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The policy advocated by Heydar Aliyev for the improvement of the quality of education

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Abstract: Heydar Aliyev, one of the prominent leaders in the field of education, implemented a rapid and independent policy to develop and enhance the quality of Azerbaijan's education system. His policy aimed at improving education quality stands out for encompassing the fundamental stages of transformation in the education sector and paying special attention to the growth and development of students.

The foundation of Heydar Aliyev's policy on enhancing education quality lies in creating broader opportunities for students to receive education and diversifying the educational offerings. Recognizing the significant role of modern education in the country's development, he sought to provide greater opportunities for students to realize their interests and potential.

In addition to emphasizing the importance of experienced and professional educators, Heydar Aliyev incorporated innovations and changes in the education sector to elevate the standards of modern education and enhance the training and preparation level of teachers.

The main goal of Heydar Aliyev's policy on improving education quality is to not only revolutionize Azerbaijan's education system with significant changes and innovations but also to provide better educational opportunities for students. As a result of this policy, the country has succeeded in establishing an education system that produces well-trained, interested, and potential-rich students in line with international education standards.

Keywords: Educational Excellence, Importance of Quality Education, Role of Science, Student's Role, Scientific Research, Modern Technologies, Student Organizations, Language Skills

•Heydar Aliyev is renowned for his policy on enhancing the quality of education in Azerbaijan. Under his leadership, the education system underwent significant changes and merged with new perspectives. Below are examples of Heydar Aliyev's policy on improving education quality:

•Education Investments: Heydar Aliyev allocated significant funds to the education sector, contributing to the development of educational infrastructure and creating better conditions for students.

•International Experience for Students: He organized various international exchange programs for students, allowing them to gain international experience.

•Support for Scientific Research: Heydar Aliyev promoted the support of scientific research activities and the enhancement of scientific potential, contributing to the elevation of the country's scientific and innovation potential.

•Job Placement for Students: He paid special attention to providing job opportunities relevant to the fields in which students received education, thereby assisting in increasing job prospects.

•Improvement of Educational Programs: Heydar Aliyev ensured the improvement of modern educational programs and a broader focus on current topics, enabling students to acquire practical and relevant skills.

•Heydar Aliyev's policy on improving education quality has ensured the country's development in the education sector and provided the new generation with conditions for better education.

1.Introduction

In the field of education, improving quality and enabling students to achieve higher levels of independent activities has been one of the most important priorities of Azerbaijan's education policy during the Heydar Aliyev era. The measures and policies implemented by Heydar Aliyev during this period have succeeded in ensuring the high quality of education content, the development of scientific research, and students' attainment of education in accordance with international standards.

Heydar Aliyev's strategy in the field of education was formulated around several key principles. The first principle aimed to ensure students' right to choose from a wide range of specialties and fields. This allowed students to choose education programs that reflected their interests and skills, helping them develop in their unique circumstances.

The second principle focused on creating necessary conditions for the promotion and development of scientific research. During the Heydar Aliyev era, great attention was given to establishing and supporting independent laboratories, research centers,

and technical facilities for universities and educational institutions. This contributed to the development of scientific research in the country, further enhancing the quality of education.

The third principle aimed at ensuring education in accordance with international standards. To achieve this goal, Heydar Aliyev's era saw the organization of international student exchange programs, international education, and scientific conferences.

Through these initiatives, students had the opportunity to test their education programs in an international environment and gain international experience. (Fig 1) The importance of these investments can be highlighted in several ways:

1.Education Investments: Heydar Aliyev's investments in the field of education are a clear example of the importance he placed on the development of the education system and providing better learning conditions for students. [2] The main objectives of these investments are to expand the country's education infrastructure, improve quality, and create an environment that allows students to receive better education.

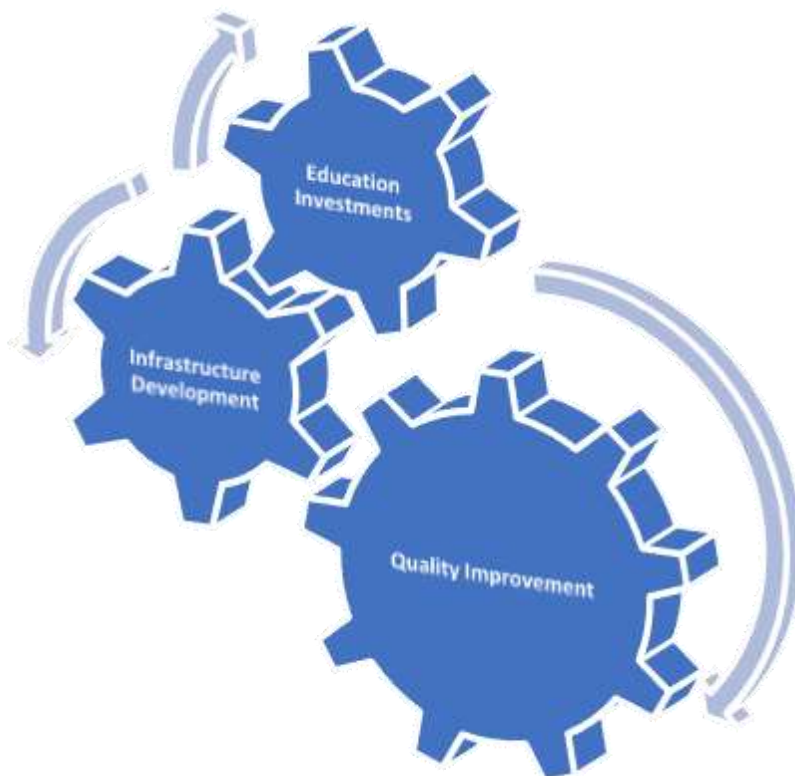


Figure 1. Opportunities for students to try and gain international experience in an international environment in their study programs

Infrastructure Development: Heydar Aliyev directed a significant portion of the funds allocated to the education sector towards the development of educational institutions' infrastructure. This includes steps such as the construction of new educational complexes, equipping laboratories and libraries, and renovating and expanding educational buildings. These efforts contribute to creating a more suitable and modern educational environment for students and educators.

Quality Improvement: Heydar Aliyev paid attention to supporting educational institutions with the goal of improving the quality of education. These supports contributed to the organization of more effective education programs for students, the development of teachers, and the adaptation of education to modern technologies, enhancing overall educational quality.[4]

Better Conditions for Students: Heydar Aliyev focused on providing better conditions for students' learning and development. Investments in the

education sector facilitated easier access for students to instructional materials and technologies needed for education, making their learning process more effective and engaging.

Heydar Aliyev's investments in the education sector demonstrate a strong commitment and belief in improving the quality of education in the country. As a result of these investments, Azerbaijan's education system has achieved greater development and created a more conducive learning environment.

International Experience for Students: Heydar Aliyev's international exchange programs for students aimed to increase opportunities for students to gain broader experience in their fields of study and on a global scale. These programs help students establish international connections in their fields, become familiar with different cultures and education systems, and test their skills on a global scale.[1]

Below is information in tabular format about international exchange programs that allow students to gain international experience:

Table 1. Heydar Aliyev's international exchange programs have provided students with opportunities to receive education in partner countries, gaining new perspectives and experiences.

International Exchange Program	Purpose and Partner Country	Student Benefits
"Erasmus+" Program	Organizations in the European Union	Students gain education experience in European countries.
Fulbright Program	United States	Students gain education experience in the U.S. within their fields.
Mevlana Exchange Program	Turkey	Students gain education experience in Turkey.
DAAD Scholarships	Germany	Students gain education experience in Germany.

Heydar Aliyev's international exchange programs have provided students with opportunities to receive education in partner countries, gaining new perspectives and experiences.(table1)

Support for Scientific Research: Heydar Aliyev's promotion and support of scientific research significantly impacted the development of the country's scientific potential and increased innovation capabilities. His steps in supporting scientific research ensured the development of the scientific field and enabled Azerbaijan to play a more sophisticated and interesting role in the international scientific arena.

One of the key principles of Heydar Aliyev's promotion in this field was ensuring financial support for scientific research. [1,4] By allocating more resources to researchers and scientists, he helped

them maximize their potential. Thanks to this support, researchers have successfully implemented larger and more complex scientific projects, enhancing the country's competitiveness in the field of scientific research.

Heydar Aliyev also encouraged international collaboration in the field of scientific research. This allowed researchers to exchange their knowledge with researchers from other countries, gaining a broader perspective. International scientific conferences, events, and research exchange programs have been key areas where Heydar Aliyev showcased his commitment.(table 2)

Below are Heydar Aliyev's steps in supporting scientific research and enhancing scientific potential in tabular format:

Table 2. International scientific conferences, events and scientific exchange programs, main areas in which Heydar Aliyev demonstrated his commitment

Step	Objective	Results
<i>Empowered Scientific Research Projects</i>	<i>Organization and support of research projects in the scientific field</i>	<i>Development of the country's scientific potential in various fields and completion of researchers' projects.</i>
<i>Scientific Conferences and Seminars</i>	<i>Organization of conferences and seminars in the field of science</i>	<i>Ensuring scientific exchange and sharing of new ideas.</i>
<i>Increase in Investments</i>	<i>Financial support for scientific research</i>	<i>Improvement of scientific and technical innovations and research of new technologies.</i>
<i>Organization of Scientific Culture Centers</i>	<i>Providing venues for events in the field of scientific research</i>	<i>Gathering of researchers and ensuring exchange of experiences.</i>
The steps taken by Heydar Aliyev have allowed the country to enhance its scientific and technical potential and foster development in the field of innovation. As a result of these steps, Azerbaijan has progressed further in the scientific field, realizing its potential to a greater extent.		

<i>Establishment of Independent Career Centers for Students</i>	<i>Providing support in the job search process for students</i>	<i>Facilitating independent career development for students and gaining experience in job search.</i>
<i>Organization of Internship Programs for Students</i>	<i>Providing internship opportunities in the field of study for students</i>	<i>Offering practical experience opportunities for students and creating opportunities to better understand the job market.</i>
<i>Collaboration with Workplaces and Organizations</i>	<i>Establishing relationships with workplaces and organizations</i>	<i>Providing students with experience and job opportunities.</i>
<i>Organization of Exhibitions and Career Days</i>	<i>Organization of exhibitions and career day events</i>	<i>Providing students with a better understanding of job opportunities and expanding connections with partner companies.</i>
Heydar Aliyev's steps in this direction aim to facilitate students' access to job opportunities related to their fields of study. These steps aim to help students obtain more job opportunities in their fields and support their career development.		

Heydar Aliyev, paying special attention to job assurance for students, has taken a series of steps to increase job opportunities related to the fields of study for students:

Sector Analyses and Labor Demand Research: Heydar Aliyev has organized sector analyses and labor demand research to consider job demand in the fields of study. Based on these analyses, creating more job opportunities for students and ensuring the

selection of an appropriate career path in their fields of study is relevant.

Industry Partnership and Internship Opportunities: Support has been provided to students by establishing relationships with various industry partners to offer internship opportunities in line with their fields of study. These partnerships allow students to gain practical experience and integrate into the job market.

Career Advice and Guidance from Experienced Professionals: Heydar Aliyev has organized events to provide career advice and guidance from experienced professionals to students. These events help students better evaluate their own experiences and skills and become more independent in their job search.

Start-Up Organizations and Innovation Centers: Heydar Aliyev has paid attention to encouraging creativity in the business sector by establishing start-up organizations and innovation centers. These centers assist students in developing entrepreneurial skills to implement their own projects and create new job opportunities. Heydar Aliyev's steps in ensuring job opportunities for students have facilitated easier access to relevant job opportunities and supported their career development.

Improvement of Educational Programs: Heydar Aliyev's initiatives to improve educational programs and focus on broader topics can be illustrated with the following examples:

Creation of Modern Educational Programs: Heydar Aliyev has supported the necessity for educational institutions to offer contemporary and modern programs. These programs provide students with the knowledge needed in technology, innovation, and the business world.

Alignment with International Standards: Heydar Aliyev has emphasized the alignment of educational programs with international standards. This ensures

that students receive education conforming to global standards and enhances competitiveness on the international stage.

Focus on Current Topics: Heydar Aliyev has directed educational programs to pay more attention to current social and sector-specific topics. This alignment helps students better match their education with practical applications in their fields and real-life demands.

Scientific and Technical Collaboration and Research Projects: Heydar Aliyev has directed educational programs towards enhancing scientific and technical collaboration and organizing research projects. This encourages students to gain practical experience and fosters the development of scientific and technical innovations.

Careful Selection of Educational Plans: Heydar Aliyev has affirmed the importance of the careful selection of educational plans based on students' interests, skills, and career goals. This ensures that students can better realize their potential in the field of study. Heydar Aliyev's steps in improving educational programs and focusing on current topics have been organized to help students gain more interesting and independent educational experiences and better realize their potential.

Please note that the translations are provided as is, and there might be nuances in the original text that may not be fully captured in the translation.[1]

3. Conclusion

Heydar Aliyev is among the leaders who made significant changes to the education system during Azerbaijan's period of independence. His policy towards education played a crucial role in the brightness of the country's star.

1.Strategic Orientation: Heydar Aliyev acknowledged the importance of education as a vital part of national development and aimed to modernize the education system according to international standards. In his policy, education was directed towards social and economic development.

2.Support for Universities: During the Aliyev era, the autonomy of universities was increased, and special attention was given to scientific research and international relations.

3.Standardization of Education: Heydar Aliyev understood the significant role standards play in

improving the quality of education. To achieve this, the curriculum was reviewed, and education programs were aligned with modern requirements.

4.International Collaboration: Aliyev recognized the importance of integrating into international education standards. For this purpose, connections were established with many international education organizations.

5.Role of Teachers: Heydar Aliyev acknowledged the vital role of teachers in the education system and paid special attention to their education and training.

In conclusion, Heydar Aliyev's policy to enhance the quality of education played a fundamental role in modernizing Azerbaijan's education system. This policy represents a significant step in gaining recognition at the international level and achieving success in the field of education.

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Tubular treatment of Okchuchay water

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Abstract: According to the monitoring carried out by the Ministry of Ecology and Natural Resources of Azerbaijan on the Okchu river in the past years, the amount of heavy metals such as molybdenum, copper, iron, manganese, zinc, chromium was found to be very high in the river during the months of January-June 2021. Okchuchay plays the role of a collector that transports waste from the mining industry away from the territory of Armenia. The water of the river is so polluted and poisoned that no living thing can live here. In the rivers flowing through the territory of Zangilan district freed from occupation, during the monitoring of water samples taken by our ecologists in January-June, it was found that the amount of copper-molybdenum compound in Okchuchay was 2 times, iron 4 times and nickel 7 times higher than normal, and the color of the river often changed due to pollution.

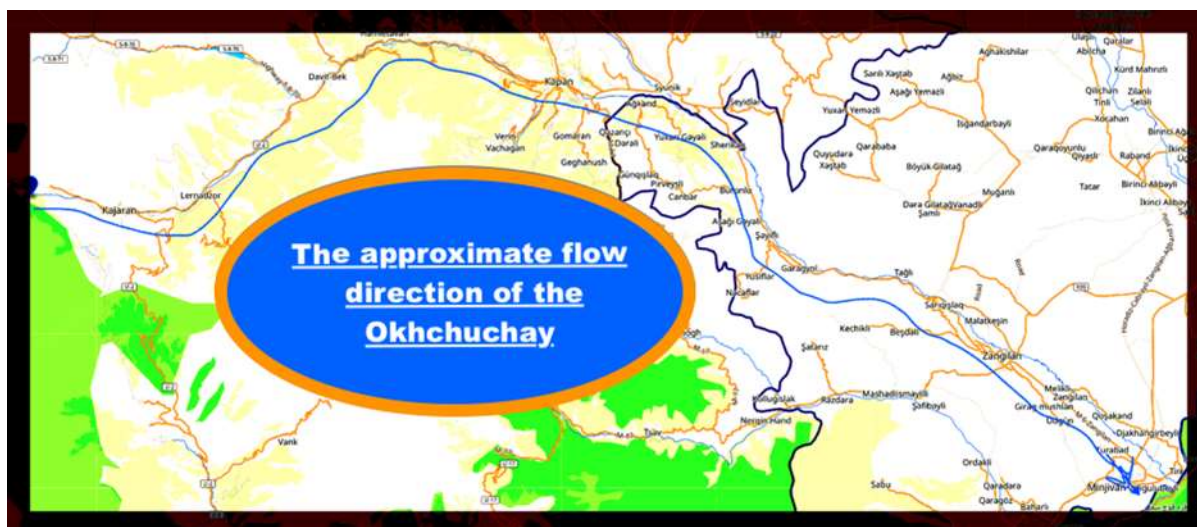
One of the appropriate methods to prevent environmental damage caused by the Okchu River in the basin of the Republic of Azerbaijan is to keep the surface water of the river to a level that does not harm the ecological biota, to allow the other part to flow through a pipe to the central collection and treatment point, and then to irrigate and re-flow in the form of a reservoir. It is to create conditions for it to reach the Araz River and from there to the Kura River.

Keywords: The treatment of the river water, Pollutant metals of the watershed, Elimination of leakage losses, Improvement of water quality, Construction of reservoirs.

1.Introduction

The length of the river is 85. The basin area is 1140 km². It starts from Kapicic mountain (3285 m) located in Zangezur. Its flow mainly consists of 46% snow, 10% rain and 44% groundwater, water consumption is 8.90-10 m³/sec, average annual volume is 315 million m³. 40% of the annual flow is for spring months. 43% in summer, 10% in autumn. 7% is formed in the winter season.

According to the monitoring carried out by the Ministry of Ecology and Natural Resources of Azerbaijan on the Okchu river in the past years, the amount of heavy metals such as molybdenum, copper, iron, manganese, zinc, chromium was found to be very high in the river during the months of January-June 2021.



The reason for this pollution is the fact that Armenia's Zangezur copper-molybdenum plant is located on the riverside and discharges copper-molybdenum production waste directly into the river without preliminary cleaning, the level of pollution is many times higher than

the norm, it makes water resources unfit for use in the country and does not comply with ecological standards. It is even noted that a large part of the joint stock belongs to the German company "Cronimet". In addition to not ending with this. The fact that further heavy metals

are dumped into the river by the Gafan ore processing plant not only destroys the fauna and

ecosystem of the river but also poses a threat to human health.



The use of contaminated water leads to human health disorders of the gastrointestinal tract, destructive

processes in the kidneys and bone tissue, and cardiovascular and nervous system disorders.

2. Experimental details

Okchuchay plays the role of a collector that transports waste from the mining industry away from the territory of Armenia. The water of the river is so polluted and poisoned that no living thing can live here. Taking into account that Okchuchay flows into the second largest river of the South Caucasus - Araz River, the pollution of

Okchuchay affects the quality of its water resources. The Araz River is also the largest tributary of the Kura River. It is the main source used in the irrigation of agricultural fields in Azerbaijan. However, a more serious change in the quality of water in the river recently has led to negative effects of its use in households and agriculture.



In the rivers flowing through the territory of Zangilan district freed from occupation, during the monitoring of water samples taken by our ecologists in January-June, it was found that the amount of copper-molybdenum compound in Okchuchay was 2 times, iron 4 times and nickel 7 times higher than normal, and the color of the river often changed due to pollution.

In March 2021, a massive fish death (Small Trout) was recorded in the river. During the investigations conducted in the Shayifli and Jahangirbeyli basins of the Okchuchay River in Zangila, it was discovered that the mass death of 227 goldfish and 330 shirbit fish included in the "Red Book" of Azerbaijan took place here.

River water and bottom sediment sample monitoring and analysis were carried out at the internationally accredited and certified German SGS laboratory on the order of the Ministry of Ecology (under contract with "Societe General de Surveillance Azeri Ltd" LLJ). According to the samples, the heavy metals in the river water were

many times higher than the norm at different times (in periods of abundant and low water). In this regard, the results recorded in the table below show that the concentration of dangerous substances in the sediment samples exceeded the norm many times over the consecutive dates, and the level of pollution of the river was shown to be critical.

	Nickel	Manganese	Iron	Cadmium	Ammonium	Molybdenum	Zinc	Lead
09.01.2021	7,1							
28.01.2021	5,7	3,6	4,6	3,5	1,6	2.5	1.2	1.3
05.02.2021	3,6	2	3,5			1,7		
09.02.2021		1,9	1,8			1,4		
26.02.2021	1.4	3.2	5.2			1.3		
04.03.2021		3,6	2,8					
10.05.2021			1,8	1,4				
21.05.2021			2					
07.06.2021			1,1					
14.06.2021		1,1	2,2					

One of the appropriate methods to prevent environmental damage caused by the Okchu River in the basin of the Republic of Azerbaijan is to keep the surface water of the river to a level that does not harm the ecological biota, to allow the

other part to flow through a pipe to the central collection and treatment point, and then to irrigate and re-flow in the form of a reservoir. It is to create conditions for it to reach the Araz River and from there to the Kura River.

3. Conclusion

The necessary conditions for this will be listed as follows:

Elimination of leakage losses. As we know, rivers and water basins also seep into the subsoil of the earth, forming the underground water table. The toxic water of the Okchu river spreads to the surrounding areas as well as the entire area where it flows and penetrates, and poisons the flora and fauna. For this, creating a canal-shaped tubular river flow is a suitable project to reduce the overall flow of the river and minimize the damage it causes to the area. Generally, the conveying efficiency for soil channels is 70% or less depending on the soil type. Pipelines eliminate leakage-related water losses and can increase conveyance efficiency up to 95-100%.

Elimination of evaporation losses. The flow of rivers exposes water to losses due to evaporation from the soil surface and transpiration from vegetation along the river bottom or banks. Pipeline conversion will eliminate evaporative losses and at the same time help us to maintain sufficient amount of runoff water.

Water saving. By eliminating water losses and increasing the efficiency of transportation,

One of the appropriate methods to prevent environmental damage caused by the Okchu River in the basin of the Republic of Azerbaijan is to keep the surface water of the river to a level that does not harm the ecological biota, to allow the

pipelines will help save water in the irrigation region. Taken from the stream, it can be stored in reservoirs, released into streams or rivers to enhance instream flows and habitat, used to irrigate additional acres, or used to extend the length of the irrigation season. Only after first being discharged from the collection and treatment station and the treatment water filters, the above mentioned is considered targeted.

Improvement of water quality. Channelization of the river will help reduce the erosion that is common in earthen channel systems. As is known, rivers carry with them various forms of wood and silt products along with water. Along with these pollutants and toxic heavy metals, erosion within water supply systems can lead to sediment transport, ultimately returning sediment-laden water to downstream surface waters through sewage or drainage systems. Erosion and sedimentation can also result in sediments causing significant maintenance and upkeep of structures in the irrigation system. By eliminating erosion, piping systems will help improve water quality in downstream receiving waters and reduce operation and maintenance throughout the irrigation district.

and re-flow in the form of a reservoir. It is to create conditions for it to reach the Araz River and from there to the Kura River.



Image. Approximate plan of the flow of Okchu river with pipes

Improvement of water quality

Construction of reservoirs. As we know, reservoirs are a very important factor for irrigation and use. At the same time, the organization and use of water reservoirs in several areas should be registered as the next step, as the movement of the river water through the pipe is not suitable for our purpose.

Increasing farm efficiency, increasing crop yields and agricultural incomes, and saving energy. In some cases, due to pressurized flow, pipelines may be more oriented in downstream directions compared to open channel flow. This allows individual users to save money/energy on pumping operations. Increasing the head in downstream streams will help increase crop yields and agricultural incomes. On-farm water application will be faster when piped water is diverted, therefore distributing water to crops more quickly and efficiently. This can lead to longer irrigation bursts during the irrigation season, more crop cuts and increased agricultural income for the individual user.

Purchase of energy. Another of the main and most important factors will be to realize the second most important task for obtaining energy at several flow points with tubular flows on that river and providing energy to the Karabakh region. The above-mentioned factors will improve the flora and fauna of the Okchu river flow areas, as well as the quality of the water mass allocated for the purpose of protecting the biological condition of the river. The flow of water diverted through the pipe and entering the treatment plant can be efficiently used by alternately supplying small hydroelectric power stations.

On the other hand, by determining the point where the energy potential of the second river pipeline, which is allocated for the next water reservoir and irrigation canals, will be effective, here by building the 2nd and later the 3rd substation with other small hydropower plants, will be possible to create a 3-point energy supply center.

The point where the water enters the pipe after being cleaned of dirt and sludge

The water passing through the 1st small hydroelectric plant enters the reservoir to be cleaned of heavy metals. Part of the water left here can be used for irrigation in the surrounding areas

Second small hydroelectric power station and small reservoir. Water from this point can be discharged through a small channel to add to the small amount of water flowing in the Okchu River.

Third small hydropower plant and reservoir.

Overall, the Okchu River, which has been deliberately polluted from the territory of Armenia and discharged into the territory of Azerbaijan, will become cleaner, preserve the health of both nature and humanity, and at the same time will lead to the strengthening of energy supply.

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Prospects for using graphene in solar panels

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Abstract: In the presented work, the application possibilities of graphene in photovoltaic material were investigated and the possibility of its use in solar panels was determined. The attributes pertaining to the electrophysical characteristics, light absorption capacity, and transparency of the substance have been delineated, thereby indicating its suitability for integration into photovoltaic solar panels. Also, the economic advantage of using graphene in solar panels has been determined.

Keywords: Graphene, Solar panel, Photovoltaic, Battery, Solar cells.

1.Introduction

The sun, which gives heat and light to the earth, is considered an endless source of energy. Solar energy is one of the most affordable energy sources in the world, and it is considered a more promising energy

source for mostly sunny areas (Fig.1). The importance of using solar energy is increasing day by day. The main reason for using solar energy is its energy capacity, so the considered energy source does not harm the environment.

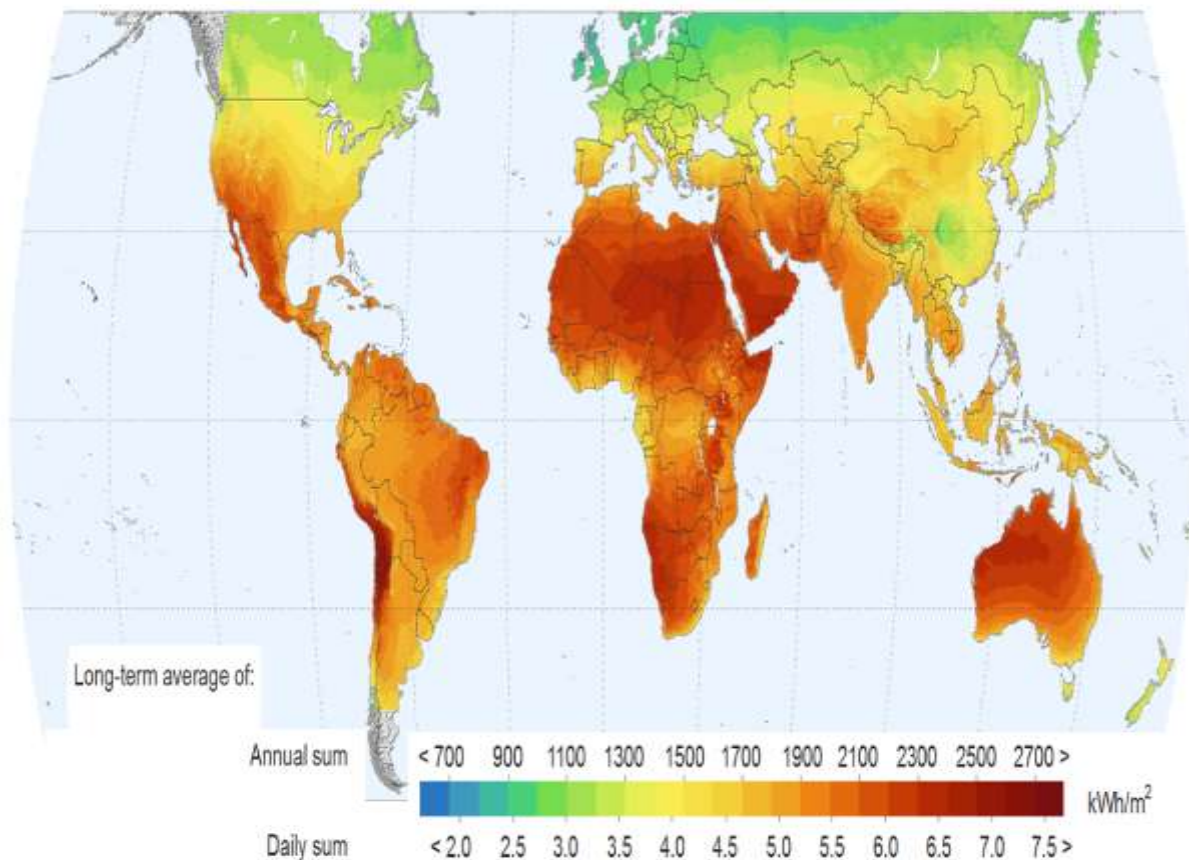


Fig.1 Distribution of solar energy in the world

The conversion of a certain part of the rays falling on the earth's surface into this energy can provide a large part of the energy needs of humanity. In recent years, photovoltaic elements made of semiconductor materials have been widely used in solar energy systems to convert solar energy into electric current. The use of silicon-based solar panels, which are economically expensive, remains relevant. Conventional silicon-based solar photovoltaic cells facilitate the conversion of sunlight into electricity. This property is due to the ability of photons, which are discrete pieces of electromagnetic energy, to tear electrons from silicon atoms after entering the silicon layer. The free electrons then generate an electric current. At this time, some difficulties arise. First, the photons here must have the necessary energy level to carry out the separation of electrons from the atom; less energy will cause the electron to remain attached to the atom. On the contrary, excessive photon energy is considered undesirable in this matter. In recent years, the investigation of other materials that are more economically advantageous in solar panels is of particular interest. One of the materials of particular interest is graphene. In this work the main objective presented is to investigate the prospective use of graphene in solar panels.

2.Experimental details

Possible application of graphene in photovoltaic cells

Due to its unique properties, the use of graphene, a two-dimensional material, in solar panels has attracted the great interest of scientists and researchers around the world (Fig.2). A large number of researches are conducted in this field in our country. This material is considered to be the smallest substance ever discovered by mankind, with carbon atoms arranged regularly in a single-layer hexagonal lattice. In recent years, due to its unique mechanical, thermal and electrical properties, graphene has attracted special interest and is considered a highly promising material among photovoltaic elements. Its remarkable advantages have the potential to significantly increase the efficiency and productivity of solar cells, thus prompting extensive and in-depth research in this field. Increasing the efficiency of converting solar energy into electricity as a photovoltaic cell is a key factor in determining the viability of solar energy as an environmentally sustainable and renewable means of electricity generation.



Fig.2 Graphene coated solar panel

Graphene's high electrical conductivity makes it indispensable in the field of solar cell technology and once again emphasizes its key role in the development of photovoltaic systems. Due to its high electron mobility, graphene has the ability to transfer electrons efficiently and quickly. Graphene's unique properties make it an ideal candidate for use as a material for the electrodes of solar panels, capable of collecting electrons generated when exposed to solar radiation. In addition, graphene is increasingly used to increase the light absorption capacity of solar panels.

This is to facilitate the efficient transfer of solar energy from the absorbed sunlight to the solar array, as graphene exhibits exceptional conductivity both electrically and thermally. In addition, graphene's remarkable electronic properties help to improve solar cell efficiency by allowing it to capture light in a wide frequency range that extends beyond the visible spectrum. Graphene demonstrates potential utility as a transparent conductive electrode in the context of photovoltaic cells, highlighting its application to harness solar energy. In modern photovoltaic cell technology, the preferred choice for transparent electrode material is indium tin oxide (ITO). Limitations surrounding ITO include its financial costs, vulnerability to external factors, and limited availability, which represent a triad of its inherent disadvantages. Indium tin oxide (ITO) is considered a less favorable choice mainly due to graphene's attributes, including its abundant availability, versatility, and exceptional transparency.

3. Conclusion

Thus, as a result of the conducted research, it was determined that the use of graphene in photoelectric materials is more effective. It has also been determined that the use of graphene in solar panels is economically more favorable. It can be concluded that due to its unique electrophysical properties and ability to absorb light, graphene can be used in photovoltaic solar panels.

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Numerous scientific studies have substantiated the potential use of graphene as a transparent electrode in photovoltaic cells, with some studies demonstrating its superior performance compared to indium tin oxide (ITO)-based batteries, especially in terms of efficiency.

Although graphene has several advantageous properties for its potential use in solar cells, the widespread commercial integration of this material is hindered by numerous obstacles that require resolution. One of the most important challenges in graphene research concerns the investigation of methodologies that enable the efficient and scalable synthesis of graphene while maintaining its exceptional quality standards. Currently, the predominant approach used to synthesize graphene involves the chemical vapor deposition (CVD) technique, which is characterized by its high cost and long time. Scientists are actively engaged in the search for new and improved techniques for the mass production of high-quality graphene with high efficiency. Another significant hurdle is the seamless incorporation of graphene into established solar cell technologies. The use of graphene in solar cell technology requires the research and development of new materials and manufacturing methodologies that differ from conventional solar cell manufacturing processes. In addition, it is important to conduct thorough and rigorous research on the long-term stability and robustness of graphene-based solar cells to determine their ability to withstand adverse environmental conditions.

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Development of a solar panel cleaning system

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Abstract: The article is devoted to the more effective operation of solar tracking systems in the current conditions and the development of a system for cleaning the panels using a remote-controlled rubber brush in cases of contamination of solar panels due to weather conditions and other reasons. The article discusses the importance of solar panels, solar tracking systems, and equipment to be used for remote cleaning of panels.

Keywords: Energy sources, Solar panel, Solar tracking system, Cleaning system, Microcontroller.

1. Introduction

Solar energy is the source of all energy on earth in one form or another. For humans and any other animal or plant, solar energy gives food and heat. In addition, there are numerous additional ways that man uses energy sources outside solar energy. Renewable energy began to be used in certain areas several decades ago. All renewable energy sources: Solar, Wind, Hydro and Geothermal have been used successfully to varying degrees. Water and wind energy were more widely used, while solar energy was used at a relatively low level. Such a situation can be attributed to the relatively high cost of solar cells

and their low conversion efficiency. Compared to other energy carriers and energy sources, solar energy has a number of important advantages.

First of all, solar energy is environmentally friendly, because during operation, the solar power plant does not emit harmful substances into the environment.

The second advantage is that solar energy has a high resource intensity. This is due to the large amount of energy that the Earth receives from the Sun.

Thirdly, the feature of installation of solar energy systems in industry and various fields makes it possible to expand them and mass produce such systems (Fig. 1).



Figure 1. Solar panels

The acquisition of usable electrical energy from the sun, the discovery of the photoelectric mechanism and the conversion of visible light into direct current became possible with the

further development of solar cells made on the basis of semiconductor material. A series of solar cells have been implemented that generate a physically usable DC voltage at the load via

electrically connected Solar panels. As efficiency increases, solar panels are becoming more widely used and especially widespread in remote areas where power lines cannot be located or cost of laying power lines is unprofitable [1].

The collection of light depends on the angle of incidence of the sun, and maximum energy collection is observed when the angle of incidence is 90 degrees. If the solar panel is installed on a flat surface, it is clear that the incidence angle of the sunlight during the day will be close to 0° in the morning and evening. For such an angle of incidence, the light-gathering capacity of the cell is essentially zero, resulting in no output, but at midday, the angle of incidence approaches 90°, causing a steady increase in power to the point where the light falling on the panel is completely perpendicular, at which point

we can get maximum power. In the evening, the reverse of this process occurs, and the decreasing angle causes the power to decrease again to a minimum. Thus, it is possible to obtain the maximum power output from the panel by keeping the angle of incidence of the sun as close to 90° as possible. This can be achieved by continuously tilting the solar panel towards the sun (Figure 2) [2,3].

Taking into account the issues mentioned above, the necessity of using solar tracking systems becomes clear. The process of sensing and tracking the position of the Sun is carried out through Sun Tracking devices. Given the need for real-time tracking, effective solar tracking requires the ability to extract maximum power from the solar panel without requiring any external input during operation [2].

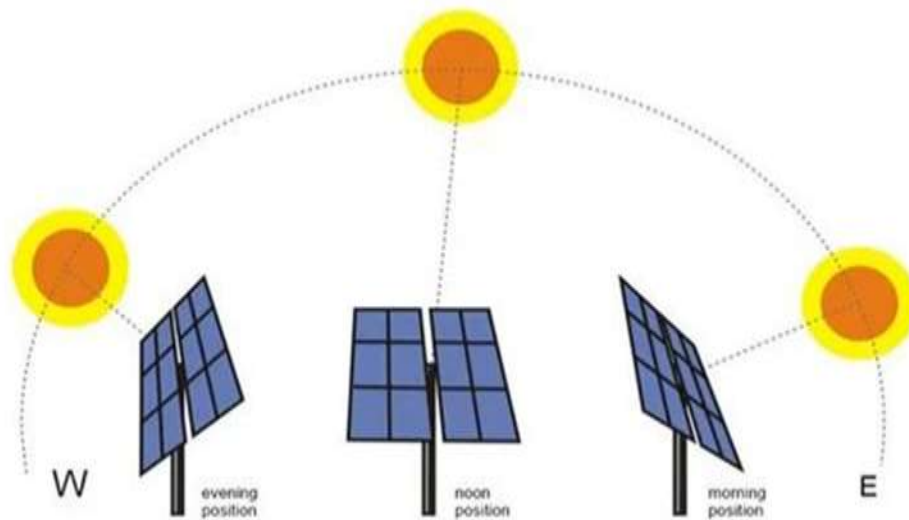


Figure 2. Solar tracking system

Experiment and discussion

This article is devoted to the development of a remote cleaning system for solar panels. The cleaning process of solar panels is an important technical tool to ensure their optimal characteristics and efficiency. Solar panels can get dirty for a number of reasons such as weather conditions, various events etc. and therefore the energy output of the panels decreases. In most cases, the cleaning of solar panels is carried out using human labor in enterprises and organizations, so the periodic cleaning and maintenance of the panels requires a long time.

During such cleaning, the surface of the panels is scratched and damaged, and for this reason, their optimal performance decreases. The proposed panel cleaning system performs cleaning using special temperature-resistant soft rubber brushes fixed on the solar panels. Requirements for the selection of rubber material: it should be resistant to temperature and different climatic conditions and not to form scratches and various defects on the solar panels. The positive aspects of such a cleaning system are that they reduce human labor, prevent damage to the panels, and at the same time, additional energy consumption is not allowed as they ensure the operation of the

cleaning system through the energy produced by the panels themselves [5].

Equipment required to create a solar tracking and panel cleaning system:

1. Microcontroller

2. Photoresistor (LDR) (Figure 3)

3. Rain Sensor (Figure 4)

4. Nema17 stepper motor (Figure 5)

5. HC-06 Bluetooth module (Figure 6)



Figure 3. Photoresistor (LDR)



Figure 4. Rain sensor



Figure 5. Nema17 stepper motor



Figure 6. HC-06 Bluetooth module

As can be seen from the structural diagram shown in Figure 7, the information obtained from the rain sensor is directly transferred to the corresponding pin of the microcontroller. The microcontroller processes that signal accordingly and sends a signal to operate the motor driver. The motor driver is powered by +12V voltage through the solar panel. After the motor drive starts, the motor of the cleaning system starts and the surface of the solar panel is cleaned. In this case, through the signal from the motor sensor, the meter counts the number of cycles of the brush, and after the cycle is completed, it stops

the cleaning process by sending a signal to the input of the microcontroller.

In the second case, we perform the same operation not through the Rain sensor, but through the Bluetooth module. The continuation of the process is repeated as in the first case.

The shown process is not just cleaning the solar panel, but also the operation of the cleaner with the energy produced by the panel itself, without the need for an additional energy source. On the other hand, it is beneficial both economically and in terms of simplifying the work process.

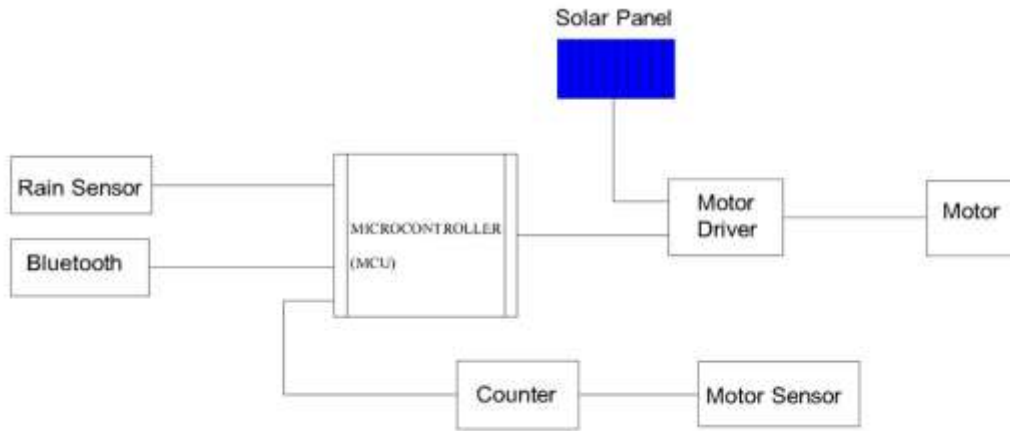


Figure 7. Structural diagram for the cleaning system of the panels

Since solar panels are installed in high places in most cases, cleaning is extremely dangerous from the point of view of human safety. For this reason, a new construction is proposed both to reduce human labor and from the point of view of safety. The general view of the proposed solar panel cleaning system is as follows (Figure 8). In the first case, the solar tracking system moves according to the position of the sun, and water drops falling on the solar panels due to rainy weather will reduce their energy output. Starting from the moment of rain, the rain sensor sends a signal to the microcontroller (MCU), and at this time, the motor, driven by the solar panel's own energy, moves the rubber brush and cleans the water drops on the panels.

In the second case, depending on weather conditions, dust, dirt, etc. in cases where the sun's rays falling on the panel are drastically reduced due to factors, a signal is transmitted to the microcontroller through the HC-06 Bluetooth module. Then water is poured over the panel and the motor driven by the solar panel's own energy moves the rubber brush and cleans the dirt on the panel. It should be noted that the range of the HC-06 Bluetooth module is 30 meters in open air, which is quite convenient for not using additional equipment. Figure 8 shows a general view of the rubber brush cleaner added to the panel cleaning system.

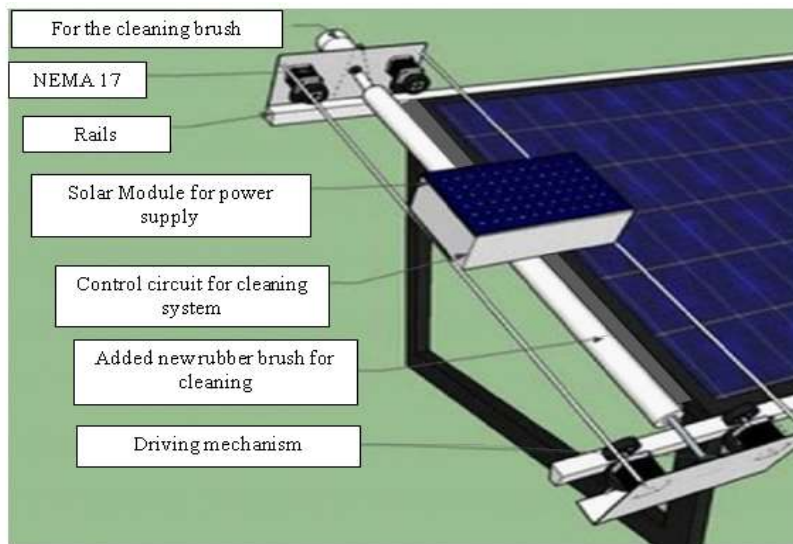


Figure 8. General view of the rubber brush cleaner added to the panel cleaning system

3. Conclusion

The design of a new model panel cleaner is proposed, which cleans the solar panels due to weather conditions and other factors, cleaning the panels using remote-controlled and temperature-resistant soft rubber brushes.

B14 type material was chosen as the rubber material, and as a result, the scratching of the surface of the panels will be significantly reduced.

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The study of the ecological damage caused by the Karabakh war and given advice

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Abstract: 20 percent of the territory of the Republic of Azerbaijan was occupied as a result of the military aggression of Armenia in 1988-1994. The occupation policy carried out by Armenia has caused serious damage to the nature and biological diversity of Azerbaijan. Consequently, the ecological situation of the region as a whole underwent degradation. What made war more complicated was severe social media disinformation campaigns carried out by Armenians toward Azerbaijanis.

Keywords: Ecological effects of war, Destruction of flora and fauna, Some recommendations for restoration, Reconstruction and development.

1. Introduction

The Nagorno-Karabakh conflict is one of the longstanding conflicts and has one of the oldest historical and cultural roots in the entire post-Soviet space. This leads to a multi-level conflict and the presence of many interwoven dimensions. The origins of the conflict go back centuries, but the beginning of its modern history can be traced back to the 1980s and these years are the last years of the existence of the Soviet Union. The first Karabakh war took place in 1988-1994, and until the second Karabakh war, our lands Lachin, Khojaly, Khojavand, Shusha, Kalbajar, Aghdam, Jabrayil, Fuzuli, Gubadli, Zangilan, Aghdara stayed under Armenia's occupation. The second Karabakh war which lasted 44 days took place in 2020. According to investigation conducted by Johns Hopkins University, the Araks Valley of Nagorno-Karabakh has 3 hydrocarbon deposits with total reserves of at

least 150 million tons of oil and up to 250 billion cubic meters, some of which were former part of the territory. The water reservoirs of the Nagorno-Karabakh Republic is also a crucial factor in defining regions value.

Taking global climate changes, land desertification, and the shortage of potable water into account, today ecology is not only one of the main issues that concerns our country and but also the entire world community. Armenia's aggression lasted for 30 years and caused serious damage to the ecology and the nature of the region. Illegal activities and exploitation of natural resources in our occupied lands have led to a number of environmental and economical problems in various contexts. The ecological balance has been disturbed as a result of deforestation – burning and cutting of forest, pollution of water resources, destruction of flora and fauna, looting of the subsoil in the region.



During and after the conflict, both sides accused each other of using incendiary munitions, such as using fire as a weapon to remove tree cover. By detecting fires and burned areas, we can better understand the frequency, type, and extent of landscape fires. In addition to landscape fires, Armenians deliberately started fires while leaving the territories of Kalbajar and Lachin. Evidence of damage to the environment has been documented by the BBC and Bloomberg. Evidence of the use of incendiary weapons includes burning the forest, or committing "ecocide", or harming civilians hiding in the forest. According to the research conducted by Azerbaijan before the occupation, it was widely used in the occupied territories. In the 260.3 thousand hectares of forest area, 460 local tree and shrub species, more than 15 percent of which existed only in this region. Previously, 24 rare animal species and 27 plant species were protected in state reserves (Basut-Chay

and Karagol), and before the war there were other protected areas (Arazboyu, Lachin, Gubadli, Dashalti). Azerbaijan did not control this region for about thirty years; favorable conditions were created for merciless exploitation and looting of natural resources by Armenians. There were cases of pollution of water resources and disruption of water flow. Trees were massively destroyed in the occupied territories of Azerbaijan by Armenia until the end of 2020. The environment was also in danger in the Karabakh region of Azerbaijan. During the occupation, the indifferent attitude demonstrated by the local authorities of Armenia led to natural disasters that disturbed the natural balance of the region. Massive forest fires covering an area of 163.3 km² in the eastern part of Karabakh were well documented thanks to the cooperation of the OSCE with Azerbaijan during the first session. The

consequences of the destruction of the environment cannot be localized.



Armed conflicts are among humanity's most destructive experiences and impacts.

It affects almost every area of life. They also have economic, political and cultural effects and it affects the environment and the ecology. Such conflicts have been a source of risks and threats. Conflicts directly and indirectly damage the environment and pose threats to the health, livelihood and security of the population.

Environmental degradation takes place in three directions: devastation of the territory due to the movement of troops, use of weapons and resources. This leads to the destruction of land and pollution of water, as well as deforestation. These issues are not being paid attention. The lands of Karabakh, including not only the former Nagorno-Karabakh Autonomous Province, but also the surrounding seven administrative regions of Azerbaijan, were recognized as part of the territory of Azerbaijan by four resolutions (822, 853, 874 and No. 884) in 1993. The UN Security Council never recognized the so-called "Nagorno-Karabakh Republic" in Armenia. Certain obligations of the occupying forces of Armenia within the framework of international law arise from this fact. Azerbaijan has launched a legal challenge against Armenia, alleging that it destroyed the environment and biodiversity of the disputed Nagorno-Karabakh region during its nearly thirty-year occupation. The international tribunal will consider evidence of

widespread environmental destruction during the conflict between the two nations, including deforestation and pollution, and demand reparations from Armenia. It is the first time that any country has resorted to interstate arbitration under the Berne Convention. If Azerbaijan wins, it will set a precedent for giving economic value to biodiversity and environmental destruction. Azerbaijan reports that habitats and species were damaged, natural resources were depleted, and biodiversity was destroyed in the freed lands.

The lawsuit is part of a wider diplomatic conflict between the two nations. Azerbaijan occupies a key strategic point between Europe and Asia from a geopolitical point of view, and is also a biological crossing point for plant and animal species. According to the Ministry of Ecology and Natural Resources of Azerbaijan, during the occupation, mining damaged a large part of the forests, which are hotspots of biodiversity and home to rare, endangered and endemic species, including the Caucasian leopard, brown bear, gray wolf, as well as larger spotted animals.

In addition to demanded compensation, Azerbaijan side intends to demand from Armenia to stop the activities that continue to damage the environment. Analyzes conducted by Azerbaijan in Okchuchay in 2021 proved extremely high concentrations of heavy metals in water and sediment, including cadmium, lead, nickel, iron, molybdenum and zinc. Azerbaijan side mentions that several protected fish and

amphibian species are at risk, and the problem is alleged to be related to wastewater from copper and molybdenum mines in Armenia, as well as household

waste. In this regard, the Bern Convention will examine this issue.



During the Karabakh war, nature died too with soldiers and people living there. The process of investigation and calculation of the damage inflicted by Armenia in various spheres of life during the years of occupation has commenced. A number of recommendations were made for our freed lands and their implementation began. The President of the Republic of Azerbaijan, Ilham Aliyev, has signed many documents to eliminate the environmental damage caused by the Karabakh war, and the restoration work has been started by the President's instructions. A number of measures are being taken to eliminate other environmental damages: planting of new trees, plants, construction of buildings, houses, schools, restoration of mosques, monuments, etc. After liberation of the Azerbaijan territories from occupation new cases of eco terrorism have been revealed. It is necessary to restore the flora and fauna of the freed territories. Good news is that, Azerbaijan

is planting trees in the freed Zangilan and Fuzuli regions and has started initiatives to restore the ecosystem of the freed territories. However, the enhancement of biodiversity and ecosystem restoration in the region will require the development of a comprehensive program. It may take decades to restore flora and fauna, as some plants have been completely wiped out and others are on the verge of extinction. As soon as experts assess the damage to the environment, it will be possible to determine the legal mechanisms for holding those responsible for the crime of ecocide. Azerbaijan government will demand compensation. In general, hostile attitude towards nature in Nagorno-Karabakh and in adjacent regions of Azerbaijan do not only pose a serious threat to the ecological balance, flora and fauna of Azerbaijan, but also provokes the people of Azerbaijan along with other provocative actions.



At the same time, “Restoration, Reconstruction and Development of Karabakh” events commenced by the order of the president of Azerbaijan republic. We will be rejoin with our former beautiful Karabakh. Karabakh is Azerbaijan!



Conclusion

Protecting the environment, preventing the destruction of flora and fauna is a crucial issue for our healthy future. Armenian aggression in the region caused damage to the nature of Karabakh: the

degradation of forests, cutting and burning of trees, the pollution of the atmosphere and potable water by chemical means of dumping, the destruction of settlements, loss of arable land, and other environmental problems.

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Implementation of a digital monitoring system for energy quality

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Abstract: By monitoring the quality parameters of energy, it is possible to detect the equipment and mechanisms that lead to the distortion of these parameters, as well as to detect the reasons why the devices that generate harmful signals produce these signals. At the same time, it is possible to check the interruptions caused by the power supplies included in the consumption, based on the times of voltage interruptions. It is considered important to have a data processing base for the execution of the mentioned processes.

Keywords: RTU, Transducer, Quality indicator, Switching process, Network, Algorithm.

1. Introduction:

The implementation of power quality control consists in checking that its electrical parameters are within the normative limits adapted to a required standard. Although this may seem like a simple measurement process at first glance, the main issue here is to consider these measurement processes during different times and their values adjusted and compared to their values in different load regimes. Also, measurement processes should be able to ensure continuity in certain time periods, so that the dependence of quality parameters changes during this time on the nature of the load and its loading coefficients are precisely determined. From this point of view, knowing that the quality parameters of electric energy consist of the initial measurement of current and voltage, it is considered very important to

pay special attention to the high accuracy of the necessary devices, or rather, transducers. The quality indicators of electric power include its frequency, voltage, active power factor, harmonics, interruptions (cuts) in electric power supply, asymmetry, etc. include parameters. Taking into account the above-mentioned features of monitoring, we can say in general that in the monitoring process, there should be devices that measure the parameters of electricity at different points of the network. There should be a "Remote Terminal Unit" device that ensures remote transmission of the obtained data to the central system. A computer that performs data processing and has a special algorithm must be installed. Data analytics should be given special importance in the development of the software algorithm. Figure 1 shows the general connection scheme of the mentioned structure.

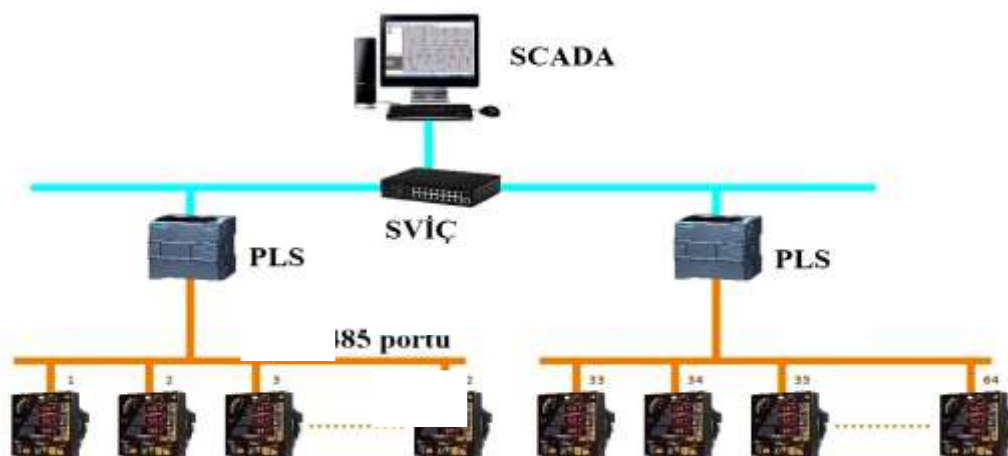


Figure 1. General connection structure of the monitoring system

2. Experimental details: We use the MATLAB Simulink program to conduct the study. The general

algorithm of the process is given in figure 2. Here, a small powerful circuit is studied as an example.

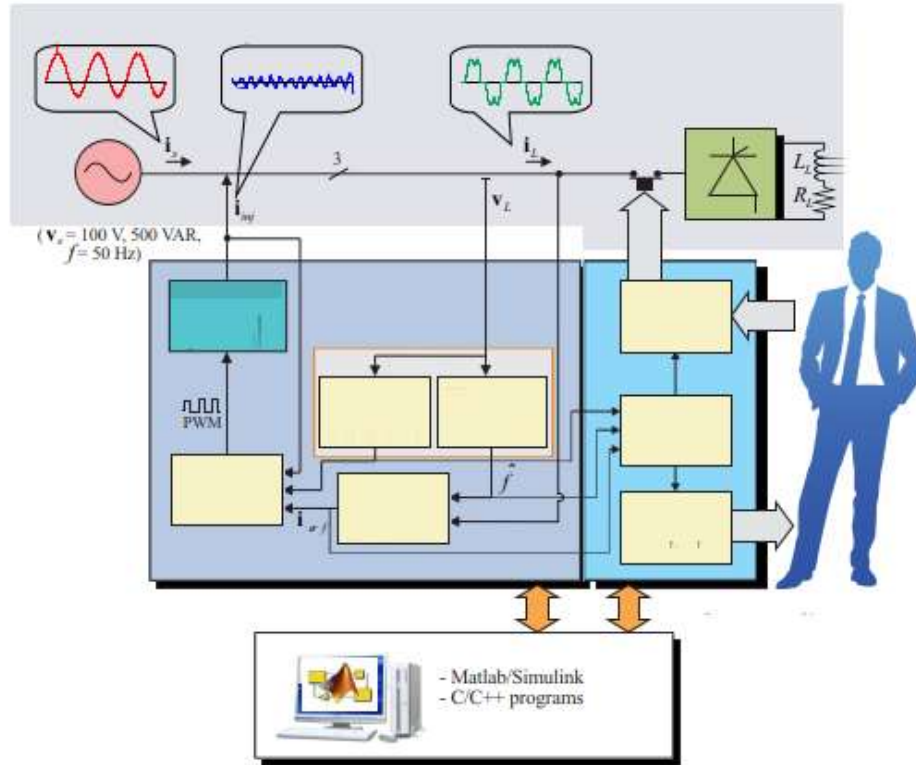


Figure 2. An example of a block diagram for a simulation study

We will consider our proposed method, the multi-output "a-line" method, and real-world measurement results on the block diagram shown. For this, let's

first consider the graphical form of the sinusoidal change results according to the given scheme in Figure 3.

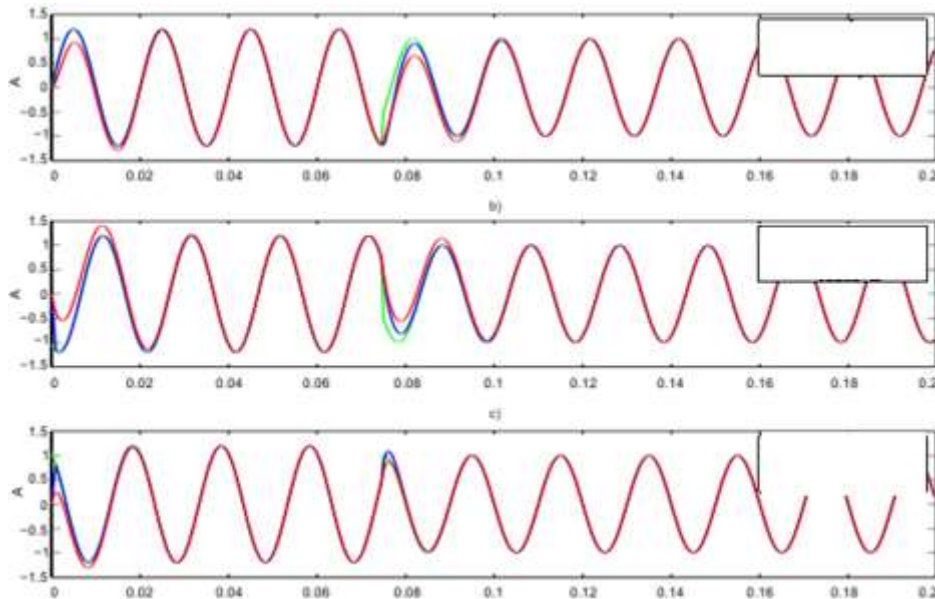


Figure 3. Measurement results of sinusoid using different methods

Let's consider the new simulation graph in figure 4 to see the shape of the graph results of the given

methods under different types of load changes.

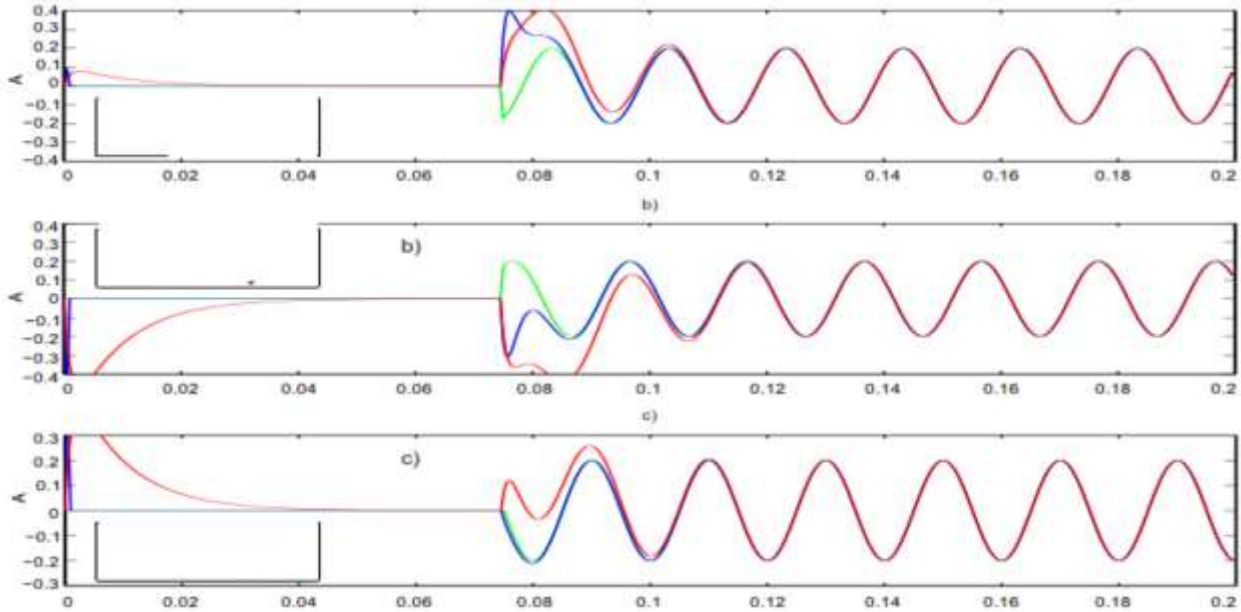


Figure 4. Effect factors of the comparison of methods at different load changes

In the graphical result, it can be seen that the load change of both methods takes the opposite direction at the moment of transition. This process is an effect caused by free currents and can be changed in the software algorithm. In addition, it can be seen from the first half-period of the transition moment that the proposed new method has a more flexible response than the Adaline method.

3. Conclusion

It is possible to analyze the possibility of applying different methods to current and voltage converters, which are the initial part of the measurement process of the power quality control mechanism, and their responses to varying load changes in real working conditions by regularly testing them. It is possible to control the quality parameters of electric power by taking into account the real-time mode in the measurement of the quality parameters of electric power and, in this regard, with the correct analysis of the transition moments in the load changes in real time.

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Control system for high-frequency harmonics in electrical networks

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Summary: The analysis of high-frequency harmonics generated in electrical networks and the development of general principles of construction of control systems and development of new approach methods for keeping them within the allowable limits due to their composition is one of the priority issues. With the introduction of modern electronic-digital devices into mass consumption, we can say that this topic is very relevant today, taking into account the strengthening of the effects of those high-frequency harmonics on the network sinusoid.

Keywords: Filter, Harmonics, Quality indicator, Frequency, Frequency emitter, Digital device

1. Introduction: There are a number of requirements placed on electrical networks. These include the reliability of the electric grid, its economic efficiency and the implementation of high-quality electricity supply. The parameters that indicate the quality of the electrical network include: Voltage within nominal limits, frequency within nominal limits, absence of asymmetry and absence of extraneous harmonics in the network. The latter can be considered as the result of mass integration of modern electronic devices into the network [1]. This is both a problem caused by electronic devices, and the resulting high harmonics cause serious problems in the operation of other electronic and digital devices. From this point of view, the study of the operation of high-frequency harmonics and obtaining certain results is a very important process, which allows to develop a mechanism that can ensure the effective operation of

0.4 kV supply networks and the quality operation of the consumer devices connected to them.

High harmonics generated in electrical networks cause distortion of sinusoidal voltage with a frequency of 50 Hz. It is possible to separate the distorted complex sinusoid into its components with the help of certain filters [2]. This separation process is shown in figure 1. Sinusoidal alternating current can contain both high frequency and frequencies below 50 Hz. In industry, only high-frequency signals are generated from electrical devices and equipment, causing harmonics that disrupt the operation of the network and other electrical devices [3]. For that reason, the application of filters that block high-frequency signals, according to the filters given in picture 1, is cheaper for the industry, and their installation and selection as a project is convenient.

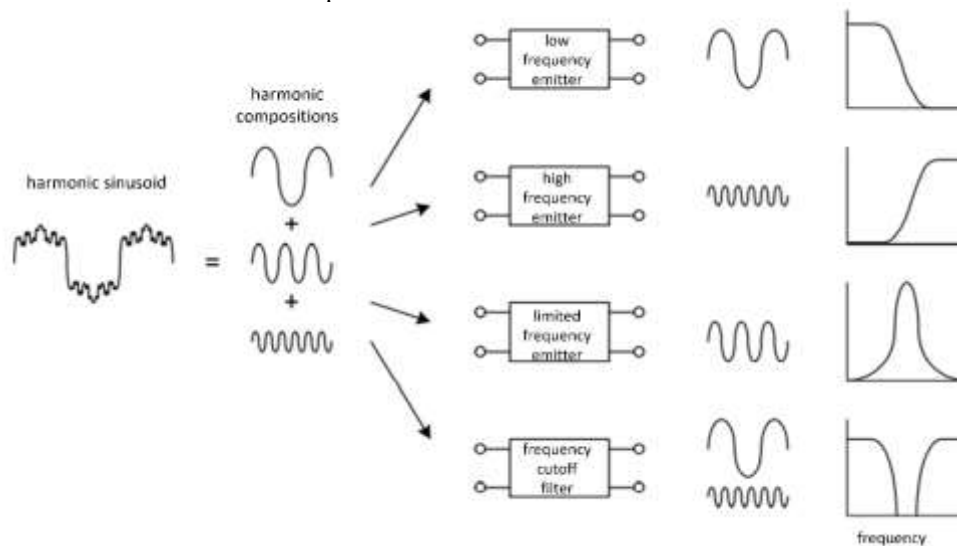


Figure 1. The mechanism of separation of harmonic components with the application of filters

2.Experimental details

We will use the "Multisim" program for the simulation study of the generation of high-frequency harmonics in electrical networks and their results. In this program, let's look at the effect of high-frequency currents generated by electrical devices connected in a three-phase electrical circuit on the general electrical circuit. This process is shown in figure 2. As can be seen from Figure 2, when a load of about 31 A flows from each phase, i.e., in the case of symmetrical mode, no current should flow from the neutral wire. But a load of about 66 A flows through the neutral wire. This is due to the fact that there are electrical devices that act as a high frequency source connected to the phases, as can be seen from the oscillograph. In the end, this process will cause the neutral wire to be overloaded more than the nominal

one, creating a dangerous potential voltage in it, as well as causing it to heat up and eventually break, and cause a malfunction in the operation of single-phase actuators [4]. In single-phase electrical receivers, it is practically impossible to accurately distribute the load by phase. The reason for this is the irregular change in their cargo demand. In asymmetrical loads, when the neutral wire heats up and breaks down due to high harmonics, the voltage distributions on the phases will change immediately, and the voltage of the phase with a low load will rise, which will cause electrical equipment to fail in a short time [4]. In order to prevent these situations, there is a need to block the high-frequency currents present in the electrical circuit. There are both active and passive filters for this. It is usually more efficient to install passive filters in industry due to their cost-effectiveness.

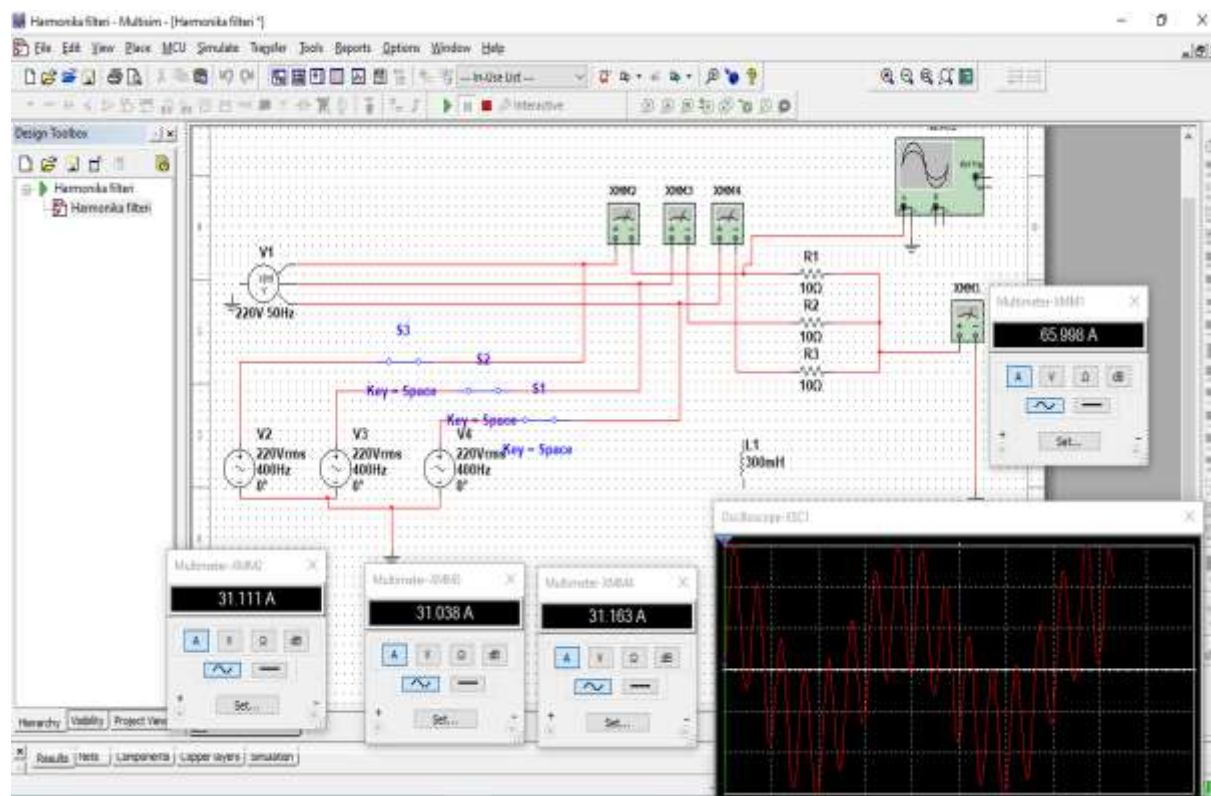


Figure 2. Simulation scheme for the study of high-frequency harmonics

To block high-frequency harmonics, either parallel capacitor banks or series-combined inductive resistance are used as passive filters. Parallel capacitor banks usually prevent high-frequency harmonics from passing through their circuit to other parts of the system [5]. However, this means that the higher harmonic has simply changed its direction, it is still present in the circuit as a charge. This is why we use series-connected inductance. The inductive

resistance does not change the direction of the harmonic composition, blocking its passage and ending its existence as a current in the electric circuit [5]. According to the results obtained from the oscilloscope in the considered simulation study, there are harmonics with a frequency of 400 Hz, and the corresponding passive inductive filter should have an inductance of 300 mH. Quantitative changes of the electrical parameters in the supply scheme after

connecting that valuable inductance to the neutral

wire are shown in figure 3.

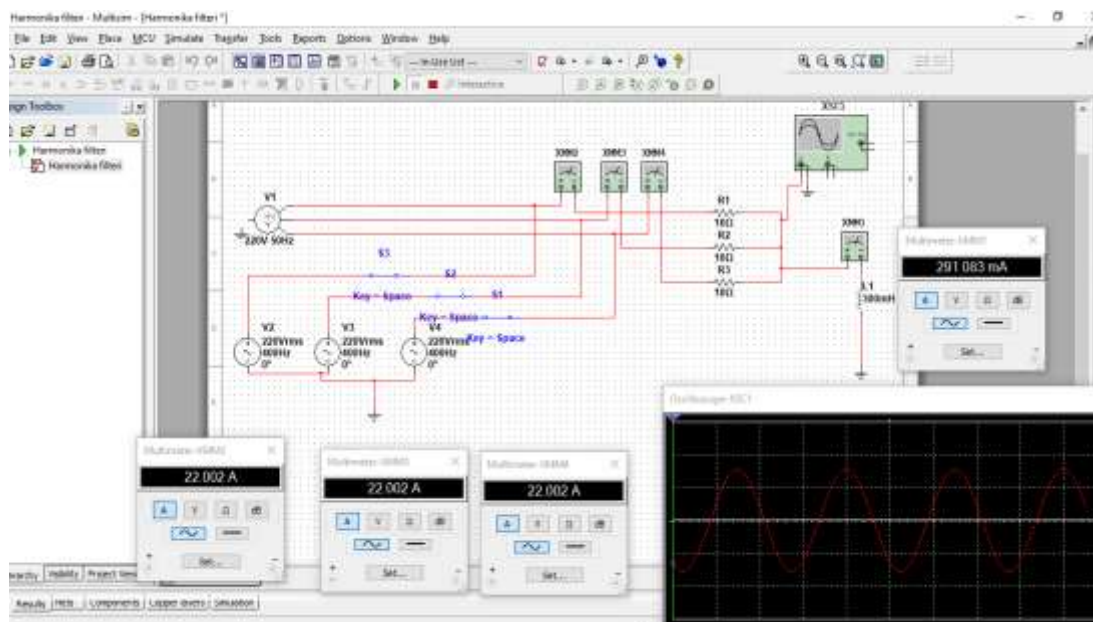


Figure 3. Analysis of load changes after applying the harmonic blocking filter

As can be seen from the scheme, with the introduction of the inductive passive filter into the scheme, the current passing through the neutral wire in the symmetrical mode has decreased to a practically negligible value. Also, as it can be seen

from the oscillograph, we see the pure sinusoidal alternating current voltage curve because the high-frequency currents are already blocked in the electric circuit.

3. Conclusion

High-frequency harmonics cause malfunction of modern digital devices, malfunction of the central frequency timer by distorting the frequency spectrum of its logic pulses. Due to the fact that the phase

shifts of high-frequency harmonics do not have the appropriate sequence, that is, they are chaotic, they are not collected and reset at the end of the zero wire. This process eventually results in the neutral wire being overloaded and heated. By using high-frequency blocking passive filters, these harmonics are prevented from flowing through the circuit and the problems we listed are prevented.

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Automatic control system of greenhouses

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Abstract: The mechanisms used in greenhouses in the classical version consisted of a set of manually controlled processes. Later, those mechanisms were replaced by semi-automatic systems. For full automation of said mechanisms, central control devices are needed, coordinated with each other in a synchronous or asynchronous form. Digital elements are required to perform this process. The rapid development of electronics and the implementation of such mechanisms using integrated circuits of semiconductors is possible. The use of complex elements is extremely important for the effective organization of the work of hydraulic systems and electrical devices.

Keywords: Analog-to-digital converter, Sensor, Actuator, Processing, Flora.

1. Introduction: A closed form of the ecosystem for existing flora in greenhouses can be provided with automatic control and measurement mechanisms. Here, the important parts are specifying and making the parameters that control the parameters to be measured to organize the ecosystem for indoor [1]. These parameters are ecosystem temperature, moisture, humidity, carbon dioxide addition and others. Therefore, the application of sensors for

reading these data listed in the ecosystem initially security. Initially, NTC and PTC thermoresistances are used for temperature measurement. NTC type thermoresistors are more widely used [2]. The reason for this is that the transformation of its analog input data into a voltage-to-temperature scale is defined by a not-too-obvious logarithmic expression. Usually 10 kOhm NTC sensors are used [3] (picture 1).

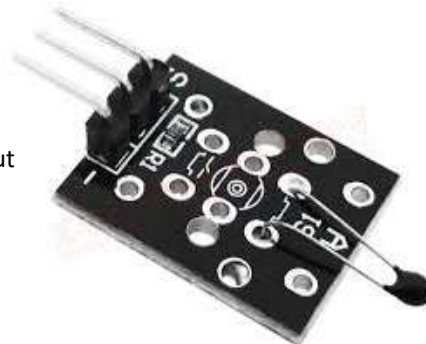
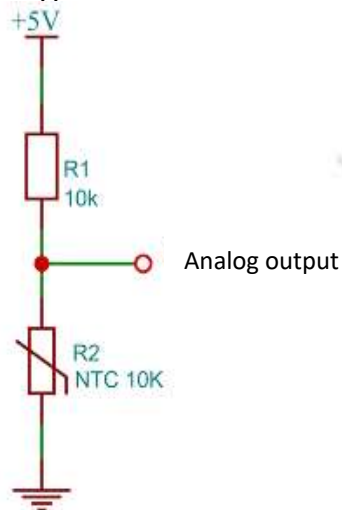


Figure 1. Connection diagram of thermoresistance for temperature measurement

Second are the sensors used to measure moisture and humidity. There are two types of sensors of this type. The first one is in analog form, which produces output according to the voltage change, and the second one is a sensor with direct digital connection.

Digital sensors are usually used for high accuracy and reliability. These sensors are manufactured in the form of DHT11 series and their schematics are given in figure 2 [3].

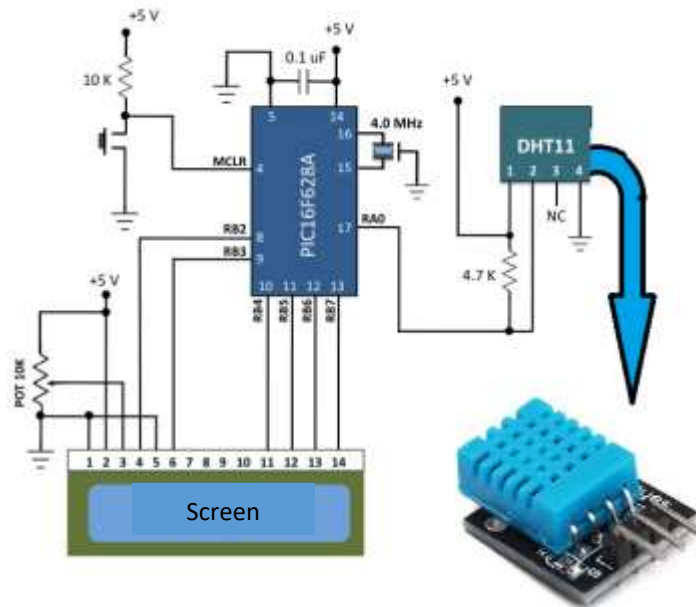


Figure 2. Connection diagram of the sensor for humidity measurement

The block diagram of the complex management of the explained elements and others in a single system is given in figure 3.

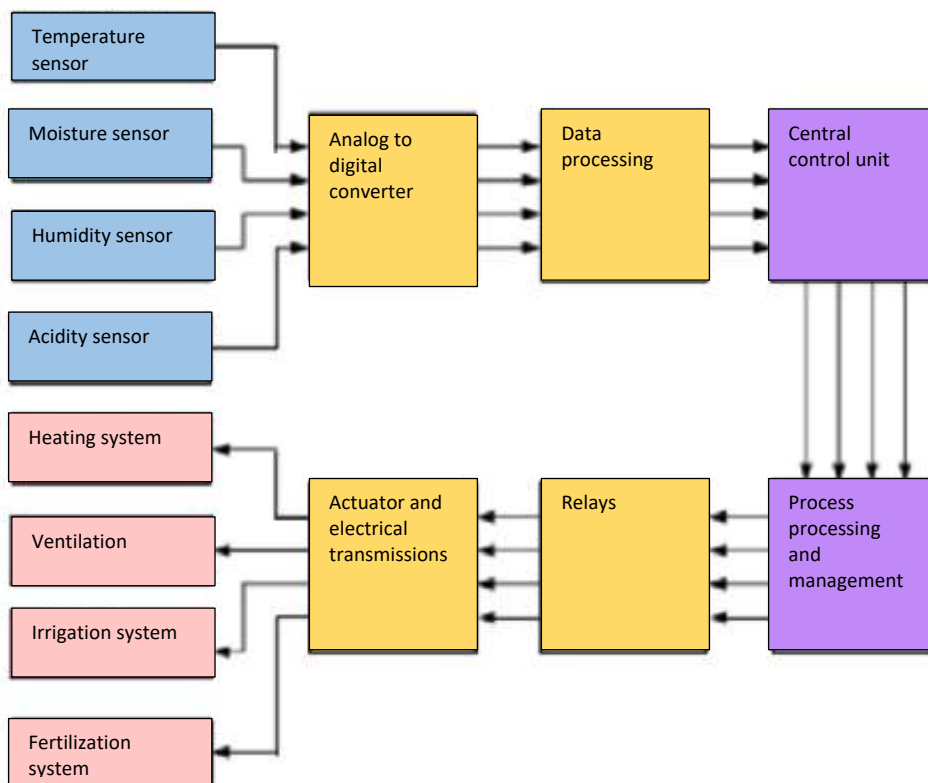


Figure 3. Block diagram of greenhouse management process

2.Experimental details

We perform the simulation process in MATLAB Simulink according to the logical sequence mentioned above [4]. Initially, we set the

temperature to be 27 °C, and we note the changes in accordance with the effect of the operation of ventilation and heating devices according to the temperature changes as a graph in figure 4.

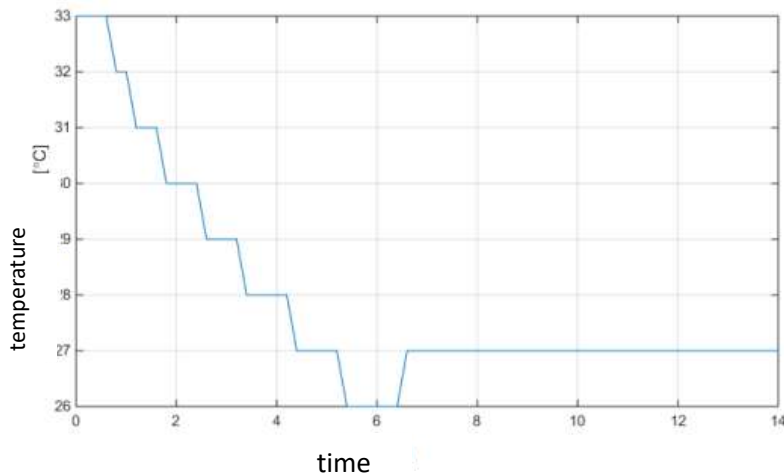


Figure 4. Temperature variation in a closed ecosystem

In the same way, we note the change curve of humidity in figure 5.

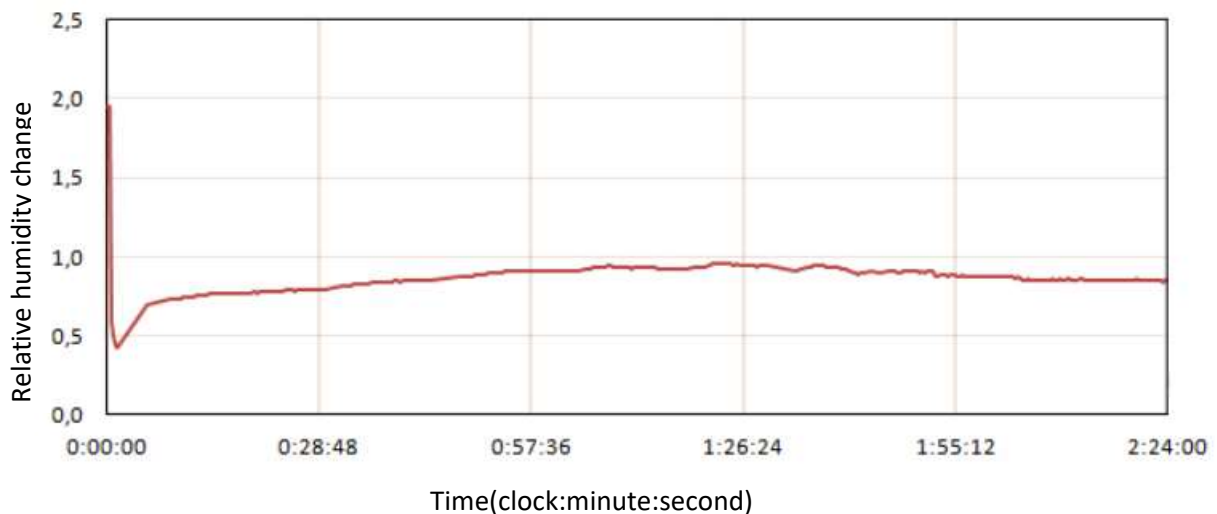


Figure 5. Graph of humidity change over time

3.Conclusion:

As a conclusion, we can say here that in a place where an ecosystem is built, keeping the parameters required for that environment under control and within the given limits necessarily requires an automated mechanism. This mechanism can be implemented by means of integrated circuits and programmed devices. Also, if any defect that may

occur in the built greenhouse cannot be eliminated with the help of installed devices, it should be ensured that warning signals are sent to a distance. These processes are possible only at the digitized level of information processing. Therefore, it is important to automate the processes in the built

systems at the microchip level using analog-to-digital

converters.

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Synchronization of terahers waves

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Abstract: This mini-review outlines the application areas of Terahers waves. It is very simply shown in the article that it is possible to create Terahers sources with adequate power for the application due to the synchronization of Josephson contacts in high-temperature semiconductors.

Keywords: Terahers waves, High-temperature superconductors, Josephson contacts, Synchronization, Adequate power, Ecology, Medicine, Secure communication.

1. Introduction

Terahertz waves lie between microwave and infrared waves on the electromagnetic scale. Although different ranges are shown in different literature, usually these waves are in the $(0.3 \div 3) \cdot 10^{12}$ Hertz range [1]. Terahers rays have a very wide range of applications. For example, safe "x-ray" devices, remote analysis of the chemical composition of explosives, application in medical non-destructive diagnostics, application in secure communication issues, ecology, etc. application can be shown [2]. These facts make the investigation of Terahers sources with adequate power for application a priority. Traditional Terahers sources can be obtained based on gyrotrons, far-infrared lasers, lasers based on free electrons, cascaded quantum lasers [1]. Such sources are usually difficult to transport, located in large areas and, most importantly, require deep cooling systems. Therefore, from the point of view of the application of the sources created on such a basis, as well as from the financial point of view, they do not seem very convenient and attractive. For this reason, the creation of mobile, cost-effective, low-space Terahers sources is being actively studied. As mentioned, this mini-review focuses on synchronization in Josephson networks. In these directions, which have potential applications in countless fields of science and technology, special attention has been paid to the role of synchronization in Josephson networks in only three areas: 1) information; 2) medicine; 3) in ecological areas.

As for the application perspectives of Terahers rays in the medical field, it should be noted that the energy of a Terahers photon is a thousand times less than that of an X-ray photon. This fact allows Terahers rays to be used in non-destructive, safe diagnostics. Terahers rays can be used to diagnose skin cancer. Stomatologists note perspectives in dental

diagnostics. In a biopsy, Terahers waves can achieve a more precise definition of the contours of cancer in the damaged area, which can reduce the risk of repeat surgery.

When researching terahertz waves in the direction of security, the main attention is focused on the fact that these waves can penetrate to a certain depth in non-metallic, non-polar substances. These waves can help detect dangerous substances from a certain distance. At airports, Terahers beams detect weapons, explosives, etc. hidden in passengers' clothes. can be applied in detection.

2.Experimental details

It is very important from the point of view of environmental aspects of application of terahertz rays that these rays can lead to detection of non-metallic, plastic mines at a certain depth. These rays can be an important factor in detecting fake paintings. In the automotive industry, in shipbuilding, Terahertz waves play a very important role in detecting areas that need repair. The contours of such areas are detected by Terahertz rays at a certain depth.

One of the most relevant fields of application of Terahertz sources is the field of communication. In the Terahertz communication scheme, information exchange can occur at the rate of Terahertz bits/second [3].

Water vapor strongly absorbs Terahertz radiation, so Terahertz-based communication systems between satellites seem more attractive. On the other hand, the rapid extinction of Terahertz waves opens the way for information exchange between closer objects, which can play an important role in the fight against terrorism [3].

In 1986, Bednorz and Müller discovered high-temperature superconductivity in some ceramic composite materials [4]. About a year later, they were awarded the Nobel Prize. One of the most promising materials is BSCCO. After this incident, a more intensive study and investigation of this substance began. As a result of such research, it became clear that there are tens of

3.Conclusion

The author has many years of experience in chaos synchronization. In particular, its chaotic synchronization between Josephson contacts and in

thousands, even hundreds of thousands of Josephson contacts in this article and articles close to it. In the schematic representation of Josephson contacts, an insulator is usually understood between the two extreme conductors. But in a broad sense, this insulator can be replaced by a metal or another superconductor. In BSCCO, the superconducting layer is CuO_2 and the insulating layer is Bi_2O_2 . Fortunately, Josephson contacts can generate beams in the Terahertz range. But the received power is in the maximum nanoWatt (nW) range. If we take into account that there are 10,000s of Josephson contacts in high-temperature superconductors, and the power received in the mode of synchronization of these contacts is directly proportional to the square of the number of tens of them, then in such materials ($T_c \approx 90 \text{ K}$; BSCCO (BiSrCaCuO) and its modifications) adequate power for application You can buy Terahertz beams with

Exactly, $1 \text{ nW} \times (10^4)^2 \approx 0.1 \text{ mW}$. This is the power that a material with a size of about a few micrometers can give. The superscript is written because Josephson contacts at such a small size are usually coherent [5]. During synchronization of coherent sources, the power is directly proportional to the square of the number of such sources. This event is also classified as Super radiation in the literature.

its network can be noted in recent years. The author's work in this field (together with co-authors) has been published in a number of prestigious SCOPUS and Web of Science journals.

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The Role of Automation in Power Systems

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Abstract: This article analyzes the fundamental role and importance of automation in the energy sector. Automation is a crucial tool for managing and controlling various processes in the energy industry, enhancing energy efficiency, and ensuring the stability of energy systems. The article highlights the key areas where automation has evolved in the field of energy and discusses new perspectives on technology, energy security, and improving energy efficiency. Automation is a critical component for the rapid and effective development of the energy sector, and the article provides an important insight into the efforts and achievements made in this field.

Keywords: Automation, Energy security, Energy industry, Improving energy efficiency, Energy infrastructures, Utilize.

1.Introduction

This article analyzes the fundamental role and importance of automation in the field of energy, associating it with various future perspectives on changes and developments in the energy sector. [2,7,13,21-36] The impact of automation on the energy sector has expanded into various areas such as enhancing energy security, improving energy efficiency, and promoting innovations in energy systems. The article highlights how automation plays a significant role in making energy infrastructures more intelligent and efficient, along with emphasizing its importance in conjunction with other technologies and development features in the energy sector.

Monitoring and controlling the main energy systems become safer and more efficient through the application of automation. The operational principles of energy automation systems are thoroughly analyzed to ensure the development and improvement of energy infrastructure. Automation systems contribute to enhancing the economy, speed, and accuracy in energy systems, helping to utilize energy resources more rapidly and securely for society and entrepreneurship. [17,32,33,65]

The article provides examples of independent research, practices, and strategies related to the roles of automation in the energy sector. It clearly demonstrates how crucial the development of automation in the energy sector is and illustrates the strategic position of improvements in this field.

Strategic plans aimed at achieving extensive improvements and advancements in the energy sector have been prepared as an example, encompassing strategic goals for the automation of energy networks and the management of energy production.

[1,45,66,70-72]. These strategic plans aim to achieve effective development and success on a global and local scale in the energy sector. These plans ensure the active use of technologies and automation systems in the energy sector, enabling higher levels of performance and efficiency in the areas of effectiveness and management in the energy sector.

This strategy ensures international and local collaboration for the progress and acceleration of energy. [10,23-57] The development of automation technologies and the cost-effectiveness of technical innovations in the energy sector ensure the rapid, safe, and efficient production and management of energy supplies. This, in turn, stimulates the development of the energy sector and contributes to achieving strategic goals.

Investment Efficiency Increasing the investment efficiency of organizations and institutions in the energy sector through the application of automation technologies for optimal management of the energy system and improvement of energy production.[8-42]

Energy Security Enhancing energy security through the application of automation, improving emergency and independent operation functions, and protecting energy systems from potential hazards.

Automation of Management and Monitoring Improving the effectiveness of applied strategies and decisions through the automation of management and monitoring processes in energy facilities.

Application of Renewable Energy Technologies Playing a role in renewable energy directions, such as power block management, and optimizing energy usage in energy systems through the application of automation technologies.

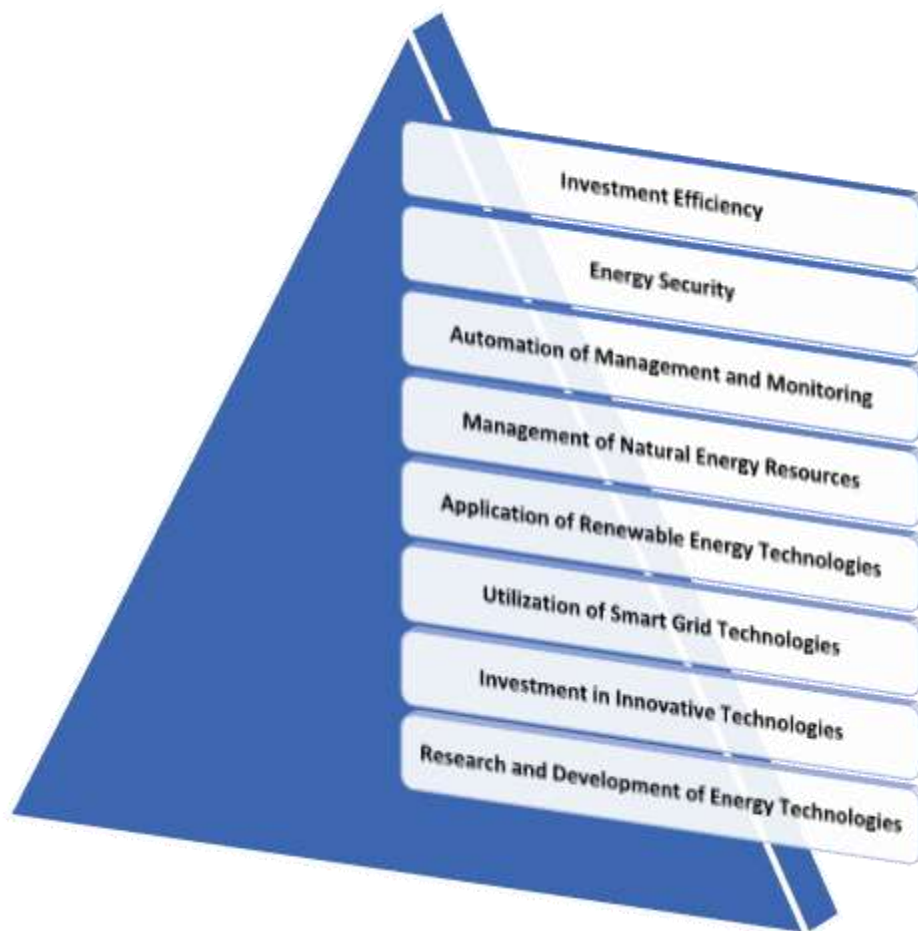


Fig 1. The Role of Automation in the Energy Sector - Strategic Objectives.

Management of Natural Energy Resources More effective and efficient management of natural energy resources through the application of automation-enabled technologies.[60,69-72]

Utilization of Smart Grid Technologies Enabling energy grids to be more agile, efficient, and intelligent in the energy sector through the application of smart grid technologies facilitated by automation.

Investment in Innovative Technologies Enhancing competitive advantage in the energy sector by investing in innovative automation technologies and algorithms.

Research and Development of Energy Technologies Providing more support for research and development projects to further advance automation technologies in the energy sector.[19-28]

In Figure 1, it helps to demonstrate the role and objectives of automation in the field of energy from a strategic perspective. Automation is one of the technologies applied to effectively control and

manage energy systems, processes, and technologies in the energy sector. [33-38] Research conducted in this field aims to achieve goals such as increasing energy efficiency, reducing energy consumption, and ensuring the overall security of the energy system. Below, detailed information is provided about the role of automation in the energy sector and research methods:

Role of Automation in Energy Systems:

Automation is employed for the automatic control of processes, devices, and transportation in energy systems.

It is used to achieve effective control of processes for the improvement of energy efficiency.[54,59,61-70]

Smart Grid Technologies:

- Smart grids are among the latest technologies where automation is utilized to manage energy production, transportation, and consumption efficiently.[27]

- Through automation, energy grids can be managed more effectively and efficiently.

2.Experimental details

Table1. Reserch metods analysis

Methodology	Description
Modeling and Simulation	A method used in the research of energy systems and the determination of optimal control strategies.
Artificial Intelligence (AI)	AI is used in the energy sector for prognosis, management of energy supply, optimal maintenance, and other related areas.
Sensor Information Technologies	Collection of information and control in energy systems through sensor technologies.
Optimization Methods	Mathematical and statistical methods used to determine optimal operating modes in energy systems.
Energy Management and Control Systems	Automation systems applied for the automatic control and monitoring of energy systems.

These methods and technologies play a significant role in increasing energy efficiency and the development of automation in the energy sector.

3.Conclusion

Automation plays an independent and important role in energy systems. This result emphasizes the significance of automation in the field of energy. In the energy sector, automation is used in the efficient management and monitoring of processes, systems, and equipment. This ensures more effective operation of energy facilities, as well as the improvement of energy efficiency and safety. The role of automation in energy systems ensures the acceleration of research and development in the energy sector, the protection of energy security, and the optimal realization of energy production. This facilitates the application of more innovations and technologies in the energy sector. Through automation, energy systems are more monitored, coordinated, and responsive to energy demands. This result underscores that automation is a fundamental element of modern and efficient management in the energy sector. When automation is applied, energy systems become faster, more efficient, and safer, contributing to further advancements and developments in the field of energy.

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Study of the dependence of the mechanical properties of the iron coating layer obtained on the surface of the friction joint details of flat drawers under cold electrolyte conditions on the composition and regime

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Abstract: In the research work, the study of the dependence of the mechanical properties of the iron coating layer obtained under cold electrolyte conditions on the surface of the friction junction details of the armature drawers applied in the oil-gas and chemical industries was brought to the fore. The use of cold and hot electrolytes has already been optimized in research work. It was found that the iron current densities have different characteristics. The most convenient and effective medium concentration electrolytes are considered. From this point of view, the electrolyte is stable during operation and almost does not require correction of the composition due to the amount of potassium salts. Sulfate electrolytes are recommended for iron parts working at high temperature (400-500⁰ C). In this mode, a thick coating is obtained for the working details. Productivity increases 10-15 times due to reduction of polarization of electrolytes and high current density during the ironing process. Using cold electrolytes also gives the most favorable results. Because these electrolytes are less aggressive and very useful for working time. It was determined that the fertilizing modes directly affect the hardness of the coating layer, and the increase of the hardness of the iron coating occurs due to the effect of the tension of the internal tensile layer. By studying the dependence of the strength limit on the number of cycles, it has been shown that the coating does not slip or slip from the base metal. The fatigue limit was the same in the samples annealed in the three studied electrolytes. The difference in reduction was 3-5%.

Keywords: Armature drawers, Friction junctions, Saddle, Cold electrolyte, Current density, Brazing, Modes, Coating, Mechanical property, Microstructure.

1.Introduction

One of the main goals of the current iron-making process is the creation of a hard, non-corrosive iron coating on the surface of the parts working in different conditions from hot chloride electrolytes. The process of forging is aimed both at increasing the corrosion resistance before working on the surface of the detail and at compensating the corrosion during repair [1].

Ironing process has the following advantages compared to the chroming process of the detail surface: the high yield of metal on current is 85-90% (5-6 times higher than chroming); the rapid acquisition of cover; also obtaining 0.3÷0.5 mm/h during the process in stationary electrolyte (10-15 times more than chrome plating); high corrosion resistance of the coating (not less than steel 40, 45); hardness HB=200-650 MPa in coatings with a thickness of 1-1.5 mm and more makes it possible to obtain simple and inexpensive electrolytes. Such achievements of the forging process are explained by its wide application in car repair [2].

Repairing by soldering or creating a coating on the surface is based on the deposition of metal from an aqueous solution (electrolyte) on the surface of the

part. The most appropriate method is performed on the surface of the detail for the first time and if the size of the bite is up to 1 mm. Usually, if it is deposited from an electrolyte with a temperature of 60-80⁰C, the detail does not swell. The possibility of obtaining a pure iron coating from a solution (electrolyte) containing 200-300 g/l iron dichloride (FeCl₂) and 1-1.5 g/l HCl acid has been fully revealed [3].

The use of cold and hot electrolytes for ironing has already been optimized. However, they have different characteristics according to current densities. Hot electrolyte allows operation at significant current density, but requires a large amount of additional energy for heating. At the same time, special deficit materials with chemical resistance are required to make the equipment. At the same time, the presence of aggressive solutions creates special cases. Medium concentration electrolytes are considered the most convenient and effective. Composition: It consists of (400±200) kg/m³ FeCl₂ · 4H₂O, (2±0.2) kg/m³ HCl and (10±2) kg/m³ MnCl₂ · 4H₂O. This electrolyte is stable during operation and almost does not require composition correction due to the amount of basic salts [4]. Obtaining a smooth, shiny deposit from

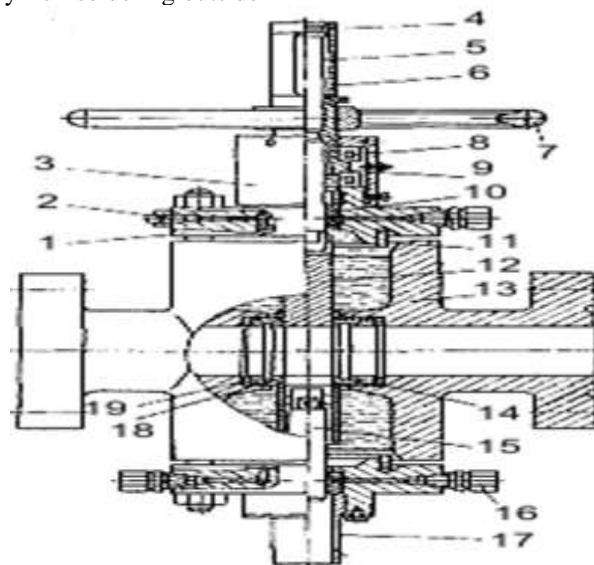
sulfated electrolytes is more pronounced. The deposited layer is distinguished by its hardness and fragility as needed. This is explained by the characteristic properties of the iron coating obtained from the cold sulfate electrolyte. Sulfate electrolytes are mainly used to increase the corrosion resistance in cases where the iron layer is not so much. In the preparation of such electrolytes, the dissolution of all components is obtained and they are introduced into the working bath by passing through a filter.

The process of creating a coating in forging is performed in steel baths, and its inner surface is covered with an acid-resistant material. It is known that chlorine electrodes are highly aggressive. The inner surface of the bath is lined with resin-impregnated graphite plates. Since such coating materials have good thermal conductivity, it allows heating of the electrolyte in such baths with a water jacket. Baths are also made of taolite material. This material is highly acid-resistant, but has low thermal conductivity. Therefore, a heater placed in the electrolyte is used to heat the electrolyte to the required temperature [5].

Ironing the working surface of details of different constructions and sizes sometimes creates certain difficulties in baths. In particular, when increasing the hardness, corrosion resistance and fatigue strength limits by surface ironening, the part itself or the working part is placed in the core of the electrolyzer. It is performed by flux soldering outside

the electrolyte bath. In this case, the electrolyte is pumped into the electrolysis core with the help of a pump, and the surface of the part is covered with iron or the eaten part is restored. An anode is placed between the surfaces to be ironed. This method is considered one of the most modern methods.

The saddle and shield used in the armature drawers (Figure 1) were chosen as objects in the research work. In the working nodes of the drawer, the details of the saddle and shield (picture 2) are exposed to friction on the head surfaces. There are signs of eating on the faces shown. These details can be ironed in two directions. The first is to iron the head of the details in advance and get a quality surface layer, and the second is to restore the eaten areas by ironing. The material of the drawer details should have properties such as resistance to general corrosion, resistance to various sulfur compounds, technology, surface corrosion resistance [6]. Therefore, the surface of the joint details working on friction should be covered with different methods of iron. Here, the influence of technological factors in ensuring high adhesion quality of the layer and obtaining stable results should be brought to the fore. The basis of the study is the study of the adhesion strength of the electrolytically deposited iron layer to the base metal, corrosion resistance, fatigue strength, hardness [7].



Picture 1. 1. Direct-flow valves of ZMS1 types: 1 - cover; 2 - discharge plug; 3 - bearing cover; 4 – adjusting washer; 5 - spindle; 6 - upper casing; 7 - flywheel; 8 - thrust ball bearing; 9 - running nut; 10 - oil seal assembly; 11 - gasket; 12 - gate; 13 - body; 14 - output saddle; 15 - rod; 16 - discharge valve; 17 - lower casing; 18 - inlet saddle; 19 - disc spring



Figure 2. General view of saddle and shield .

2.Experimental details

In the research work, the issue of obtaining high properties is solved by creating an iron layer on the surface of the saddle detail, which is one of the pair of friction and wear (Fig. 3) at the friction junction in the drawers prepared for operation, instead of

restoring the surface of the worn detail. Pre-ironing does not allow obtaining the defects shown in figure 4. Post-defect recovery technology shows its complex nature. The steel 40 material without surface hardening was selected (comparison was made with steel 45).

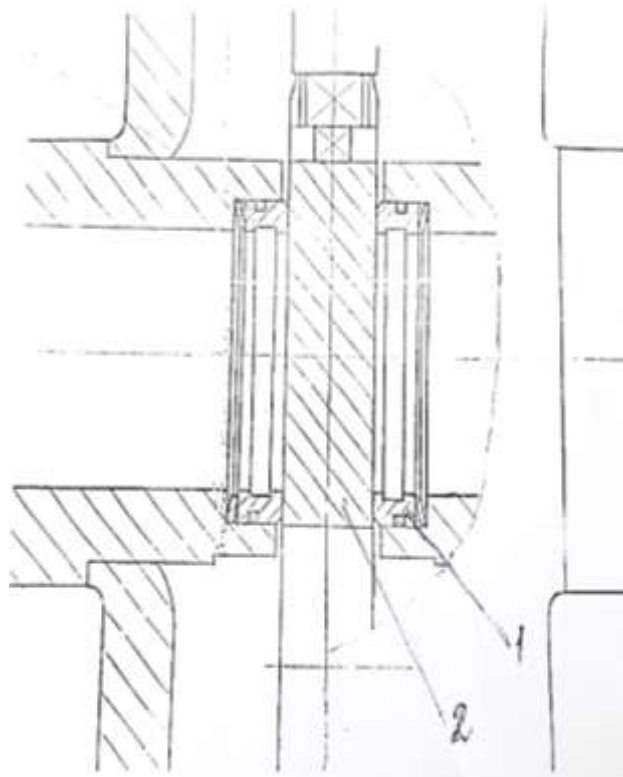


Figure 3. View of the working node of the drawer: 1-saddle; 2-shield



Figure 4. General view of the drawer shield cut from the defective area

In the first case, the mode of fertilizing and the composition of the electrolyte were selected. The composition (in g/l) of the selected cold sulfate electrolyte consists of:

Iron sulfate 200-250 Temperature, °C – 15-20

Potassium sulfate 100-150 Current density, A/dm² – 3-9

Oxalate 1-4

Sulfate electrolytes are recommended for iron parts working at high temperature (400-500⁰ C). In this mode, a thick coating is created for working details. The electrolyte composition (g/l) was taken as follows:

420 FeSO₄ · 7H₂O; 100 Al₂(SO₄)₃ · 18H₂O;
Electrolyte temperature 20-70C, current density 3-5 A/dm², acidity pH=2.5-3.

One of the most convenient methods is cold chlorine electrolyte. The content of such an electrolyte (in g/l) was taken as follows:

600-700 FeCl₂ · 4H₂O, 100-150 NaCl (HCl); 15-30 MnCl₂ · 4H₂O and 0.5-2 ascorbic acid. Electrolyte temperature 20-40⁰ C, current density 20-30 A/dm², acidity pH=1.5-3.

To prepare the sulfate electrolyte for iron, all components are dissolved, mixed and filtered before being fed to a special core for the saddle, and then fed to the electrolysis core.

The working scheme of the electrolysis core for forging is shown in figure 5. Ironing of the working surface of the saddle, which is the most important detail of the working node of the drawer, is performed in this core. They use high-quality low-carbon steels as anodes in the core. Steel 40 was selected in this research work. Productivity increases 10-15 times due to the reduction of electrode polarization and application of high current density during the iron-making process.

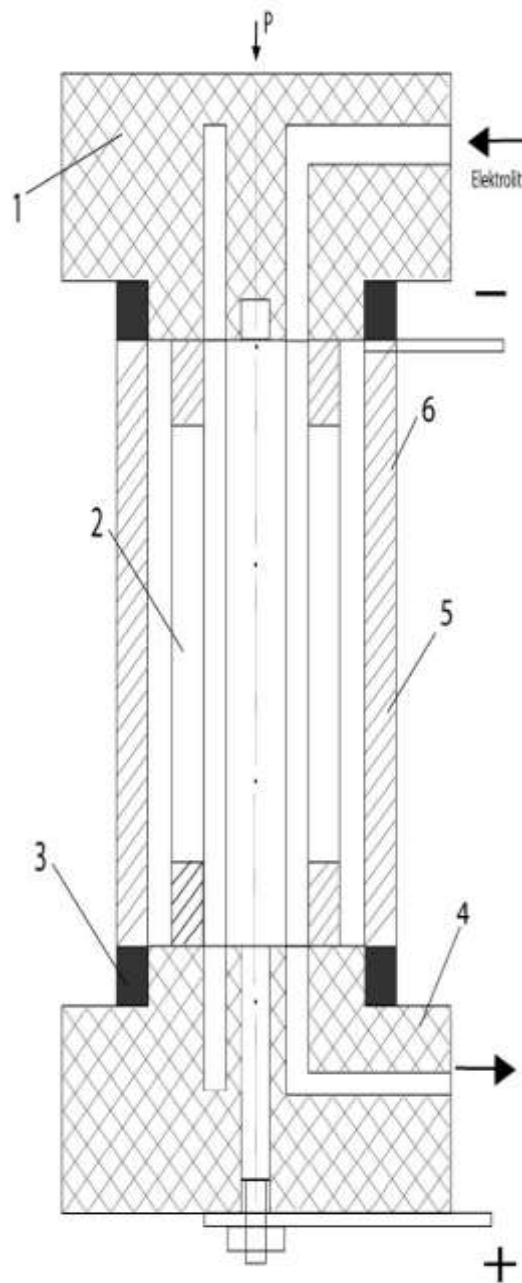


Figure 5. Working scheme of the electrolysis core for ironing the saddle detail in the drawer: 1-upper plate; 2-anode; 3-compacting rack, 4-lower plate; 5-saddle; 6-core body

According to GOST 9012-59 (ИСО 410-82, ИСО 6506-81), details and hardness of samples, the study of the microstructure was carried out in the "Neophot-21" brand optical microscope. Fatigue strength under laboratory conditions was performed

on a KTS 405 rotational bending test machine (Figure 6). Fatigue testing of reinforced samples and details was carried out for a maximum of 10×10^6 cycles [8].

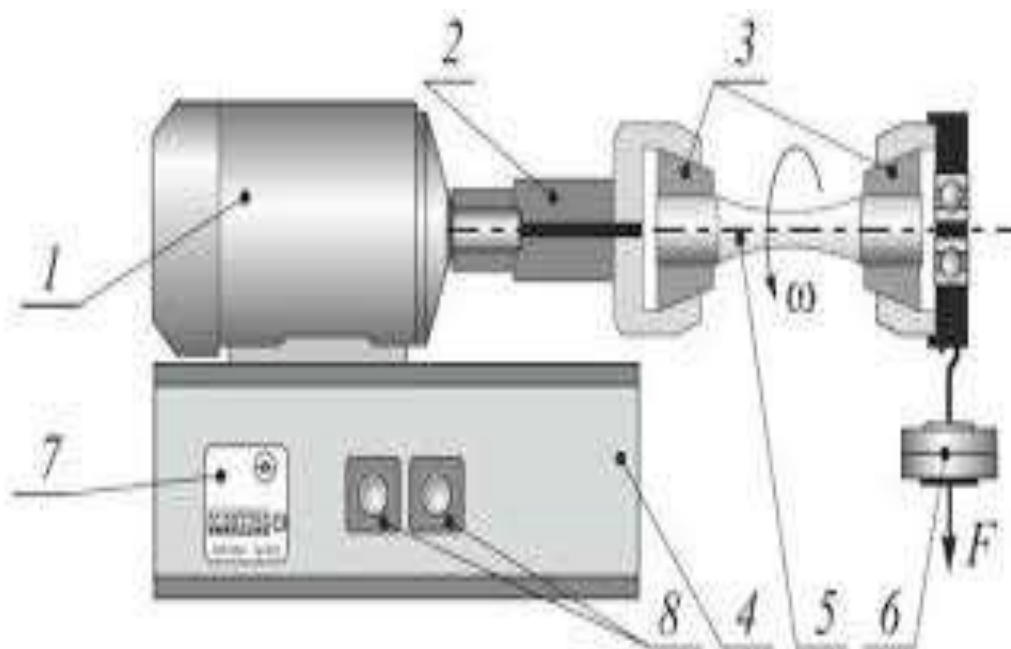


Figure 6. General view and scheme of the testing machine: 1 – electric motor, 2 – spindle head, 3 – holders, 4 – cast iron body, 5 – tested sample, 6 – variable loads, 7 – cycle counter, 8 – control panel

Studies have shown that cold electrolytes are the most beneficial for both resurfacing parts and pre-ironing the surface of in-service parts. Because the aggressiveness of these electrolytes is low and they are very stable due to working time. Depending on the conditions of electrolysis, the structure, hardness,

plasticity, and even appearance of the deposited iron layer vary widely.

As a result of the study, it was confirmed once again that cold electrolytes allow deposition at a speed of 200-350 $\mu\text{m/h}$ and provide a hardness of HB 600-700 (content FeCl_2 , NaCl (KCl), MnCl_2 and ascorbic

acid). A temperature change of 20-40° C in the electrolyte causes the current density to reach the limit of 20-30 A/dm². Here, ascorbic acid protects the electrolyte from oxidation and allows the formation of thick coatings, causing the formation of the same name (dimensional) dispersed structure. The addition of NaCl and MnCl₂ to the electrolyte increases the electroconductivity of the electrolyte. In addition, the thickness of manganese chloride allows to obtain a plastic coating up to 2-3 mm.

In addition to this process, anodic treatment in 25% sulfuric acid solution reveals the crack network and creates a porous coating.

As can be seen from Figure 7, the hardening modes directly affect the hardness of the coating layer. Increasing the hardness of the iron coating occurs due to the effect of internal tensile stresses. When the hardness is 300 kgq/mm² and due to the increase of

internal tension, there may be cases of coating disintegration. For this reason, using a cold electrolyte, a low voltage due to the effect of a low current density at a low temperature ensures the necessary hardness and brittleness. If more severe (high current density and low temperature) regimes are used, the resulting coating will have greater stress, higher hardness and brittleness.

One of its best features is easy cleaning and inspection. The low-temperature process cannot have a thermal effect on the base metal of the parts being ironed. The disadvantage of forging is the formation of a crack. The reason for this is that the hardness of the coating is HRC 38-40 (HB 350-360). Therefore, if the detail mark works for variable loading, its hardness should not exceed HB 200, and the subsequent hardness should be done by tabling or cementing.

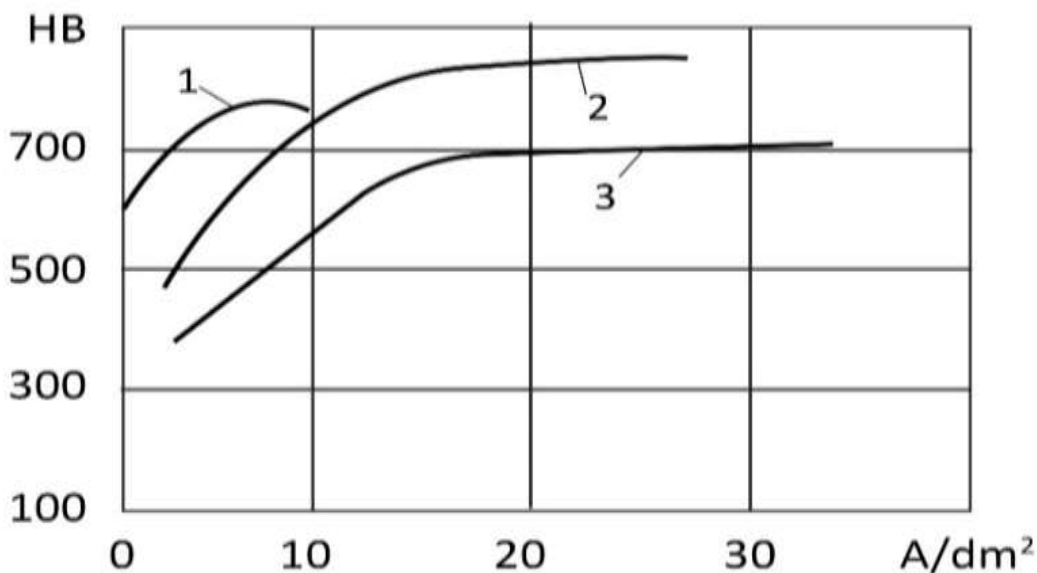


Figure 7. Effect of fertilizing regimes on the hardness of the coating layer (iron chloride content 600-700 g/l): 1 – 20° C; 2 – 30° C; 3 – 40° C

The static tests of the saddle detail made of Steel 40 after being ironed before operation are a drawback for investigating the adhesion strength of the iron coating to the base metal. Thus, the forces affecting the details of the saddle and shield, applied for the real conditions of operation, can change their value according to their quantities and directions. Among the details, depending on the operating conditions, friction and corrosion are more characteristic. In addition to static tests, determining the adhesion quality of the coating to the base metal is one of the most important tests.

Thus, the determination of the fatigue limit under the specified conditions and according to the given methodology was carried out by comparative tests on ordinary and hardened samples, the obtained results are shown in figure 8. In this graph, the dependence of fatigue strength on the number of cycles in normal and hardened samples is studied. Observations made after the test showed that there was no delamination slippage of the coating from the base metal.

The fatigue limit of 195 MPa is achieved in the 10x10⁶ cycle in non-reinforced (uncoated) samples (Fig. 8 curve 1). The fatigue limit of surface hardened samples is 175 MPa in 10x10⁶ cycle (Fig. 8 curve 2).

The main reason for the reduction of the fatigue limit by 10-12% is the generation of internal tensile

stresses in iron and electrolytic coatings.

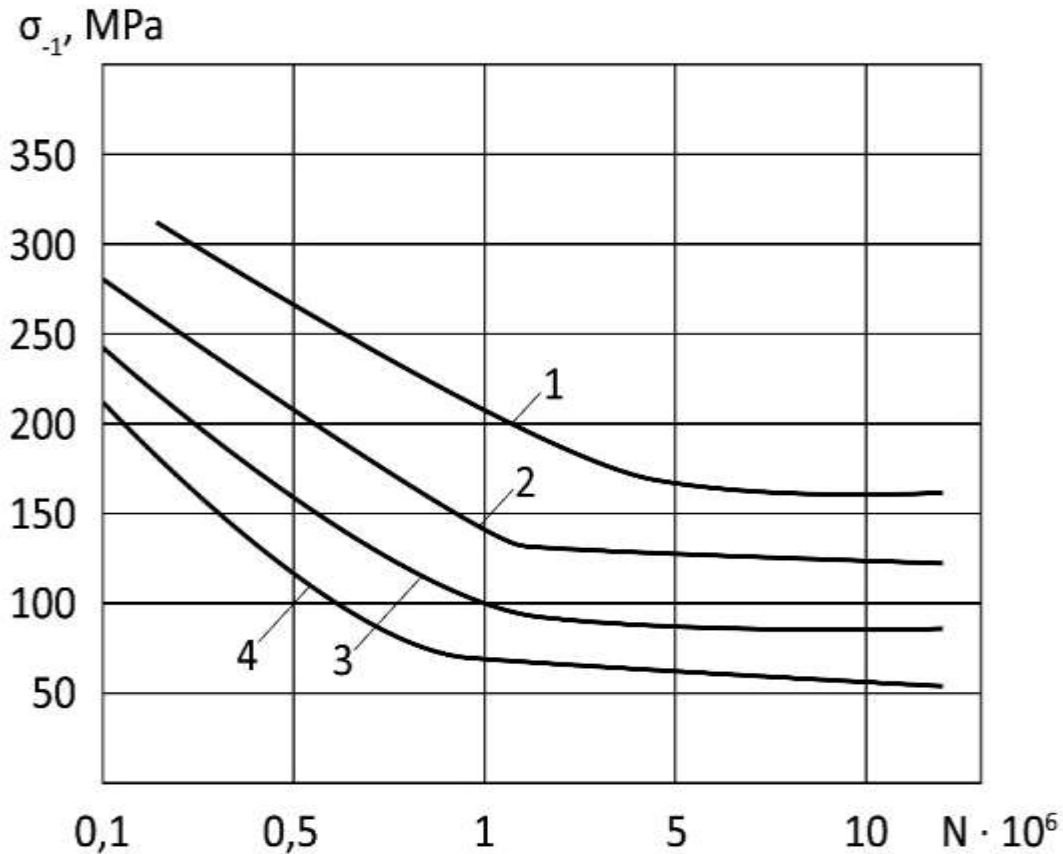


Figure 8. Dependence of the fatigue strength limit on the number of cycles: 1 - ordinary (unreinforced) sample; 2- ironed sample (600-700 g/l – FeCl₂); 3- ironed sample (420 g/l – FeSO₄); 4- ironed sample (200-250 g/l – FeSO₄)

Electrolytic coating is characterized by high corrosion resistance. The results of the research prove it by the high hardness and the main features of the structure. Usually, the small needle-like structure (Fig. 9) is highly preferred. In addition, the oxide film affects the corrosion resistance of the coating, i.e. its increase. This film is formed during the friction process on the coating surface and has effects similar to lubrication.

In order to study the dependence of the fatigue strength limit on the cycles, the results obtained in the average value of the electrolyte and current

density show that each of the three selected compositions get lower values than the unhardened samples. It is clear from this that high current density at low temperature is one of the main reasons for the increase in hardness when iron chloride and iron sulfate of different contents are ironed in electrolytes, which increases the tensile stress in the iron electrolytic layer and the fatigue strength limits are less than non-ironed samples. As can be seen from the figure, the fatigue limit of samples ironed in all three electrolytes varies with the same regularity. The difference in their reduction is about 3-5%.

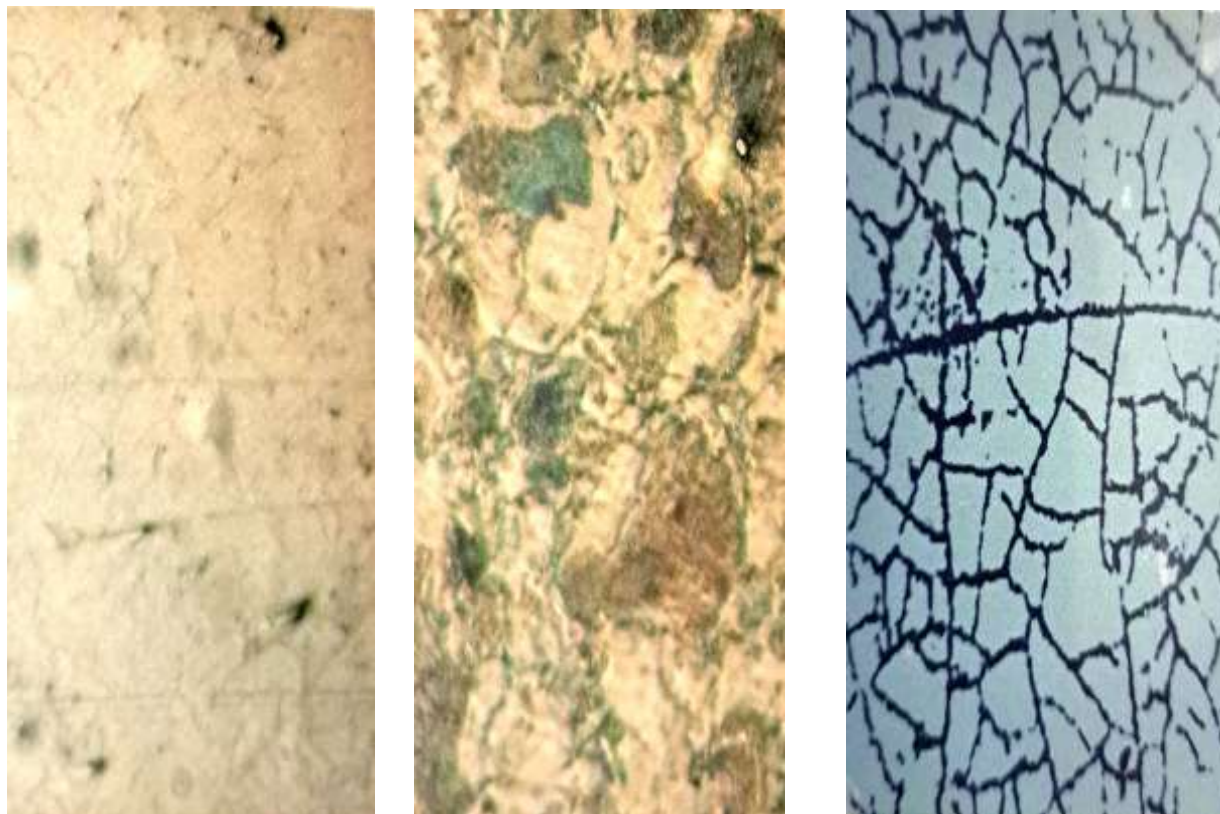


Figure 9. Surface microstructure of tempered steel: unetched and etched microstructure of non-annealed steel, respectively; microstructure of surface hardened steel

3.Conclusion

The use of cold and hot electrolytes is optimized for steel surface hardening.

From the appearance of different characteristics according to the density of the current, it was clear that a large amount of additional energy is required to heat the hot electrolyte, and the presence of aggressive environments creates special cases.

When using cold electrolyte in the study, due to the effect of not high current density at low temperature, not too large voltage provides the necessary hardness and brittleness.

It was clear from the study that the high hardness and the main characteristics of the structure proved the high corrosion resistance of the coating.

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It has been found that high current density at low temperature during ironing in electrolyte with iron chloride and iron sulfate of different composition is one of the main reasons for the increase in hardness.

It was determined that the limits of strength in fatigue are less than those of non-hardened samples.

The revealed needle-like structure is shown with great preference, which increases the resistance to pilling.

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