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# Management of education in Azerbaijan

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**Abstract:** The management of education in Azerbaijan encompasses all aspects of strategic planning and organization in the field of education within the country. This source includes various measures and processes aimed at effectively managing the education system in the country. The management of education is implemented at multiple levels, including internal and external education composition, institution management, coordination among institutions, program provision, student supervision and assessment, and the application of education technologies. The management of education in Azerbaijan is based on directives set by the state, such as the National Education Strategy and State Education Standards. These strategic documents aim to improve the quality of education, enhance students' skills, and contribute to the country's development. In the education management process, institutions established by the state, such as the Ministry of Education, higher education institutions, secondary education institutions, and vocational training organizations and universities, have authority. These organizations monitor the quality of education, ensure consistency among institutions, develop education programs, and promote student development. The field of education management in Azerbaijan is constantly evolving and open to innovations. The focus is on enhancing the quality of education in the country, providing students with broader opportunities, and developing an education system that meets international standards.

**Key words**: Ministry of Education, Education policy, School system, University education, Teaching process, Student selection, Teacher appointment, Information technologies, Education quality, Scientific research, Education innovations.

## 1. INTRODUCTION

Main aspects of education management in Azerbaijan:

1. **Centralized Organization:** The Ministry of Education of Azerbaijan constitutes the basis of centralized organization. This ministry is responsible for shaping education policies, determining programs, and overseeing the general management of educational institutions.
2. **Education System:** The education system encompasses primary education (schools), secondary education (colleges), higher education (universities), and vocational education (training centers). It includes transition rules between these levels and the selection of education paths for students.
3. **State Standards and Programs:** State standards and education programs determined by the Ministry of Education regulate the education process in educational institutions. These standards and programs help ensure consistency and quality education across institutions.
4. **Teacher Preparation:** It is essential to prepare and improve teachers to provide quality education in educational institutions. Teachers play a fundamental role in ensuring the quality of education and maximizing the benefits of the learning process for students.
5. **Assessment of Students:** The process of ssessing students' knowledge and skills plays a crucial role in measuring the effectiveness of education. Institutions evaluate students' learning through exams, tests, and projects, confirming the quality of graduates' education.

**Central Organization:** In the Republic of Azerbaijan, the management of education is primarily based on central organization through the Ministry of Education of Azerbaijan. This central organization establishes a framework for strategic planning and organization of education in the country. This central institution ensures coordination and supervision of measures, projects, and development directions in the education sector. The Ministry of Education of Azerbaijan plays a leading role in the formulation and implementation of the country's education policy. This ministry prepares strategic plans and coordinates the activities of executive bodies in the education sector to achieve the goals set by the state in an effective manner. The Ministry of Education monitors the development of the education system and plans measures to improve the quality of education. Within this framework, it determines the curriculum, programs, and standards at various levels of education. It also provides guidance for the introduction of innovations in educational materials, technologies, and teaching methods. The Ministry of Education of Azerbaijan ensures effective communication and supervision between educational institutions and students. It organizes various training and support programs for students to maximize their benefits from the education process. Through central organization, effective communication across all areas of education nationwide and better supervision of students is achieved. This central organizational model enables Azerbaijan to implement its strategic planning, organization, and control of the education sector more efficiently and effectively. Therefore, the Ministry of Education of Azerbaijan plays a crucial organizational role in developing and improving the quality of the country's education system.

**2. Education System:** Primary, Secondary, Higher, and Vocational Education in Azerbaijan

The education system in Azerbaijan has an organized structure covering different levels. This education system combines primary education, secondary education, higher education, and vocational education within itself.

⇒ Primary education level ensures that children receive education during their school years. During this period, students learn the most fundamental knowledge, skills, and societal topics. Primary education is the most common and fundamental education level in the country, and all citizens have the right to education at this level.

⇒ Secondary education follows primary education and provides students with more specific and modern knowledge. Schools operate at this level, catering to students specializing in different fields. During this period, students acquire broader skills in various subjects, arts, and sports fields.

⇒ Higher education ensures the academic and scientific development of students through universities. Universities offer education opportunities in various fields, allowing students to delve deeper and extensively into a specific area. Education at this level directs students towards a more specific career path.

⇒ Vocational education is provided by training centers for practical skills and professional fields. This education level prepares students to learn a specific profession and provides them with practical work experience.

All these education levels combine to form the education system of the Republic of Azerbaijan and provide citizens with opportunities to receive education in various fields. These four levels constitute a rich and diverse spectrum of education in the country.

**3. State Standards and Programs:** In Azerbaijan, State Standards and Programs play a significant role in the administration of education.

These standards and programs help ensure the fair and effective implementation of the education process in educational institutions.

- State Standards set minimum requirements to ensure the quality of education in educational institutions. These requirements aim to assist institutions in developing education programs and successfully educating students. The education content determined by State Standards enables the clear and understandable designation of programs and teaching materials.
- Education Programs are structured plans that provide students with essential knowledge and skills to be learned during the education period. These programs combine specified content and teaching methods for each education level, ensuring that students acquire the necessary knowledge, products, and skills to respond to various situations in specific fields.

State Standards and Programs aim to provide equal and inclusive education in the education system. This ensures that different student groups in various education levels and institutions receive education based on the same standards.

Below, Table 1 provides detailed information about state standards and programs in Azerbaijan's education sector:

**Table 1. State Standards and Programs**

| Category | Description |
|---|---|
| **State Educational Standards** | These standards determine the content and skills that students will learn at various educational levels (school, college, university, etc.). |
| **Teacher Assignment Standards** | These standards define the requirements and skills that teachers working in educational institutions must possess. |
| **Professional Development Standards** | These standards specify the knowledge, skills, and experience necessary for professional development. They are applied to individuals working in various fields. |
| **Education Programs** | These are education plans organized by institutions. These programs determine the subjects, courses, and curriculum that students will learn. |
| **Student Direction Programs** | These documents plan the implementation of education for students. These programs specify the content and experience that students will acquire. |
| **Education Institutions' Programs** | These are education programs prepared by institutions. These programs determine the subjects and teaching methods taught in the institution. |
| **Professional Education Programs** | These are programs organized in various fields for professional development and education. These programs ensure the development of professional skills and knowledge. |
| **Education Development Programs** | These are programs that support the development of specialized education professionals, teachers, and administrators in the education field. |

These state standards and programs ensure the effective organization and development of education within the framework of standards and requirements determined by the state in the field of education. These standards and programs aim to provide students and stakeholders in the education sector with higher quality education and development opportunities.

Teacher Preparation - In Azerbaijan, the preparation of teachers constitutes one of the key factors for the effective and quality implementation of the education system. Teacher preparation is the foundation for establishing an education system capable of ensuring students' development, applying innovative teaching methods and technologies, and enhancing the quality of education.

The process of teacher preparation is determined in a manner that aligns with modern regulations and standards in the education sector.

This process reflects the training of educational personnel at a level that will ensure better understanding of instructional and methodological aspects of education by students. This is implemented at various levels from educational institutions to universities.

Teacher preparation may include various training programs aimed at providing teachers with innovative teaching methods, technologies, and materials for education. These programs provide practical information such as effective teaching strategies, nuances of preparing interactive lessons, methods, and technologies for individual approach among students.

The process of teacher preparation encompasses the development of both pedagogical skills and the excellent application of teaching technologies. It is a developmental and improvement process conducted with the aim of providing students with better educational opportunities and maximizing students' individual potential. Table 2 describes different training and development methods used for the preparation of teachers in Azerbaijan. These methods help enhance teachers' pedagogical skills, broaden student experiences, and gain international exposure.

**Assessment of Students:** One of the most crucial parts of the Azerbaijani education system is the assessment of students. This process is carried out to measure and evaluate students' progress in the educational and learning process. Student assessment is an important tool for understanding their learning, developing their skills, and evaluating the effectiveness of educational programs. Within the framework of the Azerbaijani education system, student assessment is implemented using various methods and tools.

**Table 2. Application of training and development methods for teacher preparation.**

| Aspect | Description | Source |
|---|---|---|
| **Teacher Preparation** | Provided through Education and Professional Development Committees, Teacher Training Centers | Ministry of Education |
| **Training and Development Programs** | Offered by Teacher Training Centers on pedagogy, methodology, and job execution issues | Teacher Training Centers |
| **Student Experience** | Obtained through student practice and working in various education centers, helps develop skills | Various Education Centers |
| **Support from Ministry of Education** | Assists in training teachers on pedagogical methods, teaching techniques, and technologies | Ministry of Education |
| **Student Internship Experience** | Obtained by teachers working with different students | Various Education |

| | | |
|---|---|---|
| | and schools | Centers |
| **Professional Training and Certification Programs** | Long-term education programs that ensure the development of pedagogical skills | Teacher Training Centers |
| **International Experience Exchange** | Teachers gain international experience through international programs and exchange projects | International Programs |
| **Online Training Resources** | Provides easy access to training resources via the internet and technology | Online Platforms or Resources |

These include written and oral exams, projects, laboratory work, research projects, training assignments, etc. These methods are used to compare and evaluate students' progress in various skills and knowledge areas. Student assessment plays a significant role in evaluating the quality of education provided to students by educational institutions and in restructuring educational programs. This process serves as an important source of information for measuring students' knowledge in subjects and evaluating their progress. Student assessment should be carried out objectively and fairly. This helps better understand students' potentials and skills. Objectivity, transparent stages, and clarity of evaluation criteria play a key role in student

## 2. CONCLUSİON

The management of education in Azerbaijan has undergone significant developments and changes in recent years. These changes include the improvement of education structures, restructuring teacher training, integration of technologies into the education sector, and raising standards in higher education institutions.
The main stages of education in Azerbaijan are general education, secondary education, and higher education. General education is the fundamental stage, providing education opportunities to students from an early age. Secondary education is a preparatory stage involving education in literature, mathematics, and science circles. Higher education encompasses students who have gained admission to universities. In recent years, with the increased integration of technologies into education, online teaching, electronic libraries, interactive education platforms, and other technological tools are widely used in the education process.
This provides students with broader information and teaching opportunities. Higher education institutions strive to provide education in line with international standards to enhance the quality of education in the country. This helps in the international recognition of diplomas held by students. Overall, the management of education in Azerbaijan has evolved and developed in recent years in an open format for innovations. This contributes to the country's prospects in the field of education.

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# Application of modern piezoelectrics in street lighting

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**Abstract:** The article is devoted to the efficient use of the energy obtained from the people and cars moving on the pedestrian crossings by turning it into electricity through piezoelectric generators in street lighting. The article provides information on energy produced from piezoelectrics, equipment used in lighting, and charging batteries with modern charging modules.

**Key words:** Piezoelectric generator, Pedestrian crossing, Battery, Comparator.

## 1. INTRODUCTION

Current technologies used in street lighting lead to increased lighting efficiency and automatic control without human intervention. In modern times, the use of alternative energy sources is also used in street lighting. Examples of these applications include solar and mechanical energy. Obtaining electricity from the intensive movement of people and vehicles on the streets has recently become an object of research. The most suitable option is to use piezoelectrics on streets and sidewalks to convert mechanical or step energy into electrical energy [1].
Dielectrics that produce an electric field as a result of mechanical deformation are called piezoelectrics. As a result of the external force F, the piezoelectric plate is deformed, polarization charges are created on that plate, and an electric field is formed there. This effect is called direct piezoelectric effect. The reverse of this process is also true and the resulting effect is the reverse piezoelectric effect.
However, it is not the only piezoelectric material that should be considered here that has sufficient output power. For this, the piezoelectric elements that will perform the function of the generator must be connected in series-parallel with each other and the corresponding parameters must be selected preferentially [2]. This application, which will be used in street lighting, is installed in pedestrian crossings where people are more intensive in the form of piezoelectric matrices. The resulting high-value output power is used to charge batteries. The lighting is intended for typical traffic signs located near pedestrian lanes, and this lighting uses a rechargeable battery or accumulator as the power source. Also, in order to increase the efficiency of energy consumption, in accordance with the day-night mode, lighting is planned to be carried out only at night, and a corresponding system has been developed for this.

## 2. EXPERIMENT DETAİLS

In this article, suggestions have been put forward regarding the recharging of the power source used in street lighting, as well as the productive use of the energy from human and traffic movement to obtain electricity from it. Piezoelectric generators are used to convert mechanical energy generated during human movement into electrical energy [3].
The equivalent circuit of the piezoelectric generator is presented in figure 1. High values of piezoelectric element capacitance and output voltage are required to charge the produced energy into batteries [4-10].
Also, the brand of the diode used in the rectifier circuit should be selected so that the voltage drop on the rectifier is less. After determining the battery to be used, the appropriate charging module required to charge them must be selected. At the same time, in order to save energy, it is required that the lights turn on at night and turn off automatically during the day without human intervention [1-11]. For the circuit elements used here to operate at low power, the components should be selected with appropriate parameters. We consider that this application used in street lighting is more efficient to be installed in pedestrian lanes where people are more active (Fig. 2).
The material of the piezoelectric element used to convert the mechanical energy obtained during movement into electrical energy should be selected in such a way that the value of its relevant parameters is high.

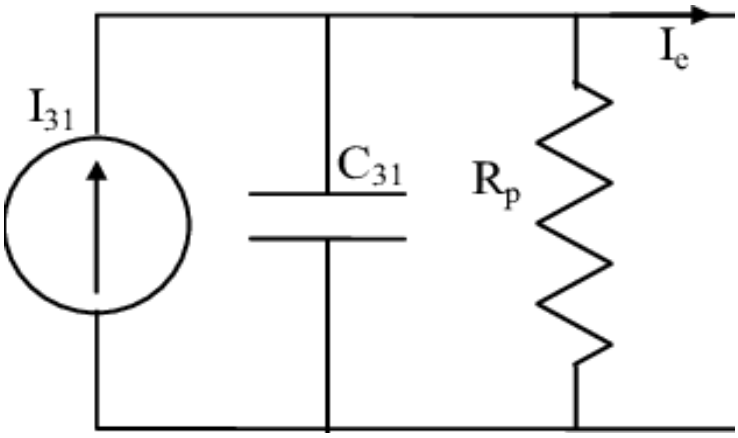


**Figure 1. Equivalent circuit of a piezoelectric generator**

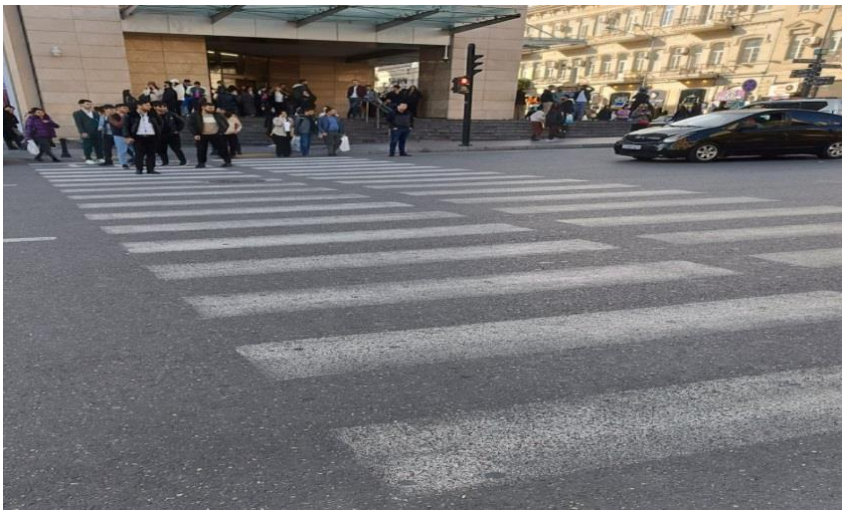

**Figure 2. Pedesterian crossing**

For this, it is considered appropriate to use PCR-73 piezoelectrics. PCR brand piezoelectrics manufactured from ceramic piezoelectric materials whose parameters are presented in table 1 are made by hot pressing method [4].

**Table 1.The main parameters of PCR-73 piezoelectric**

| Type of piezoelectric | $d_{33}$ | $g_{33}$ | $\varepsilon_{33}$ |
|---|---|---|---|
| PCR-73 | $860\times10^{-12}$ C/N | $16.1\times10^{-3}$ Vm/N | $531\times10^{-10}$ F/m |

The piezoelectric material to be used is disc-shaped and its diameter is d=20 mm and its thickness is h=0.3 mm. When the material is deformed, the output voltage varies depending on the mechanical force F applied to the piezoelectric element [4]

$$V_{out} = \frac{g_{33}Fh}{\pi r^2} \qquad (1)$$

Here $g_{33}$ is the electrical coefficient due to voltage; r = d/2. In the pedestrian crossing where the piezoelectric generator is applied, the width of each

lane is 30 cm, the length is 200 cm, and the number of lanes is 10.

Considering the areas of strips and piezoelectric elements, we can place 1000 parallel connected piezoelectric elements in one strip and 10000 in 10 strips (Fig. 3). Rectifier diodes to be used when rectifying the alternating current with a leap obtained from a piezoelectric generator should be selected in such a way that the voltage drop across them is small [5]. We achieve this by using 1N5820 series Schottky diodes. The voltage drop of this diode during forward bias is 0.475 V, and the maximum current it can release is 3 A. The stabilization voltage of the stabilitron at the output is 5.1 V (Fig. 4).

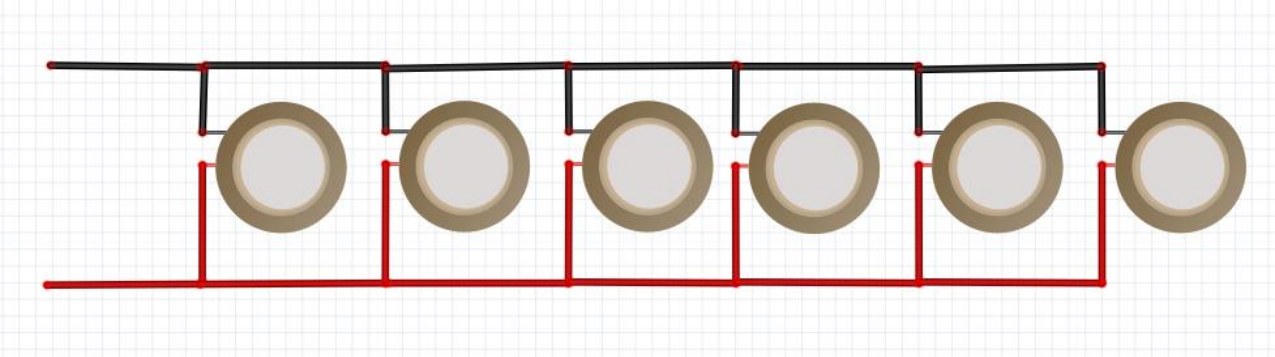

**Figure 3. Parallel connected piezoelectric plate**

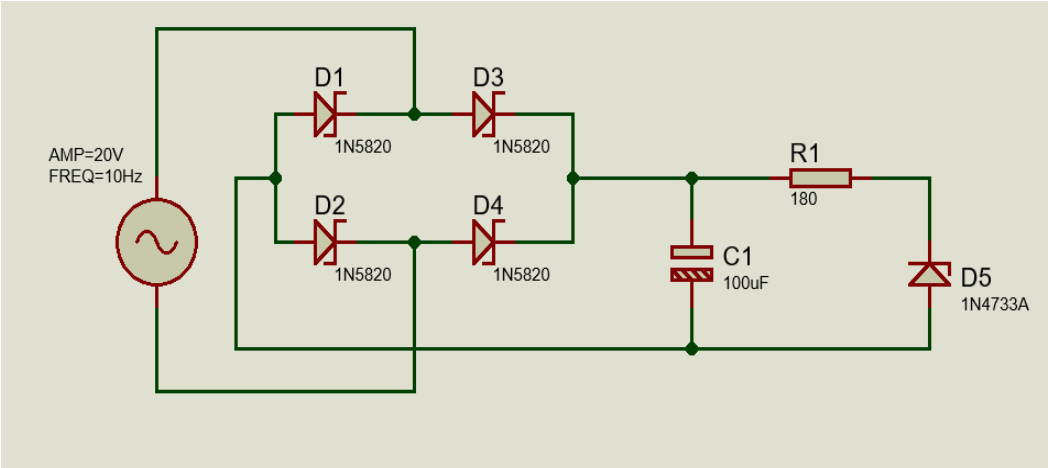


**Figure 4. Rectifier circuit on Schottky diodes**

Lithium-Ion batteries were used as the battery to be used in the street lighting (Fig. 5), and the capacity value was increased as a result of connecting several batteries in parallel to provide enough energy during the dark hours of the day. The module used to charge these batteries is the TP4056 charging module (Fig. 6).

Due to the protection circuits on the main feature of the use of this module, the failure of the battery as a result of supplying power to the output load at a low voltage after long-term operation is prevented.

New generation filament LEDs with high brightness at low voltage can be used for lighting (Fig. 7).

We consider it important to ensure that the lights automatically turn on only at night, prioritizing the increase of energy savings and the simplicity of the control circuit [6]. For this purpose, a comparator circuit was developed on the operational amplifier and photoresistor working at low currents presented in figure 8.

The two-channel OP282 series operational amplifier is capable of operating at currents below 250 µA. By using such an operational amplifier,

we achieve that the comparative circuit consumes less energy during clear hours of the day.

**Figure 5. Lithium-İon battery**

**Figure 6. TP4056 charge module**

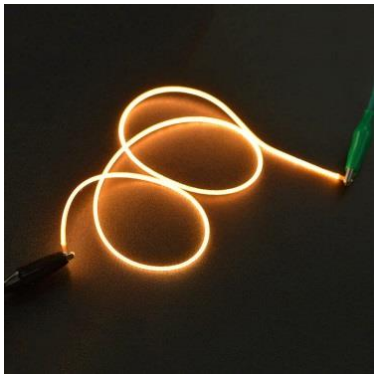

**Figure 7. Neon filament led**

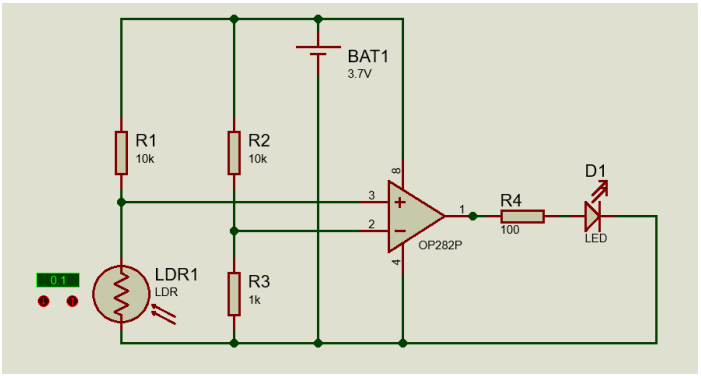


**Figure 8. Comparator circuit designed for automatic lighting**

In the application of piezoelectric generators in regulated pedestrian crossings, the first 60 seconds of the traffic light are intended for pedestrians, and the other 60 seconds are for cars.
Using the expression (1), the voltage generated on the piezoelectric elements when pedestrians pass through the passage is equal to $V_{out\,p} = 10.8\,V$. The voltage $V_{out\,c} = 271.3\,V$ when cars pass over the passage. Since the values of the resulting voltages are different, it is proposed to use two-channel Lithium-Ion batteries: one channel is designed to collect the energy generated when pedestrians and the other vehicles pass over the crossing.
The electric charge Q caused by the mechanical force F in a piezoelectric element can be determined by the following expression [4]

$$Q = d_{33}F \qquad (2)$$

Here $d_{33}$ is the quantity characterizing the piezomodule.

Using the value of piezomodulus presented in table 1 and expression (2), we find the value of the charge generated in a piezoelectric element: for pedestrians $Q_p=0.6\cdot10^{-6}$ Kl , for cars $Q_c=1.52\cdot10^{-5}$ Kl. Taking into account the parallel connection of piezoelectric elements and assuming that the crossing works for 3 hours during the day in the peak mode, the value of the load generated in the piezoelectric elements of the crossing is $Q_{gp}$=64.8 Kl for pedestrians, and $Q_{gc}$=652.3 Kl for cars.
These loads are accumulated during the day in two-channel batteries. It is required to synchronize the operation of the traffic light in order to adjust the operation of the two-channel batteries alternately for pedestrians and vehicles. Using the obtained results, it was determined that by using the loads stored in the batteries in one channel at night, we can provide the lighting of LED lamps with a voltage of 10.8 V and a current of 18 mA and various street signs for 1 hour through the energy generated in the crossing at

the expense of pedestrians. It is possible to ensure the operation of various street equipment with a voltage of 271.3 V for 3 hours, consuming a current of 60 mA, or with a voltage of 271.3 V for 1 hour, consuming a current of up to 180 mA, through the energy generated in the transition at the expense of machines in the second channel.

## 3. CONCLUSION

In order to efficiently use the energy obtained from the heavy traffic of people and cars on the streets, it was proposed to apply piezoelectric generators on pedestrian crossings and use them to illuminate neon filament LEDs with low energy consumption. Rechargeable lithium-ion batteries were used as the power source, and a TP4056 type reliable charging module was used to charge them. In addition, a comparator circuit was developed on the OP282 series operational amplifier operating at low currents to realize automatic lighting. It has been shown that by using the loads stored in the batteries in one channel at night, we can provide the illumination of LED lamps with a voltage of 10.8 V and a current of 18 mA and various street signs for 1 hour through the energy generated at the crossing at the expense of pedestrians. In the second channel, it is possible to operate various street equipment with a voltage of 271.3 V for 3 hours, consuming 60 mA of current, or consuming up to 180 mA of current for 1 hour, through the energy generated in the transition at the expense of machines.

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# Study and use of flora and fauna of Karabakh

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**Abstract:** The article provides information on the main directions of the study of the flora, vegetation, and plant resources of the Karabakh region, the author's expeditions to the Karabakh region based on the monitoring of scientific research, the analysis of herbarium and seed materials, and the analysis of printed monographs, books, and scientific articles. The priority areas of research will be freed territories .These works include the publication of the new edition of the multivolume "Flora of Azerbaijan" and the monographs ", “ Flora of Karabakh”, “ Botany of Karabakh” "Botanical Wealth of Karabakh" and preparation of the "Red Book". These studies are of great importance in restoring the biodiversity of Karabakh. There is a need for protection and restoration works that were planned before the occupation, but were not completed due to the war.
**Key words:** Flora of Karabakh, Fauna of Karabakh, Destruction of flora and fauna.

## 1. INTRODUCTİON

Karabakh has a very rich nature. Its climate is mild-hot, mountain-tundra, mild summer climate, cold and dry winter climate. Temperature - 5-10 degrees in spring, 20-30 degrees in summer, -2-8 degrees in autumn, winter - 10-15 degrees. Geography - located mainly in mountainous area. The highest points: Murovdag, Bovurkhan mountain, Vangli, Meryamdag, Cidir plain and Kirs is one of the ancient settlements in the region. The oldest human settlement was discovered in the Azikh cave in this area. This settlement proves that Azerbaijan, including Karabakh, is one of the first homelands of mankind, along with the Mediterranean basin and East Africa.

## 2. EXPERİMENTAL DETAİLS

### Karabaksh’s Flora

The territory of the Republic of Azerbaijan has a rich flora. More than 4,500 flowering, high-grade plant species are spread here. According to the total number of species, the flora of Azerbaijan is the richest of the South Caucasus republics. Thus, the species of plants that spread in the republic make up 66% of the total number of species of plants that grow in the Caucasus. Most of the plants here are endemic species and do not grow naturally anywhere in the world.

The plants common in the territory of Karabakh are mainly:

1.Single grain wheat
2. Ordinary pomegranate
3. Red Tubulga
4. Caucasian Lady
5. Gileli Karajohra
6. Transcaucasian wolfberry
7. Velasyarpag azat
8. Forest grape9. Alpine forest
10. Heavy juniper
11. Fischer Sternbergia
12. Itikanarli Susen
13. Camilla iris

14. Kuznetsov wind
15. Thin flower hiss
16. Yulia Mountain

17. Khari Bul-Bul

It should be noted that currently great part of the rich flora of Karabakh was destroyed by the Armenian invaders.

**Fauna of Karabakh**

Karabakh, which has a unique climate, vegetation and animal world, is the most characteristic part of the Lesser Caucasus natural region. Until the occupation of Armenia, Karabakh was superior to the other 4 natural regions of Azerbaijan with its animal world and rich biodiversity. Terrestrial vertebrates were particularly dominant among fauna species living in the liberated areas. Among these species, the fate of rare and endangered species that inhabit the landscape and biotopes belonging to the Nagorno-Karabakh and Aran Karabakh territories, which are part of the Small Caucasus Natural Region, is of greater concern. 25 thousand species of the fauna existing in Azerbaijan are arthropods, and 630 species belong to the vertebrate fauna. The entire fauna consists of 25,630 species and subspecies. There were 5,307 species of fauna included in this fauna and in the territory of Karabakh and surrounding regions freed from Armenian occupation, which is 20.7% of the total fauna.

Fauna species such as wolves, jackals, wild boars, badgers, bezoar goats, roe deer, rabbits and various rodents, quail, plaice, pigeons, partridges, and turaj were also found in these reserves.

1. Steppe pig,
2. Brown bear,
3. Bezoar goat,
4. Roe,
5. Monster,
6. Fox,
7. Jackal,
8. Leopard (it was assumed) and so on. small rodents, birds such as tetra, quail, plaice, partridge and birds of prey were inhabited.

The main purpose of creating the Dashalti State Reserve is to protect the state forest fund called "Topkhana" and the deer, wild boar, squirrel, rabbit, wolf, fox, jackal, etc. that live here. In this state reserve dozens of species of birds were protected. Up to 70 species of representatives of the class Insecta (Insects) inhabit the territories of Nagorno-Karabakh and its surrounding regions (Lachin, Aghdam, Fizuli, Zangilan, Gubadli, Jabrayil, Kalbajar). Nagorno-Karabakh and its surrounding regions are natural. It has a very rich invertebrate fauna, totally different from other regions of Azerbaijan due to its conditions and vegetation. About 4,500-5,000 species of cygnus are distributed in Nagorno-Karabakh and its surrounding regions. These species make up to 20% of the total arthropods distributed in Azerbaijan. As 56 species of the Juchu fauna are rare, endemic and endangered species, many of them are specially included in the Red List of the International Union for Conservation of Nature and the Red Book of Azerbaijan.

As a result of the identification and processing of the materials, it was determined that 28 rare and endangered species of bear butterflies are distributed in Nagorno-Karabakh. These are:

1. Yellowish-gray carrion,
2. Yellow pelosia,
3. Dark bear,
4. Beautiful bear,
5. Clean bear,
6. The brown yellow bear,
7. Philip's bear,
8. Mrs. Bear,
9. Black bear,
10. Karelian bear

It should be noted that, part of the rich flora of the occupied regions was destroyed by the Armenian invaders. Fauna of Azerbaijan refers to the variety of different types of animals inhabiting in a defined land or water zone in Azerbaijan The first information

about the richness and diversity of the animal world of Azerbaijan can be found in the travel notes of Eastern travelers.

Animal images on architectural monuments, ancient rocks and stones survived till our modern times. The first information about the animal world of Azerbaijan was collected during the visits of naturalists to Azerbaijan in the 17th century. Unlike fauna, the concept of animal world includes not only animal species, but also the number of individual species.

The symbol of the animal world in Azerbaijan is the Karabakh horse. This is a mountain-steppe racing and riding horse and is found only in Azerbaijan. The Karabakh horse is famous for its good nature, speed, elegance and intelligence. This is one of the oldest breeds, its ancestors trace back to the ancient world. The horse first developed it's breed in the 5th century in the Karabakh region of Azerbaijan and is named after the region.

## 3. CONCLUSİON

The ecological balance of Karabakh's fauna and flora is of immense importance, as it contributes to the overall health and sustainability of the region's ecosystems. The delicate interplay between the animal and plant species in Karabakh's environment ensures the preservation of natural habitats and the continuation of essential ecological processes. The protection and conservation of the fauna and flora of Karabakh are crucial for safeguarding the region's natural heritage and maintaining its ecological integrity.

Efforts to preserve the diverse ecosystems of Karabakh, including the establishment of protected areas and the implementation of sustainable environmental practices, are essential for ensuring the long-term viability of the region's biodiversity.In conclusion can be said fauna and flora of Karabakh is rich and diverse, comprising a wide variety of plant and animal species that have adapted to the region's unique climate and terrain. The area is home to a range of wildlife including bears, wolves, lynxes, and numerous bird species. Flora includes an array of plant species such as oak, beech, and pine forests, as well as diverse wildflowers and medicinal herbs. The ecological balance of Karabakh's fauna and flora makes it an area of great ecological importance and natural beauty

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# Ecological situation of Kura river

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**Abstract.** The article includes the ecological situation of Kura which is a transboundary river. Firstly, there is general information about Kura river. The flora and fauna of the river are described briefly. Also, the article gives information on current situation in Kura river basin. The reason of the decreasing of the water of Kura river and impact of the climate change on basin mentioned in the paper. At the end, there is a conclusion on the social, economic and environmental effect of decreasing water in the river Kura.

**Key words.** Kura river, Pollution, Climate, Water decreasing.

## 1.INTRODUCTİON

The Kura is the biggest transboundary river that links the three South Caucasus nations. This river rises between 2,200 and 2,700 meters above sea level in the east of Turkey, flows through the eastern portion of Georgia, crosses the border into Azerbaijan, enters the Mingachevir reservoir, and finally empties into the Caspian Sea.

The river is 1515 kilometers (941 miles) long overall. Azerbaijan owns 906 km of the river, 435 km in Georgia, and roughly 174 km in Turkey. Georgia and Azerbaijan share 94,760 km2 of watershed. Seasonally, melting snow (36%), groundwater (30%), precipitation (20%), and melting ice and snow in glaciers (14%), combine to form the Kura River's water.


**Figure 1. Kura river**

The Kura River originates in eastern Turkey on the slopes of Kısırındağı and intersects numerous valleys north of the Lesser Caucasus Range. The Kura originates in the Kars Mountains of the Lesser Caucasus, in a small valley in northeastern Turkey. It flows west, then north, east, and into Georgia after Ardahan. It rises in the mountains near Khashuri, flows northwest, then into a canyon near Akhaltsikhe, and finally flows 75 kilometers (47 miles) northeast into a gorge.

The river flows southeast and eastward along the Kartli Plain shortly after entering Georgia. A dam was constructed along the Mtskheta river above the Georgian capital, Tbilissi, and the river valley spanned a large plain. After Gori, close to Mtskheta, it bends east and starts to flow approximately 120 km (75 miles) from east to southeast.

It then passes through a small canyon to the south and west of Tbilisi, the largest city in the area. The river passes through pastures on the Georgian-Azerbaijani border before flowing southeast through Rustavi and turning east at the Khrami River's confluence. It then enters the Shamkir Reservoir and subsequently the Yenikend Reservoir.

Lower Kura flows into Lake Mingachevir, a reservoir with a sizable dam, where the Mingachevir hydroelectric power station was constructed, after winding through small areas close to the Azerbaijani city of Mingachevir. Many towns and villages can be found along the Kura's lower reaches. Flooding is widespread along the Kura's lower course. At last, the river empties into the Caspian Sea through a delta in the Azerbaijani district of Neftchala.

**The biodiversity of Kura river**

Fauna. Fish in the Kura River are abundant. These include the following in order of importance: weight (Cyprinus carpio), nakha (Silurus glanis), pike (Esox lucius), mursa (Luciobarbus mursa), barbus lacerta, alburnoides bipunctatus, and alburnus. There are voles (Apodermus sylvatica), gray rabbits (Lepus europaeus), wild boar (Sus scrofa), etc. in the area. The following animals are examples of predators: wolves (Canis lupus), badgers (Meles meles), common foxes (Vulpes vulpes), bears (Ursus arctos), forest cats (Felis silvestris), and jackals (Canis aureus).

Flora. There are various zones within the tugai forests that line the river. Shrubs such as sea buckthorn (Hippophae rhamnoides), blackberry (Rubus sp.), willow (Salix sp.), and common barberry (Berberis vulgaris) can be found along the banks of the Kura River. Populus hybrida forests, trembling poplar (P. tremula), black poplar (P. nigra), white mulberry (Morus alba), and different willow (Salix sp.) Tugai forests follow them. Creeping plants like Vitis silvestris, Periploca graeca, Smilax excelsa, and Clematis vitalba encircle the trees. Immense undergrowth is produced by common pomegranate (Punica granatum), willow (Tamarix sp.), blackberry (Rubus sp.), and common unicorn (Ligystrum vulgare).

**The condition in the Kura basin**

Official data shows that there has been a notable decline in rainfall in recent years as a result of climate change, and that the country's rivers have less water in them as a result of the drought lasting longer during the warm months of the year. Due to below-average precipitation and unusually high temperatures in early June of 2020, the water level in the Kura River and the rivers that feed into it dropped in May and June. As a result, the water level in the upper Kura River (Giragkesemen settlement, on the border between Georgia and Azerbaijan) dropped by 108 cm (1.08 meters) between May 15 and May 31. Concurrently, below the Kura River's Mingachevir reservoir, the water level dropped by 147 cm in Yevlakh, 127 cm in Zardab, 165 cm in Surra, 190 cm in Shirvan, 154 cm in Salyan (with a maximum decrease of 1.54 meters), and 122 cm in the Araz River's Novruzlu settlement.

Long-term observations generally show that the area downstream of the Kura River was hot and dry during the summer, with some years seeing a decline in the amount of water demand. While the decrease this year is marginally greater than in prior years, a comparable circumstance was noted in 2001. The current situation is impacted by the increased water withdrawal from the Kura River caused by the extensive use of water resources to meet demand in neighboring Georgia, Turkey, and Azerbaijan.

Due to the impact of climate change and the summer season, the volume of water has decreased due to increased demand for water in agriculture. According to Georgian media, the water level in the Kura River (Georgians call it Mktivari) has decreased since 2014, and there is a significant decrease in water levels in many cities, including Tbilisi.

**The reason why Kura river water decreasing**

It is also identified by intricate issues like water scarcity. As a result, when the Kura's water level drops, its flow rate also decreases, allowing seawater to seep into the riverbed, particularly during periods of increased northeast wind.

Human activity has also resulted in a major decline in water quality. Large volumes of pollutants are released into rivers and other bodies of water worldwide on a daily basis, either directly or indirectly. The quantity and quality of water resources on Earth are also impacted by pressure factors such as natural disasters related to water and global warming. These factors are causing the world's water supply to steadily decline, to the point where alarms are going off in some regions. Future water availability in the Kura Basin will be influenced primarily by two factors: water demand and climate change.

The rising water use in Georgia and Turkey are additional factors contributing to the Kura River's declining water level. Thus, the province of Ardahan, through which the Kura passes, overuses water in irrigation systems. The Kura River is home to

multiple hydropower plants, which is one of the primary causes.

**Impact of climate change on Kura river basin**

Water demand and availability are impacted by climate change. Furthermore, crops grown in basins will need more water for transpiration as temperatures rise.

The evaporation of water from reservoirs, rivers, lakes, and soil will also increase with warmer weather. The Kura River basin has a finite supply of potable water. Water use in the Kura Basin may be severely restricted if water flow continues to decrease as a result of climate change. This will have an impact on the Kura basin's population's quality of life and cause social and economic issues. If the basin's water resources are used more wisely and water losses are drastically decreased, then this risk can be avoided or reduced.

Dry rivers have become the norm in many areas of the Kura River basin in recent years. Reduced flow in rivers can be naturally caused by weather conditions that accelerate evaporation, but if excessive water use is added to this process, rivers may dry out over an extended period of time. Reduced river runoff damages surrounding ecosystems as well as those in the aquatic environment because the area's climate gets drier. Water use efficiency measures whether water is wasted (overused) or used efficiently in the production of goods and services.


**Figure 2. Kura river basin**

To forecast how climate change will worsen in the future, scientists utilize computer programs called climate models. These models aid in estimating the potential amount and rate of climate change under particular circumstances. Climate models, for instance, assist us in understanding how the climate will change as greenhouse gas concentrations rise or how glaciers and river flows will be impacted by temperature variations of just one or two degrees. Climate scientists from Azerbaijan estimate that between 2015 and 2050, the temperature could rise by 0.7–1.58 ℃ based on their analysis using a variety of climate models. While there won't be any changes in temperature in Georgia's east, there will probably be a major decrease in the water flow in the Kura River and its tributaries in both countries. Agriculture is going to be the most vulnerable sector to climate change.

## 3.CONCLUSİON

There are social, economic, and environmental consequences to the Kura River's decreasing water level. Social effects. The population's likelihood of unemployment and poverty will rise as income levels decline, and the state will be forced to offer financial support to those individuals. Economic effects. Azerbaijan is a country with a lot of arable land along the Kura River. Its people mostly work in agriculture and raising livestock. The population will move into cities as a result of the development of this sector ceasing entirely due to the reduction of water,

irrigation systems, and fresh water resources for The population will be deprived of actual incomes as a result, and our vast areas will be abandoned and underutilized. As a result, this industry will contribute less to state revenue and more jobs will be created. This will continue economic development while raising unemployment and having a large financial impact on the state. Environmental effects. The Kura River's decreasing water supply will entirely or partially destroy the river's native flora, particularly the tugai forests that have grown there over thousands of years. The area's desert areas will become more widespread as a result of the destruction of this forest. livestock.

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# The main directions of improving the efficiency of drilling operations: theoretical and practical aspect

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**Abstract.** The process of drilling oil and gas wells contains a complex of complex controlled subprocesses. Therefore, the reliable implementation of the well drilling process is primarily associated with the peculiarities of the implementation of these subprocesses on a sustainable basis. And since the essence of these processes is mainly expressed in conditions of complex impact of geological and technical factors, first of all it is necessary to clarify the nature of these factors. In modern conditions, there are many software tools that allow you to assess the impact of various factors on the main technological parameters of the drilling process, taking into account the possibilities of automation, and in some cases attempts are being made to use them. Such opportunities have significantly expanded the possibilities of using appropriate digital technologies. In connection with the above, the article reveals the essence of the relevant theoretical and practical issues to ensure an increase in the efficiency of drilling operations, the relevant theoretical models that are used are considered.

**Key words:** Well drilling, reliability, Technological parameters, Drilling mode.

## 1. İNTRODUCTİON

Scientific-technical problems are now solved using a variety of modern research methods, and it is important to elucidate the factors that categorize the multi-level sub-processes related to the drilling process of oil and gas wells in modern conditions and consider their complex impact on the drilling process. The application of these methods can contribute significantly to the formulation of necessary decisions in an operational regime.

In this context, the selection of factors influencing drilling regimes in the drilling process, differentiation of technological process parameters from theoretical values, and enhancement of the reliability of the drilling process are identified as key features to be explored. Analyzing methodological approaches in theoretical and empirical levels for solving these issues is currently considered a significant research direction. Addressing these issues is crucial for the cost-effective execution of drilling complex wells under present conditions, which involve substantial technical and technological complexities requiring substantial investments.

**Purpose Relevance of the problem and related research**

The reliable implementation of the drilling process for oil and gas wells is primarily ensured by the robust implementation of several relevant sub-processes, depending on the stable characteristics of drilling regimes. These processes are implemented based on clarifying the nature of essential geological and technical factors and understanding their complex impact on the drilling process. Considerable research efforts have been devoted to clarifying these issues from a theoretical and empirical perspective [1-3]. Some of these works are noted below.

A system has been developed to optimize drilling processes by controlling the constant torque of the drilling bit and other parameters that may vary within certain intervals.

Improving the efficiency of drilling operations is primarily associated with optimizing the drilling process, which is one of the most important areas. The complexity of the process, due to numerous technological variables, data streams, uncertainties in geological conditions, the influence of random factors, among others, determines the specifics of

managing the process in automatic mode. This article presents the main types of automation tools used in oil and gas fields to maintain and control drilling parameters according to local conditions to optimize the goal functions of the process. [3] discusses the statistical evaluation methodology of factors affecting the difference between theoretical and actual values of technological parameters.

[4] analyzes issues related to improving the reliability of the drilling process by optimizing controlled drilling regime parameters.Studying the results of relevant research reveals that clarifying the theoretical and empirical impact of various factors on the drilling process is currently an important issue.

**Methods Characteristics of factors influencing drilling regimes.** The efficiency enhancement of the drilling process primarily depends on the selection of drilling regimes. The selection of drilling regimes depends on several factors, including the type, hardness, and size of the drilled well or formation, the equipment used, and the objectives of drilling operations. Specifically:

- The type, hardness, and dimensions of the drilled well or formation play a crucial role in determining the drilling regime. These characteristics are critical factors that affect drilling parameters such as penetration rate, bit weight, and other critical parameters.
- The type of drilling equipment used is also a significant factor in designing drilling regimes. The weight and power of the drilling rig, the type of bit, and the drilling fluid supply all affect drilling parameters and should be considered in designing drilling regimes.
- The depth of the well, the size of the wellbore, and the drilling objectives also influence the drilling regime. The design of the drilling regime should take into account the objectives of the drilling operation and optimize drilling parameters to achieve these objectives. To determine the most accurate drilling regimes in mineral-geological conditions, it is necessary to know the drilling parameters. This allows for the compilation of tables of drilling parameters and drilling regimes during drilling in neighboring wells. The results of relevant laboratory and wellbore studies are essential for designing new wells. Two methods are used for designing regimes: the analytical and recalculative methods. The analytical method is used to identify potential capabilities for improving equipment performance when there is no statistical field data on the operation of equipment in the field. The basic parameters of drilling regimes include load on the bit, penetration rate, drilling power, bit torque, and supply of drilling fluid. To design regimes, it is necessary to know the density distribution of cuttings on the bit during drilling, the contact duration of the teeth with the cuttings when determining the drilling rate, cutting resistance, as well as the provision of drilling fluid for surface cleaning.

Considering the basic considerations when selecting drilling parameters on the bit, the distribution of cuttings volume, determining the drilling rate by the contact time of the teeth with the cuttings, cutting resistance, and provision of drilling fluid for surface cleaning.

The optimization of drilling regimes is an integral part of the drilling process and can significantly improve efficiency, safety, and costs. The selection of drilling regimes depends on the type of drilled well or formation, the equipment used, and the key parameters of the drilling regime.

**Assessment of the difference in theoretical values of technological process parameters.**

As known, deviations from given parameters are possible during the excavation of wells in technological processes. In such cases, statistical methods are used to improve accuracy. This is particularly important during drilling in deep and complex conditions. In this regard, the deviation probability is based on a statistical method relying on the normal distribution law, where the obtained results are confirmed through mathematical processing of multiple mathematical observations.

In this direction, one of the possible approaches is the automated testing of the deviation of the probability distribution according to the Shapiro-Wilk criterion (W-criterion) from the normal law. This test is carried out in two ways. First, the W-criterion is calculated, and then this value is compared with the critical value of $W(\alpha)$ (where $\alpha$ is the level of reliability). If $W < W(\alpha)$, then the null hypothesis of normal distribution is rejected. In this case, the use of special tables is necessary to determine the statistics of W and $W(\alpha)$, which simplifies the operation of the respective software by providing automatic access to them. Overcoming this complexity is ensured by using the simplified W1 form of the Shapiro-Wilk criterion. According to this approach, special tables are replaced with the respective approximations of dependencies. For example, let's consider the following selection of data:

$$X=-1;\ 0;\ 1;\ 2;\ 3;\ 5;\ 6;\ 7;\ 10;\ 15.$$

Let's consider testing the hypothesis of normal distribution for the random variable X using the W1

Shapiro-Wilk approximation measure by taking α = 0.05. In this case, the following rule is used:

$$W_1 = \left(1 - \frac{0{,}6695}{n^{0{,}6518}}\right)\frac{s^2}{B}$$

Here, n represents the number of elements in the selected plurality; s and B are parameters of the measure, and accordingly, they are calculated with the following expressions:

$$s^2 = \sum_{i=1}^{n}(X_i - X_{orta})^2;$$

$$B = [\sum_{k=1}^{m} a_k(X_{n-i+1} - X_i)]^2,$$

The calculation of the empirical numbers $a_k$ is based on the following formula for a sample with elements arranged in ascending order $X_i$ , $i$=1,2,...,$n$; $X_{avr}$ represents the sample's calculated median value. In our example, $n$=10.

$$a_k = a_0\left[z_k + \frac{1483}{(3 - z_k)^{10{,}345}} + \frac{71{,}61 \cdot 10^{-10}}{(1{,}1 - z_k)^{3{,}26}}\right]$$

$$a_0 = \frac{0{,}899}{(n-2{,}4)^{0{,}4162}} - 0{,}02; \;\; z_k = \frac{n-2k+1}{n-0{,}5}.$$

Based on the calculation results, if $W_1$<1, then the null hypothesis of the normal distribution of variable X is rejected. It should be noted that this assessment, based on a simplified heuristic criterion, can be easily programmed and implemented in the Matlab system.

**Issues of Increasing Reliability in Excavation Processes**

A modern excavation system consists of various interconnected mechanisms, devices, and tools. The malfunction of at least one critical element in a complex system can lead to the failure of the entire system. Reduced reliability of excavation equipment typically results in increased operational costs and downtime. Moreover, inadequate reliability can lead to sudden failures of components and parts due to the breakdown of installed technology, resulting in significant expenses for rectification. However, enhancing reliability is associated with the complexity and cost increase of equipment. Therefore, designing, manufacturing, and operating equipment should be based on minimizing the total cost of ownership to determine optimal reliability levels.

In this regard, improving the reliability of excavations is directly achievable by considering the complex interplay of various multidimensional factors in this process. For example, if the probability of an axe operating without issues is assumed as the researched reliability parameter, then this probability can be determined using the Laplace function as follows:

$$P(t) = \Phi_0\left(\frac{T_{orta}-t}{\sigma}\right),$$

In this formula, σ represents the root mean square slope; $T_{avr}$ is the average processing time until fatigue.

This principle is used in the analytical research of optimizing controlled drilling regime parameters to increase the reliability of the drilling process. Such analytical models, as well as the latest information technologies, especially machine learning technologies, can assist in evaluating possible disruptions during drilling according to the reliability model of equipment, which is in line with similar problems focused on forecasting disruptions during the extraction of wells. The resolution of these issues often involves the application of decision-making principles considering the uncertainty of information [5].

Increasing the volume of drilling operations requires an increase in the relevant drilling indicators. This poses significant challenges in the effective application of drilling technologies commonly used in many cases. Therefore, optimization of drilling regime parameters is considered a necessary solution to such problems. Geological-technological research enables direct solutions to the processing of information issues, thus enhancing the efficiency of the drilling process. Therefore, the implementation of an algorithm for determining optimal regime parameters is required due to the abundance of geological-technological information involved in the drilling process.

In complex structured deposits, as well as in deposits with complex stress-deformation conditions, ensuring the reliable implementation of the drilling process requires, first of all, the correct prediction of pressures and lithological-attitude parameters of formations. Another related issue is the improvement of the reliability of drilling processes in anomalies with high formation pressures. Taking into account this factor involves issues such as selecting the drilling mud, as well as determining the optimal drilling speed, which requires the formulation and resolution of respective optimization problems. In many cases, neglecting these factors can lead to complications during drilling, such as blowouts, and ultimately result in significant losses and complete loss of the well.

## 3.CONCLUSİON

The main characteristics of selecting factors

influencing the drilling regimes in the process of well drilling, differentiation of technological process parameters from theoretical values, and increasing the reliability of the well drilling process have been analyzed from a theoretical-experimental aspect in the article. Based on some factual examples, possibilities for solving these issues have been discussed.

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# Research on the use of construction materials and economic advantage of Karabakh

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**Abstract :** Only 10 months have passed since the historical Victory achieved in the 44-day Patriotic War of Azerbaijan. It is truly amazing that a country that has come out of war, and is also struggling with a pandemic, is taking part in the restoration work in the liberated areas. The Karabakh administration is being reconstructed, modern infrastructure is being built from scratch, new roads, airports, power plants, villages, settlements are being built. It goes without saying that the construction work in Karabakh is an indicator of the strength and potential of the Azerbaijan.

**Key words:** Copper, Gold and other precious mineral resources.

## 1.INTRODUCTİON

İn terms of global climate change, land desertification and the lack of clean drinking water, the environment is one of the main areas of concern to the entire international community.

These issues are reflected in the 17 Sustainable Development Goals of the UN. In particular, Goal 6 refers to the efficient use of water resources, water and sanitation. it's about speech; Goal 13 to take action to combat climate change; The 15th goal covers the protection and restoration of soil ecosystems, sustainable forest management, combating desertification, and stopping land degradation.

These goals, predicted by the United Nations until 2030, are Armenia's occupation policy that has been going on for nearly 30 years and has significantly damaged the ecology of the South Caucasus. is under serious threat. Illegal entrepreneurship and exploitation of natural resources in the occupied territories have resulted in great economic damage and numerous ecological consequences.

Forest clearing and burning, water resource pollution, flora and fauna destruction, natural resource exploitation have disturbed the ecological balance. The unhindered degradation of nature has caused a reaction of environmental organizations even in Armenia itself.

The ecological consequences of illegal economic activities in the previously occupied territories of Azerbaijan were reflected in the report of the Ministry of Foreign Affairs of Azerbaijan entitled "Illegal economic and other activities in the occupied territories of Azerbaijan".

International law classifies any military occupation as temporary by default and does not imply that the occupying country acquires sovereignty over the occupied territory; therefore, the report of the Ministry of Foreign Affairs states that the legal status of this territory should not change due to the fact of occupation.

A region's natural resources may include minerals, water resources, and agricultural land. However, the specific details and scope of these resources may vary.

1. Minerals: The region may have deposits of various minerals, including metals and non-metals. This may include copper, gold and other precious mineral resources.
2. Water resources: Rivers and water bodies in the region can be important natural resources. Access to water is crucial for agriculture and various industrial activities.
3. Agricultural Lands: The fertility of the land in the region contributes to its agricultural potential. This includes farming, orchards and vineyards.

It is important to note that the use of these resources can be affected by geopolitical factors, territorial disputes and the general political and economic situation in the region.

For the most accurate and up-to-date information about the natural resources of Karabakh, it is recommended to refer to the latest reports, studies or official sources of the relevant institutions.

## 2.EXPERİMENTAL DETAİLS

Armenia's occupation of Azerbaijani lands for thirty years and during this period the man-made activities of our own historical lands with various ruthlessness of the enemy, during the battles, as well as the

conduct of military operations, caused very serious damage to the beautiful environment of Karabakh.

Ore and non-ore deposits were looted, exploited without any man-made norms. 163 different types of mineral deposits with confirmed reserves have been discovered in the liberated territories of the Republic of Azerbaijan. Including 5 gold, 7 mercury, 2 copper, 1 lead and zinc, 1 stone coal, 1 raw material for the production of soda, 12 alloys and decorative stones - obsidian, marbleized onyx, jasper, etc., 10 sawstones, 21 facing stones , 9 clays, 20 cement raw materials, 8 different types of building stones, 6 lime raw materials, 10 sand-gravel, 4 construction sand, 1 perlite, 8 pumice-volcanic ash, 16 underground freshwater and 11 mineral water deposits are available.

Because of its versatility and abundance, clay has been used in construction for thousands of years. Its applications in construction include:

1. Brick and Tile production:

One of the most common uses of clay in construction is the production of bricks and tiles. Clay bricks are durable, fire resistant and can provide excellent insulation. They are widely used in the construction of walls, pavements and various architectural elements.

2. Land constructions:

Clay is often used in earth building techniques such as bricks and sticks. Adobe bricks are made by drying a mixture of clay, sand, straw and water in the sun. Cob involves mixing clay, sand and straw to create a pliable material used to build walls, houses or even sculptures.

3. Clay plasters and renders:

Clay plasters and renders are a natural alternative to cement-based plasters. They offer good thermal mass, breathability and a natural aestheticClay plasters are applied to walls and ceilings for both functional and decorative purposes.

4. Clay roofing:

Clay is used in the production of roof coverings. Clay tiles are durable, weather resistant and can add a distinctive architectural style to buildings.

5. Geotechnical Applications:

Bentonite, a type of clay, is used in geotechnical engineering for a variety of purposes, such as creating impermeable barriers in construction projects, particularly in the lining of ponds, landfills, and underground structures.

6. Ceramic Products:

In addition to traditional construction, clay is used in the production of ceramic products, including floor and wall tiles, plumbing and decorative elements in buildings.

7. Greening and Land Improvement:

Some types of clay can be used for landscaping and soil improvement. For example, expansive clay soils can be stabilized to improve the foundation stability of buildings and prevent swelling and shrinkage.

8. Artistic and decorative elements:

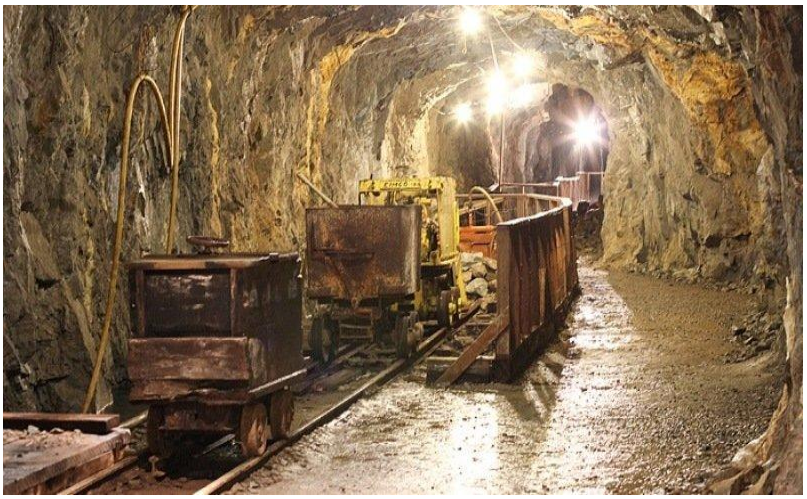
Clay is often used to create artistic and decorative elements in construction, including sculptures, bas-reliefs, and other ornamental features.

The use of clay in construction is environmentally friendly as it is a natural material that can be obtained locally. However, it is important to consider the specific properties of clay, such as its composition and plasticity, to ensure its suitability for the intended construction purpose. In addition, appropriate engineering and construction practices must be

followed to optimize the performance of clay-based materials in various applications..

It may not be possible to obtain specific information about copper deposits in Karabakh, and the geopolitical situation in the region may affect the availability of such information. However, the wider South Caucasus region, which includes Azerbaijan, is known to have significant mineral resources, and copper is one of them.

Historically, copper mining was carried out in various parts of the South Caucasus. It is possible that, taking into account the geological characteristics of Karabakh, there may be copper deposits.



Copper mining requires geological investigations, and the availability and extent of these deposits will depend on the results of such investigations.

For the latest and most accurate information about copper deposits in Karabakh, it is recommended to consult the relevant geological authorities, mining departments or official reports. Note that due to the geopolitical context, it may be difficult to obtain up-to-date and accurate information.

Specific details about gold deposits in Karabakh may not be available. However, the wider region of the South Caucasus, which includes Azerbaijan and Armenia, is known to have mineral resources, and gold is among them.

Historically, gold mining was carried out in various areas of the South Caucasus. With the geological characteristics of Karabakh, it is plausible that there may be gold deposits. Identifying and evaluating gold deposits usually requires geological surveys and prospecting.

**3.CONCLUSİON**

In order to obtain the most accurate and up-to-date information about gold deposits in Karabakh, it is advisable to consult the relevant geological authorities, mining departments or official reports. Due to the geopolitical context of the region, obtaining current and accurate information may be difficult and it is recommended to refer to the latest reports or studies from reliable sources.

Gold is not widely used as a structural material in construction due to its high cost and specific physical properties. However, it is used in a variety of construction-related applications, particularly in decorative and functional capacities. Here are some ways to use gold in construction:

1. Architectural Details:

Gold is often used for decorative purposes in architecture. It can be incorporated into building facades, decorations and interior design to add a touch of luxury and elegance.

2. Gilding:

Gold leafing involves applying a thin layer of gold leaf or gold dust to surfaces. This technique is used to decorate architectural elements such as moldings, frames and sculptures, giving a bright and rich look.

3. Jewelry in construction:

Some high-end and luxury buildings incorporate gold elements such as gold-plated fixtures, railings and decorative elements to enhance the overall aesthetic and exclusivity.

4. Electrical Applications:

Gold is an excellent conductor of electricity and is used in various electrical and electronic components. In construction, gold can be found in electrical connectors, switches and other components in buildings with special or high-tech requirements.

5. Gold Leaf in Artistic Designs:

Gold leaf is often used in artistic and architectural designs. It can be applied to ceilings, domes and religious structures, adding a reflective and decorative layer to create visually striking effects.

6. Monuments and Sights:

In some cases, gold can be incorporated into monuments or landmarks as a symbolic or decorative element. This is often seen in structures intended to convey wealth, prestige or cultural significance.

7. Gold Plated Glass:

Gold coatings on glass, known as gold-plated glass, can be used for aesthetic purposes or to provide thermal insulation by reflecting infrared rays. This application can be found in luxury buildings or structures with special energy efficiency requirements.

8. Gold Plates and Finishes:

Gold-colored tiles and finishes can be used in interior design to create a luxurious atmosphere. These can be applied to walls, floors and other surfaces to achieve the desired aesthetic.

It is important to note that the use of gold in construction is often limited to specific projects where high quality aesthetics are desired and cost considerations are secondary. In most building applications, more common and cost-effective materials are used for structural elements, while gold is reserved to accentuate the design and add a touch of luxury.

Clay is a type of fine-grained natural soil material composed of minerals, organic matter, and other components. Its physical and chemical properties can vary depending on factors such as mineral composition, particle size and the presence of impurities. Some of the main physical and chemical properties of clay are:

Physical properties of clay:

1. Particle size:

Clay particles are less than 0.002 millimeters in diameter, making them finer than silt and sand. The small particle size contributes to the plasticity and cohesion of the clay.

2. Texture:

Clay has a smooth and sticky texture when wet due to its small particle size. When dry, it becomes hard and compact, forming a cohesive mass.

3. Plasticity:

One of the main properties of clay is its plasticity. When wet, it can be easily molded and shaped, allowing it to be transformed into a variety of structures. This property is important in pottery and construction.

4. Compatibility:

Clay exhibits high cohesion, meaning that its particles tend to stick together. This combination contributes to the strength and stability of the clay when compacted.

5.Color:

The color of the clay varies and can range from light beige and yellow to red, brown or gray. This is influenced by the mineral content and organic matter present in the clay.

6. Conductivity:

Clay has low permeability, which means it has a reduced ability to allow water to pass through. This property contributes to its ability to retain moisture.

7. Shrinkage and swelling:

Clay shrinks when it dries and swells when it absorbs water. These changes in volume can affect the stability of structures built with clay.

Chemical properties of clay:

1. Mineral Composition:

The mineral composition of clay can include various minerals, for example, kaolinite, illite, montmorillonite and others. The specific minerals present affect the properties of the clay.

2. Aluminum and Silicon Composition:

Clay minerals contain aluminum and silicon in their crystal structure. The ratio of aluminum to silicon affects the type of clay mineral and its behavior.

3. Cation Exchange Capacity:

Clay has a high cation exchange capacity and allows the storage and exchange of positively charged ions. This feature is important for the retention of nutrients in the soil.

4.pH:

The pH of clay can vary, but is generally neutral to slightly acidic. pH affects the availability of nutrients in the soil.

5. Organic substances:

Clay may contain organic matter, which contributes to its fertility. Organic matter improves soil structure, water retention and nutrient availability.

6. Adsorption:

Clay particles have the ability to adsorb (hold) water and other substances, including nutrients and pollutants. This property is important for soil fertility and environmental health.

Understanding the physical and chemical properties of clay is critical in a variety of industries, including agriculture, pottery, and construction.

In construction, clay is often used in the form of bricks, tiles and other building materials due to its

plasticity and ability to create durable structures when fired.

Chemical properties of mercury:

1. Chemical Symbol and Atomic Number:

The chemical symbol for mercury is Hg, from the Latin word "hydrargyrum". Its atomic number is 80 in the periodic table.

2. Stability:

Mercury is relatively stable under normal atmospheric conditions. However, it slowly reacts with oxygen in the air and forms a thin oxide layer on its surface.

3. Merger:

Mercury can amalgamate with other metals, that is, it can melt with them to form a mixture. The compound is commonly used in gold and silver mining to extract these metals from the ore.

4. Resolution:

Mercury is not soluble in water. This property contributes to its environmental persistence and ability to accumulate in aquatic ecosystems.

5. Toxicity:

Mercury and its compounds are very toxic to humans and many other organisms. Toxicity is primarily due to the ability to form organic compounds such as methylmercury that can accumulate in living organisms.

6. Corrosion resistance:

Mercury is resistant to corrosion and does not react readily with most acids and bases. However, it can form amalgams with certain metals.

7. Thermometric properties:

The expansion and contraction of mercury with temperature changes makes it suitable for use in traditional mercury thermometers.

It is important to note that there are significant efforts to reduce mercury use and emissions due to its toxicity and environmental concerns. The Minamata Convention on Mercury is an international agreement aimed at minimizing anthropogenic mercury releases into the environment.

Mercury is a toxic heavy metal that poses serious health and environmental risks. In the context of construction, there are several potential sources of mercury exposure, and it's important to handle this substance with care. Here are some considerations related to mercury in construction:

1.Lighting Devices:

Fluorescent lamps and some types of high-intensity discharge (HID) lamps contain small amounts of mercury. When these bulbs break, mercury vapor can be released, posing a health risk. Proper disposal and recycling of these bulbs are crucial to prevent mercury from entering the environment.

2.Thermometers and Barometers:

Older thermometers and barometers may contain mercury. It's essential to handle them carefully and follow proper disposal procedures if they break. Modern alternatives without mercury are available.

3.Flooring and Coating Materials:

Some types of flooring materials, such as certain types of vinyl, may contain mercury. Be aware of the materials being used in construction, and choose alternatives that are mercury-free if possible.

4.Construction Waste:

Construction waste, including debris from demolitions or renovations, may contain materials with mercury. Proper disposal and recycling practices should be followed to prevent the release of mercury into the environment.

1. Batteries:

Mercury-containing batteries, although less common today, can still be found in certain construction equipment. Proper disposal methods should be followed for these batteries.

2. HVAC Systems:

Some heating, ventilation, and air conditioning (HVAC) systems may use mercury-containing switches. When replacing or maintaining these systems, care should be taken to minimize mercury exposure.

3. Protective Measures:

Construction workers should be educated about the risks of mercury exposure and provided with appropriate personal protective equipment (PPE) when working with materials that may contain mercury.

4. Regulatory Compliance:

Be aware of and comply with local regulations and guidelines regarding the use, handling, and disposal of mercury-containing materials. Many jurisdictions have strict rules regarding mercury to protect public health and the environment.

In summary, it's crucial to be aware of the presence of mercury in construction materials and equipment and take appropriate measures to minimize exposure and ensure proper disposal. This not only protects the health and safety of construction workers but also helps prevent environmental contamination.

Mercury is used in various industries for specific applications, but its usage has decreased significantly due to its toxicity and environmental concerns. Some historical and current industrial uses of mercury include:

1. Chlor-alkali Industry:

Mercury has been historically used in the production of chlorine and sodium hydroxide through a process called the mercury cell process. However, this process is being phased out in many regions due to environmental concerns.

2. Electrical and Electronics:
   Some switches and relays in electrical equipment, as well as certain types of batteries, historically contained mercury. However, efforts have been made to phase out the use of mercury in these applications due to environmental and health risks.
3. Thermometers and Barometers:
   Traditional thermometers and barometers often contained mercury. However, modern alternatives, such as digital thermometers, have largely replaced mercury-containing devices in many applications.
4. Dental Amalgams:
   Dental amalgams, which are used for dental fillings, traditionally contained mercury. While the use of mercury amalgams has decreased, they are still used in some dental applications. The dental industry has been exploring alternative materials to reduce mercury exposure.
5. Mining and Ore Processing:
   Mercury has been used in gold and silver mining to extract precious metals from ore. However, this practice is known to cause environmental pollution and health risks. Efforts are being made to reduce or eliminate the use of mercury in artisanal and small-scale gold mining.
6. Chemical Industry:
   Some industrial processes use mercury as a catalyst or reagent. However, alternatives are often sought to minimize the use of mercury due to its environmental impact.
7. Fluorescent Lamps and Bulbs:
   Compact fluorescent lamps (CFLs) and some types of high-intensity discharge (HID) lamps contain small amounts of mercury. Efforts are made to promote the use of mercury-free LED lighting as an alternative.
8. Laboratory Instruments:
   Some scientific instruments, such as certain types of barometers and thermometers used in laboratories, may contain mercury. Laboratories are increasingly using digital alternatives and mercury-free equipment.

It's important to note that many industries and regulatory bodies are working towards reducing or eliminating the use of mercury in various applications due to its known environmental and health risks. International agreements, such as the Minamata Convention on Mercury, aim to phase out or reduce the use of mercury globally to protect human health and the environment.

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# Taken from Gulabatli village of Tartar region artesian water analysis and environmental assessment

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**Abstract:**The purpose of the research work is to study the analysis of heavy metals, phenols and polycyclic aromatic hydrocarbons in artesian water taken from Gulabatli village of Tartar region. At the same time, the article mentions the devices used in the analysis the sample taken from that water,the results of the analysis and the reason for the results. Some substances from artesian water exceeded the permissible concentration limit, which is related to the geographical location of the water.

**Key words**: Heavy metals, Cadmium, Lead, Silver, Polycyclic aromatic hydrocarbons (PAH), Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Chrysene.

## 1.INTRODUCTİON

As we know, this water ecosystem is constantly connected with the environment surrounding it. The formation of surface and groundwater is related to industry, transportation, anthropogenic activities, agriculture and natural disasters.

Innumerable anthropogenic effects occurring in nature, harmful substances collected in the air and lithosphere eventually fall into the water environment. We know that because water is the best solvent, the environment for pollution is created. Also, one of the most important properties of water is to ensure the active participation of substances outside itself in biological, chemical and physical processes. That is why water pollution is divided into 3 parts: physical, chemical and biological.

Chemical pollutants are also divided into 2 groups, organic and inorganic pollutants. Inorganic pollutants include heavy metals, mineral salts, clay-derived substances, alkalis, acids, and others. But heavy metals and their compounds are the most damaging to aquatic organisms [1].

It was determined that the number of harmful water pollutants in water basins and waterways has increased significantly. As mentioned, each person uses 450 l of water per day. As a result of research, it was determined that the chemical composition of water depends on the geographical location, the structure of the earth's crust, and other factors.

In many areas, the amount of several mineral salts as well as calcium and magnesium salts in the drinking water is much lower than the norm necessary for humans. Due to the lack of necessary salts for life activity in the body, it tends to get infected with many diseases. At the same time, the excess of salts in the water causes diseases. In other words, when we say water necessary for drinking and life activities, we mean water that is sufficient with mineral salts and other nutrients. It is known that the water supply of many cities, towns and villages is provided by underground water. Considering the increase in the number of people and their demand for water, it is necessary to re-evaluate the need for existing aqueducts. It should also be noted that incorrect selection of the methodology during the assessment or making technical mistakes leads to obtaining incorrect results in the assessment of the reservoir reserve [2, 3].

Due to the increase of anthropogenic influence in the territory of Tartar region, the change of quality indicators of river waters has increased, especially in

the low water period. In order to better study the ecological condition of rivers, it is important to determine the factors that affect it and develop calculation methods. Excessive use of water from some rivers in industry and agriculture can lead to the loss of their function as a natural component. Currently, the implementation of various economic measures in the basin of the rivers flowing directly from the territory of Azerbaijan to the Caspian Sea has led to changes in the quantitative and qualitative indicators of river waters. From this point of view, it is considered one of the important issues to study the rivers of the territory on an ecological basis [4,5,6].

Artesian water is located in the Karabakh plain, in the Sanjali territorial unit of Gulabatli village, Tartar region. It is fresh water located at a depth of about 100-600 m. We monitored the artesian water and determined its physical and chemical composition. Thus, phenol and phenol derivatives were studied in water. Physico-chemical properties of artesian water were studied. The pH unit of water is equal to 7.5. [8]

Based on the results of the analysis, it can be noted that the artesian water is not so dirty.

Among PAHs, naphthalene did not exceed the norm, and other representatives did not exceed the norm.

**Table 1. Amount of polycyclic aromatic hydrocarbons in artesian water.**

| PAHs | mkg/l<br>Sample (water) |
|---|---|
| Naftilen | 0.03 |
| Asenaften | <0.01 |
| Fluoren | <0.01 |
| Fenantren | <0.01 |
| Anthracene | <0.01 |
| Fluorant | <0.01 |
| Piren | <0.01 |
| Benz(a)anthracene | <0.01 |
| Krizen | <0.01 |
| Benz(b+j+k)fluoranten | <0.01 |
| Benzo(a)piren | <0.01 |
| İnden(1,2,3-cd)piren | <0.01 |
| Benzo(ghi)perylene | <0.01 |
| Dibenz(ah)anthracene | <0.01 |
| **16PAH** | **0.03** |

**Table 2. Amount of phenolic organic compounds in artesian water.**

| Parameter | 23115-01-1 |
|---|---|
| Phenolic compounds | Uq/l |
| phenol | <0.02 |
| o-cresol | <0.02 |
| 2-nitrophenol | <0.04 |
| 2,4-dimethylphenol | <0.02 |
| 2,4-dichlorophenol | <0.02 |
| 2,6-dichlorphenol | <0.02 |
| 4-chloro-3-methylphenol | <0.04 |
| 2,4,5-TCP | <0.04 |

| | |
|---|---|
| 2,4,6-TCP | <0.04 |
| 2,3,4,6-tetrachlorophenol | <0.04 |
| pentachlorphenol | <0.04 |

Phenolic compounds are among the chemicals of greatest concern due to their long-term persistence and toxic effects in the environment. More is thrown into the environment from construction, agriculture and other reasons.

In the water sample we analyzed, the amount of phenols does not exceed the norm, and the artesian water was not contaminated with phenols.

When heavy metals accumulate in the body, they can cause various diseases and even death. Some heavy metals are present in small amounts in the body.

Both excess and deficiency of them create problems.

In order to determine whether heavy metals in water are harmful or harmless, the amount, type and human structure of heavy metal should be taken into account. In recent years, researches have concluded that cancer diseases and poisoning are caused by heavy metals in drinking water [7].

Lead is a heavy metal that is mainly distributed in the hydrosphere. However, it is less widespread in groundwater than in surface water, and it is a moderately harmful metal due to its effect [1]. Heavy metals were studied in the artesian water sample located in Gulabatli village, Tartar region. Water sample was taken by ISO 19458:2006 method and analyzed by EPA 200.7 method.

**Table 2. Analysis of heavy metals in artesian water taken from Gulabatli village, Tartar region**

| Metals | Mkg/l<br>Sample (water) | LTD (mkg/l) |
|---|---|---|
| Cadmium | <1 | 0.01 |
| Lead | 16.7 | 0.1 |
| Silver | <5 | 0.01 |

As can be seen in the table, the above heavy metals have exceeded the permissible limit. The reason for this is that the area where the artesian water is located is close to the war zone.

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# Peculiarities of diagnostics systems for electroenergetics facilities

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**Abstract:** Currently, the most important tasks of the electroenergetics are the implementation of operational and reliable diagnostic control of network elements, including the determination of electrical equipment operability. However, in many cases, due to the variety of causes of various faults and generally wide range of technical condition assessment, the results of such diagnostic control cannot be interpreted unambiguously, and these results are mainly expressed by high uncertainty in their content. For this reason, there is a need for effective methodological approaches that allow reliable interpretation of the obtained results of diagnostic control, which makes it necessary to clarify the main points associated with their selection and application. In connection with the above, the article considers some features of diagnostic systems, including faults of electrical equipment used in the electric power industry and factors affecting their detection, modern systems of technical condition assessment, as well as the justification of approaches that take into account the uncertainty of the data used during diagnostic control.

**Key words:** Electroenergetics, Electrical equipment, Diagnostic control, Diagnostic system, Uncertainty.

## 1. INTRODUCTİON

One of the priority tasks in the field of electric power systems is to ensure the operational capability of network elements, especially electrical equipment, within the framework of unit principles, as well as their control and maintenance through rapid and highly automated supervision, to regulate its operating modes. To address this issue, modern information and analytical systems should be integrated with program and hardware monitoring systems that allow for the collection of information about the object for subsequent processing, analysis, and management based on both traditional and high-quality new approaches. Given the diverse nature of information related to the operation of electrical equipment, including their possible uncertainties and unreliability, comprehensive approaches should be utilized for the establishment and analysis of diagnostic information systems.

Purpose Relevance of the problem and related research The development of the electric power industry aims to ensure high reliability and efficient management of power supply networks with various configurations. Solving these problems requires a certain energy information infrastructure, which includes programs and technical tools for monitoring, diagnosing, and analyzing information during the subsequent management of network elements and operating modes. The diversity of collected data necessitates the creation of specific mechanisms for processing, enabling the automatic or automated synthesis of diagnostic models in information and diagnostic systems and adapting energy equipment objects to operational conditions. Consequently, the article explores specific features of diagnostic systems for electroenergy objects.

Many scientific research works describe these features. Let's mention some of them. [1] shows that the development of power systems leads to increased complexity of their structure and demands on operational quality. It is essential to technically diagnose the current state of electrical equipment and ensure timely preventive maintenance. Currently, a technical diagnostic system that assesses the existing technical state of electrical equipment, ensures early detection of potential faults, and predicts their future development, has not yet been created. Therefore, there is a need to rely on heuristic approaches based on artificial intelligence methods such as artificial neural networks, non-linear pluralities theory, non-linear logic, and genetic algorithms. [2] notes that machine learning methods designed for binary classification can be used to solve diagnostic issues.

[3] examines the causes of technological disturbances in electrical systems, highlighting a range of characteristic conflicts in the protection and automation of power system elements, such as power transformers. Furthermore, based on examples of the use of non-linear logic and neural networks in various industrial sectors, [4] concludes on the appropriateness of using non-linear logic elements in the protection and automation devices of electroenergy networks. [5] discusses methods for modeling functional safety systems for electrical equipment, considering the uncertainty of initial data intervals. Through a comparison of efficiency indicators in various system variants, methods are developed for the optimal selection of safety systems for electrical equipment. [6] presents a new possible method for diagnosing the current technical condition of equipment based on non-linear expert evaluations and non-linear pluralities theory.

These studies demonstrate the complexity and diversity of issues related to the diagnostics of electroenergy objects and highlight the importance of developing advanced information and analytical systems for efficient management and maintenance of electrical systems.

**Methods Factors affecting the reliability of electrical equipment and their determination**

The evaluation of the technical condition of electrical equipment is the most important element of all major aspects of the operation of electrical substations and substations. One of its main tasks is to determine the usefulness or unreliability factor of the equipment during operation. It is generally accepted that if the condition of the equipment complies with all the requirements specified in normative documents, it is considered useful for operation; otherwise, it is deemed unreliable. The transition of the product from operational condition to unreliable condition occurs due to defects. The term "defect" is used to identify any individual malfunction of the equipment. Defects in the equipment can occur at various stages of its life cycle (manufacturing, installation, adjustment, operation, testing, repair) and lead to various consequences. There are quite a few types of defects. When identifying defects and making decisions regarding the subsequent operation of electrical equipment, it is important not to forget about the reliability and accuracy of the information obtained about the condition of the equipment. It should be noted that any diagnostic method of non-destructive testing does not guarantee full reliability in assessing the condition of the object. Errors are also included in measurement results, so there is always a possibility of obtaining incorrect inspection results:

- an object that is not faulty may be deemed useless (false defect or Type I error);
- a faulty object may be considered useful (undiscovered defect or Type II error). During non-destructive testing, errors lead to various consequences: Type I errors (false defects) only increase the volume of recovery operations, while Type II errors (undiscovered defects) lead to immediate damage to the equipment. It should be emphasized that for any type of non-destructive testing, it is possible to determine a number of factors that affect measurement results or data analysis. These factors can be conditionally divided into three main groups:

1. Environmental factors
2. Human factor
3. Technical aspect "Environmental factors" include factors such as weather conditions (temperature, humidity, cloudiness, wind strength, etc.) and time of day. As the "human factor," it is considered important that personnel have professional knowledge about the equipment and carry out inspections in a systematic manner. The "technical aspect" refers to the information database about the diagnosed equipment (material, passport data, year of manufacture, surface condition, etc.). Specific normative documents regulate the purpose of each type of non-destructive testing, the procedure for non-destructive testing, the tools used for non-destructive testing, the analysis of non-destructive testing results, possible defect types during non-destructive testing, and recommendations for their elimination.

**About modern systems for assessing technical condition**

The structure of all modern systems for assessing technical condition is generally similar and consists of four main components:

1. Data base (DB) - initial information for assessing the technical condition of equipment;
2. Knowledge base (KB) - a collection of structured rules in the form of expert knowledge, preserving all possible types of experience of experts;
3. Mathematical apparatus. It describes the mechanism of operation of the system for assessing the technical condition;
4. Results. Typically, this section consists of two subsections: the results of assessing the technical condition of the equipment and control measures based on the obtained assessments - recommendations for the subsequent operation of the assessed equipment. Both in guidance documents and other normative documents, various rules can be used as a knowledge base, including complex mathematical rules and functional dependencies. The results usually differ only in the "type" of assessing the

technical condition (indices), possible comments on the classification of defects, and control measures. However, the main difference between systems for assessing technical condition lies in the use of various mathematical apparatus (models), which primarily depend onthe reliability and correctness of the system itself and its operation as a whole. Despite all the advantages of existing systems for assessing technical condition, they have several significant conflicts in modern conditions:

- they are oriented towards solving specific problems for a specific owner (for specific schemes, specific equipment, etc.) and, as a rule, cannot be used without major modifications in other similar objects;
- they use data of various scales and different accuracies, which can lead to possible inaccuracies in assessment;
- they take into account the dynamics of changes in the assessment criteria for the technical condition of equipment, in other words, systems are not adaptable. All of the above, in our opinion, deprives modern systems for assessing technical condition of universality, which is why the current situation in the electric power industry requires improvement or the search for new methods for modeling systems for assessing technical condition. Modern systems for assessing technical condition should be capable of analyzing data, searching for samples, forecasting, and ultimately possessing learning capabilities.

Artificial intelligence methods provide such opportunities. Today, the use of artificial intelligence methods is not only accepted in scientific research but also successfully implemented in various areas of life for technical objects.

**Methods Possibilities of using non-probabilistic uncertainties in diagnostic systems of electric power engineering**

The diagnostic system of complex electric power objects is multilevel with the following non-probabilistic information abundance:

1. point measurements and parameter values;
2. allowed intervals for their changes;
3. statistical laws of distribution based on individual characteristics;
4. linguistic criteria and constraints obtained from specialist-experts, etc. In a complex diagnostic system, the presence of various types of non-determinacies simultaneously necessitates the use of non-probabilistic uncertainties in decision- making,

which allows for adequate consideration of existing types of uncertainties. Accordingly, diagnostic characteristics, operating modes of electric networks, permissible areas, advantages of some diagnostic methods over others, decision-making risks, etc., should be converted into a unified format and presented as membership functions. This approach enables us to consolidate all available deterministic, statistical, linguistic, and interval-shaped information. Utilizing the possibility theory to deal with non-determinacies leads to the conclusion that, in fact, despite the non-deterministic nature, uncertainties are equated with randomness, whereas in many decision-making processes, non-determinacy's primary source is non-probabilistic uncertainty. Therefore, the selection of an adequate formal language is crucial, and thus, it is necessary to highlight the advantages of describing the decision-making process in a complex multi-level hierarchical system based on the theory of non-probabilistic uncertainties. This language allows us to reflect the essence of the decision-making process and the conditions of non-probabilistic uncertainties for a multi-level system, work with non-probabilistic constraints and objectives, as well as use linguistic variables to identify them. Monitoring and managing a complex system do not always require finding the optimal solution at any given moment because the costs of collecting information and significantly eliminating discrepancies (errors) in the system can outweigh the benefits obtained. Often, resolving a specific issue requires ensuring a certain level of non-determinacy.

The formulation of real problems by an individual entails some non-deterministic conditions and certain uncertainties in goals. While examining single-purpose systems, applying clear constraints and goals artificially allows us to obtain good deterministic models, for hierarchical systems, it is necessary to consider its relationship with all subsystems at all levels from a focal point of view. Considering the non-determinacy factor during problem-solving significantly changes decision-making methods. It is also possible to directly establish a non-probabilistic zone without directly considering the characteristics of non-deterministic parameters. In this case, a series of deterministic issues are resolved, and a collection of certain variants optimal for specific (or non-random) parameter values is obtained.

## 3.CONCLUSİON

The article analyzes specific features of diagnostic systems in the field of electric power engineering, considering the approach based on non-probabilistic uncertainties, including the evaluation of malfunctions of electrical equipment used in electric power engineering, factors influencing their determination, modern systems for assessing technical conditions, and the non-deterministic nature of the information used during diagnostic control.

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# The green energy potential and natural resources in Karabakh

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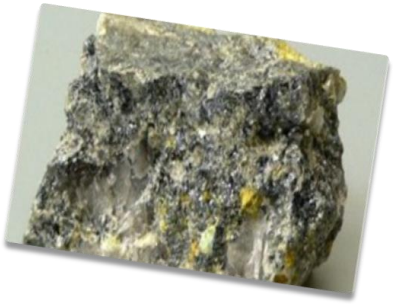
**Abstract:** This article delves into the bountiful natural resources of the Karabakh region, spotlighting the Karabakh Plain and adjacent mountainous landscapes. The fertile lands support cotton and tobacco cultivation, with the Upper Karabakh Canal facilitating irrigation for vineyards and orchards. Despite this wealth, Armenia's occupation inflicted environmental harm through unauthorized exploitation of valuable deposits. The narrative pivots to Azerbaijan's commitment to green energy, positioning itself as a frontrunner in the field. President Ilham Aliyev envisions transforming liberated territories into "green energy" zones, offering a global model. The text underscores Azerbaijan's vast potential in renewable energy, aiming to curtail greenhouse gas emissions, especially in anticipation of hosting COP29 in 2024. Ongoing green energy initiatives attract foreign investors and involve collaboration with international companies, exemplified by the "Smart Village" project in Zangilan. Specific projects, such as wind and solar power stations, are outlined, along with the systematic use of solar and wind energy as key components of the "green energy" concept. Ambitious targets for restored energy in electricity generation underscore Azerbaijan's dedication to sustainable development, with COP29 hosting serving as a diplomatic triumph amid recent criticisms.

**Keywords:** Karabakh natural resources, Irrigation systems, Geological exploration, Green energy, Renewable energy sources, Foreign investments, Sustainable development, COP29 hosting, Restoration of energy potential, Environmental commitment.

## 1.INTRODUCTİON

Many parts of Karabakh, especially the Karabakh Plain and the surrounding mountainous terrain, are rich in natural resources.

The Karabakh Plain is located on the right bank of the Kura River, between the Lesser Caucasus mountains and the Kura River. In the fertile lands of the plain, cotton and tobacco are cultivated. The Upper Karabakh Canal has been constructed for irrigation purposes.



The irrigation systems and abundance of rainfall in Karabakh provide opportunities for the development of vineyards and orchards in these areas. The Karabakh Lake is situated in this area. Additionally, the mountains and forests in Karabakh are significant natural resources.

Azerbaijan's various districts are endowed with abundant black, colored, and noble metal ores, non-metallic minerals, construction materials, underground sweet, thermal, mineral, iodine-bromine industrial waters, and so on. Gold, copper, lead-zinc

ores, and construction materials hold a special place in the exploitation of natural resources.

During Armenia's occupation of Azerbaijani territories, various technological activities and combat operations by the enemy have inflicted significant damage to the surrounding environment. Ore and non-ore deposits have been exploited (plundered) without any regard for technological norms.

Metallic valuable deposits are represented by chrome, polymetallic, copper, lead, zinc, and gold deposits. In addition to the main metals, ore compositions include precious metals such as silver, nickel, molybdenum, tellurium, selenium, and others. Among these, gold deposits hold the utmost importance. During the occupation period, the deposits of Soyudlu (Zod), Aghzibir Qiziltan, Aghduzdag, Qizilbulag and Vejnali were plundered by Armenians in collaboration with foreign companies, causing significant ecological and economic damage to our country.

As a result of the efforts of Azerbaijani geologists, gold, copper, tungsten, molybdenum, chromium, lead-zinc, and building stones, facing stones, mineral pigments, and various deposits have been discovered in Karabakh, including Soyudlu, Gazikhanli, Zargulu, Gizilitan, Aghzibir, Agduzdag, Galaboynu, and others. The exploitation of the Soyudlu-Zod gold deposit dates back to the third millennium BC. Geological exploration work was conducted in the Soyudlu area during the 1970s and 1980s. Discoveries such as ancient mine shafts, wells, caves, and gold-producing tools from that time provide evidence that gold was extracted in this area some 4,000 to 5,000 years ago. Zar village is famous under the name of "Shahrizer" (City of Gold).

As a result of geological exploration conducted in the years 1960-1964, chromite deposits of the Goydara Group in the Kelbajar region and chromite manifestations of the Silk Group in the Lachin region were discovered.

The Goydere chromite deposit is located upstream of the Su Bulag stream in the Kelbajar region.

The Agyataq copper deposit is located in the Kelbajar region. The deposit is mainly composed of upper and partly lower slope sediments. Here, the thickness of upper slope sediments is close to 650 meters.

In addition to natural resources, it has been reported that there is a sufficiently restored energy potential in the Karabakh region.

Countries worldwide prioritize the use of renewable energy sources, known as "green energy," to combat negative impacts on the environment, protect the ecosystem, and address climate change.

According to the report of the International Renewable Energy Agency (IRENA), over 80% of newly installed electricity generation capacity last year came from renewable energy sources.

Azerbaijan is one of the countries with extensive potential in renewable energy sources. According to the report of the International Renewable Energy Agency, the installed capacity of renewable energy sources in Azerbaijan amounted to 1291 MW (17% of the total capacity).

The potential volume of Azerbaijan's renewable energy sources is estimated at 27,000 MW.

The potential for solar energy is estimated at 23,000 MW, wind energy at 3,000 MW, hydropower from mountain rivers at 520 MW, and bioenergy potential at 380 MW.

Azerbaijan declared its intention at the UN Climate Change Conference (COP 26) to reduce greenhouse gas emissions by up to 40% by 2050 and create a "clean zero-emission" zone in the liberated territories. The conversion of the liberated territories into green energy zones is one of the main directions in President Ilham Aliyev's economic development course for the liberated areas.

President Ilham Aliyev's statement that the "Karabakh region will serve as an example for the world as a 'green energy' zone" is not a coincidence.

Karabakh region is rich in terms of restored energy sources.

Within the framework of creating green energy zones, measures are planned in the liberated territories, including electricity generation from restored energy sources, the use of electric vehicles, energy efficiency initiatives, deployment of solar panels for heating, cooling, and hot water supply, and the use of solar-powered LED lamps for street and road lighting.

All these sources provide an opportunity to implement new energy projects in our liberated regions.

Extensive work is consistently being implemented in this direction.

Steps are being taken to attract foreign investors to "green energy" projects.

Collaborating with foreign companies is not only essential for expanding our country's economic ties but also crucial for the rapid recovery of our completely devastated territories as a result of the Armenian occupation.

Birinci Agali village in Zangilan district is not only the first "Smart Village" project established in Karabakh but also in Azerbaijan. All residential houses, administrative and catering buildings, social facilities, and the processing and production process of village agricultural products will be supplied with restored energy sources here. The participation of experts from Turkish, Italian, Chinese, and Israeli companies in the implementation of the project is

crucial for learning from global experiences and maintaining Azerbaijan's position among world countries.

Companies like the United Arab Emirates' "Masdar," Saudi Arabia's "ACWA Power," China's "Gezhouba Group," and Japan's "TEPSCO" have shown interest in investing in "green energy" projects in the liberated territories.

The construction of a 240 MW wind power station and a 230 MW solar power station has begun as part of a pilot project in collaboration with "ACWA Power" and "Masdar" companies. In general, the construction of these stations, with a total capacity of approximately 470 MW, is planned to be carried out with a full foreign investment of around 500 million dollars. These stations will produce 1.5 billion kWh of clean energy, allowing for the reduction of carbon dioxide emissions by 600,000 tons and saving 330 million cubic meters of natural gas annually.

The systematic use of solar and wind energy is one of the key elements of the "green energy" concept. Considering the significant solar and wind potential in the liberated territories, harnessing the energy produced in these areas could create opportunities for transferring it to other regions.

Aghdam is one of the sunniest regions in Azerbaijan. The abundance of sunny days in Aghdam highlights the potential for utilizing solar energy, indicating future plans for using solar and other restored energy sources in the region.

Furthermore, the construction of a new 240 MW solar station in Jabrayil district and the establishment of wind power stations close to 10,000 MW in the Lachin-Kelbajar regions represent steps taken in the direction of applying green technologies.

As part of the recovery of electricity generation capacities, 4 Hydroelectric Power Stations with a total capacity of 20.2 MW have already been commissioned in Lachin, Kelbajar, and Sugovushan:

"Gulabird" Solar Power Plant (8 MW), "Sugovushan-1" Hydroelectric Power Station (4.8 MW), "Sugovushan-2" Hydroelectric Power Station (3 MW), "Kelbajar-2" Hydroelectric Power Station (4.4 MW).

The construction of two hydroelectric power stations is currently underway on the Araz River in the Jabrayil district, with a total capacity of 140 MW for the Azerbaijani side (100 MW in Khudafarin and 40 MW in Giz Galasi).

Approximately 25% of Azerbaijan's water resources are located in the Karabakh region. There is a potential for small hydroelectric power stations in Karabakh with a capacity of 140-150 MW.

In Kelbajar and Lachin districts, 12 Hydroelectric Power Stations, previously dismantled by Armenians, are being restored, and 7 of them have already been put into operation.

The plan is to increase the share of restored energy in the electricity generation capacity to 24% by 2025 and 30% by 2030. The initiatives have been launched, and there is also interest from foreign investors in this regard.

Yes, it is known that the 29th session of the Conference of the Parties (COP 29) to the United Nations Framework Convention on Climate Change (UNFCCC) will be held in Azerbaijan from November 11 to 24.

Sultan Ahmed Al Jaber, the Minister of Industry and Advanced Technology of the United Arab Emirates (UAE), has been announced as the president of COP28.

It should be noted that the hosting of COP rotates among the five regional groups of the United Nations. Each regional group must collectively agree on a member country to host this conference through a general consensus.

In 2024, it is the turn of the Eastern European Group, which includes our country, to host COP29. Azerbaijan has put forward its candidacy to host the conference.

Alongside Azerbaijan, Armenia and Bulgaria also put forward their candidacies. In the statement announced as a result of direct negotiations between the Administration of the President of the Republic of Azerbaijan and the Office of the Prime Minister of Armenia on December 7th, it is stated: "The Republic of Azerbaijan and the Republic of Armenia hope that the countries within the Eastern European Group will also support the candidacy of Azerbaijan."

Subsequently, Bulgaria withdrew its candidacy.

On December 9th, Azerbaijan was designated by the Eastern European regional group to host COP29 in the year 2024.

Azerbaijan hosting COP29, one of the world's largest and significant international events, is another triumph for President Ilham Aliyev.

This stands as the greatest success in our foreign policy after leading the Non-Aligned Movement and being a member of the Security Council.

At the same time, it serves as a consistent response to certain circles that have recently launched a smear campaign against Azerbaijan.

## 3.CONCLUSİON

The article highlights the rich natural resources of Karabakh, particularly the Karabakh Plain and surrounding mountainous areas. It emphasizes the ecological and economic damage caused during Armenia's occupation, detailing the plundering of valuable deposits. Despite these challenges, the

narrative shifts towards a promising future, focusing on Azerbaijan's extensive potential in renewable energy sources. The commitment to creating "green energy" zones in the liberated territories, President Ilham Aliyev's vision, and ongoing projects such as the Smart Village in Zangilan district showcase the nation's determination for sustainable development. Foreign collaborations and investments further underscore Azerbaijan's global environmental initiatives. The ambitious plans for solar, wind, and hydropower projects, as well as hosting COP29, solidify Azerbaijan's position in environmental leadership. Ultimately, the text presents a comprehensive overview of the region's natural wealth, the environmental challenges faced, and the proactive steps taken towards a sustainable, green future despite past adversities.

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# Factors influencing energy production in solar panels

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**Abstract:** Today, production facilities are constantly improving in terms of efficiency, as solar and wind energy, which is identified with the concept of nature-friendly green energy, is abundant and unlimited. Solar energy system technologies have developed greatly, especially in the last 20 years, and production facilities have increased gradually. Wind energy systems have larger energy requirements than solar energy systems. One of its disadvantages is that wind formation cannot be predicted. The position of the sun and the predictability of when and to what degree it will emit light enable production with less margin of error than wind energy systems. The production of energy obtained from factors such as sun and wind varies over time. For a stable energy production, it must be constantly monitored and managed. The communication via power line (PLC) method is preferred in Smart production systems because it uses the existing power line and has low hardware costs. In this study, parameters such as temperature, panel temperature, humidity, light rate, panel current, panel voltage, which are among the factors affecting the efficiency of solar panels, were measured. The change in the temperature behind the panel depending on the outside air temperature, solar radiation and wind speed was investigated. The obtained data was analyzed and the factors affecting energy production were examined.
**Keywords:** Solar panels, solar energy, Temperature, Affecting factors, Photovoltaic panels.

## 1. INTRODUCTİON

The development of technology and the continuous increase in the world population mean that the need for energy is also increasing. In today's world, the decrease in fossil fuels, which are the source of conventional energy, causes clean and reliable energy to become even more important. Developed countries aim to progress energy policies and increase the share of clean energy in total energy production in order to meet the emerging energy needs. Energy demand per capita in the world is one of the basic indicators of living standards. Energy consumed per person is generally indicative of a higher quality of life. Traditional fuel sources (fossil fuels, hydro, nuclear energy sources, etc.) mostly meet a large part of today's energy demand. However, the known fact is that these resources will be insufficient to meet the energy demand in the future and some of them will be depleted. Its negative effects on the environment are its role in the extinction of many living species. For these reasons, the importance of renewable energy sources is increasing day by day. It is of great importance for our country to disseminate studies on energy production from renewable energy sources.

Renewable energy sources are energy sources such as hydro, solar, wind, geothermal, biomass and tidal type. These are clean, cheap, abundant and environmentally friendly resources. Among these, solar energy is one of the most widely used sources. Solar energy is an endless form of clean energy that can be found on earth and even in space. Directly from solar energy via solar panel electricity is produced and used. Solar panels consist of photovoltaic (PV) cells. PV cells are produced in various types and structural features. The most commonly used types today are polycrystalline and monocrystalline types, and their efficiency generally varies between 15-17%. There are many experimental and theoretical studies on increasing the efficiency of solar panels. The power of solar panels does not only depend on the efficiency of the cells. It also depends on the number of cells in the panels. Depending on the number of cells, a panel is produced in different powers. This also provides significant flexibility in terms of the electrical power needed for a building. A mini solar power plant (mGES) is established to meet the electricity needs of many places such as residences, public and private workplaces, and industrial establishments with a grid-

connected PV system. Especially in developed countries, solar panels consisting of photovoltaic (PV) cells that can directly produce electricity from solar energy are widely used. Approximately 1-2% of the electrical energy produced in the world is produced by PVs [12].

İt is known to increase the efficiency of the energy production process and the preparation of solar panels on the basis of graphene-based samples [1-42].

One of the applications used to convert solar energy into electrical energy is the solar panel. These devices, which convert the sunlight falling on them into DC electrical energy, are called solar panels. It also appears as solar cell, photovoltaic panel, solar cell and solar module. The efficiency of solar panels, which are widely used today, varies depending on their structure and this value is between 5% and 20%. The fact that energy conversion efficiency is not high in solar panel technologies makes it very important to use the electrical energy obtained in the best way.

Since solar panels have non-linear current-voltage characteristics, solar panel voltage and power vary depending on the current drawn. In addition, the amount of energy produced changes as the characteristics of solar panels depending on factors such as the intensity of the sunlight falling on their surfaces, the panel angle and the temperature of the environment [3].

The Sun is a ball of gas composed of hydrogen and helium..

With the reaction called Nuclear Fusion, which occurs due to the pressure and temperature, hydrogen nuclei are transformed into helium nuclei, and a great deal of radiant energy is released during this transformation

Although the resulting energy is 1360 W/m² outside the world, the amount of energy reaching the earth's surface under the influence of the atmosphere is between 0-1110 W/m$^2$. Even a small portion of the energy coming to the earth is much more than the energy used by humanity. Activities related to solar energy gained momentum after 1975. Due to the advancement of technology used in this field and the decrease in costs, it has become available all over the world. There is a distance of 150 million km between the Sun and the Earth. The energy coming to our Earth from the Sun is approximately 20 thousand times the energy consumed on Earth in a year. Not all solar energy can reach the earth's surface; as seen in Figure 1.1, approximately 30% hits the atmospheric layer and reflects back. Approximately 50% of the radiant energy can pass through the atmosphere and reach the earth's surface.

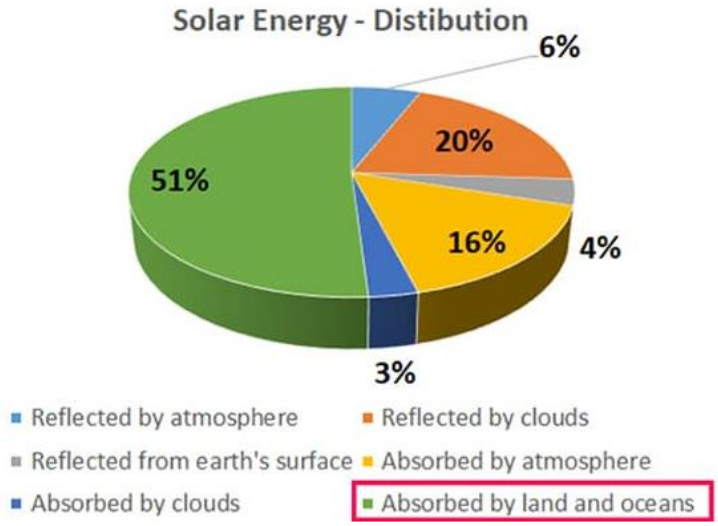


**Figure 1. Distribution of Solar Energy [13]**

Solar energy technologies vary widely in terms of method, material and technological level and can be divided into two basic groups:

1. Thermal solar technologies: In thermal solar technologies, heat is obtained primarily by utilizing solar energy. This heat can be used directly or to produce electricity.

2. Solar cells: These semiconductor materials, also called PV batteries, convert sunlight directly into electricity.

The smallest structural units of a solar cell are called cells. When modules come together, they form The panels come together to form arrays. Figure 2 shows the schematic representation of the progression of a solar cell from its smallest structural unit to panel formation.
Dozens of materials are used in making solar cells. Hundreds of materials are subjected to research and development under laboratory conditions in order to popularize their use. Material selection for photovoltaic cells is of great importance in terms of producing solar cells that are both economical and highly efficient. Silicon is the most commonly used material in solar cell production.

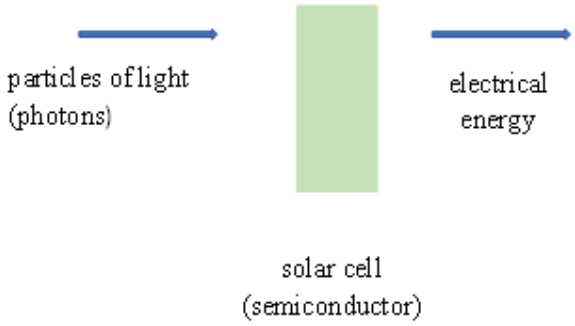


**Figure 2. Working principle of solar cells [14]**

It can be obtained from mono polycrystalline or sheet and can be produced from sliced thick crystal material or from multiple crystal or thin film layers formed on a carrier [9]. The main materials used in solar cell production are:

- Thick crystalline material: Crystalline silicon, gallium arsenic (GaAs).
- Thin film material: Amorphous silicon, cadmium sulfide (CdS), cadmium telluride (CdTe), copper indium di selenoid (CuInSe2) [9].

The fact that most of today's market activities are directed to the production of monocrystalline silicon semiconductor materials has resulted in technologically advanced monocrystalline semiconductor material production techniques. Monocrystalline Solar Panels were the first commercial solar panels. Single crystal silicon grown by crystal drawing method is used. It constitutes a very large part of the market.
However, the high production cost has increased the tendency towards other batteries. Its efficiency is quite high [1]. It provides 24% efficiency in monocrystalline silicon solar cells under laboratory conditions. In commercial modules, it varies between 15 and 18%. It is ideal for long-term investments due to its high efficiency. The payback period is 4-6 years. 7% efficiency losses occur over a 20-year period [10].
The most commonly used method in the production of polycrystalline silicon is the casting method. The starting material is the same in both monocrystalline silicon and polycrystalline silicon. The desired purity is the same in both (99.99999%). Molten silicon is poured into molds and allowed to cool. The efficiency and costs of solar cells manufactured from materials produced with this technology are relatively low [11]. In addition, solar cells with an efficiency of around 14% can be obtained from polycrystalline silicon with a particle size of a few millimeters [6].
Monocrystalline or polycrystalline silicon solar cells have been notable for their efficiency and stability since the 1950s. With the technologies developed in recent years, photovoltaic conversion efficiencies are gradually increasing. Production processes are cheaper than monocrystals. Efficiencies of around 18% in laboratory conditions and 14% in commercial modules are obtained from polycrystalline silicon solar cells [1].
It is possible to list the advantages of solar panels today as follows:

- Fuel resources are unlimited;
- They do not produce emissions and radioactive waste. Therefore, it has no effect on global warming;
- Operating costs are low;
- It has no moving parts;
- They can work at ambient temperatures. They do not seek high temperatures;
- They are quite safe. There are panels produced with a guarantee of up to 30 years;

- Annual energy data can be calculated in advance.

## 2. EXPERİMENTAL DETAİLS

Solar cell is defined as the smallest unit that converts sunlight directly into energy in PV systems. The module consists of solar cells connected in series or parallel. By connecting these modules in series and parallel, it is possible to reach PV panels at the desired voltage, power and current values. PV panel converts solar energy into electrical energy with 6%-20% efficiency, depending on the semiconductor material in the panel structure [2]. The most important factor in the operation of PV solar cells is the sunlight falling on the cells. Intensity of sunlight, angle of light falling on the cells; these directly affect the cells` electricity production. Therefore, the latitude and the time of year directly affect the operation of the solar PV system.

Solar energy coming to that region can be estimated according to the geographical location.

Low efficiency of PV panels is related to factors such as temperature, dustiness, panel tilt angle, solar radiation intensity, shading and other losses [7]. The most important parameters affecting panel efficiency are temperature and solar radiation intensity.

Changes in solar radiation intensity and temperature during the day significantly affect panel efficiency, and therefore it is important to know the effects of these parameters on panel efficiency.

However, companies producing PV panels comply with the Standard Test Conditions (STC) of 25 ºC cell temperature, 1000 W/m² solar radiation intensity and A.M.

They perform tests under 1.5 air mass ratio conditions and calculate the electrical values of the panel, and the results of these tests are stated in the panel catalogue.

The electrical values of the solar panel during changes other than STC are unknown. It is also necessary to know the electrical values of the PV panel under changing atmospheric conditions. Especially under changing atmospheric conditions, calculations made in the design of off-grid and grid-connected systems give more accurate results [8].

The efficiency of solar cells varies depending on the radiation and temperature falling on them. Voltage and current changes depending on the solar radiation falling on the solar cells are shown in Figure 3. From the figure, it can be seen that the change in current due to radiation is large [5].

Panel temperature directly affects the operation of solar cells. As the temperature of the panel increases, a decrease in the efficiency of the panel is observed. Increased temperature also increases the degradation of solar cells and causes a certain decrease in the lifespan of the panels.

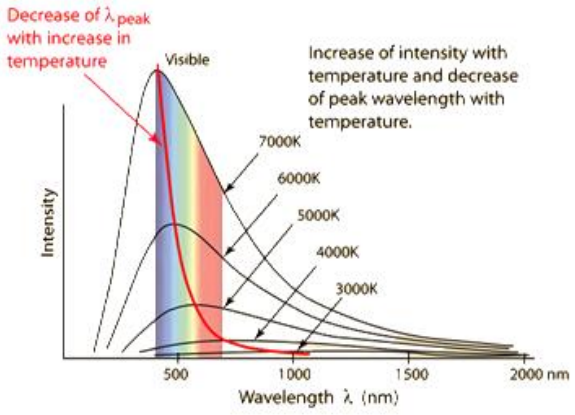


**Figure 3. Current and voltage change depending on solar radiation [15]**

The cell temperature (Tc) of a PV panel can be estimated using the NOCT temperature for a desired air temperature (Ta) and irradiance (G) value (kW/m2). µp varies between 0.38-0.45 %/K depending on the properties of the panel [4].

$$Tc = Ta + \frac{NOCT-20}{0.8} G$$

Here *G* is the radiation value.
The output power of the panel can be calculated by using the temperature value found together with the temperature dependence coefficient μp of the panel power. Here Pm, STC is the panel power at standard test conditions (STC) [4].

$$Pm(Tc)= Pm,STC[1- \mu p\ (Tc - 25)]$$

Pm (Tc) is the panel power at standard test conditions (STC). NOCT temperature in PV panels varies between 42-52°C. The observed 10°C difference Here, $I_{PV}$ is the current of the solar panel, $I_L$ is the light current, $I_S$ is the diode saturation current, q is the electron charge, V is the voltage of the solar panel, n is the diode factor, k is the Boltzman constant, and T is the cell temperature. Radiation G=100-1000 W/m$^2$ and cell temperature T varies between 0 - 75 °C [4].

results in a power difference of 3.8% - 4.5%, which is a significant amount, if the temperature dependence coefficient is accepted as μp = 0.38 - 0.45 %/K. Therefore, in panel selection, the NOCT temperature and the temperature dependence coefficient of power should be evaluated together and the ones least affected by temperature should be selected. Thus, the performance decrease will be reduced when the temperature is high [4].

$$I_{PV=} I_{L\ -} I_S\ (e^{\frac{qVPV}{NKT}} - 1)$$

In Table 1 in April, the graph of the change in solar radiation value over time and the power at the location where the photovoltaic system is located.
The change graph of production value over time is given. In addition, instantaneous radiation and power production values for 5 different times on April 1 are presented.

**Table 1. Some irradiance and power values for April**

| April | | | | | | |
|---|---|---|---|---|---|---|
| **Hour** | **Irradiance (W/m2)** | **Power (kW)** | **PO** | **Temperature (°C)** | **Moisture** | **Wind Speed (km/h)** |
| 09:45 | 459 | 23,94 | 88,3% | 12 | 63% | 15 |
| 12:00 | 648,867 | 34,17 | 89,1% | 15 | 55% | 16 |
| 16:00 | 710 | 38,86 | 92,5% | 19 | 37% | 22 |
| 18:30 | 114 | 3,82 | 56,5% | 17 | 39% | 23 |

Shadowing directly affects the operation of PV panels. The shadow falling on the panel reduces the radiation reaching the PV cells. Due to this decrease in the energy coming to the cells, the cells produce less energy. Another negative effect of shading is the partial shading effect. Even shading of just one cell in the panel can cause the energy produced by the entire panel to decrease significantly. The shaded cell produces very little energy compared to other cells and shows a resistance effect. The electric current produced by other cells begins to pass over the shaded cell and a sudden temperature change is observed in this cell. Shadowing on PV panels does not only cause a decrease in the electricity produced.

It also causes the lifespan of PV panels to decrease due to overheating on the cells due to the effect of shading. The places where PV panels are planned to be installed should be areas that do not receive shade. Care should be taken to ensure that the panels are not affected by the shadow of nearby trees and buildings.
Average radiation, temperature, humidity, wind speed and voltage values for certain hours between 3 and 22 April (Table 2) are given in the example of the condition of weather in Azerbaijan. In this table it is seen that the wind speed value was 26 km/h on April 3 and 2 km/h on April 22.

**Table 2. Some values for April 3 and 22**

| **Day** | **April 3** | **April 22** |
|---|---|---|
| Time | 11:45 | 11:15 |

| | | |
|---|---|---|
| Irradiance (W/m2) | 975 | 975 |
| Temperature (°C) | 13 | 13 |
| Humidity (%) | 34 | 34 |
| Wind speed (Km/h) | 26 | 2 |
| Voltage (Volts) | 646 | 616 |
| Current (Ampere) | 78,5 | 78,5 |
| Power production (kW) | 50,7 | 48,4 |
| P.O. | 87,9% | 83,9% |

In the same time period, it is seen that the voltage value on April 3 is higher than the voltage value on April 22, and also, depending on the radiation values, the current value on April 3 is approximately the same as the current value on April 22. When the power production values are compared, the current value is approximately equal and the voltage value is higher. It is thought that this decrease in voltage is due to the increase in panel temperature as the wind speed decreases.

Accumulation of dust particles reduces the performance of solar cells and causes significant losses in power due to solar radiation scattering effects on the surface of the solar panel. It can cause a significant deterioration in the solar conversion efficiency of PV panels. Previous studies on this subject have shown that dust accumulation; It has been shown that the inclination angle of the solar collector is closely related to dust exposure time, site climatic conditions, wind movement and dust properties. However, few studies have also evaluated the impact of PV panel properties, cell types, and surface materials on dust accumulation and efficiency degradation.

## 4. CONCLUSİON

In this study, electricity was produced with PV panels and factors affecting electricity production were examined. Electricity production of PV panels is negatively affected by temperature increase.

In some cases, electrical efficiency decreased despite the decrease in temperature, or electrical efficiency increased as the temperature increased. It has been determined that even a small shadow on the panel series can cause this situation. However, electrical efficiency is also greatly affected by dust.

In this study production data of photovoltaic panels, solar radiation, wind speed and temperature values were measured.

The effects of panel temperature, wind speed, surface dust, shading and converter losses were determined. As a result, it was seen that electricity production increased with increasing wind speed, but electricity production decreased due to converter loss, dust and shading of the panel.

The geographical structure of the place where PV panels will be installed is very important. Even a small amount of shading negatively affects the operation of PV panels. Therefore, the place where the PV system will be installed should not be shaded in any way. It has been observed that a PV system installed in a windy place will produce more electricity. However, considering that excessive wind may cause damage to PV panels, it must be installed in a suitable location.

Due to the negative effects of dust, ensuring that the air in the place where PV panels will be installed is clean and less affected by dust will also increase electricity production. It is anticipated that establishing a system to clean dusty panels will also be very useful. It has been determined that converter losses also affect electricity production. For this reason, it is predicted that installing a PV system with a power close to the power of the converter will reduce electricity losses.

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# Diodes made from carbon nanotubes

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**Abstract:** Carbon nanotube diodes are an important part of nanotechnology and a key component of the nanotechnology revolution that could have major implications for the future. Nanotechnology is a discipline that deals with the design, manufacture and manipulation of materials at the nanometer scale. Carbon nanotubes, on the other hand, are among the nanomaterials that stand out and attract great attention in this field.
**Keywords:** Carbon nanotube, Nano diode, Single-walled carbon nanotubes (SWCNT), Multi-walled carbon nanotubes (MWCNT), Electrical conductivity.

## 1.INTRODUCTİON

Diodes prepared from carbon nanotubes are diodes in which carbon nanotube material is used as electronic components.
Carbon nanotubes can be thought of as cylindrical structures formed by bending graphene sheets. These nanotubes can have electrical and optical properties and potentially be used in semiconductor components [1-31].
The crystallinity of carbon nanotubes depends on the structural arrangement of the nanotubes and the position of their atomic planes. Carbon nanotubes are formed by bending graphene sheets in a specific way.

There are two main types of carbon nanotubes: single-walled carbon nanotubes (SWCNT) and multi-walled carbon nanotubes (MWCNT).
1. Single-Walled Carbon Nanotubes (SWCNT):
Single-walled carbon nanotubes are formed by bending a single sheet of graphene into a cylindrical shape. Such nanotubes are highly ordered in crystallinity. The bonds between atoms are regular and nearly perfect, resulting in high electrical conductivity and mechanical properties.
SWCNTs usually have chirality (spiral structure) expressed with (n, m) indices, and these indices determine the properties of the nanotube.

**Table 1. Common features of semiconductor diodes and carbon nanotube diodes**

| General properties | Semiconductor diodes | Carbon nanotube diodes |
|---|---|---|
| Semiconductor material | Usually silicon, germanium, etc. | Carbon nanotubes |
| Diode function | Passes electrical current in one direction | Conducts electrical current in one direction |
| Band structure | Valence band and transmission band | Electronic band structure |
| Principle of operation | Transmission of electrons in the band structure | Transmission of electrons in the electronic band structure |
| Electronic applications | Transistors, solar panels, diodes | Optoelectronic devices, photoelectric sensors, nanoscale electronic devices, etc. |
| Material Flexibility | Standard silicon semiconductors | Carbon nanotubes, mechanically flexible |

| | | |
|---|---|---|
| Mechanical resistance | Good wear resistance | Mechanically strong |
| Applications | Electronic devices, solar cells, sensors, etc. | Nanotechnology, optoelectronic devices, advanced applications of nanotubes, etc. |

**2.Multi-Walled Multi-Walled Carbon Nanotubes (MWCNT):**

Multi-walled carbon nanotubes are formed by wrapping multiple layers of graphene around each other. [5, 6, 17-19]There may be gaps and irregularities between these layers. The positions and degrees of bending of the layers in MWCNTs can vary, resulting in less crystal order. Therefore, MWCNTs may have lower electrical and mechanical properties compared to SWCNTs.

The crystallinity of carbon nanotubes exhibits different properties depending on the atomic arrangement in their structure. Single-walled carbon nanotubes tend to have higher conductivity, strength, and other mechanical properties due to their crystal arrangement. [4,30] However, both types of nanotubes have unique properties that can be used in a variety of applications.

The table 1. shows the general aspects of semiconductor diodes and carbon nanotube diodes.[1,7,9,29,31]

The electrical conductivity of diodes prepared frm carbon nanotubes is based on their physical structure. Carbon nanotubes can be thought of as cylindrical structures formed by bending graphene sheets. These structures have a graphite-like structure with unique electronic properties. Diodes prepared from carbon nanotubes basically come about by designing structures containing p-n junctions. Diodes are semiconductor devices that allow electric current to flow in only one direction. Some of the carbon nanotubes may have p-type semiconductor properties, while others may have n-type semiconductor properties. This makes it possible to use carbon nanotubes as diodes.

Semiconductor diodes and some carbon nanotube diodes may have n-type or p-type structures, and these structures significantly affect the diode characteristics. [3-6,22,27,28] The characteristics and operation of N and P type diodes have the basic features described below:

N Type Carbon Nanotube Diodes:

- ⇒ In n-type carbon nanotube diodes, a foreign atom (for example, boron or nitrogen) is added to the structure of the nanotubes, which provides extra electrons and turns the nanotube into an n-type semiconductor. In these diodes, free electrons act as carriers.
- ⇒ Current flows when the anode (P side) is applied negative and the cathode (N side) is applied positive.
- ⇒ In N-type diodes, electrons move towards the anode side and current is generated.

P Type Carbon Nanotube Diodes:

- ⇒ In p-type carbon nanotube diodes, a foreign atom is added to the structure of the nanotubes, this time creating an electron deficiency and turning the nanotube into a p-type semiconductor. In these diodes, holes (lack of electrons) act as carriers.
- ⇒ Current flows when the anode (N side) is applied positive and the cathode (P side) is applied negative.
- ⇒ In P-type diodes, the holes move towards the cathode side and current is generated.

The n-type or p-type structures of carbon nanotube diodes determine the current-voltage (I-V) characteristics of the diode and control in which direction current can flow.[2,5] The conductivity of the diode can vary depending on the applied voltage and therefore diodes can be used in different applications.

N and P type carbon nanotube diodes have potential applications in many fields such as solar cells, sensors, radiation sensors and other optoelectronic devices. The selection of diodes must be done carefully to obtain the appropriate operation and characteristics for a particular application.

The exact mathematical formula of carbon nanotube diodes is difficult to pinpoint, especially given the complexity and different variations of such diodes. However, there are mathematical formulations that express the working principle of diodes in general. Carbon nanotube diodes are based on the electronic properties of semiconductor materials. These diodes are formed by joining semiconductor materials called a p-n junction. P-n junction is the joining of positively charged (p-type) and negatively charged (n-type) semiconductor regions. It is expressed by Ohm's Law and diode equations. For carbon nanotube diodes, the following mathematical formulas can be used:

Diode current voltage relationship (Diode equation):

$$I = I_0 e^{\frac{qV}{kT}} - 1$$

Here:

I is the current of the diode

$I_0$, saturation current (non-linear diode characteristic)
e, Euler number (approximately 2.71828)
q, electron charge (approximately $1.602 \cdot 10^{-19}$C)
V is the voltage across the diode
k is Boltzmann's constant (approximately $1.381 \cdot 10^{-23}$J/K)
T is the temperature of the diode (in Kelvin)
Modeling electrical properties of carbon nanotube:
There are several models that fully express the electrical properties of carbon nanotubes, for example the Brenner, Tersoff or Stillinger-Weber potentials. [25-31, 36,37]These models are used to explain the energy band structures, energy levels and electron transfer of nanotubes. However, the exact mathematical formulations of these models are quite complex, and these models are often used with computational methods or simulations.
By 2023, diodes made from carbon nanotubes are generally in laboratory-level research and development and are not widely used in commercial applications. However, due to the potential of carbon nanotubes, it is thought that they could be used in a number of applications in the future. Here are some of the potential consumer and industrial application areas:

1. Electronic Devices: Carbon nanotube diodes can be used in high speed and low power consumption electronic devices. In particular, they can play an important role in the development of high-frequency and high-performance transistors.[1,8,10,11,37-39]

2. Optoelectronic Devices: Carbon nanotubes can be used in optical communication and sensing systems. They have significant potential in the development of optoelectronic devices, especially photodiodes and phototransistors.[12,13-27]

3. Energy Storage and Conversion: Carbon nanotubes can be used in energy storage and conversion technologies such as batteries and supercapacitors, thanks to their high surface area and good conductivity.[14]

4. Biomedical Applications: Carbon nanotubes also have potential applications in biomedical fields such as biosensors, drug carriers and imaging technologies.

5. Sensors: Carbon nanotubes can be used in the development of gas, chemical, radiation and biological sensors. High surface area and sensitivity characteristics can improve sensor performance.
However, to achieve these potential applications, significant challenges such as fabrication methods, scalability and cost of carbon nanotube diodes must be overcome. In addition, the functional properties of diodes such as reliability, stability and repeatability need to be improved

## 3. CONCLUSİON

Diodes prepared from carbon nanotubes have the potential to have important results in many applications in the future. However, the usability and performance of carbon nanotube diodes in practical applications is still an active research topic. Some laboratory studies and experimental studies have shown that carbon nanotube diodes give some positive results. For example, the high mobility and good electrical conductivity of carbon nanotubes make diodes potentially usable in fast switching and high frequency applications.[9-13] Moreover, the use of carbon nanotubes in optoelectronic devices (for example, photodiodes) may offer advantages such as high sensitivity and fast response times. However, there are some difficulties in the usability of carbon nanotube diodes in practical applications. For example, there are technical difficulties in the production, control and sequencing of carbon nanotubes. In addition, the problems of carbon nanotubes such as surface defects, contact resistance and functional stability are also issues to be resolved.
Therefore, further research and development studies are required for the transition of carbon nanotube diodes to commercial applications and their wide availability. With advances in nanotechnology, it may be possible to realize the potential of carbon nanotube diodes and evolve into further optimized, high-performance diodes. This could open new opportunities for the development of faster, more powerful and more energy efficient electronic devices.

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# Modification and investigation of waste low-density polyethylene with functional group containing compounds

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**Abstract:** Composite materials are utilized across a broad range of applications, including automotive, aerospace, shipbuilding, wind turbine blades for wind energy production, oil and gas exploration, and the renewable energy industry. One of the challenges in recycling composite materials, particularly thermoset-based polymer composites, is their inherent heterogeneity. The management of current and future waste necessitates the proper recovery and recycling of products at the end of their life cycle, which would result in resource and energy savings. Various technologies focused on reinforcing fibers have been developed to facilitate the recycling of composite materials. This includes mechanical recycling methods, where polymers are separated from contaminants and can be transformed into granules through melting and extrusion. Mechanical recycling involves operations such as separation, melting filtration, and size reduction. A downside of mechanical recycling is the potential alteration of the product's properties at each stage. Chemically, recycling can be based on the depolymerization of polymers into monomers, which can then be repolymerized to restore the polymer. Considering composite materials as a viable energy source, their energy content can be recovered, though the synthesis process may produce environmentally harmful substances. The high cost of recycling and low quality of the recycled materials are significant barriers for composite material recycling. Identifying well-processed composites and implementing efficient separation methods are crucial for their recycling. New processing technologies will be developed for the recycling of composite materials, leading to more easily recyclable materials in the near future.

**Keywords:** Polyethylene, Oligomer, Modification, Processing, Composition.

## 1. INTRODUCTION

Composite materials, composed of two or more components with various physical and chemical properties, have been used since ancient times, such as the natural fibrous straws used in wall construction in Egypt 3000 years ago. Recycling of composite materials in sectors like wind energy, marine, oil, and automotive will reduce environmental impacts. Various processing methods have been proposed for recycling different types of fiber-reinforced composite materials, which has become a subject of scientific interest.

The recycling of high molecular weight compounds, including elastomers and other materials, is not keeping pace with increasing production. The disposal of polymer waste in landfills or incineration poses serious environmental problems due to their low biodegradability. Researchers have reviewed recycling strategies for waste thermoplastic and thermoset materials, highlighting that recycling can mitigate the problems associated with discarded or incinerated plastic waste. Choosing the correct recycling method can effectively solve the recycling problem without compromising the mechanical properties of the construction material. The importance of initial cleaning of waste polymer materials to ensure compatibility with construction materials has often been overlooked. Research is needed to facilitate the recycling of thermosets and thermoplastics, aiming for resource conservation and sustainability.

## 2. EXPERIMENTAL DETAILS

Challenges in recycling plastic waste include its disposal in landfills, the poor biodegradability of commonly used polymers, rising costs, and legislative pressures. Additionally, incinerating plastic waste creates ecological problems. Mechanical and chemical recycling are among the most effective methods for managing plastic waste. Polyolefins, widely used thermoplastics globally, primarily include polyethylene (LDPE, HDPE) and polypropylene (PP). Approximately 22 million tons of these polymers are produced and consumed annually in Western Europe, accounting for over half of the processed thermoplastics. This study investigates the recycling of LDPE, HDPE, and PP using dissolution/precipitation and pyrolysis methods. Dissolution/precipitation is part of mechanical recycling, while pyrolysis belongs to chemical recycling. The process involves separating and recycling polymers in a solvent environment, using various solvents and waste plastics under different weight percentages and temperatures. Most samples showed a recovery rate of over 90%. Additionally, the pyrolysis of LDPE, HDPE, and PP was conducted with or without an acid catalyst, analyzing the resulting gases and oils. It was determined that pyrolysis products, comprising a range of alkanes and alkenes, could serve as raw materials for producing new plastics or purified fuels in the petrochemical industry.

The import of materials with high usage rates, particularly in the iron-steel and plastic industries, leads to significant waste production during manufacturing and consumption. The most challenging wastes include the dust from the furnaces of the iron and steel industry. The increasing use of plastic materials, which do not decompose quickly once their service life ends, allows them to persist in the environment as waste for extended periods. The majority of the world's plastic materials are made from low-density polyethylene (LDPE), and their recycling can reduce environmental problems and contribute to the national economy. Studies have shown that LDPE and high furnace dust can be combined through extrusion to produce composite granules. These granules, once molded, have their mechanical, physical, and chemical properties studied and have been found suitable for use as flooring materials in the construction industry.

The consumption of thermoplastics like polyethylene and polypropylene is on the rise, causing difficulties in managing solid household waste. Plastic waste is considered a serious pollutant for water systems and the lithosphere. Mechanical recycling is a viable alternative to reduce the volume of plastic waste. Research has shown that assessing the post-industrial waste recycling process through thermomechanical and thermochemical treatments is possible. Experiments with up to 30% PP in LDPE waste and polypropylene (PP) blends have been conducted under controlled temperature and nitrogen flow, incorporating zeolite and Ziegler-Natta catalysts. Results indicate that the zeolite catalyst, during the thermomechanical processing phase, acts as a modifier of the polymer structure, leading to significant changes in the properties of the LDPE/PP blends depending on the experimental conditions. The catalytic purification of polymer wastes offers a potential method for recycling polymer materials with high contamination and improves the properties of the recycled materials.

Reducing the consumption of single-use plastic bags, identifying the best recycling methods, and managing roadside waste collection are important tasks. In terms of waste management costs and energy usage, two key aspects are the production and recycling of polyethylene (PE) waste. Studies suggest that implementing best practices can achieve economical and environmental benefits, with potential reductions in unrecycled PE waste by approximately 4.4 million tons. This reduction could decrease CO2-equivalent emissions by about 1.46 million tons and increase net energy demand by 16.5 million due to the energy produced from waste.

Among polyolefins, polyethylene and polypropylene are the most used and are difficult to degrade, accumulating in the environment and causing ecological problems. Various bacterial and fungal organisms are utilized to facilitate their biological degradation. Polyethylene, being the most commonly used polymer, has packaging materials with a short lifespan. One of the main methods of recycling PE is the production of plastic bottles that can be used up to 50 times. LDPE is applied to these bottles under specific conditions, and the bottles should be recyclable. The essential properties of the recycled bottles have been determined through testing.

Packaging materials used for product packaging are mainly made from low-density polyethylene (LDPE). Recycling LDPE-based plastic materials poses challenges as they are not easily decomposable and can harm the environment. The most effective approach for safely recycling plastic waste is converting it into simpler compounds. Biodegradation is the most common method used for this purpose, being cost-effective and efficiently conducted in specific aqueous environments. Studies on the biodegradation of LDPE have used various combinations of LDPE and starch, observing that degradation increases with higher starch content over 150 days.

Research in biotechnology primarily focuses on exploring the catabolic repertoire of natural bacteria for the biodegradation of plastic waste. LDPE is difficult to degrade and poses serious environmental risks. The biodegradation potential of LDPE using enriched aerobic bacteria from municipal waste has been studied, along with challenges like the high molecular weight preventing microbial cell penetration, chemical stability, the absence of functional groups for microbial enzymes, and crystallinity. Plastic waste, especially accumulating on roads, streets, and in water, is used in various industries like automotive, medical, and oil, posing environmental and aesthetic concerns. Studies have examined the activity of microbes and organisms in using the substrate as an energy source, indicating that low-density polyethylene can be used as a sole carbon source, confirming their ability to degrade polymers.

Using various methods, waste polyethylene has been modified with bitumen, a complex mixture of hydrocarbons and elements like oxygen, nitrogen, and sulfur. Bitumen can exist in semi-liquid, semi-solid, and solid forms. Waste polyethylene, sourced from commercial packaging bags, has been found to enhance the high-temperature stability of modified bitumen. Modified bitumens with waste polyethylene were prepared using different processing parameters and a high-speed cutting mixer. The thermal stability of the modified bitumen was analyzed using differential scanning calorimetry and thermogravimetric analysis, revealing that the modified bitumen exhibits better heat resistance than the base bitumen, independent of the preparation parameters.

Bitumen is a fundamental component of asphalt binders, used to combine gravel, sand, and mineral powder in monolithic forms, with its adhesiveness and ability to become liquid when heated and solid when cooled, also demonstrating thermoplastic properties. Lower strength properties make bitumen sensitive to transportation loads and climatic factors, softening at high temperatures and cracking at low temperatures. Modifying bitumen with polymers like elastomers and latex improves its properties and the durability of asphalt concrete, increasing adhesion strength, heat resistance, and enhancing low-temperature characteristics.

The high cost of polymer modifiers limits their use, with partially replacing them with cheaper plastic waste emerging as a promising solution. Research has shown that recycled polyethylene from agricultural films and packaging materials meets these requirements. The effect of electrical discharge on the copolymerization process of linear low-density polyethylene has been analyzed, showing changes in the physical and mechanical properties due to the energetic atoms, molecules, and ions produced, affecting chemical reactions.

Surface modification of polyethylene, assessed using various nitrogen-containing plasmas, introduces nitrogen functional groups, affecting surface tension. Plasma treatment, using N2 and Ar + NH3 mixtures, analyzed by X-ray photoelectron spectroscopy, enriched surface oxygen content, with Ar + NH3 plasma found to be effective for nitrogen and amine functionalization.

## 3. CONCLUTION

Studies have indicated that composites of recycled thermoplastics with natural fibers offer an appealing alternative, conserving natural resources, reducing waste, and providing economical materials. The interfacial adhesion between low-density polyethylene (LDPE) and aluminum (Al) foil is weak, posing challenges in multilayer packaging design. Various methods have been proposed to improve LDPE's adhesive properties, with comparative studies showing enhanced adhesion in LDPE-modified samples, particularly when using small concentrations of sulfur-containing compounds, improving the bonding strength for multilayer lamination applications.

Ziegler-Natta catalysts have enhanced the mechanical and conductivity properties of cross-linked low-density polyethylene (XLDPE), highlighting the superior activity of metallocene-based catalysts and the high performance of XLDPE produced directly by late transition metals. The use of these catalysts has improved resistance, flexibility, transparency, and productivity. XLDPE products are increasingly used in electrical, medical, and surgical fields and have the potential for industrial-scale application.

The properties of polyethylene produced at the Shurtan gas chemical complex were studied, and its suitability for use in road bitumen was assessed. The impact of the heavy fraction components of furnace oil on the properties of the diesel fraction was determined, and the technology for separating low-density polyethylene from local waste was developed.

The addition of various polymers to bitumen, a common practice, reduces its temperature sensitivity. Recycled materials are increasingly reused in road construction to improve overall performance and durability. Local governments and road agencies are paying more attention to the use of soft plastics to reduce landfill waste, with many countries implementing waste management initiatives.

Post-consumer low-density polyethylene (LDPE) has been used to address significant environmental

problems and improve bitumen's performance characteristics. The study created modified bitumen by adding different percentages of LDPE (1%, 2%, 3%, and 4%), and tests on penetration, softening point, and ductility were conducted at two different temperatures (135℃ and 165℃). LDPE additions improved the softening point and ductility compared to pure binder, with one LDPE type outperforming another in enhancing bitumen properties.

Worldwide, plastic waste constitutes a significant part of solid waste, impacting the environment and public health. Research has explored the use of recycled high-impact polystyrene (HIPS) and LDPE in producing durable lightweight concrete for cement-based composites. The inclusion of recycled plastic granules reduced workability, density, and compressive strength, demonstrating feasibility for concrete production up to 10% plastic content.

The disposal of plastic waste, given its low biodegradability and large volume, poses a major problem. Research mixing high-density polyethylene waste with Portland cement explored the production of plastic cement, assessing the impact of replacing various percentages of sand with polyethylene waste.

Recycled LDPE and waste rubber have been used to modify asphalt binder, with rheological properties measured using dynamic shear rheometry and binder beam rheometry. Mixing LDPE and waste rubber in asphalt resulted in decreased phase angle, increased ductility, and higher softening point.

Finally, recycled LDPE from agricultural films and packaging materials is used in creating asphalt surfacing, showing the practical reuse of plastic waste in construction and road building.

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