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УДК 620.1

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SOME ASPECTS OF ENERGY DEVELOPMENT

Abstract. This paper outlines the current state of the energy industry, as well as trends and opportunities for the use of renewable energy sources. In addition, the nuances of energy development in various countries and some environmental aspects and nuances are considered.

Keywords: installed capacity, power generation, global warming, renewable energy, resources and reserves.

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НЕКОТОРЫЕ АСПЕКТЫ РАЗВИТИЯ ЭНЕРГЕТИКИ

Аннотация. В данной работе изложено современное состояние энергетики, а также тенденции и возможности использования возобновляемых источников энергии. Кроме того, рассмотрены нюансы развития энергетики в различных странах и некоторые экологические аспекты и детали.

Ключевые слова: установленная мощность, выработанная энергия, глобальное потепление, возобновляемая энергетика, ресурсы и запасы.

The data presented in this paper is received from official annual reviews of the following organizations: International Energy Agency – IEA, National Renewable Energy Laboratory – NREL (USA), British Petroleum.

Unfortunately, even such authorities bring in their reports the information and data, which is very often divergent.

It is necessary to distinguish such concepts as “installed capacity” and “power generation”.

For example, you are the owner of a wind power installation with the installed capacity of 20 kW. However yesterday there was no wind and today there is no wind, and nobody knows what will be tomorrow. So the installed capacity not always coincides with the planned amount of energy.

Another example: during the very cold winter days the thermal power plant can run at a much higher load (for example, 110 or 120 %). So the real generating power will exceed the nominal output capacity.

Of course, it's difficult to imagine civilized human beings without such amenities as electricity, hot water and motor fuel. But all these amenities we have are not because of the wave of a magic wand and the grace of God. Thanks to the so-called primary energy sources.

Non-renewable energy sources exist in the form of fossil fuels which are used at thermal power plants: natural gas, oil and coal, and uranium – respectively used at nuclear power plants.

Why should we call this energy sources *non-renewable*? They are called non-renewable because they cannot be re-generated within a short span of time, because the rate of their formation is significantly lower than the rate of their consumption nowadays. It is the energy taken from the sources that are available on the earth in limited quantity and probably will vanish fifty-sixty years from now [1].

The process of coal (oil and gas) formation has taken hundreds of million years. And our times are certainly characterized by the constant growth of energy consumption. Non-renewable sources are not environmentally friendly and can have serious effect on our health.

In order to compare the local fuel reserves and production we have to introduce such a concept as reserves-to-production ratio (the so called R/P ratio). By R/P ratio coal remains by far the most abundant fossil fuel, though oil and natural gas reserves have increased over time. Some countries (as the Russian Federation and US) account for the majority of proved reserves for all fossil fuels.

Global energy demand has been slowing markedly, from above 2 % per year over the last two decades to 1 % per year after the year 2025. Just imagine: every second in the world more than 1000 barrels of oil are produced! By the way, China is becoming the largest oil-consuming country. That's why the remaining oil reserves on the Earth will be enough for about 50 years, and gas reserves – for about 60 years. While the coal reserves in the former Soviet Union will suffice for more than four hundred years [2].

Of course, these estimates are approximate and not indisputable, at least because it is necessary to understand (or to make it clear) the difference between such concepts as *"resources"* and *"reserves"*. For example, if we say "oil reserves", we are only talking about discovered (or known) oil stock, where the oil is economically feasible to extract at today's market prices.

As for "resources", this concept includes *firstly* – undiscovered (unknown) oil stocks, *secondly* – oil that is technically and economically feasible to extract at higher future prices, and *finally* – oil that presently cannot be extracted because of technological difficulties.

But the development of technology is not standing still so that the future real oil reserves and other hydrocarbons are, of course, much higher.

Now, let us get back to renewable energy.

A natural resource can be considered a renewable resource if it is produced by natural process at rate comparable to or faster than its rate of consumption by humans.

RES include solar and wind energy, hydropower, tidal energy, marine currents and waves, geothermal energy, biofuels, hydrogen.

It is interesting to compare renewable and conventional world energy reserves. For example, world primary energy supply is based on an average global power demand of 16 TW, while solar can give us 23000 TW. The only other RES, whose potential exceeds the global power demand is wind energy. All the others are not enough to cover our energy consumption.

When we talk about the world as a whole, about 80-85 % of all the energy is currently generated at thermal power plants that burn coal, natural gas and oil. The same disposition is observed, for example, in Russia. But there are some countries, in which the structure of energy consumption is radically different. For example, in France over 80 % is provided by nuclear energy, in Norway 97 % belongs to hydropower [3].

It is interesting that about 70 % of the world's energy resources are consumed in several countries: China, USA, Russia, Japan, India, Western Europe. China has finally overtaken the United States' energy consumption and taken the 1st place in the world in terms of this criteria. So, the rest of the world accounts for just over 30 % of energy resources. At the same time, 20 % of the world population consumes 80 % of energy. So not everything in this world is equally accessible [4].

Now a little bit about the ecology, greenhouse effect and global warming.

All of us live in the unified areal, and the border lines between different states cannot prevent toxic gases from trespassing these borders. That's why the reduction of toxic gases, including the so called greenhouse gases, is the global problem. Russia, for example, delivers only 4 % of carbon dioxide to the world atmosphere, while the Russian foresters convert about 25 % of the total world carbon dioxide (CO_2) emission. Even "ecologically clean" Norway, where 97 % of energy is produced by hydropower, "imports" more than 90 % of noxious emissions from other countries.

Greenhouse effect is a property of the atmosphere to pass ultraviolet solar irradiation, but partially entrap the earth (infrared) radiation, which contributes to the accumulation of heat on the earth's surface. Therefore, the greenhouse effect prevents the Sun's heat from rising out of the atmosphere and flowing back into space. Such activities as the burning of fossil fuels are creating a gaseous layer (or a kind of a cloud) that is too dense to allow the heat to escape. So the average temperature of the Earth's surface now stands at about 15 °C. Many scientists believe this is causing global warming. However, there are a lot of specialists who are skeptical about this phenomenon, considering it specially contrived. But it is a topic for special discussion.

It should be noted that there is no way of energy generation which wouldn't bring the negative impact on the environment.

Of course, air pollution with nitrogen and sulfur acids is connected with the burning of fossil fuels at thermal power plants.

However, there are also a number of negative aspects, concerning renewables.

For example, solar concentrators and wind installations quite often lead to death of birds and bats, which, certainly, causes anger of Greenpeace. Hydroelectric power stations demand huge water storage reservoirs which occupy the space – native habitat for both people and animals.

Renewable energy replaces conventional fuels in four distinct areas: electricity generation, air and water heating (or cooling), motor fuels, and rural (off-grid) energy services (so called *stand alone power system*).

Renewable energy sources exist over wide geographic areas, in contrast to other energy sources, which are concentrated in a limited number of countries.

Rapid promotion of renewable energy is resulting in significant energy security, climate change mitigation, economic benefits, reduction of air pollution and associated health costs.

At the national level, at least 30 nations around the world already have renewable energy contributing more than 20 % of energy supply.

Most renewable energy projects are large-scale, but renewable technologies are also suited to rural and remote areas and developing countries, where energy plays a very important role in human development.

Most renewable energy comes either *directly or indirectly* from the Sun which causes the wind to blow, the water to flow and the plants to grow.

But not all renewable energy sources come from the Sun. Geothermal energy taps the Earth's internal heat for a variety of uses, including electric power production, and the heating and cooling of buildings.

The energy of the ocean's tides comes from the gravitational pull of the Moon and the Sun upon the Earth.

The official reviews and reports, as a rule, make it clear, that, when we are talking about RES, it means non-hydro renewables, because the total installed capacity of the modern large-scale HPS couldn't be compared with the corresponding capacities of other renewables, such as wind, solar, geothermal, tidal energy and so on.

The installed capacity of hydro PS only in China is about 200 GW, while the total installed capacity of all PP in Russia is 220 GW. The world's largest electricity-generating plant of any kind is the Three Gorges Dam – the hydroelectric PP on the Yangtze River in China.

The future development of renewables and their marketability are determined by such important factors as capacity factor and cost of electricity (€ per kWh).

Capacity factor – what does it mean? The net capacity factor of a power plant is the ratio of its actual output over a period of time to its potential output if it were possible for it to operate at full nameplate capacity continuously over the same period of time. The highest capacity factor among renewables belongs to geothermal power plants and amounts to 70 %.

When it comes to the cost of electricity, only the onshore wind power plant could be compared with a coal and gas thermal power plant.

Top countries for renewable electricity installed capacity are China, USA, Brazil, Canada, Germany.

Along with indisputable leaders in the development of RES (China and the USA), it is possible to note the leadership of Germany in wind power generation and Spain in concentrated solar power.

In summary, all forms of renewable energy will continue to occupy a growing place in worldwide energy supply in the future. The types of renewable energy used will be different in each country.

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SOCIAL ASPECTS OF THE DEVELOPMENT OF ARTIFICIAL INTELLIGENCE SYSTEMS

"Man is the measure of all things..."
Protagoras

Abstract. The article deals with the use of elements of artificial intelligence in control systems, as well as possible changes in the social sphere and existing trends in the development of AI.

Keywords: artificial intelligence, operating model, super intelligence control algorithms, modeling, social aspects.

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СОЦИАЛЬНЫЕ АСПЕКТЫ РАЗВИТИЯ СИСТЕМ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА

«Человек есть мера всех вещей…»
Протагор

Аннотация. В статье рассматриваются вопросы использования элементов искусственного интеллекта в системах управления, а также возможные изменения в социальной сфере и существующих тенденциях развития искусственного интеллекта.

Ключевые слова: искусственный интеллект, операционная модель, суперинтеллект, алгоритмы управления, моделирование, социальные аспекты.

Discussions about the development of artificial intelligence (AI) systems and the possible consequences of their widespread adoption are currently popular. Billions of dollars have been spent on its elaboration and development. There have been impressive advances in AI-powered products in areas such as machine translation,

speech recognition, and facial recognition. Unmanned vehicles are being created. Neural networks identify tumors on X-rays and work in the background to optimize patient care. The digital technologies that underlie the creation of AI are now an avalanche-like and systemic factor, covering all industries on a global scale. Economists believe that artificial intelligence is a general-purpose technology and will affect the economy in the same way as the advent of the steam engine and electricity. Profound changes are expected in all technological areas and directions related to human intelligence, which will also affect the state of the human community.

There are a number of definitions of "artificial intelligence", and this is due to high expectations in its development. One of the first to use the term was John McCarthy. Back in 1956, at a conference at Dartmouth University, he spoke of intelligence as "the use of the computational abilities of devices to achieve a goal" [1]. The modern idea of AI is associated with the scientific direction, within which the tasks of hardware and software modeling of those types of human activity that were considered intellectual are set and solved [2].

At the same time, two obvious development vectors are distinguished, the first of which is associated with the use of information technologies for modeling various reasoning and actions based on the knowledge base of a specific subject area stored in the machine's memory, the second one connected with the development of "super intelligence" [3].

It should be noted that the conceptual and mathematical developments of classical models, such as linear regression, Markov chains, or highly enthusiastic neural networks developed in the last century only now are being formalized into AI ideas, when data is prepared with a special tool and converted from the mass unstructured information into useful information. AI-enabled operating models use analytics to automate decision making and help one make complex decisions with a complete understanding of market dynamics, technology, workforce capabilities, and product manufacturing processes.

New specialties are emerging, the requirements for the qualifications of algorithm developers are increasing, the labor market is changing with the inevitable release and displacement of a number of service and managerial personnel and the problems of reprofiling and retraining. There are changes in the levels of wages and income. There are ideas of introducing a universal basic income and other problems for various sections of society.

Even more interesting for discussion is the direction where AI is understood as "the ability of a system to create programs during self-learning to solve problems of a certain class of complexity and solve these problems" [4]. In this article, we will not dwell on the problem of autonomous robots, killer drones or other deadly threats posed by the "super intelligence" that Elon Musk and Stephen Hawking spoke about. The issues of existential development are very important, when machine intelligence can negatively affect humanity. It can happen that powerful systems try to optimize their performance to achieve goals that are inconsistent with the human values and goals that we want to achieve. This intellect, perhaps, will competently implement its own ideas that do not coincide with ours, and we will find ourselves in the future,

formed in accordance with other people's criteria [5]. This is the so-called "leveling problem" – the way AI systems are designed as extensions of the human will. It is imperative that the behavior of AI systems be shaped by human intentions and not by random outcomes within the systems themselves. There is an opinion that if AI successfully achieves the original goal, which is not only to automate specific tasks, but also to copy a universal ability, to learn and plan, this will be the last invention that a person will make [6].

In conclusion, I would like to note that in modern discussions and presentations, the capabilities of modern technologies are greatly overestimated. The problem of integrating new systems and approaches into existing industries, corporations, and governments is not recognized. But it is clear that even if artificial intelligence never fully catches up with human thinking, an increasing number of operational tasks performed by humans today will be improved or fully automated using digital systems and that will have a serious impact on the labor market and society as a whole.

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A NEW WAY TO STUDY THE MICROSTRUCTURE OF PAPER AND CARDBOARD

Abstract. The study is devoted to determining the physical and mechanical properties of paper and cardboard by the microstructure of the cross section, for which digital technologies are used in processing data obtained by using scanning electron microscopy, ion beam cutting of fibrous material and graphic processing of cross section images. The technology of ion beam cut allows to produce a high quality of cross section of paper and cardboard. Then it is possible to determine the porosity, roughness, uniformity of fiber distribution, length of fiber contact. This parameter identifies the properties of paper and cardboard. The results of study can be used as an analogue of laboratory methods of quality control of paper and cardboard

Keywords: cross section of paper and cardboard, recovered paper, microstructure.

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НОВОЕ В ИССЛЕДОВАНИИ МИКРОСТРУКТУРЫ БУМАГИ И КАРТОНА

Аннотация. Исследование посвящено определению физических и механических свойств бумаги и картона с помощью микроструктуры поперечного среза. Для этого при обработке данных используются цифровые технологии: сканирующая электронная микроскопия, ионная резка и графическая обработка изображений поперечного среза. Технология ионной резки позволяет получить срез высокого качества, после чего возможно определить пористость, шероховатость, однородность распределения волокон и области контакта между волокнами. Данные параметры определяют качество бумаги и картона. Результаты исследования могут быть использованы в качестве аналога лабораторным методам оценки качества бумаги и картона.

Ключевые слова: поперечный срез бумаги и картона, бумага и картон из регенерированных волокон, микроструктура.

The world has changed in recent years and the pandemic contributed to this. Today, the trend of digitalization of research is observed. In my opinion, this direction is also correct for our industry, especially for educational and scientific activities related to pulp and paper industry.

I was isolated and had no access to the science lab of my university as many colleagues. It was time to pay more attention to the part of the work that is associated with the digitalization of scientific research. And I would like to share some of the results, using the example of evaluating the uniformity of paper forming.

We looked at the uniformity of forming paper and cardboard in a different way. The main difference from the existing methods is that the uniformity of forming is estimated by the microstructure of the cross section. I do not criticize existing methods, which can estimate the molding index quickly and relatively easily. The proposed method to date can be seen as a supplement or alternative in some cases.

In general, the study of the microstructure of paper and cardboard originates from the end of the 17th century. The first picture of the microstructure of the beech tree was published by Robert Hooke at the Royal Society of London in 1665 (Fig. 1).

Figure 1. First microstructure of tree

After then, microscopy did not develop as actively. The breakthrough in the study of the microstructure of paper and cardboard is associated with the development of scanning electron microscopy (SEM). The resolution increased to 3-10 nm. Electron microscopy confirmed the hypothesis about the physicochemical nature of the formation of bonds between fibers.

The combination of microscopy and digital technology is successfully used in the analysis and processing of data from studies of the microstructure of paper and cardboard fibers. In this way Fiber Tester, MorFi Compact were invented. Also, the methods of microstructure of paper and cardboard were developed.

One of the directions of research development in the field of paper microstructure was the production of a high-quality cross section. Obtaining a high-quality cross-sectional image is difficult because, the fibers are deformed during preparation. You can see the difference between the quality of the slice, which is obtained by a knife tool and ion cutting.

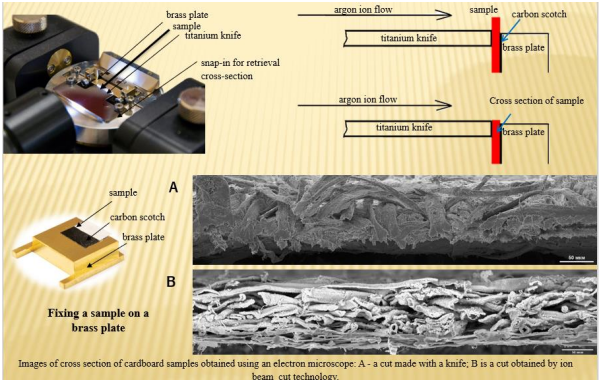

Figure 2. Investigation of cross-section of multilayer cardboard by ion beam cut technology (Patent № 2723972)

We used ion beam cut technology to obtain high-quality cross section. In order to apply it for the preparation of paper samples, indicators were selected: cutting time; ionic beam energy; material thickness (Fig. 2). We have established indicators that allow one to obtain a cross-section with high quality (Fig. 3).

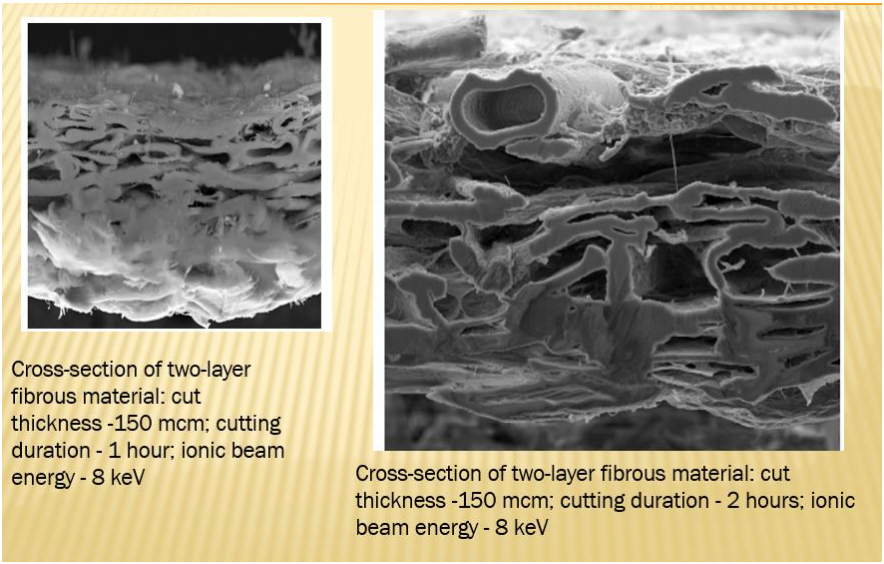

Figure 3. Investigation of cross-section of multilayer cardboard by ion beam cut technology

Interesting results were obtained by graphical and analytical processing of the cross-sectional microstructure. The developed method allows us to determine more than 12 characteristics.

We tested the method on samples different in their microstructure, obtained from the same material. In this case, three technologies for the production of double-layer cardboard have been studied (Fig. 4): A – cover layer of paperboard obtained by aerodynamic molding; B – cover layer of paperboard obtained from fibers prepared by a dry defibration and added to the stock; C – cover layer of cardboard obtained from fibres prepared by dry defibration followed by grinding in stock.

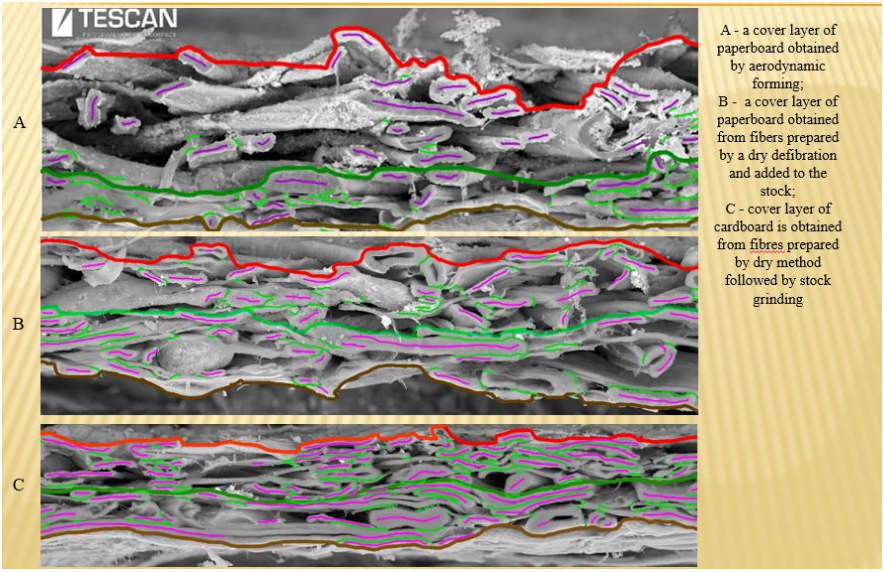

Figure 4. Cross-sections of double-layer cardboard obtained by ion cutting after graphic processing

According to the patent, the lengths of the lines along which the fibers contact and their uniformity of distribution are estimated (Fig. 5).

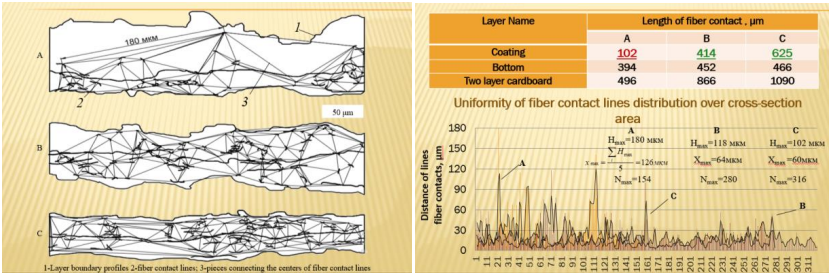

Figure 5. Method of determining uniformity of fibre contact lines distribution in cross-section

They evaluate the mechanical characteristics. Uniformity of fibre sections distribution and porosity of cardboard are determined (Fig. 6).

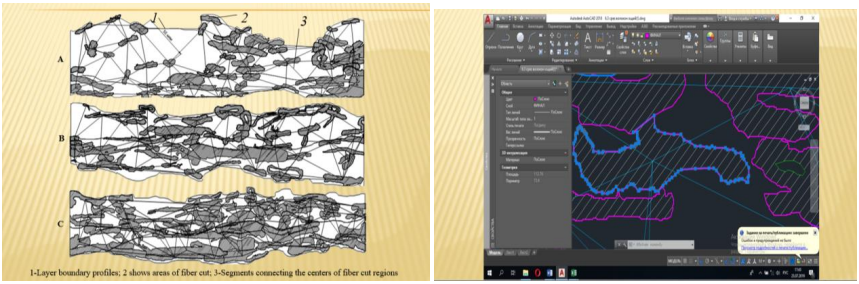

Figure 6. Areas of fiber cut and determination of uniformity of their distribution in cross section of cardboard

According to the patent, the lengths of the lines along which the fibers contact and their uniformity of distribution are estimated. By their length, mechanical characteristics are evaluated. Uniformity of fibre sections distribution and porosity of cardboard are determined (Fig. 6).

Also, uniformity of forming the layer along cross-sectional profiles is determined, for which purpose it is divided into equal sections of 5 μm and then the thickness of each layer in cross-section is set. This allows one to construct histograms of the distribution of thicknesses in the layer, which then evaluate the uniformity of forming (Fig. 7).

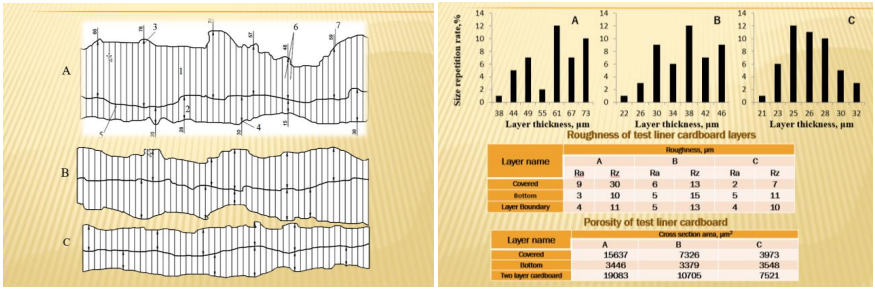

Figure 7. Cross-section areas of test liner layers

The obtained cross section profiles make it possible to determine roughness according to the method presented in GOST 25142-82.

Interesting results are obtained by estimating the chalk distribution when an electron microscope is equipped with BSE module (Fig.8). According to foreign companies, manufacturers of microscopes, today there are modules that can map the cross-section not only on chemical elements, but also on lignin and pulp.

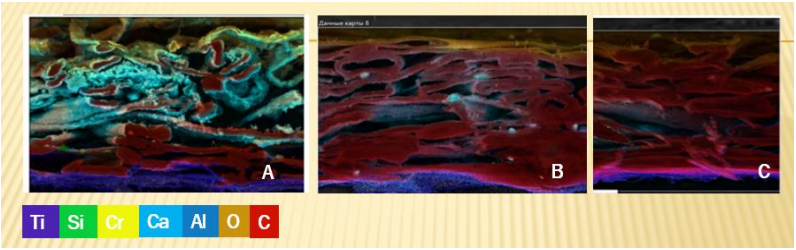

Figure 8. Element composition of cross-section of multilayer cardboard

One new study is to assess the uniformity of paper and paperboard forming, which is characterized by a formation index and considers samples at the macro level. Interesting results in this field were obtained in NArFU university. The sample is located between the light source and the detector. The light intensity is then adjusted to the distribution function by which the forming index is estimated (Fig. 9).

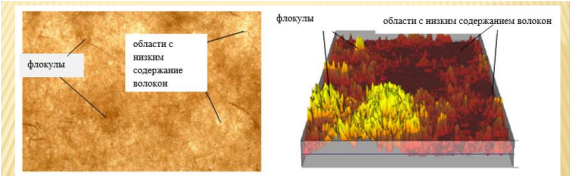

Figure 9. Evaluation of the quality of formation of multilayer fiber composite material on microstructure of cross section

An area of fibrous material cut along a vertical plane was highlighted. It was one of the results of the graphical processing of the cross section. In order to assess the uniformity of forming, it is necessary to consider the regions of fiber clots (floccules) as the existing methods. In order to quantify these methods, it is necessary to establish the relationship between the proposed and existing methods. To achieve this goal, consider one of the results of the forming index evaluation shown in Fig.9. It can be seen that the liner board has a uniformity on the lumen, there are regions where the fiber concentration is higher (floccules) or lower.

The larger the fibrous material in the thickness of the cross-section of the paperboard, the lower the intensity of the transmitted light in this section. That is, the intensity of the transmitted light is an amount inversely proportional to the thickness of the cut fibers in the cross section. Using the cross-sectional images, areas of fiber clots in each layer were isolated separately (Fig. 10).

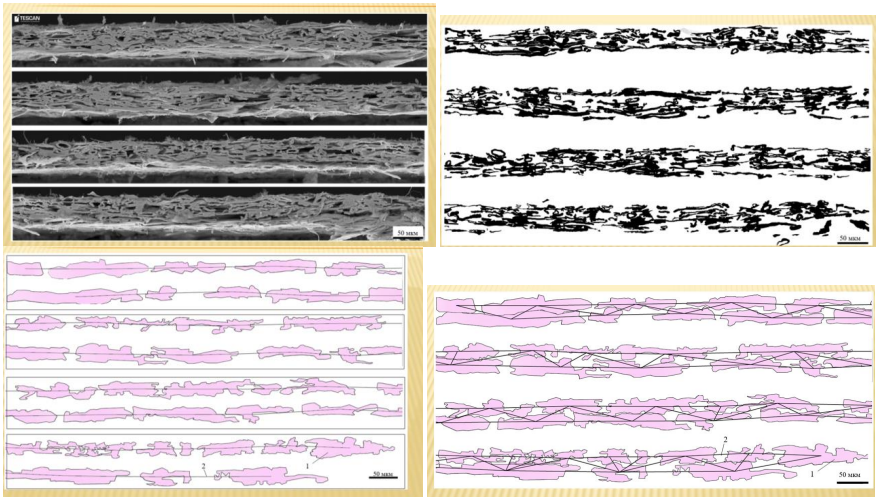

Figure 10. Selected areas of fibrous material in a cross-section of double-layer cardboard with a length of 3.5 mm

For the coating layer Imax according to the proposed method is 47 μm, for the lower – 42 μm, for the double-layer cardboard – 68 μm. The minimum value in all three cases is zero. In addition to the above calculation results, diagrams of the distribution of the sizes of flocules in the vertical plane were built, which are in reverse dependence on the brightness of the tones passing through the fibrous material of light. Fig.11. shows graphs of the vertical distribution of the flocules, which characterize the uniformity of the distribution of the flocules in the cross section of the double-layer cardboard.

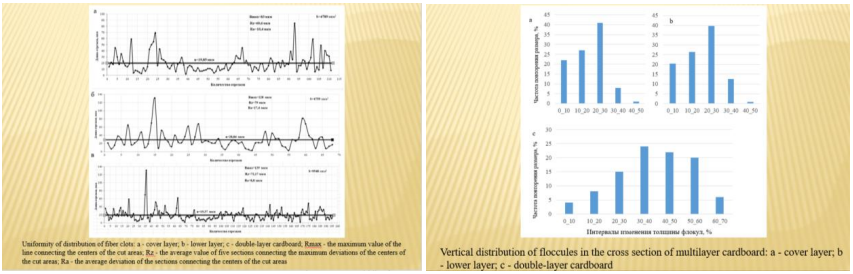

Figure 11. Uniformity of distribution of fiber clots: a – cover layer; b – lower layer; c – double-layer cardboard; Rmax – the maximum value of the line connecting the centers of the cut areas; Rz – the average value of five sections connecting the maximum deviations of the centers of the cut areas; Ra – the average deviation of the sections connecting the centers of the cut areas

The distribution diagrams of the flocules in the vertical plane shown in Fig. 11 make it possible to estimate the uniformity of the forming of each layer and the two-layer board. By analogy with the definition of the forming index, a relationship can be established between the repetition frequency of the size and the difference between the maximum and minimum floccule size. However, an important and fundamental difference is that the lumen indices are inversely proportional to those obtained from the diagrams presented on Fig. 12.

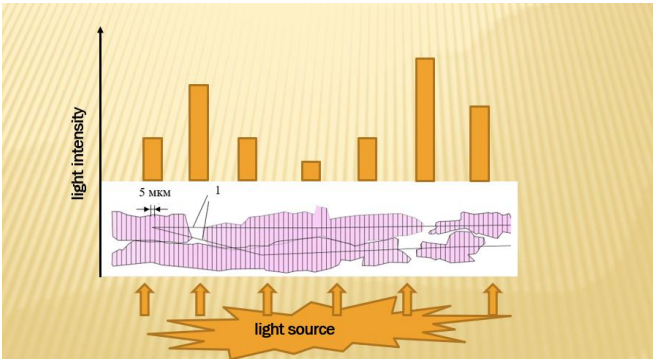

Figure.12. Evaluation of the uniformity of formation of multi-layer fiber composite material on microstructure of cross section

Thus, an estimate of the quality of paperboard forming is developed, in addition to the existing forming index, which, unlike the existing one, allows assessing the uniformity of the distribution of floccules, both in each layer individually and in the board as a whole. This index can be used either alone or in conjunction with the forming index.

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MODELING OF BIOCHEMICAL PROCESSES OF WASTEWATER OXIDATION

Abstract. The article presents a new three-component model of biochemical oxidation of organic matter, which describes the water quality of the water basin area and takes into account not only the specific indicators of wastewater from the

enterprise, dissolved oxygen, but also microorganisms involved in the processes of oxidation. The three-component model is based on the bimolecular model of biochemical oxidation, which was proposed by professor A. I. Shishkin. The concentration of microorganisms and the coefficient of microorganisms, reflecting the rate of oxidation of organic matter, were introduced into the bimolecular model by the author. The coefficient is necessary to calculate the permissible concentration and standards of permissible discharge of polluting organic substances. The paper proposes a scheme for regulating wastewater discharges into a water body using methods of mathematical modeling of the processes of biochemical oxidation of organic matter.

Keywords: modeling, biochemical oxidation, waste water, pulp and paper industry, organic substances, microorganisms, biochemical oxygen demand.

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МОДЕЛИРОВАНИЕ ПРОЦЕССОВ БИОХИМИЧЕСКОГО ОКИСЛЕНИЯ СТОЧНЫХ ВОД

Аннотация. В статье представлена новая трехкомпонентная модель биохимического окисления органического вещества, которая описывает качество воды участка водного бассейна и учитывает не только специфичные показатели сточных вод от предприятия, растворенного кислорода, но и микроорганизмов, участвующих в процессах окисления органических веществ. Трехкомпонентная модель основана на бимолекулярной модели биохимического окисления, которая была предложена профессором А. И. Шишкиным. В бимолекулярную модель автором введены концентрация микроорганизмов и коэффициент учета микроорганизмов, отражающий скорость окисления органического вещества. Коэффициент необходим для расчета допустимой концентрации и нормативов допустимого сброса загрязняющих органических веществ. В работе предложена схема регулирования сбросов сточных вод в водный объект с использованием методов математического моделирования процессов биохимического окисления органического вещества.

Ключевые слова: моделирование, биохимическое окисление, сточные воды, целлюлозно-бумажная промышленность, органические вещества, микроорганизмы, биохимическое потребление кислорода.

In the process of oxidation of organic matter, under the influence of the vital activity of microorganisms in natural water and those entering together with wastewater after biological purification, decomposition products, carbon dioxide and

water are formed, while dissolved oxygen is consumed indirectly for the oxidation process, consumed by microorganisms during respiration and partially for the oxidation of organic substances [1]:

"Organic matter"+ O_2 + Bacteria ⟶ decomposition products + CO_2 + H_2O.

When calculating the permissible discharge standards, the completeness of the oxidation processes of organic substances, the composition of the studied mixture of wastewater and natural waters, as well as the self-cleaning ability of the water body should be taken into account.

This approach requires the development of scientific and methodological foundations based on mathematical modeling of the processes of biochemical oxidation of organic matter.

To develop methods of mathematical modeling of the processes of oxidation of pollutants in the zone of influence of industrial wastewater, based on mono- and bimolecular equations developed by A. I. Shishkin, a three-component model is proposed to evaluate the processes of biochemical oxidation of wastewater, taking into account not only the indicators of organic matter, dissolved oxygen, but also the concentration of saprophytic microorganisms involved in the process of biochemical oxidation [2].

A three-component model of the biochemical oxidation of organic matter and the formation of water quality of a section of a water basin is generally represented by a system of equations (1) [2].

$$\begin{cases} \dfrac{dC_{OM}}{dt} = -\alpha \cdot C_{OM} \cdot C_{02} \cdot C_B \cdot n \\ \dfrac{dC_{02}}{dt} = -\alpha \cdot C_{OM} \cdot C_{02} \cdot C_B \cdot n + \beta \cdot \left(C_{02np} - C_{02}\right), \\ \dfrac{dC_B}{dt} = -\alpha \cdot C_{OM} \cdot C_{02} \cdot C_B \cdot n + \beta \cdot \left(C_{02np} - C_{02}\right) - \gamma \cdot C_B \end{cases} \quad (1)$$

where C_{OM} is the concentration of organic matter by BOD, mg/l; C_{O2} is the concentration of dissolved oxygen, mg/l; C_B is the concentration of microorganisms involved in the process of biochemical oxidation, mg/l; α is the coefficient of biochemical oxidation for the bimolecular and three-component models, 1/day; β is the coefficient of aeration according to the bimolecular and three-component models, 1/day; γ is the coefficient of accounting for microorganisms during the oxidation processes, 1/day; n is the dimension matching coefficient, $(l)^2/(mg)^2$, taken as 1.

The initial conditions of the model are t = 0 day; $C_{OM} = C_{OM}^0$, mg/l; $C_{O2} = C_{O2}^0$, mg/l; $C_B = C_B^0$, mg/l. The three-component model is applicable in conditions of high concentrations of organic substances, both at the wastewater discharge site and in the control line. The solution of this model is based on the *Runge-Kutta* numerical method and implemented using *MathCad15* software [2].

To obtain the initial data entered into the three-component model of biochemical oxidation, a series of sampling and laboratory analyses of water by season was carried out to determine the following indicators: dissolved oxygen,

temperature, biochemical oxygen demand (BOD) on the basis of an accredited laboratory. To evaluate the parameters of the model, the kinetic dependences of the processes of biochemical oxidation of organic matter on time were studied with the mutual influence of the concentration of dissolved oxygen and microorganisms involved in the oxidation processes. To determine the concentration of dissolved oxygen required for the oxidation of organic matter, a standardized method of iodometric titration was used.

Determination of the number of cells of saprophytic microorganisms was carried out by the Koch method by seeding on a nutrient medium for mesophilic aerobic microorganisms and facultative anaerobes [3]. In the course of research, it was revealed that in the zone of influence of wastewater, the bulk of the detected microorganisms (80 %) belongs to rod–shaped forms, 18 % of microorganisms belong to coccoid forms, usually prevailing in uncontaminated natural waters, and 2 % – to spiral forms of microorganisms that enter natural waters together with wastewater from the biological treatment system and they are an indicator of pollution of a water body with organic substances.

In the course of the study, several groups of points were analyzed from the place of deep dispersing wastewater discharge to the control gate, as well as in the background of the water body.

The calculation of the permissible concentration (C) for wastewater parameters was carried out in accordance with water protection legislation by the formula (2) with the introduced coefficient γ taking into account the activity of microorganisms during the oxidation process [4]:

$$C = n\,(TLV\,e^{-\gamma t} - C_{back}) + C_{back}, \qquad (2)$$

where TLV is threshold limit value, the maximum permissible substances concentration in water, mg/l; C_{back} is the background substance concentration, mg/l; n is total dilution coefficient of wastewater in a water body; γ is the coefficient of microorganisms in processes of substances oxidation, 1/day; t is time of oxidation, day.

Permissible discharge standards (*PDS*) can be calculated by formula 3:

$$PDS = q*C, \qquad (3)$$

where C is permissible concentration, mg/l; q - wastewater consumption, m^3/s.

Table 1 shows the results of calculating C and *PDS* by seasons, depending on hydrometeorological conditions, obtained with taking into account the self-cleaning ability of the water body and coefficient of microorganisms (γ).

Table 1 − The values of C and PDS for BOD, taking into account the self-cleaning ability of the water body

Season	Substances concentration (C) with coefficient γ				Waste water consumption (q)	Standards for wastewater discharge with coefficient γ			
	spring	summer	autumn	winter		spring	summer	autumn	winter
unit	mg/l	mg/l	mg/l	mg/l	m^3/s	tons/season	tons/season	tons/season	tons/season
BOD	15,64	18,45	13,22	13,08	0,56	69,06	81,44	58,34	57,71

**BOD – biochemical oxygen demand*

The values of permissible concentration (C) and permissible discharge standards (PDS) obtained on the basis of the developed methodology taking into account microorganisms have increased compared to the same values, but without taking into account the activity of microorganisms, which indicates that microorganisms are able to process more organic matter when discharged into a water body, which increases the self-cleaning ability of a water body.

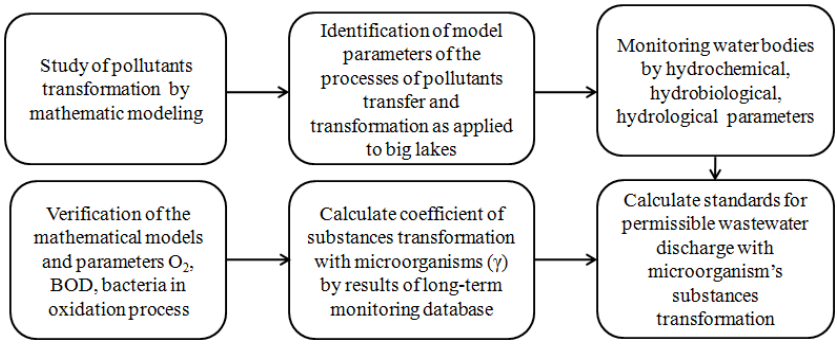

Figure 1. Scheme for regulations of wastewater discharge by pulp and paper enterprises taking into account mathematical modeling of biochemical processes

Figure 1 shows the regulation scheme of wastewater discharges, taking into account the self-cleaning ability of a water body and a three-component model of biochemical oxidation by microorganisms.

The scheme for normalizing wastewater discharges, with respect to the self-cleaning ability of a water body, includes modeling results obtained by calculating a three-component model of biochemical oxidation of the substance under study, which are taken into account when calculating environmental and technological standards and environmental costs for specific parameters can be optimized [4].

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TOOLS FOR SUSTAINABLE DEVELOPMENT

Abstract. The article presents a classification of instruments for sustainable development. Particular attention is paid to the Principles of Responsible Finance and the implementation of this instrument in Russian practice.

Key words: sustainable development, Principles for Responsible Investment, ESG factors, ESG rating, ESG ranking.

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ИНСТРУМЕНТЫ УСТОЙЧИВОГО РАЗВИТИЯ

Аннотация: В статье представлена классификация инструментов устойчивого развития. Особое внимание уделено принципам ответственного финансирования и внедрению данного инструмента в российскую практику.

Ключевые слова: устойчивое развитие, принципы ответственного инвестирования, ESG факторы, ESG-рейтинг, ESG-рэнкинг.

The dramatic events taking place in the world do not negate the need for sustainable development. Sustainable development refers to an increase in the standard of living as long as the natural environment is not degraded. All the instruments that motivate action can be divided into three broad groups.

1. Regulators and standards. The application of the instruments in this group implies that the subject is told how he or she should act. If the actor does not act as prescribed, he/she will be punished. The group of instruments includes legislative acts, norms and regulations, limits and standards. The Russian Federation has environmental legislation and a system of environmental regulation.
2. Economic instruments. In this case, the subject itself chooses the way and direction of action, but if these actions are desirable, the actor will receive an

economic benefit. This group of instruments includes taxes, impact fees, credit terms, etc.

3. Upbringing. In this case, a person's upbringing lays down certain desirable behaviours and, when the time comes to make decisions, they behave in a certain way regardless of influences and benefits.

In real life, there are no pure forms. Standards have economic support, economic instruments have legislative frameworks, and on top of all this there is some civic education. An example of complex instruments are national programmes and projects, which combine ideology, legislative framing and an economic component.

The shape of the future economic development model is formed by the nature of investments being made today. The transition to sustainable development requires the diffusion of socially responsible investment.

The Principles for Sustainable Investment were developed at the initiative of UN Secretary-General Kofi Annan by Investors for Investors and were launched in 2006 on the New York Stock Exchange. They were signed by 63 financial institutions in 2006 and reached 3,000 in 2000 [1].

Responsible investing involves taking into account the risks associated with sustainability factors, namely environmental, social and corporate governance factors, when selecting and managing investment targets.

Six principles of responsible investing are formulated:

1. Include environmental, social and governance considerations in investment analysis and decision-making processes;

2. Integrate environmental, social and governance considerations into policy and practice;

3. Require recipients of investments to make adequate disclosure on environmental, social and governance issues;

4. Promote the adoption and implementation of the Principles within the investment sector;

5. Improve the implementation of the Principles;

6. Report on activities and progress made in terms of implementation [2].

Shortly after the Principles for Responsible Investment were introduced, numerous agencies emerged in developed countries to assess investors' commitment to these principles, and these assessments were taken into account by financial institutions when selecting investment projects, negotiating loan terms, and assessing the likelihood of government support and shareholder support when issuing social bonds, including green bonds.

In 2020, there were more than 100 such agencies. From 2006 to 2020, assets under management of companies that have adopted the PRI have grown from $6 trillion to $103 trillion. The PRI's assets have grown from $6 trillion to $103 trillion and 50 % of these assets must be placed in instruments compliant with the principles.

In 2019, 985 institutional investors from 37 countries removed $6.24 trillion worth of assets from their portfolios due to non-compliance with responsible investing principles. As of 2020, 130 banks from 49 countries support the Principles

for Responsible Investment, and the Responsible Investment Association has 3,000 international investors with $100 trillion in assets under management [1].

In June 2020, the Bank of Russia Bulletin published Recommendations on the Implementation of the Principles for Responsible Investment. The Recommendations are intended to provide guidance to Russian institutional investors in their investment processes, while recommending that compliance with the Recommendations be publicly announced and that measures be taken to promote sustainable investing. The Recommendations define the term "Sustainability factors – factors considered when making responsible investments: environment (environmental factors, including climate risks), society (social factors) and corporate governance (corporate governance factors)". International practice uses the term ESG factors (Environmental, Social and Governance Factors) [3].

Environmental factors take into account data on greenhouse gas emissions, energy consumption, water consumption, waste generation and other environmental impacts. Social factors include employee working conditions, wages, occupational health and safety and injury rates, employee training costs, human capital formation approach, contribution to regional development, charity and other social factors relevant to society. Corporate governance factors include capital structure, management system efficiency, implementation practices, internal control and risk management tools, and social and environmental responsibility disclosure practices.

During 2021, the Russian Federation was implementing the Principles for Responsible Investment. Expert RA surveyed more than 100 banks, which account for 60 % of the banking sector. The respondents were asked whether they had implemented a sustainable investment strategy KPI for investments in sustainable instruments or loans. According to the survey results, only 15 % of respondent banks will have sustainability strategies in place by the end of 2021, while 62 % of those surveyed plan to implement these practices in 2022 and beyond. At the same time, the share of the top 20 banks with approved KPIs for sustainable investments was expected to reach 40 % by the end of 2021, which should create additional demand for green and social bonds in the financial market [4].

Meanwhile, major Russian exporting companies have been ESG-ranked since 2018 for access to financial resources in foreign countries and for the purpose of increasing company capitalization. Since 2021, RAEX-Europe's ESG ranking has been compiled on a monthly basis. The latest RAEX-Europe ESG ranking is as of 14 April 2022. The ranking includes 160 companies; the top ten includes companies in energy production, metals, telecommunications and oil extraction. The list includes 6 companies operating in the pulp and paper industry. Positions of pulp and paper companies were distributed as follows: Segezha – 33, Arkhangelsk PPM – 91, ILIM Group – 92, Solikamskbumprom – 104, Mondi SLPK – 100, Karelia Pulp – 155 [5].

Recent unfavorable events for the Russian and global economies will slow down, but not eliminate, the transition to responsible investment and the development of a sustainable financing market.

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SOME FEATURES OF INTER-INDUSTRY PRODUCTION COMPLEXES FUNCTIONING

Abstract: The article describes the key features of functioning and advantages of inter-industry production complexes, vertically integrated production structures.

Keywords: mesoeconomics, inter-industry production complexes, vertically integrated structures, mergers and acquisitions.

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НЕКОТОРЫЕ ОСОБЕННОСТИ ФУНКЦИОНИРОВАНИЯ МЕЖОТРАСЛЕВЫХ ПРОИЗВОДСТВЕННЫХ КОМПЛЕКСОВ

Аннотация: В статье описаны ключевые особенности функционирования и преимущества межотраслевых производственных комплексов, вертикально интегрированных производственных структур.

Ключевые слова: мезоэкономика, межотраслевые производственные комплексы, вертикально интегрированные структуры, слияния и поглощения.

In the context of globalisation and informatisation of economy inter-industry production complexes have become one of the main subjects of economic relations. The importance of their role is increasing in the current difficult situation, when economic and inter-business relations are breaking down. Therefore, it is necessary to build stainable meso-economic structures within the Russian Federation.

In a broad sense, inter-branch production complexes are defined as technologically connected vertically organized production chains. [1, p. 688]. The integrated activity of enterprises ensures optimal use of resources and increases the added value. In this case, each vertical chain link is more closely connected with its "native" links than with other producers of similar products. This creates a new type of partnership, which is able to combine the advantages of the market economy and

the planned economy in a successful way. This is particularly important for Russia, which has a long history of mesoeconomic planning.

Horizontal links are also established between the vertical links inside the inter-industry production complex. Moreover, they are mostly carried through long-term internal contracts, but not through the free market mechanism. In this case, each of the inter-industrial production complex participants enters the market not as an independent economic agent, but as one of the unity (similar participants). The additional advantage of this approach is further benefit from joint use of resources.

There is an opinion [2, p. 25-40] that inter-industry production complexes are a modern alternative to the middle management level in administrative-command economy. For example, the head-offices of branch ministries, nationwide, republican and other industry associations represented it in the USSR. It is considered, that their abolition in the 1990s was one of the reasons for the catastrophic production decline.

There are three modern types of inter-industry production complexes:

- diversified conglomerates, with significant state participation;
- networks of horizontally integrated small and medium-sized companies, which are integrated into national and world markets;
- specialized economic associations headed by large corporations.

Inter-industry production complexes of the first and third types are the most common in the Russian Federation at present.

The inter-industry production complexes formation occurs through mergers and acquisitions. A merger is the new enterprise creation by consolidating all the assets and liabilities of two or more companies. After the merger companies no longer operate as separate entities. The owners of the united company participate in the capital of the new enterprise in the proportions, corresponding to the value of their companies before the merger. A takeover is the establishment of control over other enterprises by buying up their shares, assets and debts. A takeover assumes changes in the company's management and governance structure [1, p. 734].

Regular research on the effectiveness of mergers and acquisitions has been carried out since the early 2000s in different sectors of the economy [3, 4, 5]. Studies show that the effectiveness of integration depends on its comprehensiveness. According to statistics, only about 20 % of simple mergers and acquisitions achieve their goals. After integration, enterprises often operate less efficiently and lag behind their competitors. More than 60 % of mergers and acquisitions fail to recoup their investment.

At the same time, mergers and acquisitions within cross-industry production complexes are much more effective. Vertical integration within a single production chain increases the sustainability of all integrated businesses and reduces risks. Horizontal integration decreases the real level of competition by allowing companies to spread out into different markets, product modifications or customer types.

We consider the timber industry as an example of the particular value in creating vertically integrated inter-sectoral production complexes. Here are the main positive results highlighted by experts:

- a single control center allows to optimize the entire production cycle from start to finish;

- access to R&D and technology ensures that consumers' needs are more fully met;
- the single logistics center operation helps to reduce expenses and manage the cost of production;
- vertical integration helps to eliminate bottlenecks in the processing chain (this is particularly relevant for forestry companies interested in developing logging in areas with large reserves of timber in the form of overmatured forests);
- orientation to a unified quality management system provides greater competitiveness.

The main disadvantage of inter-industry production complexes functioning is their low adaptability. Nowadays enterprises need to be very flexible in order to adapt to the changing environment, when specialization across customer groups is increasing, opportunities for processes informatisation become more widespread, competition is on the rise due to the growing diversity range of goods and services.

This is why inter-industry production complexes have been actively restructured since the beginning of the 21st century. So-called "digital platforms" are emerging as part of their structure. The use of these platforms helps to find the most profitable suppliers and customers, as well as to reduce all kinds of costs.

Setting up digital platforms is a complicated multi-stage process that requires significant investment [6, pp. 294-302]:

Stage 1: Organization of digital document flow.

Stage 2: Organization of buying and selling goods and services through the Internet.

Stage 3: Digital management of the entire process chain.

Digital platforms enable digital management of cross-industry production complexes. This leads to the following results:

- increasing the number and diversity of business units in the integrated framework;
- reducing the scale of certain business units of the integrated structure;
- increasing the competitiveness of the final products of the integrated structure.

For example, timber companies are developing networks of subsidiaries in different parts of the country. As the result, the price of their goods is close to the price, which is equally acceptable to both the producer and the buyer.

The gradual building of cross-industry production complexes is a systemic solution that will increase production and import substitution in the face of sanctions. The tightening of sanctions is an additional motivation to build complex vertical and horizontal production chains. A few years ago, it was possible to buy specific components or raw materials for the production process on the free market. In the current conditions, only a closed production cycle can guarantee the smooth running of all production cycle stages. For complex industries involving different sectors, this closed cycle can only be achieved through inter-industry production complexes.

The formation of such complexes takes considerable time. However, every integration effort will already have a positive effect. The first steps towards the creation of new inter-industry production complexes could be:

1. Value chain analysis. Finding bottlenecks – sanctioned materials and components, which have no direct equivalents. An analysis of the importance of such resources and their share in the final product.
2. Search for enterprises that have the potential to produce the required resources, possibly through e-platforms. Inclusion of such enterprises in the complex structure to increase their sustainability.
3. Development of investment programmes for the creation new enterprises – producers of scarce resources. This is required in cases when the necessary enterprises simply do not exist in Russia. It is important, that these new enterprises are initially created as elements of the complex structure.
4. Gradual increase of the competitive strength of the product and the sustainability of the whole inter-industry production complex by adding new horizontal chains to the structure.

Inter-industry production complexes transform supply and demand mechanisms, consumers and producers behavior. Complexes also transform ways of profit maximizing in every specific type of market structure. Integrated enterprises achieve better results together rather than each of them does separately, namely, increased profits, reduced costs and risks, new opportunities to enter prospective markets, the ability to maneuver all kinds of resources and target accumulated funds [6, p.244-245]. That are the most important competitive advantage of inter-industry production complexes. In the context of sanctions, the formation of inter-industry production complexes can be an effective solution to support the growth of the Russian economy.

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SIGNIFICANCE OF THE NORTHERN LATITUDINAL RAILWAY ROUTE

Abstract. Construction of the Transpolar Mainline is an ambitious project of our time, since it will be built on permafrost. The Northern Latitudinal Railway can be viewed as the western part of the future railroad to Eastern Siberia. The article provides information about the history of construction and the current status of the project.

Keywords: Northern Latitudinal Route, NSR, mainline, Northern Sea Route.

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ЗНАЧЕНИЕ СЕВЕРНОГО ШИРОТНОГО ЖЕЛЕЗНОДОРОЖНОГО ХОДА

Аннотация. Строительство Трансполярной магистрали является амбиционным проектом современности, т. к. будет строиться на вечной мерзлоте. Северный широтный ход можно рассматривать как западную часть будущей железнодорожной магистрали в Восточную Сибирь. В статье приведены сведения об истории строительства и о современном состоянии проекта.

Ключевые слова: Северный широтный ход, СШХ, магистраль, Северный морской путь.

The idea of building a railroad from the Barents Sea to the Tatar Strait, bypassing the Pechora and Ob River basins, emerged in the early twentieth century. The goal of the project was to develop the northern and territories of Siberia lying northeast of the Ural Mountains. By this time deposits of gold were known in the Shchugor River basin and on Podkamennaya Tunguska, a deposit of graphite on Nizhnaya Tunguska, and oil was found in Ukhta. It was becoming clear that Lomonosov's prediction that the wealth of Russia would come from Siberia had a tangible foundation. The railroad project began to be called "The Great Northern Railway". The logic behind the development of Siberian lands was to build roads to the north of the Trans-Siberian Railway after the organization of through traffic in 1904. In the 20s and 30s the implementation of the project was on the agenda, but in those years the country was faced with another primary task – industrialization. Without solving this problem, it was impossible to provide such a grandiose project with everything necessary for construction, primarily rails, locomotives and rolling stock. In addition, the technical difficulties of building on permafrost and the related costliness of the project prevented the project from proceeding.

The project was revived in 1947. This was due to the need for protection against possible raids by bombers with nuclear weapons on board from the former allies, the United States. At that time the U.S. already possessed nuclear weapons, and the shortest way for aircraft to reach our country was through the North Pole. Since 1946 American pilots from the airfield at Cape Barrow conducted training flights to the Pole and back, practicing the methods of navigation, the suitability of equipment and gear, and studying the condition of the pilots. In addition, they began to develop large ice floes as intermediate airfields and build polar stations. It turns out that in those years the Americans were the first to build ice airfields [1].

The north of our country was not covered, there were no fixed or temporary airfields capable of receiving fighter aircraft. In order to protect against raids and retaliatory strikes it was supposed to build air bases on drifting ice. A railroad was urgently needed to supply these bases and place anti-aircraft guns on railroad platforms.

By 1953 the Chum-Salekhard-Nadym-Pur road section was built (Fig. 1). Time forced to build quickly, so the bridges were mostly wooden, the embankments on permafrost required constant care and strengthening. Ferry crossings were arranged instead of bridges over major rivers, there was not enough money for more, and the road was needed urgently [2].

Figure 1. Chum – Salekhard – Nadym – Pur railroad scheme

In the same year, construction was discontinued with the death of Stalin. The road was abandoned and fell into complete disrepair over 60 years. However, the discovery and development of new oil and natural gas fields in Western Siberia prompted a return to the idea of building a trans-Eurasian high-latitude highway potentially connecting Europe to the United States and Japan (Fig. 2).

Figure 2. Scheme of the trans-Eurasian high-latitude highway

In addition to economic reasons – the development and maintenance of mineral deposits – political and defense tasks arose again. First of all, it is to ensure the security of the country from the northern direction and the safety of the Northern Sea Route exploitation, which has been claimed by NATO countries for free use. At present Russia has built a number of modern military bases in Arctic zone, which are operated all the year round, have a high degree of autonomy and solve the problems of air defense and safety of navigation along the Northern Sea Route (Fig. 3). A transpolar railroad line will make it easier to supply these bases.

Figure 3. Military bases of the Russian Ministry of Defense in the Arctic

Construction of the Arkhangelsk – Syktyvkar – Perm (Solikamsk) (“Belkomur”) and from the Barents Sea to the Urals (“Barentskomur”) lines will provide the cargo base of the Northern Sea Route. The role of the ports of Murmansk

and Arkhangelsk will increase. In [3] it is noted that: “The role of Arkhangelsk will noticeably increase after the construction and commissioning of the BELKOMUR railway. This infrastructure project will not only increase the load on the terminals of Arkhangelsk sea port, but also become the port an important anchor point on the route of the International transport corridor from China to the USA (China – Kazakhstan – Russia / the ports of the Arctic coast Arkhangelsk, Murmansk / the ports of the east coast of North America)”.

The Northern Latitudinal Railway (NSR) can be regarded as the western part of the Transpolar Mainline, which is already under construction. It is assumed that the throughput capacity of the NSR will be 23.9 million tons of cargo per year. The main line will shorten the way from the fields in the northern regions of Western Siberia to the ports of the Baltic, Barents and Kara seas, ensure the development of the Arctic regions and create conditions for the construction of new ports on the Northern Sea Route. For example, the port of Indiga, which is located right on the route of the Northern Sea Route in the estuary of the river of the same name, is already under construction. The depths near the coast are 18 meters, which allows receiving ships with deadweight of 100 thousand tons and more. The estuary of the river practically does not freeze up, which enables ships to sail to the East for 4-5 months a year and to the West for 7-8 months. The expected capacity of the port will be 80 million tons of cargo per year [5]. Construction of the port reduces cargo delivery to the final consumer by about 400 km and increases the efficiency of ice-class vessels by about 30 %.

Thus, it is very difficult to overestimate the importance of the Northern Latitudinal Railway for the development of the Arctic regions of Siberia both economically and in the defense sense.

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APPLICATION OF CONTACTLESS BIOMETRIC SYSTEMS AS A MECHANISM TO IMPROVE THE EFFICIENCY OF SERVICE LOGISTICS ON THE EXAMPLE OF PUBLIC TRANSPORT IN THE RUSSIAN FEDERATION

Abstract. This article outlines the relevance of implementing domestic technologies and software products that enhance service logistics of various activities. The advantages of using contactless biometric systems for public transport in the Russian Federation are considered using a specific example.

Keywords: contactless biometric systems, service logistics enhancement mechanisms, import substitution, anti-spoofing algorithm, public transport.

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ПРИМЕНЕНИЕ БЕСКОНТАКТНЫХ БИОМЕТРИЧЕСКИХ СИСТЕМ КАК МЕХАНИЗМ ПОВЫШЕНИЯ ЭФФЕКТИВНОСТИ СЕРВИСНОЙ ЛОГИСТИКИ НА ПРИМЕРЕ ОБЩЕСТВЕННОГО ТРАНСПОРТА В РФ

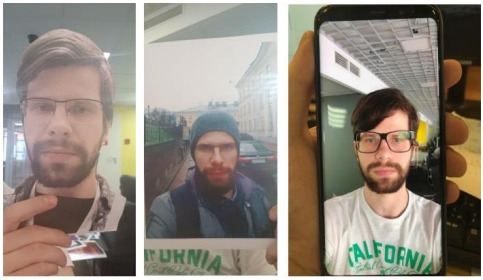
Аннотация. В данной статье обозначена актуальность внедрения отечественных технологий и программных продуктов, повышающих сервисную логистику разных направлений деятельности. На конкретном примере рассмотрены преимущества применения бесконтактных биометрических систем для общественного транспорта в РФ.

Ключевые слова: бесконтактные биометрические системы, механизмы повышения сервисной логистики, импортозамещение, алгоритм антиспуфинга, общественный транспорт.

At present, due to the aggravated geopolitical situation and as a consequence, the increased risks, the need for import substitution in various economic, business and social spheres of the country is growing manifold. Therefore, the development of domestic technologies and software products that enhance, in particular, the service logistics of various areas of activity is becoming increasingly important.

In this regard, the development and widespread adoption of technologies based on biometric approaches is of great relevance. This is due to the fact that, according to user surveys the verification systems used in various security systems involving intentional contact with the device (such as fingerprint verification systems or iris verification systems) are inconvenient.

As an alternative, facial recognition is the most popular method for solving this problem. However, it is vulnerable to various spoofing attacks that use photos or video of a person from the Internet or a camera. In the context of computer vision, a spoofing attack is a situation in which one person (or program) successfully masquerades as another by falsifying their visual data in order to gain illicit advantages. For example, printed photos (Fig. 1b), mock masks (Fig. 1a) and screenshots (Fig. 1c) are used for unauthorised login attempts [1].



a) b) c)

Figure 1. Options for the use of photographs in spoofing attacks

It is encouraging to note that, in recent years, Russian companies that specialise in developing and implementing technologies used to improve the efficiency of various sectors of the economy have begun to emerge.

For example, the company OVISION (Onega LLC), a Skolkovo participant since 2021, has been successfully developing facial recognition technology, and has worked on the entire production cycle, from software development itself to the production of finished devices. And, most importantly, this company uses its own production capacity, which reduces the risks to its sustainable development in an unstable international supply chain. Such developments are actively used in various spheres, in particular in the nuclear and shipbuilding industries, navy organisations and others.

Separately, a wide range of contactless biometric systems enabling the use of big data and computer vision technologies are needed to develop public transport and improve its service logistics.

Within the framework of the topic of the article, let us focus on the example of a specialized product developed by OVISION (Onega LLC) – OPAY, which is the most advanced contactless payment terminal [2].

The main advantages of using a specialized software product include the following:

- working with any card and payment system via the app;
- integration with any cash register;
- all loyalty cards are linked to facial biometrics;
- presence of NFC chip for traditional payment;
- the fastest face recognition (0.2 sec).

Figure 2 shows that data storage security, data recognition accuracy and the ability to fight spoofing attacks have been achieved by the OVISION company at a decent level, which makes this software product competitive and in demand.

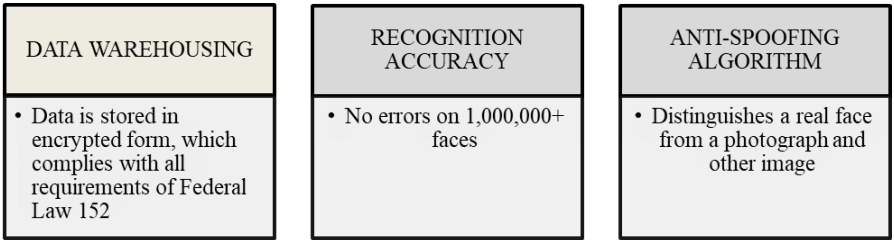


Figure 2. Application security parameters. OPAY biometric system

Let's take a step-by-step look at the algorithm of the OPAY biometric system, which consists of fairly simple but effective features, giving this system a number of advantages over its competitors.

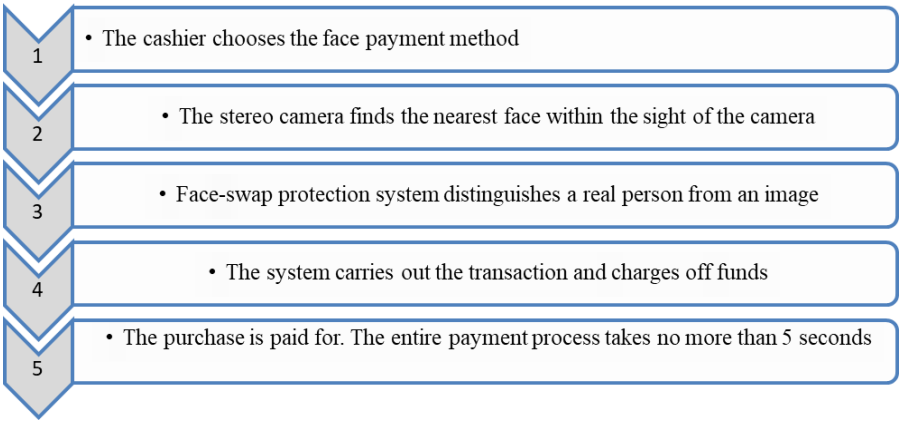


Figure 3. Operating algorithm of OPAY biometric system

Thus, this domestic development is increasingly being used in practice. According to statistics, in 2021 more than 100 companies in different cities and regions of Russia were already using OVISION products, and about 70.000 people per day pass through facial recognition devices developed by the company.

From the point of view of consumers, logistics services should include flexibility, reliability, comprehensiveness and competence. If these requirements are met, consumers demonstrate increased loyalty to the results of the company's business activities, in particular to the services provided. In turn, this has a positive impact on sustainable long-term interaction between loyal customers and the service company, which enhances the competitiveness of the organization in market conditions.

It is important to remember that the realization of the main objectives of a logistics service implies taking into account the specifics of such a commodity as a service (which is intangible, non-preserved and inseparable from its source). And most importantly, the speed of service delivery in logistics services is of crucial importance. The higher the speed of service, the greater the economic effect for service companies. As practice shows, it is the speed of service that is one of the main criteria (along with quality) when consumers choose a particular logistics provider [3].

The introduction of high-quality domestic development of contactless biometric systems in public transport has significantly increased the level of logistics services in this area of activity. This explains the particular demand for such programmes among transport organizations at the present stage. Let us dwell in more detail on the mechanism of application of contactless biometric systems in railway public transport.

The operating scheme in the case of the OPAY biometric system is as follows: the passenger approaches and the system recognizes his / her face and measures his / her temperature; the system confirms the ticket and the passenger's positive temperature; the system sends information to the conductor's handheld personal computer and confirms the passenger's identity; the conductor may also ask the passenger to present his / her passport; the passenger boards the train (this takes less than 5 seconds). The benefits of this system are shown schematically in Table 1.

Table 1 − Benefits of implementing the OPAY biometric system on railway transport

Evaluation parameters	**Advantages for passengers**	**Advantages for railway companies**
Remote measurement at train entrance	Improved level of service, Passenger comfort	Authorisation of conductor performance
Customer loyalty	Obvious benefits for those who – are very late; – forgot their passport; – have their hands full.	Reducing the number of conflicts with passengers during boarding through the introduction of new, comfortable and safe technologies
Security	– Augmented security; – Reducing the number of contacts between conductors and passengers in the face of COVID 19 proliferation constraints.	Ability to see "blacklisted" passengers from the stop list
Speed	Significantly reduced waiting time to board the train	Increased speed capacity when boarding the train (3-7 sec)
Financial aspect	Discounts and promotions for users	7-10% revenue increase

An analysis of the benefits of using contactless biometric systems for both passengers and railway transport companies clearly demonstrates the prerequisites for the sustainable development of service logistics in public transport, which makes it possible to recommend this positive experience for further implementation and spread throughout the Russian Federation.

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GREEN KEY: UNLOCKING SUSTAINABILITY IN THE HOSPITALITY INDUSTRY

Abstract. The Green Key international programme is run by the Foundation for Environmental Education in 60 countries of the world. The paper gives a brief overview of the programme and its value for sustainable tourism and 17SDGs of the United Nations.

Keywords: Green Key, hospitality, sustainable development, Foundation for Environmental Education.

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«ЗЕЛЁНЫЙ КЛЮЧ» – КЛЮЧ К УСТОЙЧИВОМУ РАЗВИТИЮ В СФЕРЕ ГОСТЕПРИИМСТВА

Аннотация. Международная программа «Зелёный ключ» проводится Международной организацией по экологическому образованию в 60 странах мира. В статье дается краткий обзор программы и её значение для устойчивого туризма и 17 ЦУР Организаций Объединенных Наций.

Ключевые слова: Зелёный ключ, гостеприимство, устойчивое развитие, Международная организация по экологическому образованию.

"Green Key" is the international program of voluntary environmental certification in the field of hospitality, which is held in 60 countries of the world by the Foundation for Environmental Education (FEE). FEE runs 5 programs worldwide: two of them are in the field of tourism – "Blue Flag" (since 1994) for beaches and marinas and "Green Key" (since 2002) for the hospitality industry, and three of them are for educational organisations "Eco-schools" (since 1994), "Young Reporters for the Environment" (since 1994) and "Learning about Forest" (since 2000). Since 2012, the coordination centres of all five international programs have been located at the head office of FEE in Copenhagen [1].

All programs are aimed at promoting the ideas of sustainable development through environmental education. Education is understood as "lifelong learning", which includes formal, non-formal and informal education. Formal education leads to, for example, getting a school graduation certificate or diploma. Informal education means courses, seminars, trainings, including those held for the hotel staff, according to the results of which participants get various participation certificates. Informal education is, in fact, an expansion of horizons.

The Green Key programme was created to motivate the management of accommodations to reduce the load on the environment through implementation of sustainable management and educating employees and customers. The program is run by the non-governmental organisations-members of the Foundation for Environmental Education (FEE) or other organisations according to special agreements. The main goals of the program are:

- education for sustainable development and environmental education of owners, employees and customers;
- taking care of the environment – a number of practical measures for reduction of the environmental load of an accommodation and gradual implementation of the principles of sustainable development;

– cost-efficient management aimed at reasonable consumption, and therefore at reducing costs;
– marketing strategy aimed at promotion of eco-labels and certified institutions [2].

To get the Green Key certificate, the accommodation must ensure sustainable energy and water consumption, the use of environmentally friendly means for cleaning rooms, washing dishes and laundry, introduce a system of selective collection of at least three types of waste, ensuring that they are sent for further processing, as well as many other things that require certain efforts and investments. For example, in order to meet the criteria for limiting the water flow, the accommodation usually has to purchase and install special water flow regulators or aerators.

Environmental certification in the frame of the Green Key program is carried out by the audit held by a specially trained expert representing an independent organization (a third party). If the accommodation meets all the imperative criteria of the program, it can get a Green Key certificate. Then the audit is carried out a year later, and after that every 3rd year. During subsequent audits, the accommodation must meet not only imperative, but also an increasing percentage of guideline criteria. After 10 years of participation in the program, the accommodation must meet at least 50 % of the guideline criteria.

As foreign experience shows, the eco-label has a positive effect on the image of the accommodation, increases its competitiveness in the market and is a powerful marketing tool. Due to it, travel agencies and tour operators prefer such accommodations for cooperation, which is beneficial and profitable of the accommodation. It should be noted that most international companies, including those operating in Russia, have a developed policy in the field of corporate social responsibility and sustainable development. The environmental policy of such companies contains the terms for choosing an accommodation to host employees and hold events, i.e. the presence of an eco-label or any other official confirmation of the accommodation's desire to reduce the environmental load and implement the principles of sustainable development.

The Green Key program is recognized by the United Nations Environment Programme (UNEP), the United Nations World Tourism Organization (UNWTO), the Global Sustainable Tourism Council (GSTC) and a number of other international organizations.

The Green Key program is the most popular one worldwide in the hospitality industry because it:
– has no geographical limitations;
– was initiated by a professional community from the hospitality industry;
– was designed only for hospitality establishments;
– is conducted by non-governmental organizations, ensuring objectivity;
– has a well-structured list of clearly defined criteria;
– holds regular audits by specially trained independent experts to verify compliance with the criteria;

– is based on the results of the audit, the expert fills out a standardized report form used in all countries participating in the program;
– is recognized by the Global Council for Sustainable Tourism (GSTC).

After the adoption by the United Nations General Assembly of the program document "17 Sustainable Development Goals until 2030", FEE has done a lot of work to ensure the contribution of each of its five programs to reaching of each of the seventeen Sustainable Development Goals. The texts of the documents are posted on the website of FEE and the websites of all its programs [3].

Choosing the Green Key site for your stay you contribute to the world sustainability!

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THE RAUNER FAMILY IN RUSSIA: IN REMEMBRANCE OR IN OBLIVION?

Abstract. Based on archival materials, rare and inaccessible publications, as well as materials from private collections, little-known pages of the history of forestry, land reclamation, climatology of Russia and the USSR are reflected on the example of the Rauner dynasty, scientists, engineers, military, musicians of Austrian origin, who were on Russian service for almost a century and a half. Representatives of this dynasty, who made a great contribution to a number of scientific and engineering fields, are now undeservedly forgotten.

Keywords: history, Rauner, forestry, land reclamation, soil erosion, landscaping, mountain afforestation

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ДИНАСТИЯ РАУНЕРОВ В РОССИИ: ПАМЯТЬ ИЛИ ЗАБВЕНИЕ

Аннотация. На основе архивных материалов, редких и малодоступных публикаций, а также материалов из частных собраний представлены малоизвестные страницы истории лесного хозяйства, мелиорации, климатологии России и СССР на примере династии Раунеров, учёных, инженеров, военных, музыкантов австрийского происхождения, которые находились почти полтора века на российской службе. Представители этой династии, внёсшие большой вклад в ряд научных и инженерных областей, в настоящее время незаслуженно забыты.

Ключевые слова: история, Раунер, лесное хозяйство, мелиорация, эрозия почв, озеленение, облесение гор.

The name Rauner says little to the current generation, except for narrow specialists and in connection with the 500th anniversary of Lutheranism recently celebrated in Europe. Bankers brothers Rauner provided financial support at the beginning of the development of this Christian movement, for which they later received the title of nobility and the prefix “von” (Fig. 1).

Figure1. Rauner’s coat of arms

The appearance of Rauners in Russia is connected with the reforms of Catherine the Second. At the end of the eighteenth century Joseph Rauner (1760-1805), a bassoonist from Austria successfully performed in the staff of the Imperial Orchestra. One of his sons, Karl Johann Nicholas Rauner (1789-1867), took Russian

allegiance. That is what he wrote on the 12th of February 1818: “living here, in Russia, I have desire to obtain Russian allegiance… I obediently ask to allow me to swear this allegiance… I am 28 years old, of average height, chestnut-hair…” [1].

Tempestuous development of Russian mining and metallurgical industries, including the region of the Urals, required highly qualified specialists of forestry. Exactly in this period there was appearance of Julius Karlovich Rauner (1818-1888), who studied at Saint Petersburg Mining University at the beginning, and then at the forestry college of Lisino. After graduation from the college of Lisino, Julius Rauner was promoted from the state of a junior shift master to a head forester of the mining district of Yekaterinburg. He was awarded with the Order of Saint Anna of the 3rd class and the Order of Saint Stanislaus of the 2nd class, to which an imperial crown was added later [2].

From 1871, Julius Rauner was a church council chairman of the Lutheran Church of Yekaterinburg, also he was the founder of a gymnasium for girls and the house of the Lutheran Church of Saint Peter and Saint Paul of Yekaterinburg (1876) having formed the modern district called Church Side. In the 1950s, the church was destroyed, and a residential house with many levels and shops, so called the House of Artists, was built instead of it [3].

Julius Rauner was married to Caroline (1830-1910), a daughter of a famous mining engineer, Andreas Grigoryevich Jossa (1777-1835). His son Julius Yulyevich Rauner became the first bicyclist of Yekaterinburg. In 1868, he had ordered an iron bicycle weighing about 5 pounds, with 3 wheels, and “having cycled with it a little, he remade it to one with two wheels in the next year and went by it on the streets of Yekaterinburg for a long time.” The two-wheeled bicycle is kept “in the museum of the Shaytanka Plant” nowadays. [4].

The greatest prominence in forestry was achieved by Stanislaus Yulyevich Rauner (1858-1921), a forester, an ameliorator, a theorist and a practitioner of mountain afforestation works performed with an aim of protection from ground erosion and mudflows.

In school, Stanislaus Rauner realized himself as a natural scientist. From 1874 to 1876 he participated in the first archaeological excavation at lake Shitovskoye’s coast, and in its result was discovery of camps of primitive people and other things, which proved primitive people had dwelled in those places [5].

In 1877, Stanislaus Rauner entered the Forestry Institute in Saint Petersburg. According to a request note from privy councilor Alexander Jossa (1810-1894) to Pyotr Valuyev (1817-1890), the Minister of Internal Affairs of the Russian Empire then: “My nephew Stanislaus Rauner, a forester’s son, having graduated from the Technical School of Yekaterinburg now, wishes to enter the Forestry Institute, to be accepted for government maintenance with respect of his father’s service as a forester for 35 years”. [6].

After graduating from the Forestry Institute, S. Rauner was sent to various countries to study the latest achievements in the field of irrigation facilities, the influence of forests on the surface and groundwater, methods of bonding sands in arid regions with the help of green spaces [2].

From the middle of the 1880s to 1917, Stanislaus Rauner performed most of his scientific works, made a plenty of programs directly for geographical, biological and other researches. Stanislaus Rauner was the Proxy of the Head of the Hydrological Committee of the General Administration of Land Use and Agriculture, a member of the Regular Water Control Commission in Saint Petersburg, a member of society "Russian Grain" (from 1908 to 1917), a member of the Regular Ecological Commission of the Imperial Russian Geographical Society [7].

After the Revolution in October 1917, Stanislaus Rauner worked as the Assistant of the Head of the State Planning Committee. In 1920, he was elected as a professor of the Forestry Institute in Petrograd.

Stanislaus Rauner had a grandson, Yuriy Lvovich Rauner (1930-1982), who was a Doctor of Geographical Science. After graduation from Moscow State University in 1953, he was working in the Institute of Geography of the Academy of Sciences of the USSR for 25 years (1957-1982), moreover, he headed the Institute's Climatology Department during 10 years. Yuriy Lvovich Rauner had researched changing of crop rate in general grain-producing areas of the world in connection with fluctuating weather conditions, and then he offered a theoretical model describing stochastic structure of draught phenomena on territories of the USSR, the USA, Canada and Western Europe. General conclusions of these researches have great significance in strategy of raising grain plants in dependence on weather conditions. Under his guidance, reconstruction of climate of the past was done in the department of climatology of the Institute of Geography of the Academy of Sciences of the USSR. He published a large series of articles and monographs determining co-dependence of natural climatic conditions and opportunities of raising of a wide variety of plants [8, 9].

The nephew of S. Yu. Rauner – Ernst Elievich Rauner (1896-1966) – also planned to connect his life with forestry and entered the Imperial Forestry Institute in 1915. However, in the same year he asked for military service due to well-known reasons and served in the hydraulic organization of the department of land improvements for the needs of the Northern Front Army with the right of return entry, but then, since the war was going on, in 1916 he entered the Pavlovsk military school [10].

The further fate of Ernst Rauner can be learned from his 1954 questionnaire, fragmentary data taken from various sources and memoirs of descendants – a participant of the First World War (1915-1917) and the White movement (1918-1920); lieutenant of the Finnish Life Guards Regiment; in the Armed Forces of Yugoslavia and the Russian Army before the evacuation from the Crimea. Ernst Rauner evacuated from Sevastopol by ship "Inkerman". From 1920, he lived in emigration in Austria. In 1929, he graduated from the College of Technology of Vienna. From 1929 to 1932, he was working in the field of water supply in French Guiana. In 1933 he returned to Europe and was working in Austria until 1945. In Vienna, gestapo captured Ernst Elyevich Rauner and his brother Vladimir for they listened to a Soviet radio channel. However, they evaded from any punishment some way. Ernst Elyevich Rauner together with his family hardly reached Finland, and he did it because of possible Soviet occupation, which was a threat to him. From 1950,

he lived in the USA and worked in the field of housing and road construction, particularly in the firm "Worthington" in New Jersey [11, 12].

Moloch of time destroyed almost all representatives of the Rauner dynasty in the USSR as a result of repressions and wars. It was difficult to survive with such a surname. Those who managed to emigrate remained. They were not lost and found a worthy place for themselves in their new homeland. In the early 90s of the last century, representatives of the German embassy tried to find representatives of famous German surnames in the Russian Federation, but to no avail. People prefer to keep silent about the origin of their ancestors. Rauners and their merits are simply forgotten.

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