulation of material wealth and money, and up to that point it is stated in the Law of Great Justice: "We should not belittle the wealth acquired by righteousness and spent in good deeds." And not as it happens today: "Aid to a foreign country today is money paid by the poor in a rich country and received by the rich in a poor country."

5. It is not enough to recognize that properly formulated economic theories and factors can account for the "making of bread" of human existence, unless it is taken into account that "Moses has not given you the bread from heaven, but My Father gives you the true bread from heaven. (John: 6,32)

„It is written and forever remains written, 'Man shall not live by bread alone, but by every word that comes out of the mouth of God.“ (Matthew: 4,4)

6. Only the recognition that it is necessary to develop the theological-economic principles is not enough for the perfect solution of this problem, if it is not taken into account to which period of human government the vector of this problem leads. What is needed to fix this and why? Therefore, we come to the conclusion that the current situation requires fundamental study, analysis and implementation of certain experiences and views of that time. We have in mind the period of the rule of the judges to show the present and future generations that the main political, economic, social power and strength of mankind is a strong religious feeling, fear, love of the Lord and modesty to Him, which led to the recognition of the theocratic period as the period of ideal governance in human history.

And finally, no matter how many reforms, theories, concepts, proofs, arguments, practical examples we should consider, it is undeniable that axiom of caring for well-being of humanity lies in salvation of humanity from the sin.

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TECHNICAL SCIENCES

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FEATURES OF THE THERMAL PLUTONIUM EFFECT AND DYNAMICS OF THE ACCIDENT AT UNIT III OF THE FUKUSHIMA 1 NUCLEAR POWER PLANT

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Abstract

Before the Fukushima Daiichi Nuclear Power Plant (NPP) accident, the prospect of expanding the nuclear power plants fuel base was also associated with the use of MOX fuel (mixed oxide uranium-plutonium fuel). The Fukushima Daiichi nuclear accident, which has led to the reactor core meltdown, revealed an insufficient knowledge of the fuel nuclides temperature properties in a temperature range wider than the operating temperatures ranges of existing reactors (above 1000 K).

The paper presents the results of calculating the temperature dependences of the fission and radiative capture nuclear reactions cross-sections averaged over the thermal neutron spectrum for uranium 238, uranium 235 and plutonium 239. A fundamental difference in the temperature dependences of the uranium 235 and plutonium 239 nuclear reactions cross sections averaged over the thermal neutron spectrum is found and explained for the studied temperature range. The temperature dependences of the heat sources densities for MOX fuel and uranium oxide fuel for thermal reactors are calculated as well.

For the first time, the fundamental difference between the temperature dependences of the heat sources densities for the MOX fuel and uranium oxide fuel is shown.

The accident dynamics theory based on the fundamental difference in the temperature dependences of the heat sources densities for the MOX fuel and oxide uranium fuel is presented. It allows to identify and explain several characteristic temperature features of the accident dynamics at the Fukushima Daiichi Nuclear Power Plant Unit 3, where one third of the reactor fuel load was MOX-fuel.

Keywords: Fukushima Daiichi NPP 1 severe beyond design basis accident, thermal reactors, core meltdown, MOX fuel, uranium oxide fuel, plutonium 239, accident dynamics.

1. Introduction

The most important tasks of the further nuclear energy development strategy include ensuring the safe operation of nuclear power plants, fuel base expansion and spent nuclear fuel reprocessing.

All operating nuclear reactors and even the latest advanced reactors, including the so-called Generation IV reactors, are fundamentally dangerous, since they all have a supercritical fuel load that ensures their campaign duration, and the chain reaction is maintained using a control system that regulates the reactor reactivity. And only now the development of nuclear reactors fundamentally differing from the previous generations reactors, which do not have a super critical load of nuclear fuel and do not require the reactor reactivity regulation, is carried out. The authors classify these nuclear reactors as the Generation V reactors.

The safety requirements for the new Generation V reactors are fully met by the wave uranium-plutonium reactor of L.P.Feoktistov (also called in the USA as "Traveling-wave reactor" and in Japan as "CANDLE" reactor) characterized by internal safety [1-52]. This new type of a reactor also allows to eliminate the nuclear fuel enriching procedure in the nuclear fuel cycle and to use in it the natural (and even technical) uranium, i.e., spent nuclear fuel.

At the same time, the wave reactor dynamics is the open physical system dynamics, which is described by the nonlinear dynamics theory, i.e., is characterized by several features that are fundamental for the nonlinear dissipative structures theory. One of those is the uranium-plutonium fissile medium nonequilibrium under conditions of neutron field high densities and high temperatures. It should be also noted that in the wave nuclear reactors a strong change of the fuel nuclide composition occurs, e. g., under the appropriate modes of wave neutron-nuclear burning in a uranium-plutonium fuel medium, the burnup of uranium 238 may exceed 70 % of its initial concentration, and plutonium 239 may be completely absent initially. This fundamentally distinguishes the wave nuclear reactors from the previous generations reactors, in which operating modes are implemented using the reactor control system, in which a fuel burnup is about 4 %-6 % per a campaign, that is, the fuel composition practically does not change, and the neutron flux density and temperature are not high (e. g., for VVER $F \sim 10^{13} \div 10^{14}$ n/(cm^2 s) and $T \approx 280^0$C).

The basic kinetics of a wave reactor (the neutrons and nuclides kinetics) are connected by direct and inverse relationships with the kinetics of heat transfer and radiation-induced fuel defects [59; 60]. The fuel defects kinetics affects the reactor reactivity through a geometric dimensions change caused by plastic deformation, swelling or destruction of fuel under load and irradiation, as well as through its density change. The dissipative thermal structures formation and temperature nonlinear modes with Kurdumov blow-up implementation [44, 45, 47-49] or the dissipative structures formation of uranium-plutonium fissile medium defects can significantly affect the reactor kinetics, mainly, the very implementation and stability of the slow nuclear burning wave in a reactor.

The hypothesis of a wave-type georeactor located at the boundary of the liquid and solid Earth's cores also requires that its kinetics should be studed at temperatures from 5000 K to 7000 K [37].

Before the Fukushima Daiichi nuclear accident, the prospect of the NPP fuel base expanding was also associated with the use of the MOX fuel (mixed oxide uranium-plutonium fuel).

The Fukushima Daiichi nuclear accident, which has led to the Generation III reactors core meltdown, revealed insufficient knowledge of the temperature properties of fuel nuclides in a wider temperature range (exceeding 1000 K) than the operating temperature ranges of existing reactors.

The paper authors' previous works, in which the temperature properties of the reactor fuel fissile media were studied, e. g. [44, 45, 47-51], were mainly focused on the temperature features of the wave neutron-nuclear burning processes.

After the Fukushima Daiichi nuclear accident, several papers were published, e. g., [52-53], in which the peculiar temperature properties of the thermal nuclear reactors fuel nuclides were associated with the possible features of the accident development at the Fukushima Daiichi NPP Unit 3. However, this was performed very carefully, in the form of conjectural hypotheses since there were very few physical data on the Fukushima Daiichi accident itself. The paper [58] was almost entirely devoted to nonlinear temperature blow-up modes in fissile media, but their possible connection with the Fukushima Daiichi nuclear accident dynamics features was given only a brief mention.

However, today, years after the Fukushima Daiichi nuclear accident, some data have appeared, albeit in a very meager volume and, unfortunately, published not in scientific journals, but in the media, confirming the authors' theoretical assumptions. The paper [49] was mainly focused just on the accident features. Thus, the decision was made to publish it, apparently, because of the lack of other publications on this topic in scientific journals and due to the fact that the paper was given attention in the electronic media, e. g., in [54], which in itself was a rarity for scientific papers, and in [55] posted on the Internet website and available to a wide range of readers interested in the accident causes and consequences, which was evidently of considerable public interest for obvious reasons.

Indeed, in [55] there is a section titled "Fukushima plutonium effect", which is almost entirely based on the statement in [40] about a possible connection between the features of the accident at the Fukushima Daiichi NPP Unit 3 with nonlinear temperature blow-up modes in uranium-plutonium fissile environments. However, this chapter is supplemented with an important Figure 21 [55, 56], which is a video recording of the Fukushima Daiichi NPP Unit 3 accident dynamics with its analysis and conclusions made by the nuclear reactors designer Setsuo Fujiwara in [57, 58]. The video indicates that there were three explosions, which could be heard when the video was played back slowly. The first was an explosion of hydrogen formed as a result of the steam-zirconium reaction of water decomposition, to which the smoke white color corresponds in the video; the orange color of the burning flame above the Unit 3 reactor indicated a very high temperature of ~ 3000 K, that is, the melting point of the reactor oxide fuel during the second explosion; and the third explosion, accompanied by black smoke, indicated an explosion in the uranium-plutonium fuel medium and its release. Setsuo Fujiwara [57,58] believed that the second explosion was caused not by a hydrogen explosion, but by the reactor rapid transition to a supercritical state, that is, by its acceleration on prompt neutrons due to a temperature and pressure increase inside the reactor vessel, which resulted in the boiling bubbles collapse. Such process led to the reactor reactivity increase because the void reactivity coefficient was negative, and therefore Setsuo Fujiwara called the accident at Unit 3 a nuclear explosion.

It should be noted that, as will be seen below in this paper, the independent expert's conclusion in [57,58] about the neutron runaway of the Unit 3 reactor was an important argument in favor of the authors' theory, which initially assumed the presence of neutrons.

In [59, 60], experimental data are presented from [61] on measuring the radioactive isotope sulfur-35 concentration in sulfate aerosols and in gaseous sulfur dioxide in the oceanic air in the La Jolla Village on the Pacific Beach of California, based on which it was concluded that ocean water was irradiated by neutrons with a fluence of 4×10^{11} n/m^2, since the sulfur-35 radionuclides were formed in ocean water containing chlorine-35 during neutron irradiation.

It is worthy of mention that in both [55] and [57,58] the assumption was made about the Unit 3 reactor fuel melting, which also testified in favor of nuclear reactions involving neutrons, since due to the chemical reactions it would hardly be possible to heat up to melting points and melt such an amount of oxide fuel.

In the paper [62] it was reported that TEPCO (Tokyo Electric Power Company) published the results of a month-long study that began on February 12, 2015, in the Unit 1 reactor building in collaboration with the International Research Institute for Nuclear Decommissioning (IRID). The two companies collected the experiment data from its inception to March 10. The project used cosmic rays to view the building interior [63, 64]. Analyzing the muons flux generated by elementary particles during cosmic rays colliding with the atmosphere,

TEPCO was able to generate an X-ray image of the reactor interior. Muons can pass through concrete and iron, but they get blocked and change direction, when collide with the high-density materials such as plutonium and uranium, creating a "shadow" on the X-ray image. According to the study, TEPCO stated that the fuel has melted because there was no shadow around the reactor core, i.e., that the fuel was not where it should be, which indicated that the fuel was likely to have been melted and "moved down." The operator also reported that there was not any water accumulation in the reactor pressure vessel core and that it was possible that fuel fragments were in the spent fuel pool, but their sizes would be calculated later. TEPCO also said that the results confirmed the previous assumptions about the fuel meltdown. They planned to continue measurements until enough data should be obtained to conduct a statistical analysis and to get a possibility for the obtained data use in determining the fuel masses configuration. This would allow the work plan development for their removal. Perhaps the removal would to be performed by robots due to the high radiation doses in the reactor.

Thus, in [62] the first experimental evidence of the reactor core melting is presented.

Consequently, today enough data is already available to reasonably assert that the accidents have developed in accordance with a theoretical model based on the dynamics of nuclear reactions involving neutrons, since due to chemical reactions it would hardly be possible to heat up to melting temperatures and melt such an amount of oxide fuel.

Therefore, in compliance with the foregoing, this paper presents the results of a theoretical study of the reactor fuel nuclides temperature properties in a wide temperature range (above 1000 K) and the temperature dependences of the heat sources densities for MOX fuel (a mixture of uranium and plutonium 239 dioxides) and oxide uranium fuel (a mixture of uranium 238 and uranium 235 dioxides) aiming to identify the possible differences between these dependences, as well as to identify and explain several characteristic temperature features of the accident at the Fukushima Daiichi Nuclear Power Plant Unit 3, where one third of the reactor fuel load was the MOX fuel.

To summarize, it should be noted that the text relating to wave nuclear reactors and the nonlinear dynamics of wave neutron-nuclear burning is included at the beginning of the introduction to this paper not by chance, since to explain the dynamics features of the destroyed nuclear reactors nuclear fuel during the accident, after it and up to the present is possible using the dynamics of wave burning, temperature blow-up modes, and radiation defects dissipative structures in nuclear fuel.

2. Theory.

Firstly, let us first note that the theoretical model, on which the hypothesis of the accident development at Fukushima Daiichi Unit 3 presented in the article is based, is a development and addition to the model, the development, and study of which we began earlier, for example, in works [56-62] and are still under way. However, all of our previous works only mentioned the accident at Fukushima Daiichi Unit 3 and suggested the possible contribution of the aggravation modes to this accident.

2.1. Dependences on the reactor fuel temperature for the cross sections averaged over the thermal neutron spectrum.

Since the accident at the Fukushima Daiichi Nuclear Power Plant occurred at BWR reactors (boiling water reactors having the thermal neutron spectrum), this paper presents the results of the temperature dependences calculations obtained for the nuclear fission and radiative capture reactions cross sections averaged over the thermal neutron spectrum for uranium 238, uranium 235 and plutonium 239. It is known that the neutrons energy spectrum in thermal reactors differs from the Maxwellian spectrum due to its non-equilibrium because in the reactor core the neutrons formation processes during nuclear fission (with the neutron energies being distributed over the fission spectra for fissile nuclides), as well as the neutron moderation and absorption processes take place all the time. As a rigorous theory of neutron moderation in a reactor fuel fissile medium, which could naturally include neutron thermalization, does not exist, the model approximations use for estimating the neutron spectra is necessary. The most widely used approach is based on the neutron gas model assuming that thermalized neutrons are distributed over the Maxwellian distribution energies, but not at the core fissile medium temperature, but at the neutron gas temperature. In this case, the effect of absorption or insufficient moderation in the medium on the spectrum shift from the "pure" Maxwell is evaluated using the input temperature of the neutron gas given by the following semi-empirical expression [65, 66]:

$$T_{NG} = T * \left[1 + 1{,}4 * \Sigma_a(kT) / \xi\Sigma_s(1eV)\right], \qquad (1)$$

where T is the fissile medium temperature; Σ_a is the macroscopic (thermal) cross section of the medium absorption; ξ is the average logarithmic energy decrement during moderation; Σ_s is the macroscopic cross section of the medium scattering; $\xi\Sigma_s(1\,\text{эВ})$ is the medium moderating capacity at 1 eV.

The fissile medium temperature coincides with the neutron gas temperature only in two cases: zero absorption and infinite moderating power of the medium. Nevertheless, this expression is quite convenient for obtaining average cross sections in the thermal region for thermal reactors.

The cross sections are averaged over the neutron spectrum according to the following expression:

$$\left\langle \sigma(E_g, T) \right\rangle = \frac{\int_0^{E_g} E^{1/2} e^{-E/(kT_{NG})} \sigma(E,T)\, dE}{\int_0^{E_g} E^{1/2} e^{-E/(kT_{NG})}\, dE}, \qquad (2)$$

where σ is the nuclear reaction microsection; E is the neutron energy; $E_{\text{гр}}$ is the limiting energy of thermal neutrons.

The result of averaging according to expression (2) for the capture, fission, and absorption microsections with the microsections σ dependences on the neutron velocity v_n of the $\sigma \sim 1/v_n$ type (or different from them) typical for exothermic nuclear reactions has a general form (here the expression for the fission reaction microsection σ_f is given):

$$<\sigma_f>=\frac{\sqrt{\pi}}{2}\sigma_f^T \cdot \sqrt{\frac{300}{T_{\text{NG}}}} \cdot g_f\left(T_{\text{NG}}\right) \cdot F\left(z_{\text{g}}\right), \quad (3)$$

where σ_f^T is the fission thermal microsection at a neutron velocity of 2200 m/s; $T_{\text{НГ}}$ is the neutron gas temperature calculated according to (1); $g_f\left(T_{\text{НГ}}\right)$ is the Westcott factor (Tables 1, 2) for the fission reaction [66-68]; $F\left(z_{\text{гр}}\right)$ is the correction function; $z_{\text{гр}} = E_{\text{гр}} / \left(kT\right)$ is the dimensionless maximum energy for the Maxwell spectrum, i.e., the "crosslinking energy" of the Maxwell and Fermi neutron spectra.

For the microsections of other neutron nuclear reactions, e.g., radiative capture and absorption, expression (3) with the cross sections averaged over the thermal neutron spectrum has a similar form. The Westcott factor (Tables 1, 2 [68]) describes the difference between the microsections σ dependence on the neutron velocity v_n and the $\sim 1/v_n$ law and strongly depends on the medium temperature. The Westcott factor equals 1 if the corresponding reaction cross section exactly obeys the $\sim 1/v_n$ law.

The correction function $F(z)$ is obtained from the solution of the transcendental equation for crosslinking the Maxwell and Fermi spectra: $\Phi_{\text{M}}(E_{\text{гр}}) = \Phi_{\Phi}(E_{\text{гр}})$. It is known that its argument z depends on the limiting "crosslinking energy" and approximately equals 5 for VVER and 6 for RBMK [66, 67]. The values of the function $F(z)$ are tabulated and available in reference books. It should be noted that the function values change with temperature, which affects the average cross sections.

Expressions (1) and (3) are used to calculate the temperature dependences of the nuclear fission and radiative capture reactions cross sections averaged over the thermal neutron spectrum for $^{235}_{92}\text{U}$ and $^{239}_{94}\text{Pu}$, and the temperature dependences of the radiative capture cross sections averaged over the thermal neutron spectrum for $^{238}_{92}\text{U}$.

When calculating the neutron gas temperatures according to expression (1), the fissile fuel medium temperature varied in the interval from 300 K to 2100 K and the neutron absorption microsections varied in the thermal energies range from 0.025 eV to 0.181 eV; the neutron scattering microsections at an energy of 1 eV for the fissile fuel medium nuclides were taken from the nuclear database ENDF/B-VII.0. The upper limit of 2100 K for the investigated temperature range was determined by the Westcott factor values limited by that temperature of the neutron gas [68].

When calculating the temperatures of the neutron gas according to expression (1) as applied to thermal reactors with water as a moderator, the medium moderating capacity, i.e., the $\xi\Sigma_s$ term, is determined mainly by the hydrogen moderating capacity. The medium absorption macroscopic cross section contained in expression (1) as the numerator of the second term enclosed in brackets, is determined mainly by the absorption cross sections values in the thermal region for $^{238}_{92}\text{U}$ as a nuclide, which usually makes up more than 90 % of the nuclear fuel composition for thermal reactors. Therefore, for the values of $\xi \approx \xi_{\text{H}} = 1,0$, $\sigma_s \approx \sigma_s^{\text{H}} \approx 20,4$ barn, $\sigma_a^{238} = \sigma_c^{238} \approx 2,7$ barn, where ξ_{H} is the average logarithmic energy decrement for hydrogen and σ_c^{238} is the radiative neutron capture reaction microsection for $^{238}_{92}\text{U}$, the bracketed second term in expression (1) can practically be neglected, and the neutron gas temperature will practically coincide with the fissile medium temperature. If the nuclei heavier than hydrogen, e. g., carbon, oxygen, or $^{238}_{92}\text{U}$ itself, were considered as the main moderator, then the second term in the brackets in expression (1) could no longer be neglected, and the neutron gas temperatures would significantly exceed the fissile medium temperature. In calculations, e. g., for the uranium dioxide fuel or MOX fuel without a water moderator, the main moderator is oxygen, and the main absorber, as in the previous case, is $^{238}_{92}\text{U}$. Then, since $\xi_{\text{O}} = 0,12$, $\sigma_s^{\text{O}} \approx 3,45$ barn, and $\sigma_a^{238} = \sigma_c^{238} \approx 2,7$ barn, the neutron gas temperature calculation according to expression (1) for the fissile medium temperatures in the interval from 300 K to 2100 K will give the temperatures values interval from 1200 K to 4600 K for the neutron gas. In this case, the application of the approach based on the relations (1) and (3) is impossible due to the lack of the Westcott factor tabular values for neutron gas temperatures exceeding 2100 K [68].

The calculated temperature dependences of the nuclear fission and radiative capture reactions cross sections averaged over the thermal neutron spectrum for $^{235}_{92}\text{U}$ and $^{239}_{94}\text{Pu}$ are shown in figures 1 and 2. In Fig. 2 the calculated temperature dependence of the radiative capture cross sections averaged over the thermal neutron spectrum for $^{238}_{92}\text{U}$ is shown as well.

Table 1.

Westcott factor for $^{239}_{94}Pu$ fission and radiative capture reactions [68].

T, K	**300**	**400**	**500**	**600**	**700**	**900**	**1100**	**1300**	**1500**	**1600**	**1800**	**1900**	**2100**
g_f	1,058	1,150	1,305	1,518	1,768	2,290	2,746	3,091	3,328	3,412	3,521	3,552	3,572
g_c	1,154	1,374	1,713	2,159	2,672	3,724	4,630	5,314	5,782	5,947	6,164	6,226	6,269

Table 2.

Westcott factor for $^{235}_{92}U$ fission and radiative capture reactions [68].

T, K	**300**	**400**	**500**	**700**	**800**	**900**	**1000**	**1100**	**1200**	**1300**	**1400**	**1500**	**1700**	**2100**
g_f	0,976	0,954	0,938	0,920	0,914	0,910	0,907	0,903	0,900	0,893	0,891	0,887	0,887	0,885
g_c	0,978	0,964	0,960	0,970	0,978	0,987	0,993	0,998	1,000	1,001	0,999	0,996	0,986	0,958

Table 3.

Nuclear reaction cross sections for thermal neutron energies [66, 69].

Nuclide	$\nu^{T}*$	σ_f^T, b	σ_c^T, b	$\alpha^T=\sigma_c/\sigma_f$	I_c, b	I_f, b
U-235	2.42	580	107	0.184	142	277
U-238		0	2.7	0	277	0
Pu-239	2.88	750	315	---	188	312

As is seen from Fig. 1, in the studied temperature interval there is a fundamental difference in the temperature dependences of the $^{235}_{92}U$ and $^{239}_{94}Pu$ nuclear fission reactions cross sections averaged over the thermal neutron spectrum. The averaged cross section of the $^{239}_{94}Pu$ fission increases with the temperature increase and reaches a maximum at 1500 K, and then decreases with the temperature increase, i.e., the dependence has a resonant form. The averaged cross section of the $^{235}_{92}U$ fission gradually decreases with the temperature increase. Similar temperature dependences of the $^{235}_{92}U$ and $^{239}_{94}Pu$ nuclear fission reactions cross sections averaged over the thermal neutron spectrum are also obtained in [69].

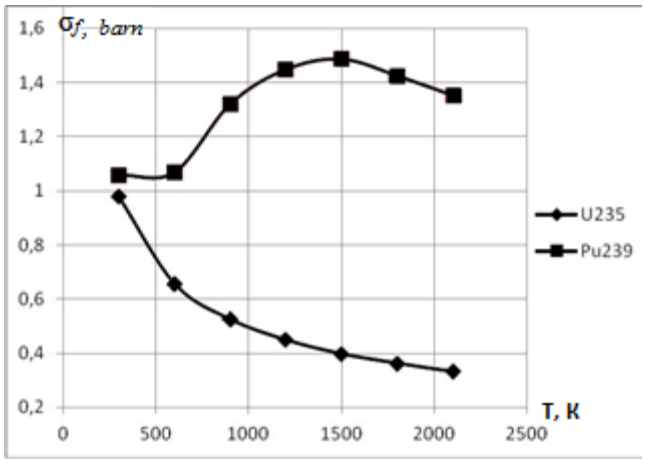

Fig. 1. Dependence on the fissile fuel medium temperature for the $^{235}_{92}U$ and $^{239}_{94}Pu$ fission cross sections averaged over the thermal neutron spectrum (the cross sections values are normalized to σ_f^T (fission thermal microsection) and given in Table 3).

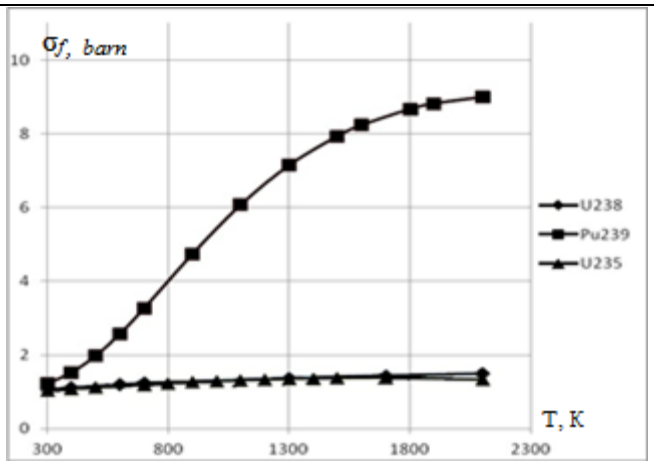

Fig. 2. Dependence on the fissile fuel medium temperature for the $^{235}_{92}\mathrm{U}$, $^{238}_{92}\mathrm{U}$ *and* $^{239}_{94}\mathrm{Pu}$ *radiative capture cross sections averaged over the thermal neutrons spectrum (the cross sections values are normalized to the thermal microsection* σ_c^T *of the neutron radiative capture with their values given in Table 3).*

Dependences in Fig. 2 show a significant increase of the $^{239}_{94}\mathrm{Pu}$ radiative capture cross section with the temperature increase and a slight increase of the $^{235}_{92}\mathrm{U}$ and $^{238}_{92}\mathrm{U}$ radiative capture cross section.

2.2. Dependences on the reactor fuel temperature for the cross sections averaged over the total neutron spectrum.

As already noted, the calculation of the cross sections averaged over the thermalized part of the spectrum using expression (3), which includes the tabular values of the Westcott factor, is possible for thermal reactors with a water moderator and with moderators consisting of nuclei with small atomic numbers, and therefore having a high moderating ability. However, if heavier nuclei, such as carbon and oxygen, serve as the main moderator, problems already arise with calculations according to (3) due to the lack of tabular values of the Westcott factor at neutron gas temperatures above 2100 K.

To calculate the dependences on the fissile medium temperature for the cross sections averaged over the neutron spectrum, an approach has been developed that does not rely on the Westcott factor values use. This approach, in contrast to the one presented above, is developed not only for thermal reactors, and therefore allows to calculate the cross sections averaged over the total neutron spectrum (for neutron energy range from thermal to 10 MeV). Its main provisions are published in [41, 42, 43, 47-51].

As is known, the influence of the medium nuclei thermal motion is reduced to the resonances width increase and the resonances height decrease. This effect, by analogy with optics, is usually called the Doppler effect [66]. Since in the low energies range the resonance levels are observed only for heavy nuclei, the Doppler effect is noticeable only during the neutrons interaction with such nuclei and is stronger, the higher the medium temperature.

In the Microsoft Fortran Power Station 4.0 (MFPS 4.0) software environment a computer program has been developed that allows calculating the resonant neutron reactions cross sections dependences on the neutron energy with an allowance for the Doppler effect. In the calculations, the neutron reactions cross sections dependences on the reactor nuclides neutron energy taken from the ENDF/B-VII.0 database and corresponding to an ambient temperature of 300 K were used as input data. For instance, in Fig. 3 the result of calculating the radiative neutron captures cross sections dependences on the $^{235}_{92}\mathrm{U}$ energy (in the lower energy range) at the various fissile medium temperatures in the range from 300 K to 3000 K are shown.

Using this program, the dependences of the scattering, fission, and radiative neutron capture reactions cross sections for the main reactor fuel nuclides $^{235}_{92}\mathrm{U}$, $^{238}_{92}\mathrm{U}$, $^{239}_{92}\mathrm{U}$ and $^{239}_{94}\mathrm{Pu}$ at various temperatures in the range from 300 K to 3000 K are obtained.

A program has also been developed and used for obtaining the calculated dependences of the cross sections $\overline{\sigma}_j^i(\vec{r},T,t)$ averaged over the neutron spectrum for the main reactor nuclides and the main reactor nuclear neutron reactions at the indicated temperatures. Here the neutron spectrum was specified in a combined form as follows: in the form of a Maxwell spectrum $\chi_1(E_n)$ for energies below the limiting thermalization energy $E_{\text{гр}}^{\text{терм}}$; in the form of the Fermi spectrum $\Phi_{\Phi}(E_n)$ for the moderating and absorbing medium if energies were above $E_{\text{гр}}^{\text{терм}}$, but below E_f (E_f was the upper energy of the Fermi spectrum neutrons); as the fission spectrum for $^{239}_{94}\mathrm{Pu}$ if energies were above E_f, but below $E_n^{\max}$ [70, 71]. The neutron gas temperature for the Maxwell distribution was

specified by a relation like the expression (1), but somewhat modified based on the approach given in [66]. According to this approach, formally, the shortcomings of the standard moderation theory in the sphere of thermalization can be partially reduced if, instead of the average logarithmic energy loss ξ of the standard theory (which does not depend on the neutron energy and, as is known, is used for a medium of nuclei with atomic numbers exceeding 10 $\xi \approx 2/A$), the variable $\xi(z) = \xi\varphi(z)$, where $\varphi(z) = (1 - 2/z)$ and $z = E_n/kT$, should be introduced.

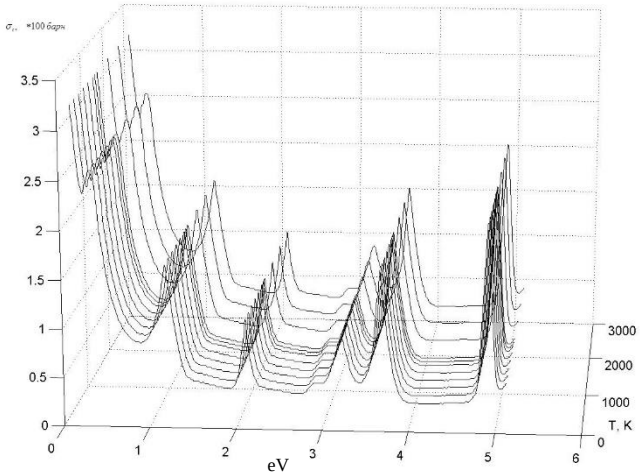

Fig. 3. Calculated dependences of the $^{235}_{92}\mathrm{U}$ *neutron radiative capture reaction cross sections on* $^{235}_{92}\mathrm{U}$ *energy at the various temperatures in the range from 300 K to 3000 K.*

So, within the framework of the considered formalism, the neutron gas temperature was specified by the following expression:

$$T_n = T\left[1 + 1{,}8\frac{\Sigma_a(kT)}{\overline{\xi}\Sigma_s}\right], \qquad (4)$$

where $\overline{\xi}$ was the averaged logarithmic energy decrement during moderation over the entire Maxwellian spectrum energy range $\xi(z)$ at kT =1 eV.

In Fig. 4 the calculated temperature dependences of cross sections $\overline{\sigma}_j^i(\vec{r}, T)$ averaged over the neutron spectrum for the main reactor nuclides $^{235}_{92}\mathrm{U}$, $^{238}_{92}\mathrm{U}$ and $^{239}_{94}\mathrm{Pu}$ for the main reactor nuclear neutron reactions are shown.

As is seen, the calculated dependences on the fissile medium temperature in the range from 300 K to 6000 K for the cross sections averaged over the combined Maxwell and Fermi spectrum can behave as follows:

- first grow and then fall with the temperature increase, i.e., have a resonant character (e. g., for $^{239}_{94}\mathrm{Pu}$);
- both grow with the fissile medium temperature increasing (e. g., for $^{238}_{92}\mathrm{U}$) and fall (e. g., for $^{235}_{92}\mathrm{U}$).

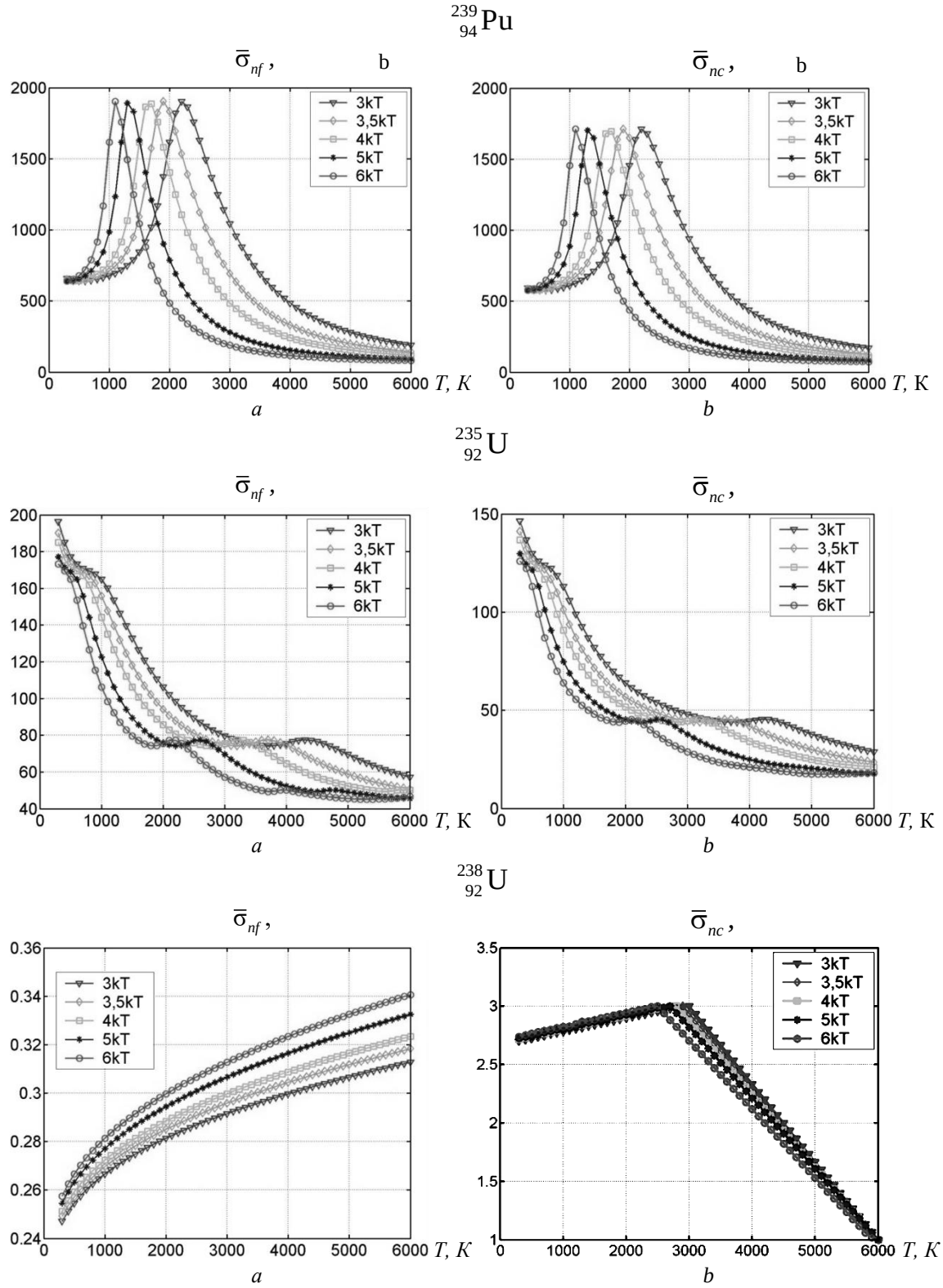

Fig. 4. Dependences on the fissile medium temperature at various values of the Fermi and Maxwell spectra limiting energy for the $^{239}_{94}$Pu, $^{235}_{92}$U *and* $^{238}_{92}$U *fission cross sections (*a*) and radiative capture cross sections (*b*) averaged over the combined Maxwell and Fermi spectrum.*

This can be explained by the fact that for $^{239}_{94}$Pu the resonant region begins at much lower energies than for $^{235}_{92}$U (Fig. 5 [72]), and with the fuel temperature increase the neutron gas temperature also increases and causes a shift of the Maxwellian neutron distribution maximum towards higher neutrons energies, i.e., the neutron gas spectrum hardening, at which the number of neutrons falling into the $^{239}_{94}$Pu resonant region increases, which just makes the averaged cross sections

to grow. For $^{235}_{92}U$ this process is not so significant because its resonant region is located higher in energies, and the neutron gas spectrum hardening associated with the fuel temperature increase (in the considered range) does not cause a significant increase in the number of neutrons falling into the resonant region. Note that, as is seen from the same Fig. 7, for uranium 235, the resonance, which can cause the dependence of the fission cross section averaged over the thermal spectrum like for plutonium 239, is located much higher than for plutonium 239, approximately at about 1 eV.

The $^{238}_{92}U$ data presented in Fig. 4 (due to the high fission threshold exceeding 1 MeV, the averaged cross section of the $^{238}_{92}U$ fission is practically insensitive to the neutron spectrum hardening caused by the fuel temperature increase) confirm the temperature dependence of the radiative capture cross section, since its resonant region is located as low as the $^{239}_{94}Pu$ resonant region.

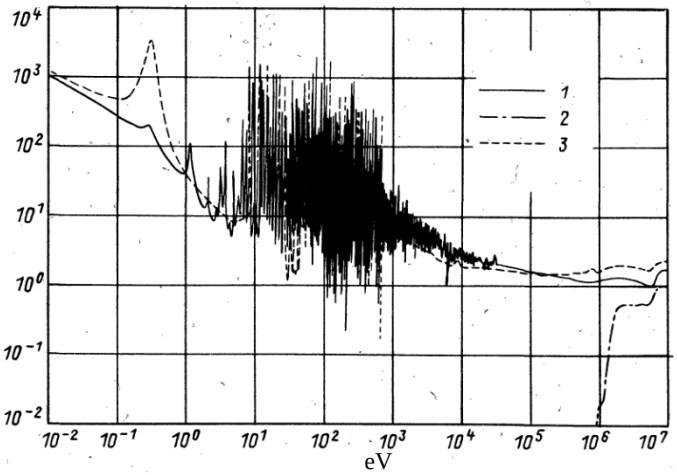

Fig. 5. Nuclides fission cross sections for uranium 235 (curve 1), uranium 238 (curve 2) and plutonium 239 (curve 3) depending on neutron energies [72].

2.3. Dependences on the reactor fuel temperature for the MOX fuel and uranium dioxide fuel heat source densities.

The heat source density of the MOX fuel (a mixture of ^{238}U dioxide and $^{239}_{94}Pu$ dioxide) in a thermal reactor with water as a moderator, e. g., BWR, was calculated according to the expression:

$$S(T) = Q_{Pu} \cdot \Phi \cdot \langle \sigma_f^{Pu}(T) \rangle \cdot N^{Pu}, \quad (5)$$

where Q_{Pu} =210.3 MeV was the thermal energy of one ^{239}Pu nucleus fission; $\Phi = 10^{13}$ 1/(cm^2 s) was the neutron flux density; $\left\langle \sigma_f^{Pu} \right\rangle$ was the fission cross section averaged over the $^{239}_{94}Pu$ thermal spectrum (see expression (3)); N^{Pu} was the plutonium nuclei concentration.

In calculations, the MOX fuel density value was assumed 10.82 g/cm^3.

The heat source density for uranium dioxide fuel (a mixture of $^{235}_{92}U$ dioxide and $^{238}_{92}U$ dioxide) in a thermal reactor with water as a moderator was also calculated according to an expression similar to (5), at Q_{235} =203.0 MeV and the uranium dioxide fuel density of 10.82 g/cm^3.

It was assumed that the neutron flux density Φ should remain constant with the fissile medium temperature increase, since the main neutron absorption was associated with $^{238}_{92}U$, and its radiative capture cross section averaged over the thermal spectrum should increase insignificantly with the medium temperature increase in the studied range (Fig. 2, Table 2).

An analysis of the heat source density dependences on the fissile medium temperature obtained for MOX fuel (Fig. 6) shows that with a temperature increase from 300 K to 1500 K the source density nonlinear increase by 45 % at 300 K is observed. With a further temperature increase to 2100 K, some density decrease is observed. But an analysis of the heat source densities dependences on the fissile medium temperature obtained for uranium dioxide fuel (Fig. 7) shows that with the temperature increase from 300 K to 2100 K, a nonlinear decrease in the heat source density is observed. Such behavior of the heat source densities is explained by the obtained temperature dependences of the $^{239}_{94}Pu$ fission cross section and the ^{235}U fission cross section averaged over the thermal spectrum (Fig. 1).

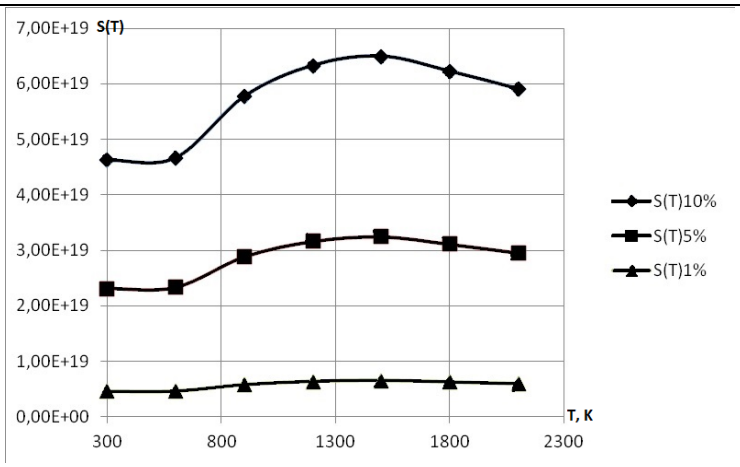

Fig. 6. The heat source densities dependences on the temperature of the fuel fissile medium of the $^{238}_{92}\mathrm{U}$ *and* $^{239}_{94}\mathrm{Pu}$ *dioxides mixture for three compositions (*$^{239}_{94}\mathrm{Pu}$ *enrichment of 1 %, 5 %, 10 %).*

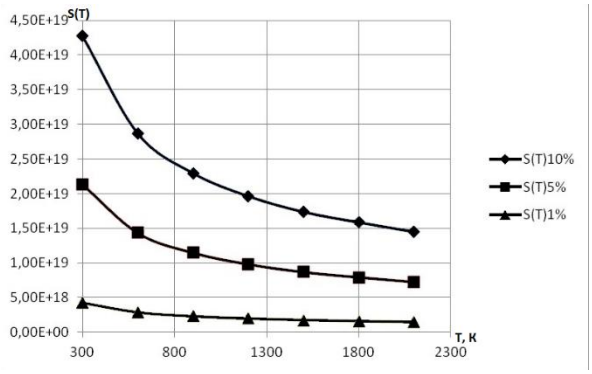

Fig. 7. The heat source density dependences on the $^{238}_{92}\mathrm{U}$ *and* $^{235}_{92}\mathrm{U}$ *dioxides fuel mixture temperature for three compositions (*$^{235}_{92}\mathrm{U}$ *enrichment of 10 %, 5 % and 1 %).*

3. Experiment: the temperature dependences obtained for heat source densities and the dynamics features of the accident at the Fukushima Daiichi Nuclear Power Plant Unit 3.

Thus, a fundamental difference in the temperature dependences of the heat sources densities for MOX fuel and uranium oxide fuel has been discovered and explained for the studied interval of temperatures. Moreover, the obtained temperature dependences of the heat source densities for the fissile fuel medium presented in Figs. 6 and 7 allow to identify some features of the accident at the Fukushima Daiichi Unit 3

As is known, one third of the nuclear fuel load at this Unit was MOX fuel, the rest of the fuel was uranium dioxide one. The accident developed as follows. When trying to cool the overheated nuclear reactor by pumping cold sea water through it, due to the water decomposition an uncontrolled formation of hydrogen gas occurred, which led to an explosive mixture formation and explosion, which caused the nuclear reactor destruction. The thermal water decomposition temperature is quite high, 3800 K. Therefore, most likely, the hydrogen formation occurred not as a result of thermal hydrolysis of water, but at a lower temperature as a result of the steam-zirconium reaction [82-85], i.e., the exothermic reaction of the interaction of fuel elements zirconium cladding and water with the zirconium dioxide formation and the gaseous hydrogen release ($Zr + 2H_2O = ZrO_2 + 2H_2 + Q$, where Q=6530 kJ/kg was the released heat).

The steam-zirconium reaction has several features as follows: it starts at approximately 1173 K – 1223 K, develops very quickly, and at 1473 K (as the released heat additionally heats the zirconium, an autocatalysis develops) becomes self-sustaining.

Since the hydrogen explosion at the reactor occurred after the restoration of the cooling water supply to the reactor, it could be concluded that due to the long-term disruption of the heat removal system caused by the tsunami impact, the superheated reactor fuel temperature reached the values of the steam-zirconium reaction beginning in the interval from 1173 K to 1223 K. The heat source density dependence on the fuel temperature obtained for the MOX fuel (Fig. 6) showed that in that case the heat source density of the Unit 3 MOX fuel should increase, reaching a maximum at 1500 K. Such behavior of the heat source density of the MOX fuel could cause the further MOX fuel heating to a temperature of 1473 K, at which the steam-zirconium reaction of the hydrogen gas formation would begin to

develop very quickly and would become the self-sustaining one. It should be emphasized that according to the heat source density dependence on the fuel temperature obtained for the uranium dioxide fuel (Fig. 7), there would not be any very rapid formation of hydrogen for the uranium dioxide fuel.

Therefore, the difference in the temperature dependences of the heat sources densities for MOX fuel and uranium oxide fuel could cause a more intense hydrogen release, and, consequently, a more powerful hydrogen explosion of Unit 3 compared to the case when its total fuel load would be the ordinary uranium dioxide fuel. This conclusion coincides with information reports about a more powerful hydrogen explosion at Unit 3 compared to the hydrogen explosion at the Fukushima Daiichi NPP Unit 1, where there was no MOX fuel loading.

Further fuel heating to the oxide fuel melting point 2800 K could be explained by the water pumping system destruction during a hydrogen explosion, and hence by the long-term absence of heat removal necessary to prevent fuel melting. This is also possible with the same dependences of the heat source densities for MOX fuel (Fig. 6), although, as already noted, there is some decrease of the heat source density when the temperature rises from 1500 K to 2100 K, and, apparently, even at the thermal sources densities dependences of the uranium dioxide fuel (Fig. 7). For eliminating all the above assumptions as to the fuel temperature change, it is necessary to look for the solutions of the heat transfer equation with the heat source densities obtained for given initial and boundary conditions. Now it is not possible to do this just because of the lack of information about the initial and boundary conditions and their possible changes during the accident development at the Fukushima Daiichi NPP.

However, to explain the possible kinetics features of the fuel heating to a melting temperature of 2800 K associated with the discovered temperature features of the MOX fuel (Fig. 6), and the ^{239}Pu cross sections averaged over the neutron spectrum (Fig. 4), the following considerations seem to be of interest.

As a result of the steam-zirconium reaction, especially after a hydrogen explosion that disrupted the system of water supply to the reactor, the water amount in the reactor decreases, which causes its moderating ability decreasing and the neutron spectrum hardening, i.e., the maximum of the Maxwellian distribution of thermalized neutrons shifts towards higher energies. For a harder neutron spectrum, the temperature dependence of the ^{239}Pu fission cross sections averaged over the thermal neutron spectrum shown in Fig. 1 and used for calculating the temperature dependence of the MOX fuel heat source density (Fig. 6) should be replaced by the temperature dependence of the $^{239}_{94}\mathrm{Pu}$ fission cross sections averaged over the neutron spectrum for $E = 3kT$ (Fig. 4). Since this temperature dependence of $^{239}_{94}\mathrm{Pu}$ fission cross sections averaged over the neutron spectrum demonstrates a nonlinear growth with a maximum at a temperature of 3000 K, the temperature dependence of the heat source density for the MOX fuel, which is calculated according to expression (5), should behave in the same way. In other words, in contrast to the dependence in Fig. 6, in this case the temperature dependence of the heat source density for the MOX fuel with a maximum at 3000 K is obtained. Thus, due to such a heat source density temperature dependence, a smooth, non-linear increase of the MOX fuel temperature can occur from the steam-zirconium reaction beginning temperature of 1173 K…1223 K, through its autocatalysis temperature of 1473 K to the fuel melting temperature of 2800 K. Consequently, first the MOX fuel in the Fukushima Daiichi NPP Unit 3 should have melted and contributed to the reactor uranium dioxide fuel melting.

The periodic (pulsating) emergency increase of the temperature and pressure in the Unit 3 destroyed reactor during the reactor cooling, the cause of which was previously unknown, can also be explained by the nonlinear temperature dependence of the heat source density for MOX fuel obtained in a resonant form (Fig. 6).

The revealed features of the MOX fuel temperature behavior and their supposed influence on the accident kinetics in the Unit 3 could be eliminated by excluding the thermalized tail (the Maxwellian part of the spectrum) from the energy spectrum of neutrons being moderated. To do this, at the first stage of an overheated reactor cooling, it would be necessary to technically implement the replacement of a water moderator-coolant with a moderator-coolant having a mass number significantly greater than the mass number of hydrogen, e. g., nitrogen, carbon monoxide, liquid metal tin, lead, mercury, bismuth or a bismuth-lead mixture, which would lead to the neutron spectrum hardening and would also allow to avoid the hydrogen explosions.

It should be especially noted, as noted above in the introduction to this paper, that the authors' theoretical model of the accident dynamics, which, in their opinion, explains well the known experimental data on the accident dynamics, is based on the dynamics of nuclear reactions involving neutrons. But where did neutrons come from? The authors try to find an answer to this difficult question, since according to information reports, the nuclear power plant reactors were "shut down" after having received a message about a tsunami and there should not seem to be any neutrons.

Several events scenarios are possible here.

It can be assumed that the operator, having received a message about the tsunami and not assuming that something extraordinary might happen, i.e., that the protective breakwater would not be able to prevent the wave hitting, did not execute an emergency shut down of the reactor, but launched the usual procedure for automatically bringing the reactor to minimum power, which is usually carried out before any preventive works. Note that the procedure itself for the reactor power reduction from the operating level is carried out via a gradual power decrease by small amounts and therefore takes a rather long time.

It is also known that after the reactor is "shut down", in the reactor core for a long time (about 1 hour, there is even a corresponding term in the formula for

the correct calculation of the reactor residual heat release, taking into account the delayed neutrons contribution), there is enough of delayed neutrons emitted by accumulated fission fragments. Indeed, the epicenter of the earthquake that occurred on March 11, 2011 and generated a tsunami was located at a 180 km distance from the coast, where the Fukushima Daiichi NPP industrial site was located [68]. Tsunami speed was 200 m/s. Consequently, it reached the nuclear power plant in 15 minutes after the reactor was "shut down".

It is also possible that after the reactor was subject to emergency “shut down”, due to the MOX fuel temperature features described in detail above the fuel melted and accidentally formed its supercritical mass, which created a neutron flux during the fission chain reaction development.

It is also known that after the reactor is “shut down” in the reactor core for a long time (about 1 hour, there is even a corresponding term in the formula for the correct calculation of the reactor's residual heat release, taking into account the contribution of delayed neutrons) a sufficient number of delayed neutrons emitted by the accumulated fission fragments. Indeed, the epicenter of the earthquake that occurred on March 11, 2011, and generated the tsunami was 180 km away from the coast where the Fukushima Daiichi nuclear power plant site is located, for example [86]. I VICTUED A tsunami velocity of 200 m/c. Consequently, the tsunami reached the nuclear power plant 15 minutes after the reactor was “shut down”.

Thus, at the time of the tsunami strike, there could be enough neutrons in the NPP nuclear reactors to start all neutron-nuclear processes mentioned above.

Moreover, based on the current state of the fuel, which continues to heat up during four years after the accident and therefore requires continuous pumping of thousand tons of water through the destroyed reactors to cool them, as well as on the reports about the periodic pulsations of the pumped water temperature, it can be assumed that it is the neutron-nuclear processes, such as wave burning, temperature blow-up modes, and the dynamics of dissipative structures of radiation-induced defects, that are responsible for these processes.

In conclusion, the authors of the article express their gratitude to all of their colleagues V. D. Rusov, A. A. Kakaev, E. V. Grehan, S. I. Kosenko, O. I. Pantak, who in their works have laid the basic foundation for the development of further research into the very important features of the great accident at unit 3 of the Fukushima Daiichi nuclear power plant.

Conclusions.

A fundamental difference in the temperature dependences of the fission cross sections averaged over the neutron thermal spectrum for $^{235}_{92}U$ and $^{239}_{94}Pu$ is found and explained.

The heat source densities temperature dependences for the thermal reactors MOX and UO_2 fuels are calculated.

The MOX fuel temperature behavior features discovered during the research made it possible to explain some dynamics features of the accident at the Fukushima Daiichi Nuclear Power Plant Unit 3.

It is necessary to note in conclusion that so far, no data have been published on neutrons either during the accident at the Fukushima Daiichi Nuclear Power Plant, or after it and even up to the present day, although a remote antineutrino technology for monitoring the reactor fuel nuclide composition has already been developed, e. g. [38, 78], which can also be used to obtain data on neutrons.

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VETERINARY SCIENCES

TREATMENT OF ENDOMETRITIS

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Abstract
Timely detection and treatment of sick cows in the early stages of the disease will ensure rapid recovery and restoration of their reproductive ability. In the system of measures for the elimination of infertility and cow manure, accounting and analysis of reproduction is of great importance.

Annotasiya
Xəstə inəklərin xəstəliyin erkən mərhələlərində vaxtında aşkar edilməsi və müalicəsi onların tez sağalmasını və reproduktiv qabiliyyətinin bərpasını təmin edəcəkdir. İnəklərin sonsuzluğunun və sonsuzluğunun aradan qaldırılması üzrə tədbirlər sistemində çoxalmanın uçotu və təhlili böyük əhəmiyyət kəsb edir.

Keywords: endometritis, infertility, pathological process, microbial infection, pregnancy, economic damage
Açar sözlər: endometrit, qısırlıq, patoloji proses, mikrobla yoluxma, boğazlıq, iqtisadi ziyan

İnəklərin qısır qalması hər bir təsərrüfata böyük iqtisadi ziyan vurur, çünki bu zərər cavan heyvanların alınmamasından və qısır inəklərin saxlanmasına çəkilən xərclərdən ibarətdir. Dəyərsiz qidalanma, pis qulluq, heyvanların düzgün saxlanmaması və istifadəsi kimi bir çox səbəblər buzovların qısırlığına və aşağı məhsuldarlığına səbəb olur. Qısırlıq cinsiyyət orqanlarının müxtəlif xəstəlikləri, o cümlədən endometrit nəticəsində baş vAzerir.

Doğumdan sonrakı endometritlər əsasən də südçülük komplekslərində böyük iqtisadi ziyana səbəb olur. Buna görə də, doğumdan sonrakı endometritin qarşısının alınması və müalicəsinə xüsusi diqqət yetirilməlidir.

Bu günə qədər doğumdan sonrakı dövrün ilk 10-14 günündə kəskin və xroniki endometritlərlə xəstə inəklərin qarşısının alınması və müalicəsi üçün kifayət qədər səmərəli üsullar tam işlənib hazırlanmamışdır.

Bu xəstəliklərin müalicəsi uzun müddət ərzində dərmanlardan istifadə və böyük iş vaxtının sərf olunmasını tələb edir. Endometrit çox vaxt inəklərin müvəqqəti qısırlığına və qısırflığına gətirib çıxarır ki, bu da sürünün çoxalmasını aşağı salır və təsərrüfata böyük iqtisadi ziyan vurur. Sürünün artıb-çoxalması – heyvandarlıqda çox vacib və mürəkkəb prosesdir.

Endometrit- balalığın selikli qişasının iltihabıdır. Gedişanına görə kəskin və xroniki, təzahürünə görə aydın kliniki əlamətləri qeyd olunan və subkliniki (gizli), eksudatların xarakterinə görə - seroz, kataral, irinli, fibrinozlu endometritlər qeyd edilir.

Endometritlərin inkişafının əsas səbəbləri streptokoklar, stafilokoklar, diplokoklar, Escherichia coli və paratifoz çöpləri, vibrioz, trixomonoz, brusellyoz və vərəmin törədiciləridir.

Valyuşkin K.D. qısır inəklərin 84% -də mikrobları ayırıb və balalığın mikroblarla çirklənməsi və xroniki

endometrit, həmçinin inəklərdə endometrinin digər patologiyası arasında müsbət əlaqənin olmasını müəyyən etdi[3].

Bir çox müəlliflər hesab edirlər ki, inəklərin əksəriyyətində endometritlər zamanı qarışıq mikrofloranın inkişaf etməsi baş verir.

Mikroblar süni və təbii mayalanma, vaginal müayinə zamanı, döşənək və qulluq əşyaları vasitəsilə inəklərin cinsiyyət orqanlarına daxil olur. İnəkləri yoluxmuş sperma ilə mayalandırdıqda mikroorqanizmlər sperma üzərinə düşür və onlarla birlikdə balalıq buynuzlarına və yumurtalıq yollarına nüfuz edərək orada iltihabın baş verməsinə və yaxud yumurta, ziqot və rüşeymin ölümünə səbəb olurlar.

Doğumdan 2-3 həftə sonra baş verən endometritlər çox vaxt sonun ləngiməsi, balalığın düşməsi, balalıqda doğumdan sonra baş verən iltihab proseslərinin nəticəsi, həmçinin boğazlığın müxtəlif mərhələlərində baş verən balasalmaların ağırlaşmasıdır.

Balalığın iltihabı iltihab prosesinin balalıq yolu və balalıq boynundan, düz bağırsaqdan, sidik kisəsindən yayılması nəticəsində də inkişaf edə bilər.

Qaraciyər, böyrəklərdə, ağciyərlərdə və digər orqanlarda olan infeksiya ocaqlarından mikrobların bura düşməsi ehtimalı da istisna edilmir. Rasionda A, E, D vitaminlərinin və B qrupunun vitaminlərinin, mineralların, xüsusilə kobalt, sink və mis mikroelementlərinin çatışmazlığı endometritin gedişatını mürəkkəbləşdirir. Orqanizmin müqavimətinin zəifləməsi, böyük qan itkiləri, uzun məsafələrə daşınma da endometritin inkişafına şərait yarada bilər. İnəklərin qaranlıq, rütubətli, havasız binalarda saxlanması, gəzintinin olmaması, bir çox alim və praktiklərin fikrincə, balalıqda iltihabi proseslərin inkişafına səbəb olur.

Endometritlərdə patoloji proses selikli qişada və vəzili birləşdirici toxumada lokalizə olunur. Balalığa daxil olmuş mikroblar həyati fəaliyyətinin məhsulları ilə toxumaları qıcıqlandırırlar. Mikrobların və onların toksinlərinin təsiri nəticəsində iltihab ocağı meydana gəlir ki, onun yayılması mikrobların virulentliyindən, balalıq yolunun toxumalarının müqavimətindən və patogen amilə onun reaksiyasından asılıdır. Mikrobların zəif virulentliyi, orqanizmin və balalıq toxumalarının isə güclü reaksiyası nəticəsində iltihab ocağının ətrafında tez bir zamanda qranulyasiya səthi əmələ gəlir ki, onun leykositləri mikrobların balalığın daha dərin təbəqələrinə nüfuz etməsinə mane olur. Orqanizmin belə bir reaksiyası xüsusilə yay və payız-qış dövründə cavan heyvanlarda özünü daha aydın göstərir və adətən iltihab prosesinin lokallaşması və balalığın selikli qişasında - kəskin kataral endometritin inkişaf etməsi ilə başa çatır[1,2].

Qoca, yaxud dəyərsiz yemləmə, xəstəliklər nəticəsində zəifləmiş inəklərdə orqanizmin qoruyucu reaksiyası zəif görünür, yaranan qranulyasiya səthi mikrobların və onların toksinlərinin ballaığın daha dərin qatlarına nüfuz etməsinin qarşısını ala bilmir. Kəskin irinli-kataral endometritin daha ağır forması inkişaf edir. Eyni zamanda, balalığın vəzili təbəqəsi və əzələ qişası iltihab prosesinə qoşulur, eyni zamanda reflektor pozğunluqlar daha çox özünü göstərir. İltihabi prosesin inkişafı hiperemiya və toxumanın sulu şişi ilə başlayır. Balalığın damarları genişlənir və qanla dolur, güclənmiş transudasiya sulu şişin inkişafına səbəb olur. Hiperemiyanın bu mərhələsində balalıq toxumalarında oksidləşdirici proseslərin aktivliyi kəskin şəkildə artır.

Hüceyrələr arasında leykositlər, mono- və polinüvəli hüceyrələr əmələ gəlir, çox vaxt qanaxma baş verir. Balalıq vəziləri selikli qişada baş verən iltihaba tez cavab verir; onların şişkinliyi və epitelin büzüşməsi, vəzilərin boşluğuna qanaxma qeyd edilir. Selikli qişanın və vəzilərin reaksiyası, həmçinin mikrobların təsiri nəticəsində balalıq boşluğunda kataral və ya irinli-kataral etsudatın əmələ gəlməsinə səbəb olur. Damarların reaksiyası və onların güclü genişlənməsi qanaxmaya səbəb ola bilər və o zaman eksudat çəhrayı və ya qırmızı rəng alır. İltihabın bu ilk mərhələsi, ödem səbəbindən balalıq divarının bir qədər qalınlaşması, onun yumşalması ilə özünü göstərir.Hüceyrələr arasında çox vaxt leykositlər, mono və polinüvəli hüceyrələr yaranır.Patogen amil öz təsirini davam etdirərsə, onda patoloji proses uzunmüddətli, yarımkəskin xarakter alır və birləşdirici toxumanın artması ilə özünü göstərir. Bəzən selikli qişada fibrinoz çöküntülər yığılır.

Bu mərhələ balalıq yolunun toxumalarında oksidləşdirici proseslərin aktivliyinin azalması ilə müşayiət olunur - oksigenin udulma göstəricisi və katalaza və peroksidaza fermentlərinin aktivliyi azalır. Xroniki formaya keçid zamanı balalığın selikli qişasında, əzələ və vəzili qatlarında stabil dəyişikliklər baş verir; çox vaxt bu dəyişikliklər geri dönməyən xarakter alırlar[3,4].

Balalıqda yığılan kataral və ya irinli-kataral ekssudat, mikrobların həyat fəaliyyətinin məhsulları və onların toksinləri epitelin degenerasiyasına, onun dəyişilməsinə səbəb olur. Epiteldən məhrum olan selikli qişanın sahələri və inkişaf edən birləşdirici toxumada çapıqlar əmələ gəlməyə başlayır. Bu vaman, qan damarlarının kəskin sıxılması səbəbindən toxumaların qidalanması pozulur. Balalıq vəziləri çapıqlar ilə sıxılır, onların damar mənfəzi tutulur, bunun nəticəsi olaraq kistoz baş verir. Balalığın qan damarları dəyişir. Birləşdirici toxumanın təzyiqinin altında onların mənfəzləri kəskin şəkildə daralır və balalığın bəzi hissələrində toxumaların qidalanması pozulur. Bununla paralel olaraq toxumalarda maddələr mübadiləsi proseslərin fəallığı kəskin şəkildə aşağı düşür və qan axınının sürəti azalır. Bir sıra tədqiqatlarla müəyyən edilmişdir ki, balalıqda xroniki iltihabın inkişaf etməsi nəticəsində onların təqəllüsetmə qabiliyyəti kəskin şəkildə aşağı düşür.

Bütün bu patoloji proseslər balalığın selikli qişasının nazilməsi və atrofiyası, qalan qatlarının isə qalınlaşması ilə başa çatır. Miometriyada balalıq divarlarının qalınlaşmasına səbəb olan hiperplaziya əlamətləri inkişaf etməyə başlayır.

Diaqnozun qoyulması bir çətinlik yaratmır. Vaginal və rektal müayinə, həmçinin anamnez məlumatları diaqnozun qoyulması üçün kifayət qədər əsas verir.

Orqanizmin müqavimətini artırmaq məqsədilə inəkləri kifayət qədər tam dəyərli yemlə, yaxşı saxlanma şəraiti ilə təmin etmək, müntəzəm gəzintilər

vermək ən vacib məsələdir. Doğumdan sonrakı mürəkkəbləşmələrin qarşısının alınması üçün heyvanların boğazlıq dövründə və doğumdan sonrakı dövrdə onların hərəkəti xüsusi əhəmiyyət kəsb edir.

Boğazlıq dövründə gəzintinin olmaması və ya heyvanların kifayət qədər hərəkət etməməsi sinir-əzələ sisteminin zəifləməsinə, balalığın tonusunun və onun təqəllüsetmə qabiliyyətinin pozulmasına və bunun nəticəsi olaraq çətin doğuma, ciftin ləngiməsinə və cinsiyyət orqanlarının zəif involusiyasına səbəb olur. Doğumdan sonrakı dövrdə bu fəsadların qarşısını almaq üçün heyvanların düzgün qidalanması ilə yanaşı, gündəlik gəzinti (doğumdan 2-3 gündən sonra başlayaraq) təmin etmək lazımdır. Boğaz inəklərə boğazlığın son gününə qədər əlverişli doğumu təmin etmək məqsədilə fəal gəzinti vermək lazımdır ki, buda doğumdan sonrakı dövrə müsbət təsir göstərir və ciftin vaxtında ayrılmasına kömək edir.

Doğumdan sonrakı mürəkkəbləşmələrin qarşısını almaq üçün doğumdan sonra 7%-li ixtiyol məhlulu və V.V.Mosinə görə plevraüstü novokain blokadası tətbiq oluna bilər.

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