ENERGETIKA
ENERGETICS

Published from 2004
Ministry of Press and Information
of Azerbaijan Republic,
Registration number 3337, 07.03.2011

ISSN 1816-2126
Number 04, 2022
Section: English

ECOENERGETİCS

PUBLISHING OFFICE
5, M.Rahim, AZ-1073, Baku Azerbaijan
Tel.: 99412 538-23-70,
99412 538-40-25
Fax: 99412 538-51-22
E-mail: info@ieeacademy.org
ekoenergetics@gmail.com

Internet: http://ieeacademy.org,
www.innovationresearch.az

Contents

Effect of 25MPa compressıon force on X-ray diffraction scattering of carbon nanotube obtained by electric arc discharge method

R.G. Abaszade

Azerbaijan State Oil and Industry University, Baku, Azerbaijan,
abaszada@gmail.com

Abstract: The presented article analyzes the carbon nanotube obtained by the electric arc discharge method after compression under normal conditions and under pressure. The synthesized carbon nanotube was first shaped into a rectangular paraleopiped and then studied by X-ray phase analysis. Changes in the mechanical properties of the carbon nanotube as a result of the compressive force. Changes in the curves observed in the X-ray diffraction graph were observed. The dimensions of the nanoparticle before and after pressing were also calculated using the Debye–Scherrer expression, which is considered an important method in particle measurement.

Keywords: Electric arc method, Carbon nanotube, Pressure X-ray diffraction scattering.

1. Introduction

Researches related to the applications of carbon nanotubes obtained by various methods are of great importance in the preparation of basic elements of modern electronics. Carbon nanotubes, distinguished by their unique physical properties, are widely used in various fields of industry. The purity, quality, and surface morphology of the carbon nanotube obtained by the electric arc method were analyzed by scanning electron microscope (SEM), energy dispersive analysis (EXD), X-ray phase analysis, and Raman scattering methods [1,16].

The dependence of the X-ray diffraction peaks of the carbon nanotube obtained by the electric arc method on the morphological properties of the substance was studied. These studies allow obtaining initial information about the dimensions of carbon nanotubes and the distance between their walls [2].

A pure and gadolinium-doped (xGd =10%) carbon nanotube obtained by the electric arc method was shaped into a rectangular parallelepiped. Then the prepared samples were studied by X-ray phase analysis and Raman scattering methods. With the change of the mechanical properties of the carbon nanotube, noticeable changes occur in the X-ray phase and Raman scattering curves. This is also explained by the weakening of sp^2 hybridization [3]. Various properties of graphene-based samples have been studied and investigated [4-9]. X-ray phase analysis and properties of carbon nanotubes and related works have been investigated [10,11].

Carbon nanotubes are widely used in forming the element base of transistors and converters. Therefore, it is very important to study the electronic and mechanical properties of carbon nanotubes.

The mechanical properties of carbon nanotubes formed by twisting graphene layers into a cylindrical shape were investigated [12].

Due to the emission properties of carbon nanotubes, they are widely used in electronic displays, X-ray sources, luminescence sources, and various electronic devices [13]. There is a limited number of studies investigating the properties of carbon nanotubes compressed under pressure. In this regard, our research has led us to pay special attention to the investigation of carbon nanotubes compressed under different pressures.

The purpose of the presented article is to determine the changes in the structure of carbon nanotubes obtained by the electric arc method under the influence of compression under a pressure of 25 MPa, based on the X-ray diffraction method.

2. Experimental details

The X-ray diffraction scattering method is considered one of the important methods for studying the structural properties of carbon nanotubes. The structural properties of the carbon nanotube obtained by the electric arc method were studied by X-ray phase analysis. The X-ray phase analysis was carried out in the D2 Phaser diffractometer manufactured by the German "Bruker" company, with CuKα rays (λ=1.5406Å) in the 2θ=0.50÷800 angle interval [1]. Carbon nanotubes were pressed in the form of a

paraleopipe under a pressure of 25 MPa, and then X-ray phase analysis was carried out. Sizes calculated from the broadened diffraction peak describe the smallest scattering centers (various cores, crystallites). Using the angular dependence of the scattering intensity, it is possible to distinguish the reasons for the broadening of the diffraction peaks. Thus, the shape of the diffraction peak depends on both the shape and size of the nanoparticles. In addition, homogeneous elastic deformation causes only the shift of the position of the diffraction peaks due to the change of the lattice parameters. From the shift of the state of the diffraction peaks, it is possible to calculate the change of the distance (d) between the planes of the atoms [14].

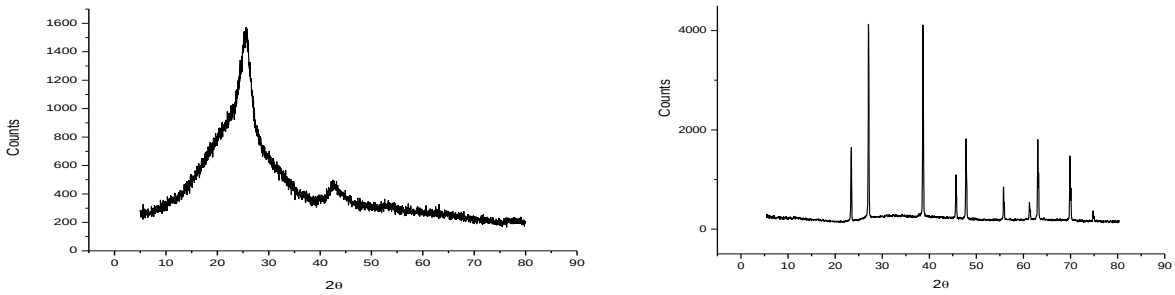


Figure 1. X-ray diffraction scattering of carbon nanotube (a), X-ray diffraction scattering of carbon nanotube compressed under 25 MPa pressure (b).

Three methods were proposed by the authors of Williamson and Hall, Warren and Averbach, and Debye–Scherrer for the deformation of the sample and the determination of the dimensions of the nanoscale crystallites of the substance. If there is no inhomogeneous deformation in the material, the average nanosize of the crystallites is determined by the full half width of the broad diffraction peak according to the Debye–Scherrer formula.

$$D = \frac{K\lambda}{\beta Cos\theta}$$

Here: D- is the diameter of the nanotube and β- is the full width at half-width (FWHM) of the diffraction peak.

The value of Scherrer's constant (K) shown in the formula varies in the range of 0.9 ÷ 1.15 in the case of different crystallographic Miller index (hkl) diffractions of the cubic crystal lattice.

Usually, for simplicity, the value of K in cubic materials is taken to be 0.9. In our study, K=0.94 was taken [13-15]. During the calculation, the beta value is expressed in radians.

The parameters of the diffraction peak calculated according to the Debye–Scherrer formula are described in the table below.

Example	2θ	β, dər.	D,nm	Cosθ
Carbon nanotube	25,595	4,77	1,786	0,9744
Pressed carbon nanotube	23,5	0,4228	19,637	0,979

3. Conclusion

Structural properties of carbon nanotubes were comparatively studied with the help of X-ray phase diffraction analysis. Using X-ray phase analysis, it is possible to examine the quality, quantity, particle size, structure of the sample, and the size of the crystallites of the sample. The X-ray phase analysis of the carbon nanotube in Figure 1a was performed according to the Debye–Scherrer formula. The broadening of the diffraction peak observed in the spectrum can occur for various reasons. In small nano-sized particles (<100 nm) and irregularly oriented crystals, broadening of diffraction peaks can occur due to the lack of complete constructive and destructive interference of X-rays. X-rays that cause diffraction at an angle different from the Bregg angle can cause a broadening of the diffraction peaks [13,14]. In Figure 1b, according to the X-ray phase analysis of the carbon nanotube obtained by the electric arc method and compressed under a pressure

of 25 MPa, the diffraction peaks are related to the morphological characteristics of the sample, which helps to obtain initial information about the dimensions of the carbon nanotube and the distance between the walls. Based on the X-ray phase diffraction analysis, a spectrum corresponding to the nature of the samples was obtained. The results of the conducted research show that due to the effect of compression under pressure, a transition from the amorphous phase to the crystalline phase is observed in the considered substances. As a result, the half-width of the diffraction scattering curve decreases, and the diameter of the nanotube increases harply. This, in turn, can be related to the effect of mechanical properties on the structure.

References

1.R.G.Abaszade, S.A.Mammadova, R.I.Alekbarov, A.M.Nabiyev, E.M.Aliyev, Sh.K.Safaraliyev, O.A.Kapush, Purchase and analysis of carbon nanotubes, Technical University Scientific Works, №3, pp.11-18, 2019.

2.R.G.Abaszade, X-ray phase analysis of carbon nanotubes, Technical University Science Works, №3, pp.88-93, 2019.

3.S.R.Figarova, E.M.Aliyev, R.G.Abaszade, R.I.Alekberov, V.R.Figarov, Negative Differential Resistance of Graphene Oxide/Sulfur Compound, Journal of Nano Research Submitted, Vol.67, pp.25-31, 2021.
http://dx.doi.org/10.4028/www.scientific.net/JNanoR.67.25

4.R.G.Abaszade, O.A.Kapush, S.A.Mamedova, A.M.Nabiyev, S.Z.Melikova, S.I.Budzulyak, Gadolinium doping influence on the properties of carbon nanotubes, Physics and Chemistry of Solid State, Vol.21, №3, pp.404-408, 2020.
https://doi.org/10.15330/pcss.21.3.404-408

5.R.G.Abaszadeh, O.A.Kapush, A.M.Nabiyev, Properties of carbon nanotubes doped with gadolinium, Journal of Optoelectronic and Biomedical Materials, Vol.12, №3, pp.61–65, 2020.
https://www.chalcogen.ro/61_AbaszadeRG.pdf

6.R.G.Abaszade, S.A.Mamedova, F.H.Agayev, S.I.Budzulyak, O.A.Kapush, M.A.Mamedova, A.M.Nabiyev, V.O.Kotsyubynsky, Synthesis and Characterization of Graphene Oxide Flakes for Transparent Thin Films, Physics and Chemistry of Solid State, Vol.22, №3, pp.595-601, 2021.
https://doi.org/10.15330/pcss.22.3.595-601

7.R.G.Abaszade, A.G.Mammadov, V.O.Kotsyubynsky, E.Y.Gur, I.Y.Bayramov, E.A.Khanmamadova, O.A.Kapush, Modeling of voltage-ampere characteristic structures on the basis of graphene oxide/sulfur compounds, International Journal on Technical and Physical Problems of Engineering, Vol.14, №2, pp.302-306, 2022.
http://www.iotpe.com/IJTPE/IJTPE-2022/IJTPE-Issue51-Vol14-No2-Jun2022/37-IJTPE-Issue51-Vol14-No2-Jun2022-pp302-306.pdf

8.R.G.Abaszade, A.G.Mamedov, I.Y.Bayramov, E.A.Khanmamadova, V.O.Kotsyubynsky, O.A.Kapush, V.M.Boychuk, E.Y.Gur, Structural and electrical properties of sulfur-doped graphene oxide/graphite oxide composite, Physics and Chemistry of Solid State, Vol.23, №2, pp. 256-260, 2022.
https://doi.org/10.15330/pcss.23.2.256-260

9.R.G.Abaszade, Synthesis and analysis of flakes graphene oxide, Journal of Optoelectronic and Biomedical Materials, Vol.14, №3, pp.107–114, 2022.
https://doi.org/10.15251/JOBM.2022.143.107

10.E.W.Wong, P.E.Sheehan, C.M.Lieber, Nanobeam mechanics: elasticity, strength, and toughness of nanorods and nanotubes. Science, Vol.277, pp. 1971–1975, 1997.

11.M.Olek, J.Ostrander, S.Jurga, H.Mohwald, N.Kotov, K.Kempa, M.Giersig, Layer-by-layer assembled composites from multiwall carbon nanotubes with different morphologies, Nanoletters, Vol.4, №4, pp.1889-1895, 2004.

12.P.C.Ma, N.A.Siddiqui, G.Marom, J.K.Kom, Dispersion and functionalization of carbon nanotubes for polymer-based nanocomposites: A review. Composites: Part A, Vol.41, pp.1345–1367, 2010.
https://doi.org/10.1016/j.compositesa.2010.07.003

13.A.V.Eletskii, Carbon nanotubes and their emission properties, Phys.Usp., 45:4, pp.369–402, 2022.

14K.G.Rajendra, Nanomaterials and Nano-composites Synthesis, Properties, Characterization Techniques, and Applications, Taylor & Francis Group, LLC CRC Press is an imprint of Taylor & Francis Group, an Informa business, 350 p., 2020.
https://www.routledge.com/Nanomaterials-and-Nanocomposites-Synthesis-Properties-Characterization/Goyal/p/book/9780367572785

15.B.C.Yadav, K.Ritesh, S.Richa, Sh.Tripti, Flame Synthesis of Carbon Nanotubes using Camphor and its Characterization International Journal of Green Nanotechnology, Vol.3, pp.170–179, 2011

https://doi.org/10.1080/19430892.2011.628579
16.R.G.Abaszade, R.Y.Safarov, Growth of graphene and applications of graphene oxide, Ecoenecgetics, №2, pp.9-15, 2022.
http://ieeacademy.org/wp-content/uploads/2022/06/Ecoenergetics-N2-2022-papers.pdf#page=10

Evaluation of the Ecotourism Potential of Karabakh

T.N.Ahmadli, S.A.Baghirova, U.N.Kazimova

Special Constructor Technology Bureau of the National Aerospace Agency

Abstract: Tourism is one of the sectors whose importance is increasing day by day. Tourism in the world is growing and developing every year more than before. However, the number of incomes from tourism is increasing day by day and more people are participating in the tourism movement every year. With the great economic and social benefits that tourism brings to the region, great competitive environments have emerged between the regions where the tourism event takes place. The most important tool that will be effective in dealing with competitors and meeting the demand of tourists in the created competitive environment is tourism resources in the region. It becomes more interesting when various tourism products are created with these resources. Today, interest in mass tourism has begun to decline and environmental awareness has increased, awareness of environmental protection has developed, and militant approaches to environmental protection have emerged. However, the tourism sector has become more sensitive to the environment and this sensitivity has begun to increase. After providing information about ecotourism in this study, the Karabakh region was examined from the point of view of ecotourism. Karabakh region has an important place in the region in terms of both geographical and touristic values. Karabakh has an important place for ecotourists who want to explore cultural and historical values. According to the results of the conducted research, it is predicted that trekking, bicycle tourism, cave tourism, horseback riding, agrotourism, botanical tourism and many ecotourism activities can be carried out within the framework of ecotourism in the restored Karabakh region.

Keywords: Karabakh, Ecotourism, Ecotourism, Natural resources.

1.Introduction

The presence of 9 out of 11 climate zones in Azerbaijan, its natural resources, rich historical and cultural heritage, national cuisine, socio-economic development of the country have recently led to an increase in the flow of tourists from all over the world. One of the fastest growing parts of the tourism industry is ecotourism. According to some, ecotourism contributes to the economy of poor countries, helps people to develop ecology and cultural values, contributes to the family budget of people living in rural areas, protects ecosystems, educates and satisfies tourists, and ensures world peace. is to do. Although Hetzer (1965) first used the term ecotourism, he divided ecotourism into 4 main principles: Minimizing environmental impacts, respecting the culture of the country you visit, maximizing community benefits, and maximizing tourist satisfaction. Wear (2014) divided ecotourism into 4 basic principles: Recreational natural areas, along with diversity, protection of biological richness; Increasing the economic stability of ecotourism regions; engaging in ecotourism activities, improving the culture of the participants; the characteristics and protection of ethnographic recreation areas in the field of taking necessary precautions [5]. More than half of the species composition of the very good flora of the Caucasus, as well as 4,500 species of higher plants, is another proof of the existence of ecotourism in our country. 240 of them are relict and endemic species. As for fauna species: 14,000 insects, 123 fish, 9 amphibians, 54 reptiles, 99 mammals and 360 birds, 108 of which are included in the "Red Book" [6]. Another factor that shows the development of ecotourism is that tourism companies organize ecotours in parks in the country. However, it is still too early to talk about the development of this field. Ecotourism according to the definition of the International Ecotourism Society (TIES-The International Ecotourism Society); It is described as an ecologically responsible travel and trip that protects the environment by actively contributing to the socio-economic life of the local population by traveling through the natural areas of the earth, enjoying nature, enjoying the environment . people Although different organizations approach the essence of ecotourism from different perspectives, each of them essentially comes to the same conclusion. There are enough fertile conditions for the development of ecotourism in our country. To ensure the development of ecological tourism in the Republic of Azerbaijan by increasing enough interest in this field, to produce new products for ecological tourism, to expand the range of products and to ensure that ecotourists come to the country after being identified in the world market. Ecotourism is expected to account for 5% of the tourism market by

2024, according to World Tourism Organization forecasts.

Table 1. GZIT analysis of the tourism sector

Strengths	Weaknesses
1. Azerbaijan's ancient history, rich cultural monuments, geographical location, wonderful nature, folklore and location at the junction of various religions;	1. lack of quality and quantity of education in the field of tourism to meet the requirements of the labor market
2. availability of conference rooms, hotels and other related service infrastructure;	2. Deficiencies in environmental protection
3. State support for the development of tourism	3. Tourism business in Baku is mainly concentrated in the city.
4. Geographically Convenient Location - Being close to Asia, Europe and the Middle East	4. fewer tourist information centers in the regions of the country
5. having the experience of holding large-scale international events	5. The opportunity to travel mainly by road to the regions
6. identifying the tourism sector as one of the priority areas in the development of the non-oil sector.	6. the small number of people who know foreign languages in the regions
	7. Incomplete rapid transit at border crossing points for foreign citizens arriving in the country
	8. Lack of regular monitoring to measure the level of satisfaction of foreign tourists visiting the country

2. Experimental details

Azerbaijan's geographical position, ancient history, climatic conditions, availability of Naftalan oil and other factors can be considered advantages of the tourism sector in Azerbaijan. Along with the advantages of the tourism sector, there are also some weaknesses. The lack of qualified personnel in the field of tourism, the fact that the people living in the regions are interested in learning foreign languages, and many other reasons for the lack of development of tourism can be cited as an example.

First of all, after providing information about the concept of ecotourism in the study, finding answers to questions such as what type of ecotourism is profitable for the Karabakh region and the role of the natural resources of Karabakh in ecotourism, and these are the ways to solve these questions.

In the study, first the literature on the concept of ecotourism was examined, then the relief and natural resources of the Karabakh region, which were selected as a sample for the study, were studied from the point of view of ecotourism.

Karabakh Region.The Karabakh region has forest areas, rich flora and historical monuments, including the most fertile black soil and abundant water for agriculture. 25% of Azerbaijan's 1,213.7 thousand hectares of forest land is located in Karabakh. During the occupation of Karabakh, the most valuable forests were destroyed by the Armenians. destroyed. More than 2000 types of plants can be found here [7]. The predominance of mountainous terrain, wonderful nature, historical monuments and rich culture necessitate the development of ecotourism in this region. After checking the three main factors, the opportunities of tourism can be taken advantage of here. These are the provision of security in the liberated lands, the return of the population and the creation of infrastructure. According to tourism experts, each region has its own tourism potential.

In 1968, mandibular bones of Azikhanthropus male were found in Azikh cave [1]. This cave is the main proof of the existence of the old Paleolithic period in the Fuzuli region of Karabakh. Azikh cave is the third largest human settlement in the world. This monument in Fuzuli region is an important indicator of the development of cave tourism used in ecotourism in Karabakh.

The favorable meteorological conditions of Nagorno-Karabakh, the presence of numerous orchards, water and mineral springs increase the importance of the recreation center of this region. There are 63 water sources in Lachin-Kalbajar region. They are divided into two places, Istisu (Kalbajar district) and Ilighsu

(Lachin district). These stream water deposits are very valuable mineral water deposits located in the central part of the Lesser Caucasus Mountains at an altitude of 1500-2800 m above sea level. As an example of these mineral water deposits, we can count Yukhari Istisu, Ashagi Istisu, Koturlu, Cheraktar, Iligsu, Turshsu and similar mineral water deposits. There are 8 underground water reservoirs with mineral water deposits. Of these, 7 deposits with a reserve of 3,093 thousand m3/day are located in Kalbajar, and 1 deposit with a reserve of 4,300 thousand m3/day is located in Lachin. The presence of rich thermal and natural resources of the Karabakh region will be beneficial for health-conscious tourists to come here. The increase in tourist flow here will lead to the opening of new jobs in the region, which will help to reduce the level of unemployment in the region [2].

The fact that the land is mainly mountainous means that mountain tourism will develop more rapidly in the Karabakh region. If mountain tourism is successfully implemented within ecotourism, it takes the first place among types of tourism. According to the terrain, after the wings are prepared in Kalbjar, it will make a great contribution to the development of mountain tourism. By creating the largest tourism center in the Caucasus, the direction of the flow of tourists from Georgia can be changed. Trekking and nature walks in mountainous areas and more in groups will bring more tourists to the region.

After the reconstruction of Karabakh, the resettlement of people will give a great impetus to the development of agrotourism. The development of agrotourism will increase the socio-economic well-being of the population living in the region and will lead to the promotion of the culture of the population of the region. Also, supporting agriculture will support the export of agricultural products produced in the region to the world market.

The fact that Karabakh has rich underground and surface natural resources is a pool of natural resources for Azerbaijan. These are; 5 pieces of gold, 6 pieces of mercury, 2 pieces of copper, 1 piece of lead-zinc, 19 pieces of face stone, 10 pieces of emerald stone, 4 pieces of cement raw materials, 13 pieces of stone chips, 1 piece of soda raw materials. production, 21 pieces of pumice-volcanic ash, 10 pieces of clay, 9 pieces of sand-gravel, 5 pieces of construction sand, 9 pieces of gypsum-anhydride, 1 piece of perlite, 1 piece of obsidian, 3 pieces of vermiculite, 14 pieces of decorative stones (agate, jasmin , onyx, jade, pefritoid, etc.), there are 11 freshwater groundwater and 10 mineral water deposits, which are also important for the country's economy [3, p62]. In addition, there are Shusha paving stone, Kecheldag (Lisokor) clay, Shusha underground fresh water, mineral water deposits of Syrlan and Turshsu villages in Shusha region. The gold deposits of Zangilan and Kalbajar were exploited by foreign companies during the Armenian occupation. It was reported that 51% of the money coming into the budget of Armenia is collected from the Kalbajar and Zangilanda gold mines. The damage caused by the Armenians to the country's ecology can be considered as ecological terrorism. The destruction of rare trees by Armenians in Karabakh by cutting or burning them led to the violation of the ecological balance in Karabakh. Since the beginning of June 2006, the burning of forests and houses by Armenians has damaged the ecosystem and human health. In terms of groundwater, every place of Karabakh is a natural resource. The city of Shusha in Karabakh is richer in underground water [4]. Cleanup of contaminated soils is carried out with even higher quality with the help of grapheme-besed materials [8-18].

3. Conclusion

After the restoration of Karabakh and the resettlement of people there, it is necessary to properly take advantage of the rules of ecotourism. It is important to implement some environmental programs implemented in developed countries, and to rework for the protection of nature. For the sustainability and protection of nature parks to be built in Karabakh, hiking routes should be improved, historical buildings should be restored without disturbing their texture, and new buildings should be built with ecological residential structures. The design of these buildings as an eco-residence will contribute to the tourism of the region, the hotels and restaurants to be built should be inspected within a certain period of time and a warning should be given to the objects that damage the ecotourism. The wealth of natural resources and geographical location of Karabakh played an important role in the development of the region. Karabakh assumed the role of a locomotive in the economy.

With its fountains, lakes, flora and fauna, springs and free cultural values, the city of Shusha is one of the areas where hiking, nature walks and safaris can take place. If the rules of ecotourism are followed, the city of Shusha can become the most important ecotourism

city of Azerbaijan. The historical monuments and unique architecture of Shusha, the pearl of Azerbaijani culture, will allow the creation of new tourism routes.

The fact that the cities of Fuzuli and Jabrayil are rich in thermal resources in addition to archaeological remains and natural beauty, and the presence of thermal tourism, photo safari, trekking, bird watching, caving, agriculture and farm fields in these places shows it. rapid development of ecotourism here.

Aghdam and Kalbajar cities are important cities of Karabakh in terms of natural resources and vegetation. Horse trekking, bird watching, wildlife observation, cycling and winter tourism can be done as tourism activities.

It is possible to combine the liquor industry with tourism in Lachin, to create a liquor industry-tourism-recreation. The Lachin Reserve, which has medicinal mineral resources, rich flora and fauna, and an area of more than 21 thousand hectares, will expand the tourism potential of these areas.

At the same time, the "Caucasus Albania tourism route" will play an important role in exposing Armenian lies that falsify the history of Karabakh. The route is prepared based on the advice and recommendations of scientists who study Caucasian Albania. The route of Albanian culture covers 3 main corridors of Azerbaijan — Baku-Sheki-Zagatala, Ganja-Kazakh and Karabakh. There are more traces of Albanian culture in Karabakh and Eastern Zangezur. There is a rich heritage of Caucasian Albania here. It has temples, churches, traditions, etc. includes. It should be noted that the tourism route that will be created in the footsteps of the ancient Albanian culture will be of special importance in the direction of promoting the rich and historical tourism potential of our country, as well as Karabakh. Khudafarin bridge, Azikh cave are considered to be the most popular tourist routes in the future. Although our cultural-historical monuments were destroyed, after their restoration, the organization of tours to those destinations will be realized. There is a modern "Silk Road" project. The Kars-Igdir-Nakhchivan route will be created to enter Azerbaijan, and the cost of the tour package will decrease after the construction of the railway line through the territory of Iran.

Determining the tourism resources of the destination is the most important stage of the tourism destination. In order for tourists to be able to carry out ecotourism activities, it is necessary to determine the areas where they can carry out their activities. If the destinations do not have these areas, it will not be possible to talk about the potential of ecotourism. After the completion of infrastructure construction in Karabakh, the development of the tourism sector of Karabakh will have a positive effect on the rapid economic revival of the region. The mountain tourism, ecotourism, medical and cultural tourism potential of Shusha, Lachin and Kalbajar, which are beautiful tourist destinations, can contribute to the economic revival of Karabakh.

At the same time, the Karabakh region not only opens up new opportunities for tourism, but is also considered one of our regions with sufficient potential for the development of alternative tourism. In order to organize the development in the Karabakh region in an even more efficient form, it will be possible to make the economic development of the region in an even more effective form by taking advantage of the help of international organizations specialized in technical fields. At the same time, it will be possible to fulfill the principles mentioned by the functional theories for the diversification of the economy and spread in different areas. Together with all these, we can clearly express how important the Karabakh region plays in the economic and political life of Azerbaijan. Taking into account domestic and foreign tourists, Karabakh is expected to receive 1 million people in the next 4 years

References

1.I.Sariyeva, Why is Azikh not included in the list of UNESCO?, Baku News, p.15, 2012.
2.G.Mirzeyeva, Evaluation of the Karabakh region as a tourist destination: on the example of Ecotourism, pp.14-17, 2020.
3.K.Shikhiyev, Study of ecological tourism characteristics and development problems. Master's thesis. Azerbaijan Economic University. Baku, 2018.
4.N.Aydin, "Turkey's Nagorno-Karabakh Policy", Firat University Middle East Studies Journal, Vol. 9, No.2, pp.153-169, 2013.
5.N.Aydin et al., Underground resources of the Republic of Azerbaijan, MTA Natural Resources and Economy Bulletin Vol.29, pp.63-74, 2018.
6.N.Aras, B.Dedeyev, R.Yilmaz, B.Ibayev, Karabakh War: Political-Legal-Economic Analysis. Baku: Caucasus Studies Institute Publications, pp.85-92, 2008.
7.E.Özyılmaz, "Nagorno-Karabakh from the past to the present" Gazi University Faculty of Economics and Administrative Sciences Journal 15/2, pp.191-208, 2013.
8.S.R.Figarova, E.M.Aliyev, R.G.Abaszade, R.I.Alekberov, V.R.Figarov, Negative Differential Resistance of Graphene Oxide/Sulphur Compound, Journal of Nano Research Submitted, Vol.67, pp.25-31, 2021.
http://dx.doi.org/10.4028/www.scientific.net/JNanoR.67.25
9.R.G.Abaszade, O.A.Kapush, S.A.Mamedova, A.M.Nabiyev, S.Z.Melikova, S.I.Budzulyak, Gadolinium doping influence on the properties of carbon nanotubes, Physics and Chemistry of Solid State, Vol.21, №3, pp. 404-408, 2020.
https://doi.org/10.15330/pcss.21.3.404-408
10.R.G.Abaszade, O.A.Kapush, A.M.Nabiyev, Properties of carbon nanotubes doped with gadolinium, Journal of Optoelectronic and Biomedical Materials, Vol.12, №3, pp.61–65, 2020.
https://www.chalcogen.ro/61_AbaszadeRG.pdf
11.Kh.M.Popal, R.G.Abaszade, Research and modeling of hybrid energy systems (review), Ecoenergetics, №1, pp.65-69, 2022.
http://ieeacademy.org/wp-content/uploads/2022/05/ECOENERGETS-JOURNAL-No1.-2022.pdf#page=66
12.R.G.Abaszade, S.A.Mamedova, F.H.Agayev, S.I.Budzulyak, O.A.Kapush, M.A.Mamedova, A.M.Nabiyev, V.O.Kotsyubynsky, Synthesis and Characterization of Graphene Oxide Flakes for Transparent Thin Films, Physics and Chemistry of Solid State, Vol.22, №.3, pp.595-601, 2021.
DOI: 10.15330/pcss.22.3.595-601
13.R.G.Abaszade, A.G.Mammadov, V.O.Kotsyubynsky, E.Y.Gur, I.Y.Bayramov, E.A.Khanmamadova, O.A.Kapush, Modeling of voltage-ampere characteristic structures on the basis of graphene oxide/sulfur compounds, International Journal on Technical and Physical Problems of Engineering, Vol.14, №2, pp.302-306, 2022.
http://www.iotpe.com/IJTPE/IJTPE-2022/IJTPE-Issue51-Vol14-No2-Jun2022/37-IJTPE-Issue51-Vol14-No2-Jun2022-pp302-306.pdf
14.R.G.Abaszade, A.G.Mamedov, I.Y.Bayramov, E.A.Khanmamadova, V.O.Kotsyubynsky, O.A.Kapush, V.M.Boychuk, E.Y.Gur, Structural and electrical properties of sulfur-doped graphene oxide/graphite oxide composite, Physics and Chemistry of Solid State, Vol.23, №2, pp. 256-260, 2022.
DOI:10.15330/pcss.23.2.256-260
15.R.G.Abaszade, R.Y.Safarov, Growth of graphene and applications of graphene oxide, Ecoenecgetics, №2, pp.9-15, 2022.
http://ieeacademy.org/wp-content/uploads/2022/06/Ecoenergetics-N2-2022-papers.pdf#page=10
16.R.G.Abaszade, Synthesis and analysis of flakes graphene oxide, Journal of Optoelectronic and Biomedical Materials, Vol.14, №3, pp.107–114, 2022
https://doi.org/10.15251/JOBM.2022.143.107
17.R.G.Abaszade, Photoconductivity of carbon nanotube obtained by arc discharge method, International scientific journal Grail of Science, pp.248-250, 2022.
https://archive.journal-grail.science/index.php/2710-3056/article/view/446/451
18.A.G.Mammadov, R.G.Abaszade, E.A.Khanmamedova, I.Y.Bayramov, H.D.M.Muzaffari, Optoelectronic information processing devices, Ecoenergetics, №3, pp.23-25, 2021.
http://ieeacademy.org/wp-content/uploads/2022/01/Ekoenergetic-journal-2021.-1.pdf

Creation of an expert system for diagnosting accidents in electrical networks

I.Y. Bayramov, G.E. Askerova

Azerbaijan State Oil and Industry University, Baku, Azerbaijan,
imranb1963@mail.ru

Abstract: Today, more and more businesses are so dependent on electricity that prolonged power outages can spell disaster for production. Since the dispatcher has to process a large amount of information, difficulties arise with the geographical location of nodes at the stage of alternative route selection, in which case the question of economic costs arises, human resources, other resources, the load of substations, the priority of substations, the absence of "double" connection, for the response team. reference etc. should be taken into account.

Keywords: Electric network, Feeder, Expert systems, Graphs, Dijkstr's algorithm.

1. Introduction

Errors in the operator's work can cause more harmful consequences than the lack of electricity from consumers [1].

Also, without the help of a computer, a lot of time is spent to formulate the whole process and to make a decision about the connection of the stock. Taking into account all the factors listed above, it can be assured that without computer computing systems, it is difficult to respond properly and in time to accidents. The application of carbon-based models is very important in the construction of modern electric networks [2, 8-21].

The goal of creating an expert system is to automate the decision-making process. Recently, in the development of decision-making methods, there has been a trend of approaching the description and formulation of the issue to natural human language and understanding. It is often difficult for a dispatcher to specifically evaluate an object according to any criteria. The dispatcher may have doubts and therefore will look for an average rating. Often, such difficulties arise not because of a lack of experience, but on the contrary. Subsequently, taking into account the uncertainty in the increasing number of measurements, there is a need to develop methods that are flexible for human information perception.

The use of expert systems in the industry will free the dispatcher from routine tasks and reduce the number of errors.

First, let's functionally analyze the electrical network. The functional structural analysis of the expert system (ES) consists of the formation of a chain of logical judgments that lead to unambiguous conclusions about the state of the network. These judgments are presented in the form of a tree, so that by moving along the branches, one can reach one or another conclusion to the question about the state of the network.

In order to present the switching network as an object with a level structure, its four semantic and three functional variants can be distinguished.

Semantic variants are:

1. Flow transfer according to the "normally connected scheme".
2. Flow transfer according to the forced scheme (deviation from normal).
3. No flux transfer to loads.
4. Disconnection of a part of the network (elimination of tension).

The functions are as follows:

1. Transmission of energy flow for all consumers with the required level.
2. Flow transmission for all consumers is carried out using redundant routes.
3. Lack of energy flow (elements fired without reserve).

The result of the work of the ES will be the process of comparison (normal and intended connection), aggregation (network diagrams), classification (accident or backup road), report preparation.

Thus, the report should reflect the complete state of the network and its switching scheme.

An "improved Dijkstra algorithm" was chosen to solve the problem. Because this algorithm is more suitable for solving the problem of finding a route with the minimum possible number of links. This algorithm has the following advantages over other algorithms:

- Work on the weighted graph;
- Including the largest number of substations;
- Excluding the introduction of two feeders to one substation;

• Preference for the regular power supply of the electric network and the absence of the shortcomings of its predecessors.

Let's explain the working principle of this algorithm. Let's show the current state of the electrical network in the form of a graph (Figure 1), so it includes:

Graph languages have the following attributes:

• language ID;
• state of emergency (active / reserve / accident);
• connected nodes (2 units);
• the length of the electric transmission line (weight of the tongue - int),

2. Experimental details

The nodes of a graph have the following attributes:

• node id;
• minimum route calculation weight (int);
• the id of the first current node of the graph during the calculation of the minimal route;
• status (active / inactive (backup) / emergency).

In the current state, all nodes have an "active" state.

All feeders in blue color - means open state.

The yellow color of the feeder means the backup route.

Red - indicates an emergency situation.

The initial state of the graph is shown in figure 1.

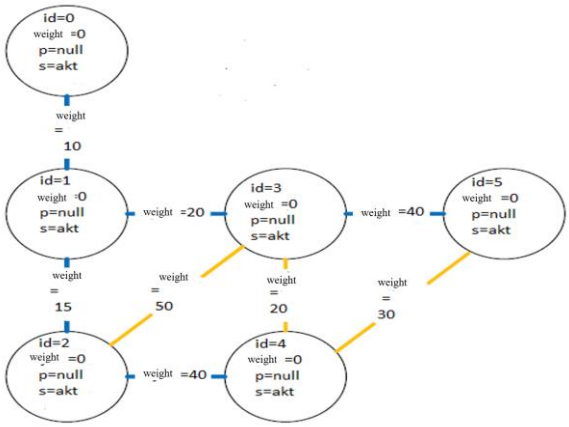


Figure 1. Initial state of the system.

When one of the highways fails, the following algorithm is executed:

1. Figure 2 shows the first step of the algorithm, so that the state of the selected language is set to "crash".

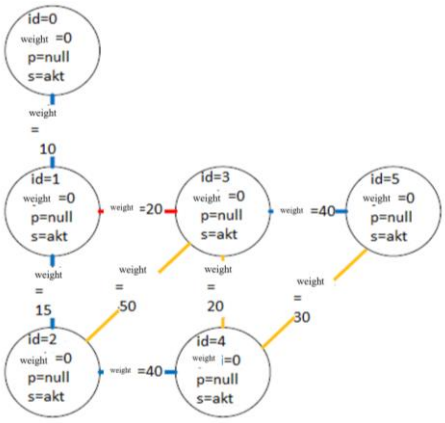


Figure 2. The state of the system during the accident

2. In Figure 3, it is shown that all the subsequent nodes associated with the active languages without active languages are set to fail.

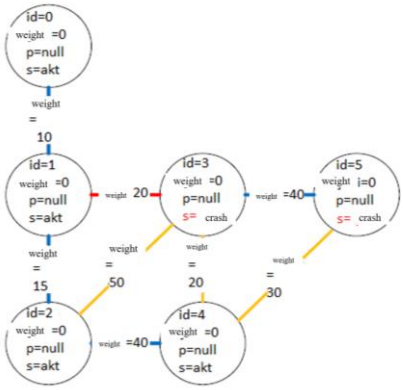


Figure 3. Putting all connected substations into the "crash" state.

3. Basic algorithm (improved Dijkstra algorithm):
a). we assign the maximum possible value to the calculated weights of all nodes. The obtained form of the graph is shown in figure 4.

b) id = null for the starting node of the graph when calculating the minimum route.

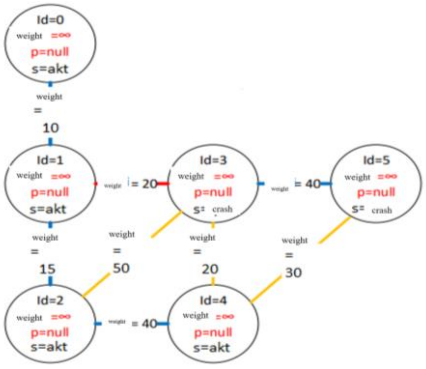


Figure 4. Setting weights and resetting id nodes

c) We start to fill in the calculation nodes of the graph and the id of the initial nodes considering the starting (main substation) node. In this case, we use only active languages as languages. For this, starting from the initial node, we define the nodes connected to it. If a connected node has a computed weight less than the computed weight of the current node + the connecting thread weight, then for the connected node calculated weight = calculated weight of the current node + weight of the connecting thread and we set the id of the initial node equal to the id of the current node. Recursive filling obtains a filled graph about the emergency. In this case, the system state is shown in figure 5.

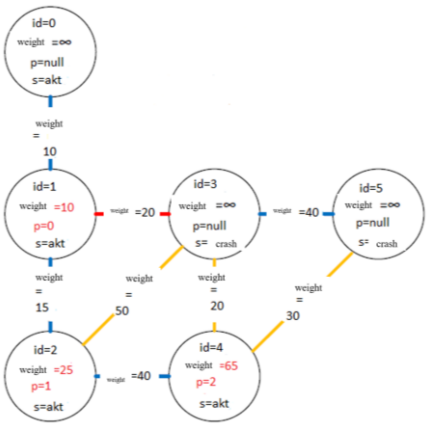


Figure 5. Filling the graph with the help of calculation nodes

d) Next, the algorithm must cover all nodes that have an "active" state. We continue to fill the graph. But now we're filling in for spare tongues. If the associated language is in an accident, we calculate the calculation weight. If a connected node has a computed weight less than the computed weight of the current node + the weight of the connecting edge, then for the connected node The calculated weight = the calculated weight of the current node + the weight of the associated thread, and the id of the current node is equal to the id of the original node. In this case, recursion is not performed. The result of this step is shown in figure 6.

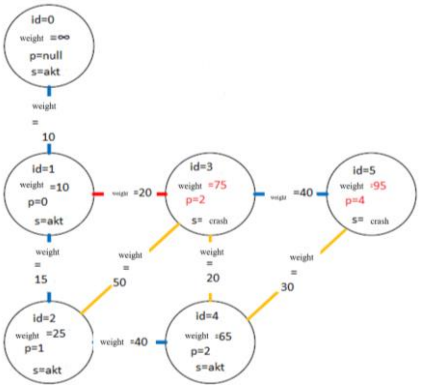


Figure 6. Filling the graph according to spare languages.

e) The next step, the algorithm should go through all the failed nodes and find the minimum value of the calculated weight (minimum route). This will be the solution to find the shortest path (in Figure 6, this is the node with id = 3).

f) To determine which languages to include, it is necessary to traverse the ids of the initial nodes of the graph from the node found at the beginning until reaching the active node. The result of the algorithm is shown in figure 7.

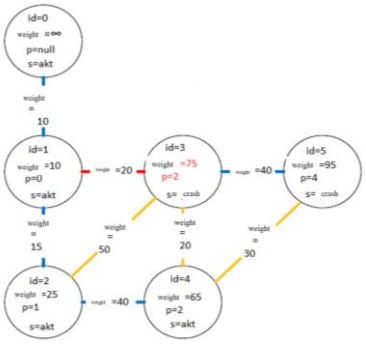


Figure 7. Searched minimum route

.

3. Conclusion

An expert system was developed to determine the most cost-effective way to open a backup path to provide electricity to energy consumers in the shortest possible time.

References

1.I.V.Emelyanov, A.V.Petrishchev, Formalization of the analysis of the switching state of high-voltage electrical networks for its automation. Collection of scientific works of NSTU. No.3, p. 98103, 1999.

2.A.A.Filatov, Switching in electrical switchgears. Moscow: Energy, 1985.

3.S.A.Mandrykin, A.A.Filatov, Operation and repair of electrical equipment of stations and networks. Moscow: Energoatomizdat, 1983.

4.V.D.Samoilov, V.P.Bereznikov, A.P.Pisarenko, Smetana S.I. Automation of the construction of simulators and training systems. Kyiv: Nauko-va Dumka, 1989.

4.V.G.Ornov, M.A.Rabinovich, Tasks of operational and automated control of power systems. Moscow: Energoatomizdat, 1988.

5.V.G.Ornov, Yu.Ya.Lyubarsky, Dialogue systems in the dispatching control of power facilities. M.: Energoatomizdat, 151 p., 1987.

6.V.G.Ornov, V.A.Zabegalov, V.A.Semyonov,

Automated dispatch control systems in power systems. M.: Energoatomizdat, 264 p., 1984.

7.S.R.Figarova, E.M.Aliyev, R.G.Abaszade, R.I.Alekberov, V.R.Figarov, Negative Differential Resistance of Graphene Oxide/Sulphur Compound, Journal of Nano Research Submitted, Vol.67, pp.25-31, 2021.
http://dx.doi.org/10.4028/www.scientific.net/JNanoR.67.25

8.R.G.Abaszade, O.A.Kapush, S.A.Mamedova, A.M.Nabiyev, S.Z.Melikova, S.I.Budzulyak, Gadolinium doping influence on the properties of carbon nanotubes, Physics and Chemistry of Solid State, Vol.21, №3, pp. 404-408, 2020.
https://doi.org/10.15330/pcss.21.3.404-408

9.R.G.Abaszade, O.A.Kapush, A.M.Nabiyev, Properties of carbon nanotubes doped with gadolinium, Journal of Optoelectronic and Biomedical Materials, Vol.12, №3, pp.61–65, 2020.
https://www.chalcogen.ro/61_AbaszadeRG.pdf

10.Kh.M.Popal, R.G.Abaszade, Research and modeling of hybrid energy systems (review), Ecoenergetics, №1, pp.65-69, 2022.
http://ieeacademy.org/wp-content/uploads/2022/05/ECOENERGETS-JOURNAL-No1.-2022.pdf#page=66

11.R.G.Abaszade, S.A.Mamedova, F.H.Agayev, S.I.Budzulyak, O.A.Kapush, M.A.Mamedova, A.M.Nabiyev, V.O.Kotsyubynsky, Synthesis and Characterization of Graphene Oxide Flakes for Transparent Thin Films, Physics and Chemistry of Solid State, Vol.22, №.3, pp.595-601, 2021.
DOI: 10.15330/pcss.22.3.595-601

12.R.G.Abaszade, A.G.Mammadov, V.O.Kotsyubynsky, E.Y.Gur, I.Y.Bayramov, E.A.Khanmamadova, O.A.Kapush, Modeling of voltage-ampere characteristic structures on the basis of graphene oxide/sulfur compounds, International Journal on Technical and Physical Problems of Engineering, Vol.14, №2, pp.302-306, 2022.
http://www.iotpe.com/IJTPE/IJTPE-2022/IJTPE-Issue51-Vol14-No2-Jun2022/37-IJTPE-Issue51-Vol14-No2-Jun2022-pp302-306.pdf

13.R.G.Abaszade, A.G.Mamedov, I.Y.Bayramov, E.A.Khanmamadova, V.O.Kotsyubynsky, O.A.Kapush, V.M.Boychuk, E.Y.Gur, Structural and electrical properties of sulfur-doped graphene oxide/graphite oxide composite, Physics and Chemistry of Solid State, Vol.23, №2, pp. 256-260, 2022.
DOI:10.15330/pcss.23.2.256-260

14.R.G.Abaszade, R.Y.Safarov, Growth of graphene and applications of graphene oxide, Ecoenecgetics, №2, pp.9-15, 2022.
http://ieeacademy.org/wp-content/uploads/2022/06/Ecoenergetics-N2-2022-papers.pdf#page=10

14.R.G.Abaszade, Analysis of carbon nanotube doped with five percent gadolinium, III International scientific and theoritical conference, Theory and practice of modern science, April 1, Kraków, Poland, pp.82-83, 2022.
https://previous.scientia.report/index.php/archive/article/view/21

15.R.G.Abaszade, Synthesis and analysis of flakes graphene oxide, Journal of Optoelectronic and Biomedical Materials, Vol.14, №3, pp.107–114, 2022
https://doi.org/10.15251/JOBM.2022.143.107

16.R.G.Abaszade, Photoconductivity of carbon nanotube obtained by arc discharge method, International scientific journal Grail of Science, №17, III CISP Conference «Science of post-industrialsociety: Globalization and transformation processes», pp.248-250, 2022.
https://archive.journal-grail.science/index.php/2710-3056/article/view/446/451

17.R.G.Abaszade, A.G.Mammadov, V.O.Kotsyubynsky, E.Y.Gur, I.Y.Bayramov, E.A.Khanmamadova, O.A.Kapush, Photoconductivity of carbon nanotubes, International Journal on Technical and Physical Problems of Engineering, Vol.14, №3, pp.155-160, 2022.
http://www.iotpe.com/IJTPE/IJTPE-2022/IJTPE-Issue52-Vol14-No3-Sep2022/21-IJTPE-Issue52-Vol14-No3-Sep2022-pp155-160.pdf

18.R.G.Abaszade, R.Y.Safarov, Growth of graphene and applications of graphene oxide, Ecoenergetics, №2, pp.9-15, 2022.
http://ieeacademy.org/wp-content/uploads/2022/06/Ecoenergetics-N2-2022-papers.pdf#page=10

19A.G.Mammadov, R.G.Abaszade, E.A.Khanmamedova, I.Y.Bayramov, H.D.M.Muzaffari, Optoelectronic information processing devices, Ecoenergetics, №3, pp.23-25, 2021
http://ieeacademy.org/wp-content/uploads/2022/01/Ekoenergetic-journal-2021.-1.pdf

Obtaining ceramic mass with the use of Dashkesan pyrophillite for the production of clinker tiles

Y.H.Halilov, S.M.Akbarova, M.A.Babayeva

Baku Engineering University, Khirdalan, Azerbaijan,
y.halilov@mail.ru, babayevamalahat2022@gmail.com
Azerbaijan Architecture and Construction University, Baku, Azerbaijan,
sev10@rambler.ru

Abstract: Clinker tiles, which have high strength, wear resistance and frost resistance, low water absorption, chemical and thermal resistance, are a versatile building material and are widely used for cladding facades, floors, interiors, fireplaces, swimming pool cladding, road surfaces and playgrounds, and are also used in various finishing works. Clinker materials are also widely used by landscape designers. The unusual texture, slight surface sheen, warm ocher brown tones and improved performance make it an ideal choice for builders and consumers. It is made from refractory clays by extrusion or semi-dry molding followed by firing at high temperatures. In terms of properties, such a tile is not inferior to natural stone, and in some respects it often surpasses it. Unfortunately, the scientific, theoretical and practical aspects of the development of the composition and production technology of clinker tiles based on local raw materials have not yet been given due attention. In this study, compositions of clinker tiles with high performance properties were developed using Dashkesan pyrophyllite and the optimal technological parameters of firing were established. With the help of volumetric coloring and coating, samples with high decorative properties were obtained. During the experiments, it was found that the use of pyrophyllite provides low shrinkage at high temperatures (11600C-12000C), and the color stability of the clinker tiles is ensured by solid-phase reactions at high temperatures and the formation of spinels.

Keywords: Clinker tiles, Pyrophyllite, Shrinkage, Water absorption.

1.Introduction

Clinker tiles with high strength, abrasion resistance and frost resistance are a versatile building material with low water absorption, chemical and thermal resistance and are widely used for finishing facades, floors, interiors, fireplaces, swimming pools and road areas [1]. Clinker materials are also widely used by landscape designers. The unusual texture, slight surface sheen, range of warm mustard brown colors and improved performance make it an ideal choice for builders and consumers. Clinker tiles are obtained by firing at high temperatures from refractory clays by extrusion or semi-dry molding. According to its characteristics, such a tile is not inferior to natural stone in terms of impressions, and in some it even surpasses it.

Employees of the Kazan State University of Architecture and Civil Engineering also worked on the technology for manufacturing clinker bricks based on low-melting clays in Tatarstan [2]. In studies led by Professor M.G. Gabudullin, it was found that the compressive strength of samples of ceramic material for clinker bricks increases from 140 MPa to 200 MPa when up to 5% perlite is added to the ceramic mass. The moisture content of these samples is below 5%, and their density is 2.1 g/cm3 [3].

Russian researchers recommend using argillite-like clays containing aluminosilicate, as well as argillite rock, as raw materials in the production of clinker bricks. The composition of argillite-like clayey rocks includes mainly hydromicaceous minerals, montmorillonite, and quartz. According to the work of A. Kotlyar [Kotlyar A.V., 2018], it is possible to obtain clinker bricks with water absorption of 2% by firing a ceramic mass made on the basis of fractions of 0-0.63 mm of argillite-like clays at a temperature of 1050^0C. The researcher used glass waste to reduce the clinker brick sintering temperature [4].

V.A. Ezarsky, based on his research, concluded that the quality of clinker bricks depends on the ratio of oxides Al_2O_3, SiO_2, CaO, MgO and Fe_2O_3. His research shows that increasing the amount of SiO_2 in the ceramic mass used for clinker bricks reduces the resistance of the product to changes in ambient temperature. The researcher experimentally established that the amount of Fe_2O_3 in clay should not exceed 6-7%.

Ukrainian researchers prepared charge for the production of clinker bricks from a mixture of hard and light clays and suggested modifying this mixture with chemical additives [Koleda V.V., 2009]. The ceramic mass was molded and fired at 1140^0C-

1200^0C for 1.5-2.0 hours. The compressive strength of the ceramic material was 59-67 MPa, the maximum shrinkage was 4%. Since 55-70% of the composition of the studied material contains clays, the mixture melted at temperatures above 900^0C, causing shrinkage of the material. According to the authors, one of the main reasons for the dense structure of ceramic materials is their chemical composition. Kolleda V.V. and others believe that in order to form a high-density structure, the chemical composition of the clinker brick should be as follows: 62.8 - 67.1 SiO_2, 17.5 - 23.2 Al_2O_3, 7.3 - 10.0 (RO + R_2O), 5 .45 - 6.10 (RO+R_2O). Fe_2O_3 + TiO_2) [5].

Unfortunately, until now, due attention has not been paid to domestic raw materials, scientific, theoretical aspects of obtaining the composition and developing the technology of clinker tiles. An analysis of literary sources shows that the reserves of refractory kaolinite, kaolinite-hydromicaceous and hydro-micaceous clays suitable for these purposes are very limited. Therefore, the study and study of raw materials for the production of ceramic building materials, including clinker tiles, is a very urgent task, both from a practical and theoretical point of view.

Our studies have shown that on the territory of our republic there are large reserves of pyrophyllite, which is a promising raw material for the ceramic industry [5]. According to some data, the reserves of Dashkesan pyrophyllite are about 50 million tons. Therefore, we set ourselves the task of investigating the possibility of using pyrophyllite in the production of clinker tiles. Literary searches show that pyrophyllite is little studied as a raw material for ceramics, and this is due to the fact that the prevalence of pyrophyllite in the world is insignificant. At the same time, the relatively low content of crystallization water in its composition compared to kaolin and hydromica has a positive effect on the stability of the geometric dimensions of semi-finished products and products, and in our opinion, therefore, pyrophyllite is a very promising raw material.

The purpose of our research is to obtain the composition of a high-quality clinker slab mass using pyrophyllite from the Dashkesan deposit.

2. Experimental details

To obtain clinker tiles, mixtures were made on the basis of pyrophyllite, which forms an aluminosilicate base and is also an exfoliator, fluxes taken in the form of feldspar from the Goy-Gol reservoir, volcanic ash from the Jeyranchel deposit and plastic clay from the Akdash deposit. At the first stage of research with the participation of a geologist, samples were taken that were as representative of the area as possible. The samples were dried, crushed and averaged by quartering, and the samples sifted through a 0063 sieve were studied to determine their chemical and mineralogical compositions. The chemical composition of the raw material was studied on an S8 TIGER spectrometer, Bruger (Germany) (Tables 1, 3, 5), the mineralogical composition was studied on a Miniflex 600 Rentgen diffractometer, Riqacu (Japan), on a copper anode (Tables 2, 4, 6 and Fig. 1, 2, 3).

For clinker tiles on cubic samples 5x5x5 cm and cylinders 50x50x5 mm, the construction and technical properties of materials based on ceramic mass prepared by the plastic method were studied [1-5].

The amount of water for plastic pressing was 22-25% by weight of the dry mixture.

After selecting 500 g of raw material and drying it in an oven at a temperature of 90–105°C, porcelain was ground in a mortar and sifted through sieves with 1 mm holes. The sifted materials are weighed (individually) according to the appropriate recipe, placed in a special container and thoroughly mixed for 10-15 minutes, then poured into molds by stirring for 5 minutes with the appropriate amount of water and mold moisture. Cubic samples are also removed from the mold after drying at room temperature for 3-4 hours in the mold, then the samples are fired after drying at 90-105^0C for 3-5 hours in an oven.

Samples are fired at selected temperatures in muffle furnaces. After combustion, the samples are cooled and tested. To determine the drying and agglomeration of the ceramic mass by plastic casting, cylindrical samples 50x50x5 mm in size were made.

At the first stage of our experiments, the chemical and mineralogical composition of the raw materials used was analyzed. This allows us to better know the raw materials we use, to have a preliminary idea of the nature of the physico-chemical processes that occur during the preparation of recipes and the cooking of the mixture. Thus, as can be seen from the diffraction pattern of the Jeyranchel volcanic ash (Fig. 1) and the results of chemical and mineralogical analysis, it mainly consists of a glass phase (74%), quartz and feldspars (11 and 12%, respectively). Given that feldspar also has fluxing properties, there is no doubt that volcanic ash can play an effective fluxing role in the pyrophyllite system.

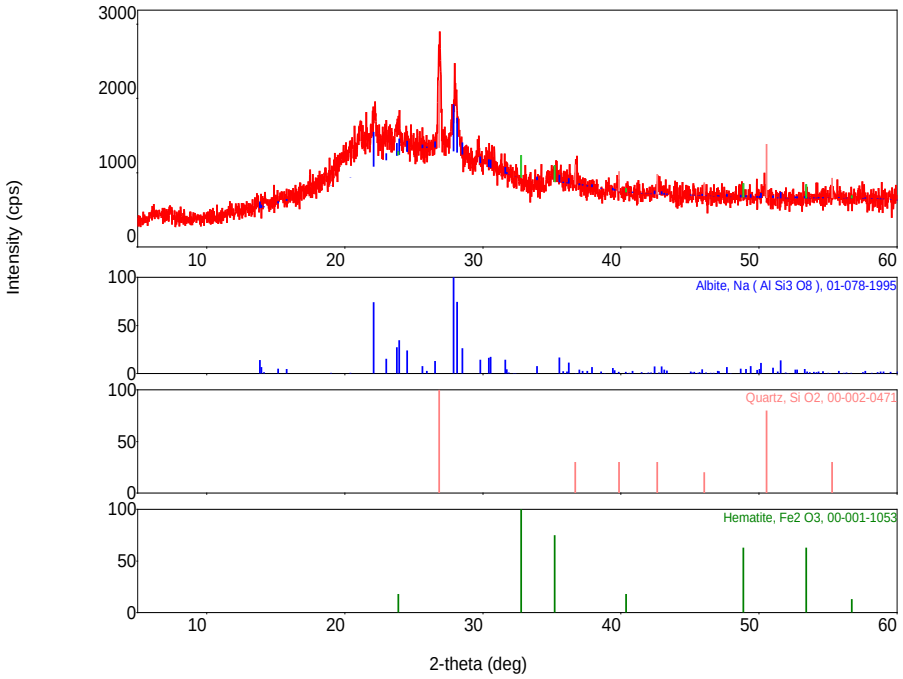


Figure 1. Diffraction pattern of volcanic ash

Table 1.Mineralogical composition of volcanic ash

Volcanic ash of Jeyranchel	Mineralogical composition of volcanic ash, % wt.				
	Quartz	Feldspar	Hematite	Volcanic glass	Total
	11	12	3	74	100

Table 2.The chemical composition of volcanic ash

Volcanic ash of Jeyranchel	Chemical composition of volcanic ash, % wt.							
	Na_2O	MgO	Al_2O_3	SiO_2	K_2O	CaO	FeO	Total
	3,67	1,05	13,91	71,86	3,93	2,33	3,25	100

It is known that feldspars, especially potassium feldspars: orthoclase and microcline are widely used in most ceramic systems. The addition of potassium feldspar gives the melt a very high viscosity, which significantly increases the resistance of ceramic products to sudden temperature changes.

Chemical-mineralogical analysis of Goy-Gol feldspar showed that it mainly consists of 39% potassium-sodium feldspar, 59% quartz. The abundance of orthoclase compared to albite allows the material to have a relatively high resistance to temperature changes at high temperatures.

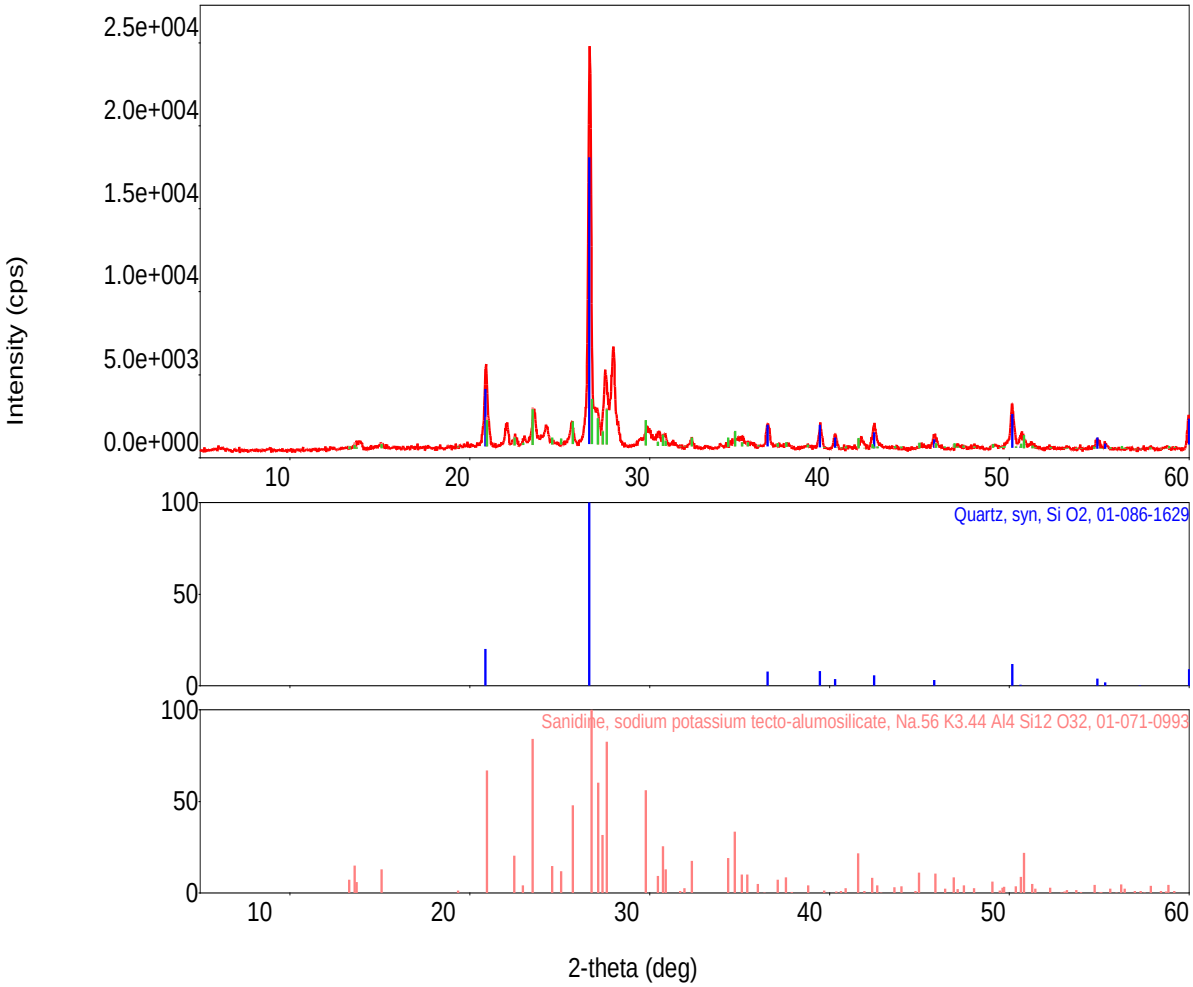


Figure 2. Diffractogram of Goy-Gol feldspar

Table 3.Mineralogical composition of feldspar

Feldspar	Mineralogical composition of feldspar, wt.%			
	Quartz	Feldspar	Other	Total
	59	39	2	100

Table 4.The chemical composition of feldspar

Feldspar	Chemical composition of feldspar, % by mass											
	Na_2O	MgO	Al_2O_3	SiO_2	P_2O5	SO_3	K_2O	CaO	TiO_2	MnO	FeO	П.п.
	3,2	0,0,38	13,14	72,61	0,01	0,001	5,85	1,48	0,5	0,01	1,87	0,5

For molding tiles by the plastic molding method, a certain amount of plastic hydromicaceous clay is needed. For this purpose, the chemical and mineralogical composition of the Akdash clay was studied and it was found that the amount of illite in the mineralogical composition of the clay from this deposit reaches 15%. At the same time, the presence of up to 12% kaolinite in the composition suggests that Akdash clay can be useful for the production of clinker slabs. However, the presence of montmorillonite (15%) in clay can cause some problems.

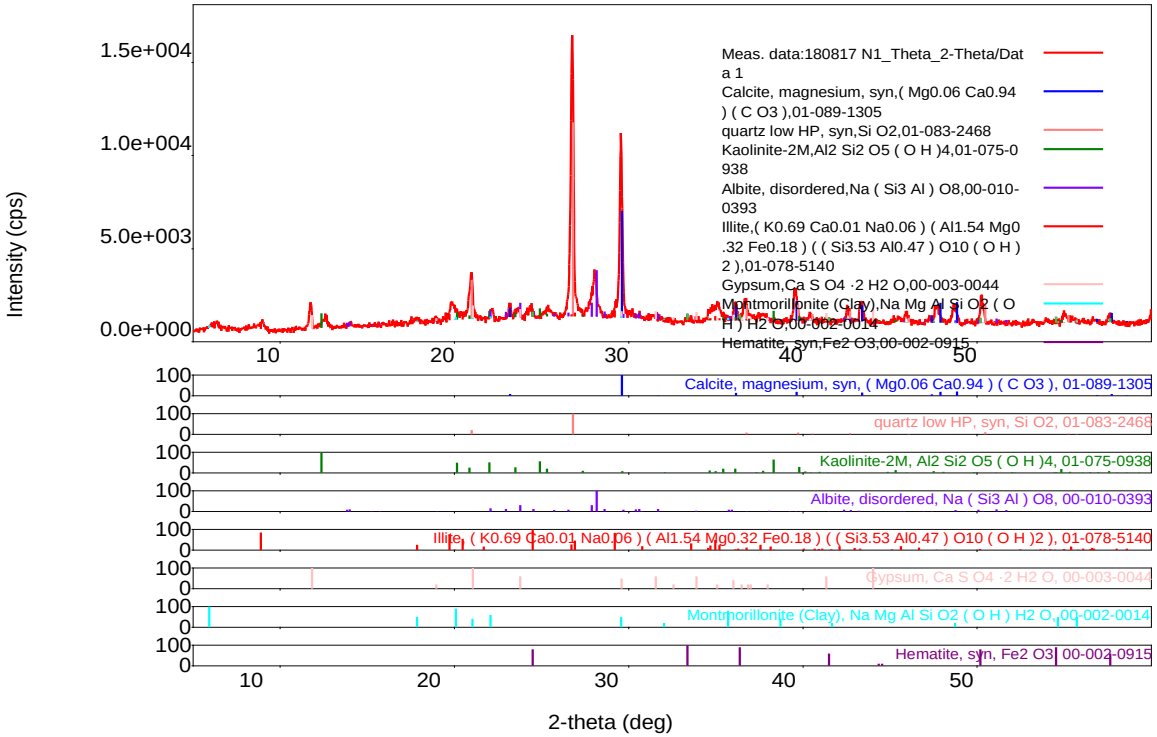


Figure 3. X-ray diffraction pattern of Akdash clay

Table 5.Mineralogical composition of Akdash clay

Akdash clay	Mineralogical composition of Akdash clay, wt.%								
	Quartz	Feldspar	Illite	Kaolinite	Montmorillonite	Gypsum	Calcite	Hematite	Total
	23	12	15	12	15	3	16	4	100

Table 6.Chemical composition of Akdash clay

Akdash clay	Chemical composition of clay, wt.%										
	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	TiO2	MnO	FeO	ki
	1,3	2,29	13,64	48,19	0,64	0,92	2,8	10,4	0,63	0,17	5,2	13,6

Thus, having a complete understanding of the composition of the raw materials used, we determined the values of shrinkage (%) and water absorption (%) by preparing compositions of pyrophyllite components according to certain recipes and firing (Table 7). The mass fraction of Akdash clay was taken over 100% in the amount of 20 m.f.

After plastic molding and drying of the mixtures, they were fired in a muffle furnace at 1180°C.

Table 7.Obtaining compositions of clinker tiles based on pyrophyllite and studying their properties

No.	Raw material composition, %			Indicators	
	Pyrophyllite	Volcanic ash of Jeyranchel	Feldspar Goy-gol	Total shrinkage, %	Water absorption, %
0	100	-	-	2,2	18,0
1	95	5	-	4,7	16,5
1	2	3	4	5	6
2	90	10	-	5,8	14,3
3	85	15	-	7,6	12,0
4	80	20	-	11,0	2,1
5	75	25	-	The tile is deformed	Water absorption not determined
5	95	-	5	3,2	21,2
6	90	-	10	4,2	18,6
7	85	-	15	5,0	16,9
8	80	-	20	6,8	14,7
9	75	-	25	8,4	4,6
10	70	-	30	The tile is deformed	Water absorption not determined

As can be seen from Table 7, the best results were obtained with a ratio of pyrophyllite: ash Jeyranchel - 80:20 and pyrophyllite: Goygol feldspar - 75:25. At other ratios of components, the water content was higher than required, or the samples were severely deformed.

At the next stage of the experiments, the temperature dependence of the optimal composition, water absorption and shrinkage for various types of floodplains (feldspar or volcanic ash) was studied (Fig. 4 and 5).

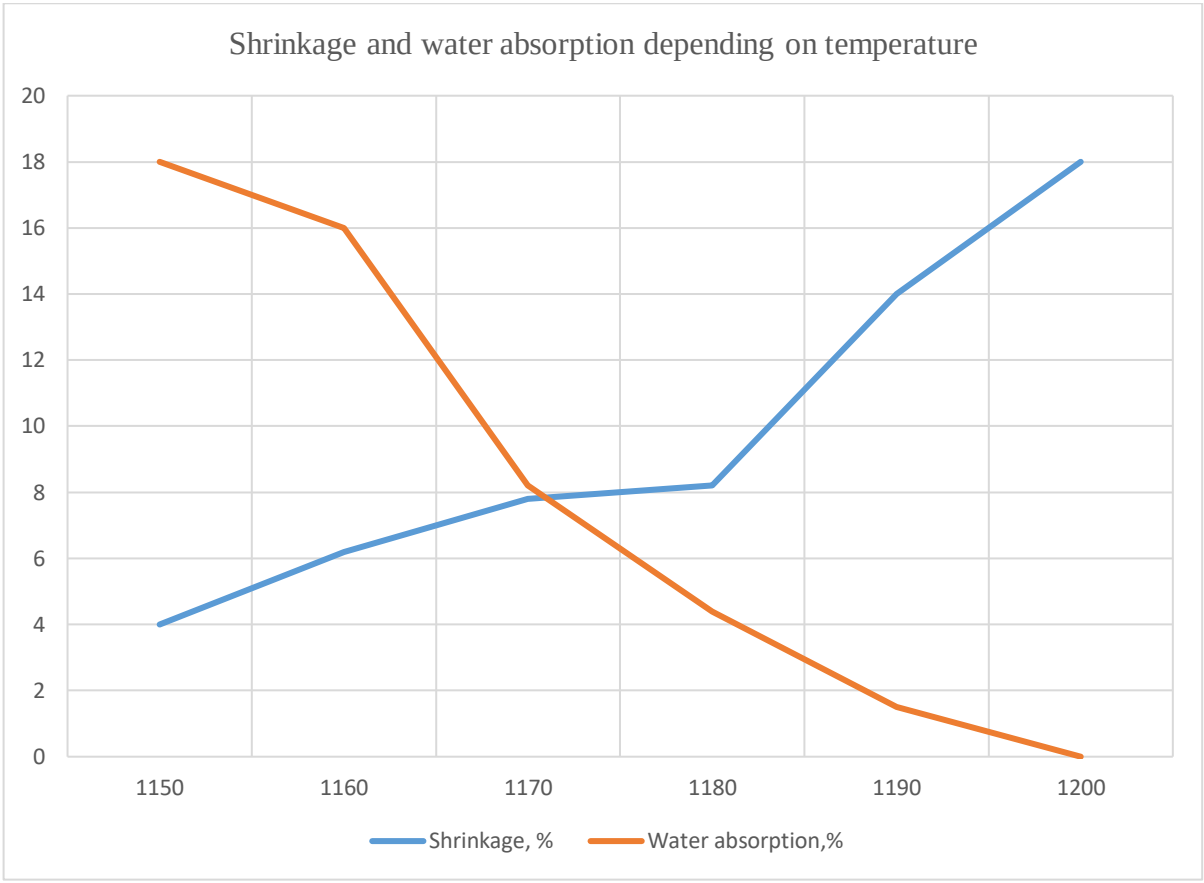


Figure. 4. Temperature dependence of shrinkage and water absorption of a feldspar mixture

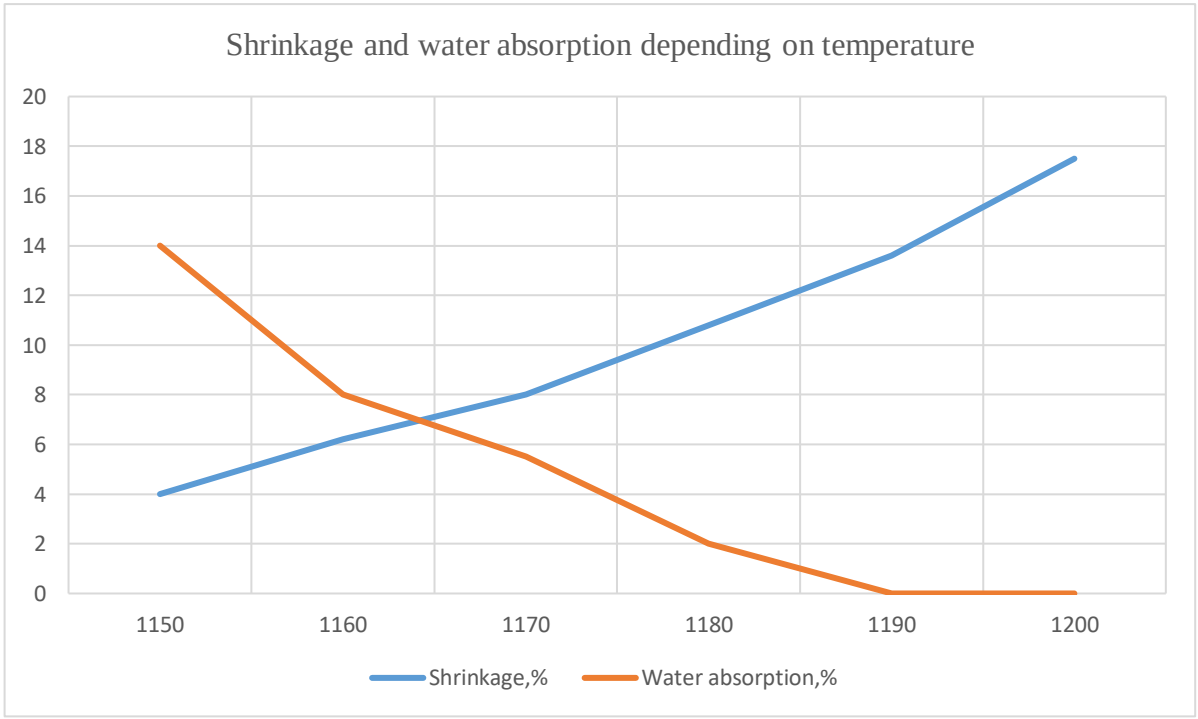


Figure. 5. Temperature dependence of shrinkage and water absorption of a mixture containing volcanic ash

As can be seen from Figures 4 and 5, the optimum firing temperature for a feldspar composition is 1173°C, and the optimum cooking temperature for a mixture containing volcanic ash is about 1165°C.

The appearance of samples fired with optimal materials is very attractive in terms of decor. The mechanical strength of the plates obtained under optimal compositions and conditions was 54 MPa and 49 MPa, respectively.

3. Conclusion

As a result of the research, the possibility of obtaining high-quality decorative facing clinker tiles based on Dashkesan pyrophyllite, volcanic ash, feldspar and local Akdash clay was proved, and the optimal parameters of the technological process were determined

.

References

1.A.Arcasoy. Ceramic technology. Beşiktaş, march, 1983, 277 p

2.M.MMindubaev, Gabudillin M.G. High quality clinker brick. News of KazGASU. No. 2., 2012.

3.A.V.Kotlyar, Clinker brick of low-temperature sintering based on argillium-like clays and argillites // Abstract of the dissertation for the degree of candidate of technical sciences. Volgograd. 23p., 2018.

4.V.A.Ezarsky, Technology and properties, Construction Materials. Scientific, technical and industrial journal. pp.79-81, 2011.

5.M.M.Alieva, M.A.Kashkaya, A.D.Sultanova, Geology of Azerbaijan. Ed., Publishing house, at the Academy of Sciences of the Azerbaijan SSR. 555 p.,1957.

Automatic managemnet of the most essential equipment of substation transformer

L.A.Aliyeva, H.S.Nuri

Azerbaijan State Oil and Industry University, Baku, Azerbaijan,
nhesen20@gmail.com

Abstract: Generally like whole forms of energy in the world, the main demand for electricity is constantly and exponentially growing. Therefore, development of manual and automatic management of electric power systems is one of our priority goals. In our research, we directly addressed some of the problems we mainly research the management of transformer stations, which are the most important and at the same time functional part of the energy system. During the research process, direct contact was established with leading energy companies and technical and scientific contributions were made in the field of manual and automatic control of a number of substations.

Keywords: Automatic control, Transformer center, Scada, Distance, Transformer, Analog, Management

1.Introduction

Actually, We consider that automatic control of substations means control and measurement of all controllable electrical equipment from a single point. The transformer center control principle is created as a result of the joint work of different schemes and different types of equipment. Here, the problems of remote switching (opening, closing) and measurement and monitoring of system parameters are solved. The remote central control system of the equipment, RTU or data transmission is realized through appropriate communication protocols. Every element to be used here must be very precise and reliable[3]. Communication is mainly carried out via the local network or global network with the RS485 communication module protocol. In this research, we and our team mainly focused on transformers, which are the leading and responsible element of transformer centers. We will look at the solutions to the problems encountered in automatic management.

Objective management of substation operations, in turn, contributes to system management. Given that the intelligent control system of transformer stations allows us to make a continuous, correct analysis of the system parameters values. From our research, we have come to the conclusion that we need to look closely at a number of issues in order to ensure that the substation operates safely and without accidents. Currently, the control of the remote field element is done by SCADA remote control software. According to this information we collected from the field, attention should be paid to the intelligent management of transformers, which are one of the most important elements of transformer centers. Both the protection of these elements and at the same time precise control of the parameters, automatic signal or opening at the moment of deviation of the parameters from the given value, ensure common and stable operation of the equipment.Transformer centers, which make up the most important and largest part of the electricity supply, are a general electric and automatic protection process to set in various ways. These devices contain equipment that requires special attention because it is a product in the implementation of effective energy conversion. Let's say that some equipment performs an auxiliary function, the malfunctions or accidents occurring in them do not affect the operation of the system so clearly. However, there are several elements to which the actual system is dynamically connected. At the head of this equipment is a transformer. If I look the main task of transformer, it can change the value of voltage of electricity. If we look at its parts, it is a device consisting of a core inside the frame and the coils around it. The working principle of the transformer is based on Faraday's law of magnetic induction.a The core and windings we mentioned together are called the active part. This active part is placed inside the transformer frame. Then special silicone oil is poured into this tank, the burning point of this oil is high, usually 135-145 degrees [1-5]. The research conducted in recent years has focused on obtaining more sustainable energy in the field of energy, in which grapheme is considered to be a material of exceptional importance [12-22]. The internal faults in transformers primarily changes the quality of transformer oil to a noticeable extent. Unsupervized management of loads causes heating of the active part, which increases the temperature of the oil. At the moment, the temperature control in transformer stations is being carried out normally, that is, the technical team is inspecting according to

certain programs. It seems impossible to control the change in the thermometer value if the controller is not done regularly.

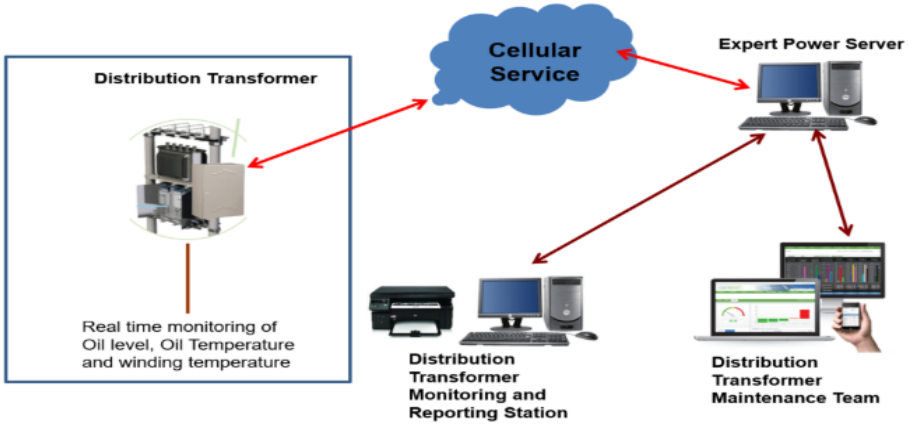


Figure 1. Monitoring system of automatic control of the transformer over the local network, which is an important element of the transformer center

2. Experimental details

The currently used variant system uses the mechanical protection of the thermostat. But in our opinion, this is not reliable, the received values are not correct, we will directly convert the non-electrical amount of temperature into an electrical signal and take a real value as an analog and send it directly to the interface checkpoint. PLC S71500 DC/DC/DC for offer; RTD PT100 TSt 4-20 mA temperature-sensitive measuring element and measuring device developed by us will be used[10]. It is clear that transformer oil provides insulation in the case and cooling of the active part at the same time. We can control the temperature with the equipment listed above. Since it is not possible to create a reliable control by just controlling the temperature, our work does not end here. Here, in addition to temperature, oil moisture and breakdown voltage of oil should be taken into account.One of the biggest challenges in transformer management, which is the main equipment of a substation, is the automatic acquisition of these values of transformer oil. Tens of tons of oil are used in large powerful transformers, which can lead to undesirable results if the technical parameters are not checked in time. The device we created with a mechanical-based system for automatic oil testing automatically pulls a certain amount of working oil into the device by giving a command via SCADA, and the conditions for starting the test are determined.

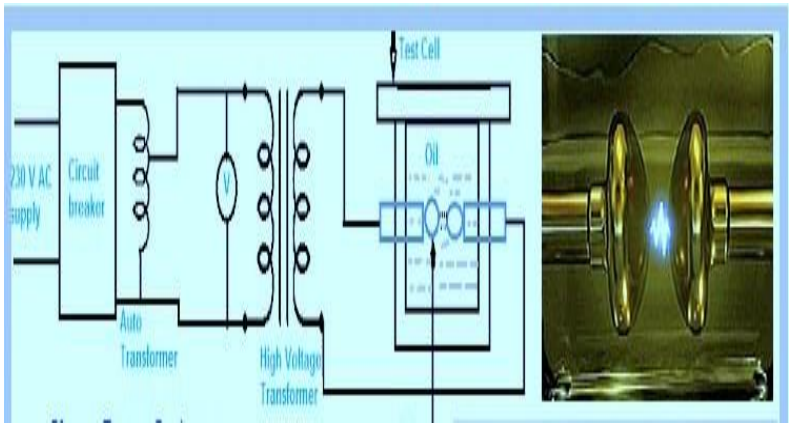


Figure 2. Operating area and electrical diagram of the device for remote real-time measurement of transformer oil quality and durability

Three main parameters Ud (puncture stress) moisture level are measured. The received values are converted to analog and sent to the interface via SCADA. EE381 humidity sensor fault voltage is calculated by a built-in special circuit. Various commands can be executed according to the results obtained with special measurement methods. The technical device we make consists of a main body frame, a pump to draw oil from the transformer to the device, a main work piece for testing and measurement, and a suction pump to remove the oil after measurement. Since the first values obtained from the measurements are non-electrical quantities, these signals are converted into 0-10V or 4-20mA static signals using special converters and sent to the main data processor RTU or PLC [5] . Accurate and remote control of transformers, which are a very important part of the electrical system, is the basis of reliable transmission and distribution of electrical energy. As we have shown, the temperature and oil quality control of the transformer is integrated into the automatic control system.

Also, to protect the transformer of the substation from accidents

According to the 50/51 protection codes, opening (opening) and signal (alarm) commands are designed.

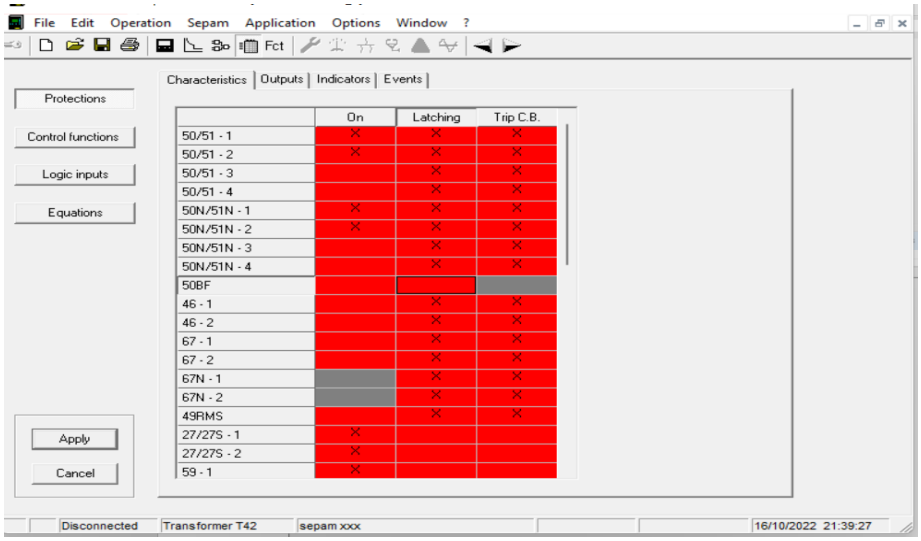


Figure 3. Programming interface to protect the transformer from events caused by remote electrical and non-electrical quantities with T20 type microprocessor relay

The value of the constant current is smoothly controlled, when it exceeds the set values set according to the protection codes, the relay output saturates the opening coil of the switch in 0.01+0.03 time. Delays up to 300-400 ms can be used in level 50 coded protection. Also, the use of voltages 27 and 59 in price protection is important for correct control and automatic control. Here, 59-coded protection against voltage increase and 27-coded protection against voltage drop sends a command to the opening coil of the switch from the output of the automatic signal relay. Either the received error signal (alarm) or opening (opening) is displayed on the relay interface. At the same time, a signal is sent to the Scada automatic control system via the RS485 communication protocol [6].

3. Conclusion

First of all, we wrote about the goals we set for ourselves, solutions and integration into the sector. The problems we are looking at were identified during the interview with the employees working directly in the real industrial system. As you can see, in our research, we mainly examined the problems related to transformers, which are the main power element of substations. At the end of the research, we found solutions suitable for our goals. As we mentioned when we looked at automatic regulation systems, converting non-electric quantities into electrical signals and sending them to the RTU central control system ensures seamless control of these quantities. In addition to control, we can set up protection for the values of these quantities and automatically signal or open when any malfunction occurs. The temperature cone is very important in transformers, in order to facilitate temperature control, in our research, we convert the current temperature value into a 0-10v or 4-20mA electrical signal by means of special elements and send it to the RTU. This electrical signal is converted into a 0-27876 bit data with the Norm command in the RTU,

and then it is converted with the Scale command and appropriate calculations can be made on it. We explained this issue in detail above. In addition, an additional measuring box was added to the transformer to continuously monitor other oil quality indicators. With its help, a test is started with a signal sent through the HMI at any time according to the operator's request. The oil breakdown voltage in the fixed case is tested with a special circuit and the oil breakdown limit is determined. Also, the moisture content of the oil is determined. Both results are sent directly to the HMI system. The topics discussed above were researched on real problems in the industrial system and the results were obtained. The system is seamlessly controlled by an automatic control system.

References

1.K.Tomsovic, M.Tapper, T.Ingvarsson, A fuzzy information approach to integrating different transformer diagnostic methods, IEEE Transactions on Power Delivery, Vol.8, №3, pp.1638–1646, 1993.

2.A.Jahromi, R.Piercy, S.Cress, J.Service, W.Fan, An approach to power transformer asset management using health index, IEEE Electrical Insulation Magazine, Vol.25, №2, pp.20–34, 2009.

3.J.Bak-Jensen, B.Bak-Jensen, S.D.Mikkelsen, Detection of faults and ageing phenomena in transformers by transfer functions, IEEE Transactions on Power Delivery, Vol.10, №1, pp.308–314, 1995.

4.Thermal performance of transformers, CIGRE WG A2-24 (Declerq), Technical brochure, №393, 2009.

5.M.Sechilariu, B.Wang, F.Locment, Building-integrated microgrid: Advanced local energy management for forthcoming smart power grid communication. Energy and Buildings, №59, pp.236-243, 2013.

6.P.Siano, Demand response and smart grids-A Survey, Renewable and Sustainable Energy Reviews, 30, pp.461-478, 2014.

7.A.G.Mammadov, R.G.Abaszade, V.O.Kotsyubynsky, E.Y.Gur, I.Y.Bayramov, E.A.Khanmamadova, O.A.Kapush, Photoconductivity of carbon nanotubes, International Journal on Technical and Physical Problems of Engineering, Vol.14, №3, pp.155-160, 2022.
http://www.iotpe.com/IJTPE/IJTPE-2022/IJTPE-Issue52-Vol14-No3-Sep2022/21-IJTPE-Issue52-Vol14-No3-Sep2022-pp155-160.pdf

8.R.G.Abaszade, Synthesis and analysis of flakes graphene oxide, Journal of Optoelectronic and Biomedical Materials, Vol.14, №3, pp.107–114, 2022
https://doi.org/10.15251/JOBM.2022.143.107

9.R.G.Abaszade, Analysis of carbon nanotube doped with five percent gadoliniumu, III International scientific and theoritical conference, Theory and practice of modern science, April 1, Kraków, Poland, pp.82-83, 2022
https://previous.scientia.report/index.php/archive/article/view/21

10.O.A.Kapush, I.O.Mazarchuk, L.I.Trishchuk, V.Y.Morozovska, S.D.Boruk, S.I.Budzulyak, D.V.Korbutyak, B.N.Kulchitsky, O.G.Kosinov, R.G.Abaszade, Influence of the nature of the dispersion medium on the optical properties of CdTe nanocrystals during sedimentation deposition, Chernivtsi University Scientific Herald. Chemistry (819), pp.7-11, 2019
https://doi.org/10.31861/chem-2019-819-01

11.R.G.Abaszade, A.G.Mamedov, I.Y.Bayramov, E.A.Khanmamadova, V.O.Kotsyubynsky, O.A.Kapush, V.M.Boychuk, E.Y.Gur, Structural and electrical properties of sulfur-doped graphene oxide/graphite oxide composite, Physics and Chemistry of Solid State, Vol.23, №2, pp. 256-260, 2022.
DOI:10.15330/pcss.23.2.256-260

12.R.G.Abaszade, A.G.Mammadov, V.O.Kotsyubynsky, E.Y.Gur, I.Y.Bayramov, E.A.Khanmamadova, O.A.Kapush, Modeling of voltage-ampere characteristic structures on the basis of graphene oxide/sulfur compounds, International Journal on Technical and Physical Problems of Engineering, Vol.14, №2, pp.302-306, 2022.
http://www.iotpe.com/IJTPE/IJTPE-2022/IJTPE-Issue51-Vol14-No2-Jun2022/37-IJTPE-Issue51-Vol14-No2-Jun2022-pp302-306.pdf

13.R.G.Abaszade, S.A.Mamedova, F.H.Agayev, S.I.Budzulyak, O.A.Kapush, M.A.Mamedova, A.M.Nabiyev, V.O.Kotsyubynsky, Synthesis and Characterization of Graphene Oxide Flakes for Transparent Thin Films, Physics and Chemistry of Solid State, Vol.22, №.3, pp.595-601, 2021.
DOI: 10.15330/pcss.22.3.595-601

14. S.R.Figarova, E.M.Aliyev, R.G.Abaszade, R.I.Alekberov, V.R.Figarov, Negative Differential Resistance of Graphene Oxide/Sulphur Compound, Journal of Nano Research Submitted, Vol.67, pp.25-31, 2021.
http://dx.doi.org/10.4028/www.scientific.net/JNanoR.67.25

15. R.G.Abaszade, O.A.Kapush, S.A.Mamedova, A.M.Nabiyev, S.Z.Melikova, S.I.Budzulyak, Gadolinium doping influence on the properties of carbon nanotubes, Physics and Chemistry of Solid State, Vol. 21, No. 3, pp. 404-408, 2020.
https://doi.org/10.15330/pcss.21.3.404-408

16. R.G.Abaszade, O.A.Kapush, A.M.Nabiyev, Properties of carbon nanotubes doped with gadolinium, Journal of Optoelectronic and Biomedical Materials, Vol.12, №3, pp.61–65, 2020.
https://www.chalcogen.ro/61_AbaszadeRG.pdf

17. Kh.M.Popal, R.G.Abaszade, Research and modeling of hybrid energy systems (review), Ecoenergetics, №1, pp.65-69, 2022.

http://ieeacademy.org/wp-content/uploads/2022/05/ECOENERGETS-JOURNAL-No1.-2022.pdf#page=66
18.A.G.Mammadov, R.G.Abaszade, E.A.Khanmamedova, I.Y.Bayramov, H.D.M.Muzaffari, Optoelectronic information processing devices, Ecoenergetics, №3, pp.23-25, 2021.
http://ieeacademy.org/wp-content/uploads/2022/01/Ekoenergetic-journal-2021.-1.pdf

Uncertainties in the oil and gas industry

S.B.Nurmammadova, I.Y.Bayramov, T.N.Zeynalova

Azerbaijan State Oil and Industry University, Baku, Azerbaijan
sevincnurmammadova@gmail.ru
imranb1963@mail.ru

Abstract: Contemporary issues of geological exploration and oil and gas industry are associated with the need to study fields with a complex geological environment characterized by significant spatial heterogeneity.A complex environment is a multiparameter system, whose parameters are characterized by spatial distribution according to some unknown laws.For example, these are hydrocarbon deposits with complex types of layers.Complex collectors are characterized by complex mixed porosity: bulk, fissured, ordinary, etc. and they are heterogeneous. Under the spatial heterogeneity of the layer with mixed density, it is necessary to understand the change of the value of porosity according to the volume of the layer. The results of reservoir heterogeneity studies have applications in information provision for making technological decisions in the development of hydrocarbon fields and predicting physical and geological parameters of field models based on geophysical data.

Keywords: Fuzzy, Hydrodynamic factors,information, Parametres.

1.Introduction

Another example is deposits with spatially distributed heterogeneous reservoir capacity.During the operation of the deposits, the permeability of the layers changes significantly, and after long-term operation, relief zones are formed.Such zones are spatially distributed and not homogeneous. Construction research in the oil and gas industry is devoted to the synthesis and diagnossis of new materials, and the construction of their mathematical models.Their study is an urgent issue for the optimization of field development technologies and increasing the productivity of the layers[1,2, 9-20]. Mathematical models of such environments are characterized by spatial variability of their parameters. When building them, it is common for the modeling result to be uncertain.

The problem of predicting the parameters of physical-geological models of geological environments is one of the main issues that arise during the search and exploration of mineral deposits, studying the geological structure, predicting productivity, and evaluating mineral resources. In modern geophysical conditions, this issue is characterized by the following: firstly, forecasting takes place under conditions of uncertainty, secondly, the data on which the forecasting is carried out is fuzzy, fuzzy, and the forecasting itself is carried out using indirect signs that carry information about the required parameters based on some intermediate results. The uncertainty of the data - is manifested in the incompleteness of the distribution of data in a certain area. The incompleteness (Fig. 1 a) is due to the lack of regularity of data assignment. A typical example is the absence of required measurements due to the impossibility of doing the work. For example, the most reliable information about the properties of rocks (petrophysical, filter-volumetric, physical, etc.) can be obtained only by studying the main kern samples. Measuring with 100% coring from each well is impractical and not economically viable. As a result, often in deposits, the kern is represented only by the intersection points of a limited number of layers [3-5].

Scattering in a certain area (Figure 1 b) is associated with measurement errors that occur due to the inhomogeneity of the studied object and the limited accuracy of the equipment and the imperfection of the measurement technique. For example, when analyzing the petrophysical properties of rocks (porosity, density, etc.), repeated measurements of the same parameter lead to different results due to the heterogeneity of the layer according to the measured parameter, although all measurements refer to the same layer (Figure 2).

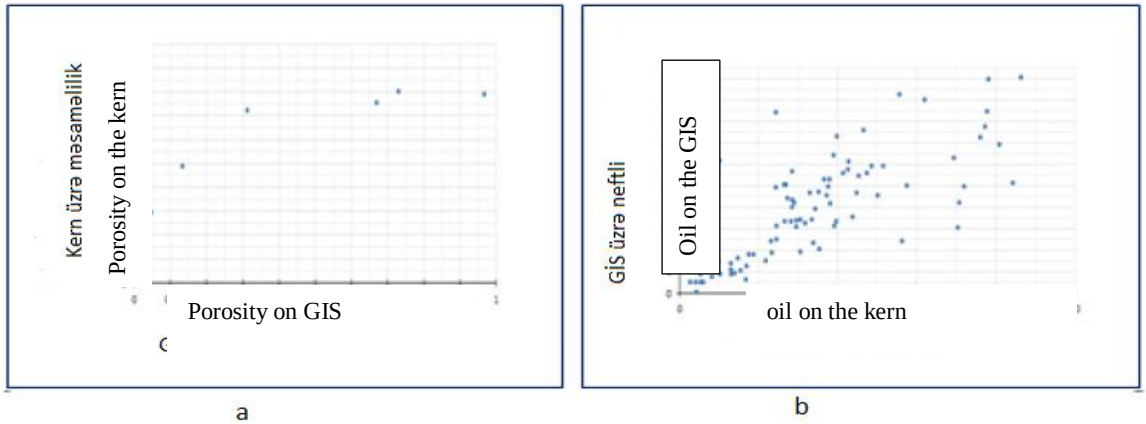


Figure 1. An example of documenting uncertain data: a) incompleteness of data, b) scattering of data.

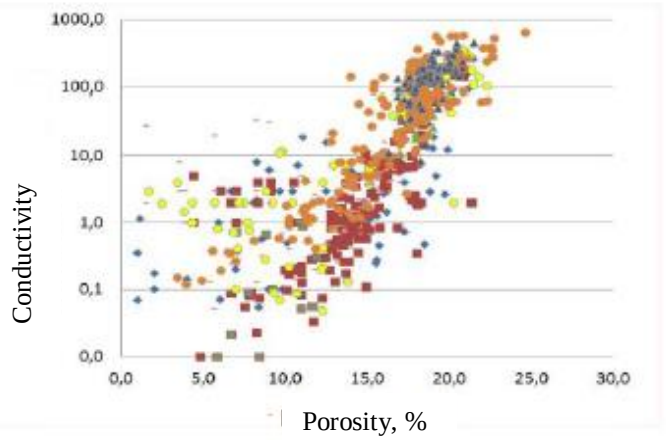


Figure 2. An example of the dependence of porosity and permeability obtained from the kern in different measurements

The process of studying mathematical models of complex geological environments in the prediction of field parameters is based on methods of analogy using existing reference objects. In reference objects, the relationships between the indirect data that will be available for measurement at the object under study and the forecast parameters that should be found at the object under study are studied experimentally (Figure 3).

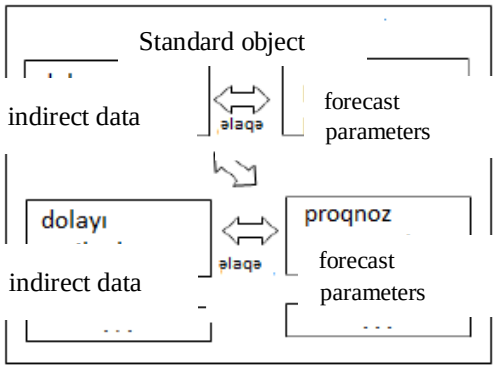


Figure 3. Prediction of parameters on reference objects

The relationships between the parameters of the various components of the models are most often obtained from experimental studies of the values of the parameters in the rock samples - the parent material. These dependencies are based on petrophysical dependencies of "kern-kern", "kern-GIS", "GIS-GIS" types. When using the "kern-GIS"

relationship, the petrophysical and geological parameters measured in the kern samples are taken.
Some geophysical parameters used from the "GIS-GIS" dependency or the results of layer tests are taken to interpret the layer properties of the rocks .
Calculation of values of field parameters such as phase permeability, porosity, fluid saturation using a number of geophysical data as a fairly typical situation in oil and gas geology during the calculation of hydrocarbon resources. The measured geophysical parameters should be recalculated in geological-mining values and the values of the latter distributed in the established spatial physical-geological model of the environment should be used to calculate the required field properties such as reservoir resources.
The simplest relationships between the same and different parameters are established experimentally in petrophysics laboratories, because real theoretical relationships between physical and geological parameters have not been established or have been established under very strict assumptions. As a rule, permeability is determined by porosity according to dependencies obtained as a result of laboratory studies of the kern.

2.Experimental details

Another issue characterized by uncertainty is the prediction of the filtration properties of the medium that predetermine the recovery of stocks. Here, uncertainty exists both in the data and in the dependencies, but above all in the dependencies.
Before drilling for the extraction of hydrocarbons from the reservoir, its reservoir and porosity model is built, which must be multivariate.
Wells are subjected to various physical, chemical, biological and other changes during the entire service life of the field.
The filtration pattern changes, filtration flows vary, and this necessitates obtaining constantly updated information about wells and formations.
As a result of all the changes and processes occurring in the layer, viscosity zones and rising zones are formed, oil clots are formed, asphaltification effects are created (pore space is blocked with asphaltites).
These effects are supported by hydrodynamic and thermomechanical factors.
Hydrodynamic factors are based on hydromechanical contamination of the filtration surface with mechanical impurities and hydrocarbon compounds in the water injected into the layers. These are small particles of sand, clay and carbonates, iron oxides, iron oxide hydrates, wastes of microorganisms and plants.
For example, the composition of mechanical particles with increased adhesion, covered with a layer of petroleum products (consisting mainly of resins and asphaltenes), contributes to the intensive siltation of the layer pore space. The low temperature injected in winter helps to strengthen this structure.
The same and many other factors lead to the formation of compressed low-permeability zones, large stagnant zones, resulting in complete relief effects of formation capacity and significant areas of the field being effectively removed from production.
The availability of information about stagnant areas depends on the correct acceptance of the decision to conduct activities in wells, in the development area or in certain parts of such an object. From this point of view, data on the spatial distribution of filtration resistance, which characterizes the carrying capacity of the productive layer, is of considerable interest.
Currently, it is possible to obtain filtration characteristics by studying the transient processes that occur in the formation during well shut-in and shut-in.
The change of the pressure in the elastic layer at a point far from the point of failure - the change of the well from the distance r- to the time t after the start of the failure is described by the following equation:

$$\Delta P(t,r) = -\frac{q\mu b}{4\pi kh} E_i\left(-\frac{r^2}{4\chi t}\right), \quad (1)$$

In here:

$\Delta P(t,r)$ - formation pressure change at an arbitrary point in the formation (in the reacting well), MPa;

q - flow rate change in the disturbing well, m^3/day;

μ - viscosity of liquid, Pa s;

b - volume factor of production;

k - coefficient of permeability;

h - layer thickness, m;

E_i - is the definition of an exponential integral function, usually given in tabular form;

r - distance from the disturbing well to the responding well, m;

χ - coefficient of piezoconductivity, m^2/sec;

t - observation time, sec.

For analysis, we linearize expression (1) as follows:

$$\Delta P(t) = \frac{Q\mu b_n}{4\pi kh} \cdot Ln\frac{2{,}25\chi}{r_q^{\,2}} + \frac{Q\mu b_n}{4\pi kh} \cdot Lnt$$

$\Delta P(t)$ - Pressure change on the well wall when the well is started with a constant flow rate Q or when it is stopped after working with a flow rate Q;

r_q – well radius, m;

b_n – volume coefficient of formation oil, m

Then the graph is plotted.

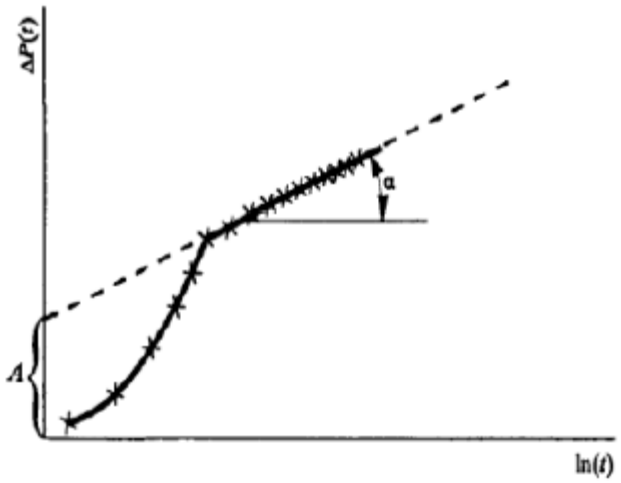


*Figure «ΔP – **lg**t » dependence*

A - $y = A + \alpha \cdot x$ is found based on the regression equation in Fig., where

$$y = \Delta P(t), A = \frac{Q\mu b_n}{4\pi kh} \cdot Ln\frac{2{,}25\chi}{r_q^{\,2}} + \frac{Q\mu b_n}{4\pi kh}, \alpha = \frac{Q\mu b_n}{4\pi kh}, x = Lnt$$

Then other characteristics are determined according to the measured tangent of the known Q, bn and α angle.

3. Conclusion

Analyzing the above, we can conclude that the prediction of parameters of geological environments in modern conditions is characterized by the study of significantly heterogeneous environments, which manifests itself in a significant dispersion of data. From this point of view, the question of development of uncertainty forecasting and description methods for forecasted models, taking into account the blurriness and fuzziness of the data on the interdependence of physical-geological and geophysical parameters of complex, heterogeneous models, is relevant.

References

1.I.Y.Bayramov, S.B.Nurmammadova, Control algorithms for an automated system of group metering, Ecoenergetic, №3, pp.45-48, 2021. http://ieeacademy.org/wp-content/uploads/2022/01/Ekoenergetic-journal-2021.-1.pdf

2.I.Y Bayramov, A.N.Gurbanov, O.M.Mirzayev, I.Z.Sardarova, Numerical determination of gas and oil reserves. 11th International Conference on Theory and Application of Soft Computing, Computing with Words and Perceptions and Artificial Intelligence - ICSCCW-2021, pp.522-529, 2021. https://link.springer.com/bookseries/15179

3.L.A.Zadeh, Fuzzy sets as a basis for a theory of Possibility, Fuzzy sets and systems, №1. pp.3-28, 1978.

4.L.A.Zadeh, A theory of approximate reasoning(AR), Machine Intelligence, Vol.9, pp.149-194, 1979.

5.L.A.Zadeh, Fuzzy Logic, Neural Network and Soft Computing, Communication of the ACM, Vol.37, №3, pp.77-84, 1994.

6.L.A.Zadeh, Fuzzy Logic Computing With Words, IEEETransactions of Fuzzy Systems, Vol.4, pp.103-111, 1994.

7.L.A.Zadeh Toward a perception-based theory of probabilistic reasoningwith imprecise probabilities, Journal of Statistical Planning and Inference, Vol.105, pp.233-264, 2002.

8.H.J.Zimmermann etc.all, Quantifying vagueness in decision models, European Journal of Operational Research, №22, pp.148-158, 1985.

9.A.G.Mammadov, R.G.Abaszade, V.O.Kotsyubynsky, E.Y.Gur, I.Y.Bayramov, E.A.Khanmamadova, O.A.Kapush, Photoconductivity of carbon nanotubes, International Journal on Technical and Physical Problems of Engineering, Vol.14, №3, pp.155-160, 2022. http://www.iotpe.com/IJTPE/IJTPE-2022/IJTPE-Issue52-Vol14-No3-Sep2022/21-IJTPE-Issue52-Vol14-No3-Sep2022-pp155-160.pdf

10.R.G.Abaszade, Synthesis and analysis of flakes graphene oxide, Journal of Optoelectronic and Biomedical Materials, Vol.14, №3, pp.107–114, 2022. https://doi.org/10.15251/JOBM.2022.143.107

11.R.G.Abaszade, Analysis of carbon nanotube doped with five percent gadoliniumum, III International scientific and theoritical conference, Theory and practice of modern science, April 1, Kraków, Poland, pp.82-83, 2022
https://previous.scientia.report/index.php/archive/article/view/21

12.O.A.Kapush, I.O.Mazarchuk, L.I.Trishchuk, V.Y.Morozovska, S.D.Boruk, S.I.Budzulyak, D.V.Korbutyak, B.N.Kulchitsky, O.G.Kosinov, R.G.Abaszade, Influence of the nature of the dispersion medium on the optical properties of CdTe nanocrystals during sedimentation deposition, Chernivtsi University Scientific Herald. Chemistry (819), pp.7-11, 2019
https://doi.org/10.31861/chem-2019-819-01

13.R.G.Abaszade, A.G.Mamedov, I.Y.Bayramov, E.A.Khanmamadova, V.O.Kotsyubynsky, O.A.Kapush, V.M.Boychuk, E.Y.Gur, Structural and electrical properties of sulfur-doped graphene oxide/graphite oxide composite, Physics and Chemistry of Solid State, Vol.23, №2, pp. 256-260, 2022.
DOI:10.15330/pcss.23.2.256-260

14.R.G.Abaszade, A.G.Mammadov, V.O.Kotsyubynsky, E.Y.Gur, I.Y.Bayramov, E.A.Khanmamadova,O.A.Kapush, Modeling of voltage-ampere characteristic structures on the basis of graphene oxide/sulfur compounds, International Journal on Technical and Physical Problems of Engineering, Vol.14, №2, pp.302-306, 2022.
http://www.iotpe.com/IJTPE/IJTPE-2022/IJTPE-Issue51-Vol14-No2-Jun2022/37-IJTPE-Issue51-Vol14-No2-Jun2022-pp302-306.pdf

15.R.G.Abaszade, S.A.Mamedova, F.H.Agayev, S.I.Budzulyak, O.A.Kapush, M.A.Mamedova, A.M.Nabiyev, V.O.Kotsyubynsky, Synthesis and Characterization of Graphene Oxide Flakes for Transparent Thin Films, Physics and Chemistry of Solid State, Vol.22, №.3, pp.595-601, 2021.
DOI: 10.15330/pcss.22.3.595-601

16.S.R.Figarova, E.M.Aliyev, R.G.Abaszade, R.I.Alekberov, V.R.Figarov, Negative Differential Resistance of Graphene Oxide/Sulphur Compound, Journal of Nano Research Submitted, Vol.67, pp.25-31, 2021.
http://dx.doi.org/10.4028/www.scientific.net/JNanoR.67.25

17.R.G.Abaszade, O.A.Kapush, S.A.Mamedova, A.M.Nabiyev, S.Z.Melikova, S.I.Budzulyak, Gadolinium doping influence on the properties of carbon nanotubes, Physics and Chemistry of Solid State, Vol. 21, No. 3, pp. 404-408, 2020.
https://doi.org/10.15330/pcss.21.3.404-408

18.R.G.Abaszade, O.A.Kapush, A.M.Nabiyev, Properties of carbon nanotubes doped with gadolinium, Journal of Optoelectronic and Biomedical Materials, Vol.12, №3, pp.61–65, 2020.
https://www.chalcogen.ro/61_AbaszadeRG.pdf

19.Kh.M.Popal, R.G.Abaszade, Research and modeling of hybrid energy systems (review), Ecoenergetics, №1, pp.65-69, 2022.
http://ieeacademy.org/wp-content/uploads/2022/05/ECOENERGETS-JOURNAL-No1.-2022.pdf#page=66

20.A.G.Mammadov, R.G.Abaszade, E.A.Khanmamedova, I.Y.Bayramov, H.D.M.Muzaffari, Optoelectronic information processing devices, Ecoenergetics, №3, pp.23-25, 2021.
http://ieeacademy.org/wp-content/uploads/2022/01/Ekoenergetic-journal-2021.-1.pdf

Determination of the allowable limit of the shift of tact moments of pulse sequence in digital transmission systems

E.I.Muradzadeh

Azerbaijan State Oil and Industry University, Baku, Azerbaijan,
muradzade.elvin36@gmail.com

Abstract: The article is devoted to determining the minimum allowable value of the shift of clock moments, when recognizing of the symbols by the gating method in digital transmission systems take place. To calculate the minimum allowable value of the clock moments shifting during the transmission of two successive pulses with the condition of their superposition on each other, the expansion of the total signal in a Taylor series is used. Taking into account the features of elementary pulses widely used in practice, an expression is obtained for determining the minimum allowable value of the shift of clock moments. The calculations were carried out on the exam-ple of cosine-square pulses, and the influence of interference and noise was not taken into account.
Keywords: Gating method, Shift of clock moments, Taylor series, Elementary pulse, Cosine-square pulse.

1.Introduction

In the case of optimal radio reception of signals, methods of individual recognition of symbols ("elemental receiving") or "receiving in general" are used [1-2]. In the sec-ond case, the decision device must recognize the code word (the individual signal elements corresponding to the code symbols are first analyzed, and then the recon-structed code combination is decoded, i.e., converted to an element of the message.

This is a relatively complex method, and therefore reception by symbols is more often used. During single-element reception, the receiver's decision device must recognize each element of the signal separately.

For recognition in digital broadcasting systems, decision device is used in both ideal and real receivers. Ideal receivers provide potential interference immunity. This is the highest possible immunity. However, in practice, there may be radio re-ceivers that provide immunity close to potential immunity. In such radio receivers, quasi-optimal filtering is performed first, then coherent or incoherent detection is per-formed, and the modulating signal is separated [3]. Symbol recognition is performed as the third operation.

Correlation method, integral method or gating method is used for symbol recognition [1]. The latter method is widely used because it is simpler and easier to implement.

In the initial modulation stage, the format of the signal is determined. A simi-lar problem has been studied for various digital transmission systems [4]. In televi-sion broadcasting systems, pulses with a cosine quadratic cut of the spectrum, which ensures high transmission speed and high interference immunity, are used, and they can be transmitted under the condition that they overlap each other. In the simplest gating method, the level of the binary signal at clock moments is compared with a threshold level equal to half of its maximum value [1,5]. A level above this value is known as a one symbol, and a level below is known as an oppo-site symbol. Errors may occur when the decision device can't recognizes distorted symbol. One of the reasons for the occurrence of these errors is the change of clock moments in the gating method [6]. The change of clock moments generally causes distortions on the leading and trailing edges of pulses (edges distortions), or even di-vision of pulses into pieces [5-6]. There are random, regular and characteristic types of edge distortions.

The purpose of this paper is to calculate the allowable limit of the variation of the clock moments at the condition when two consecutive pulses are transmitted by overlap each other.

2. Experimental details

When the level of interferences is small, the possibility of the decision device trigger-ing by mistake is negligible. In this case, the recording level fluctuates. This fact should be taken into account when recording pulses in the receiver. The instability of the registration threshold can lead to incorrect recognition of symbols. Let us assume that the

threshold device is inertia less and evaluate its instability.

When Nyquist pulses are used, we can transmit them by overlapping each other (Fig. 1). When the pulses are transmit without distortion, there is no mutual in-terference between them at the clock moments.

The excursions theory is used to solve a number of issues in telecommunica-tion theory [7-9]. Here, the excursions theory can be used to estimate the instability of the decision device, when weak noise is added to the deterministic pulses.

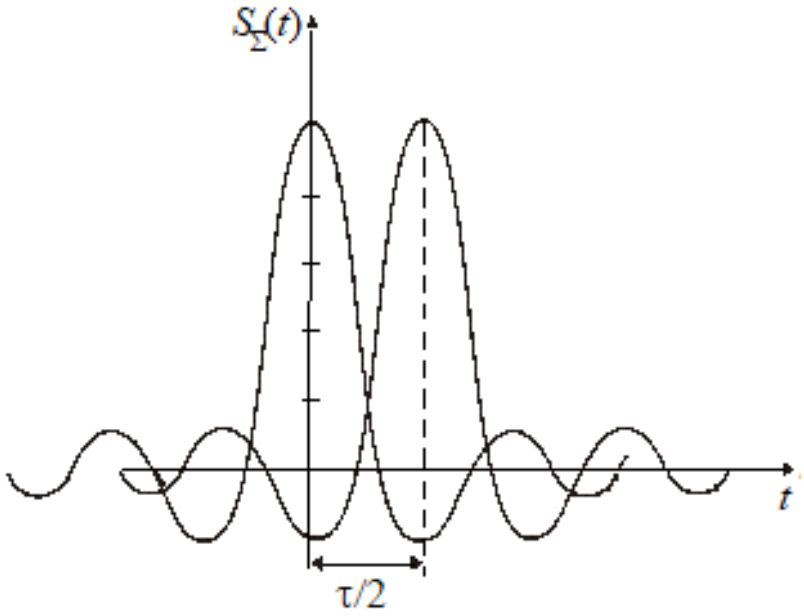


Figure.1. Overlapping transmission of two pulses

During the transmission of impulses, a fluctuation of the clock moments may occur for various reasons. This can lead to inter-symbol interferences and incorrect recognition of pulses in the receiver. Let's determine the accepta-ble value of the shifting of clock moments. Suppose that two pulses are transmitted with the condition of over-lapping each other, and in the general case, there is a shift in the clock moments of both pulses.

Let us denote the shift of the clock moment of the first pulse by Δt_2 and the shift of the clock moment of the second pulse by . Obviously, in the general case these two shifts will be different from each other: $\Delta t_1 \neq \Delta t_2$.

Figure 2 shows the overlapping transmission of two pulses (solid curves) and the sequence of this pulses after their shift to Δt_1 and Δt_2 respectively (dashed curves).

Suppose that in a binary system the decision device recognizes pulses by level H_0, that is, a level above H_0 is recognized as a one symbol and a level below H_0 is recognized as an opposite symbol. In the first case, we can write the symbol recognition condition by the gating method as follows:

$$S(t_0) \geq H_0, \qquad (1)$$

here t_0 – is gating moment, $S(t)$ – is time characteristic of pulses, H_0 – is selected assessment level.

In figure 2 two pulses are transmit overlapping each other, and the clock moments of both pulses are time-shifted. In this case, we can write condition (1) as follows:

$$S_1(t_0 - \Delta t_1) + S_2(t_0 - \Delta t_2) \geq H_0 \qquad (2)$$

here $S_1(t)$ and $S_2(t)$ – are the time characteristics of the first and second pulse, respectively.

The initial delay time of the pulses relative to each other is $\tau / 2$, where τ – is the duration of the base of the pulse. Let's assume that the fluctuation levels of the clock moments Δt_1 and Δt_2 are not large (this is consistent with the results obtained from practice. So, the shift of clock moments due to

instability is not large in modern telecommunication equipment). Then we can apply Taylor series expansion for $S_1(t)$ at the point t_0 and for $S_2(t)$ at the point $t_0 + \tau/2$. If we are satisfied with the first three members of this series, we get:

$$S_1(t_0)+S_1^{'}(t_0)(t-t_0)+S_1^{''}(t_0)\frac{(t-t_0)^2}{2}+S_2(t_0+\tau/2)+$$

$$+S_2^{'}(t_0+\tau/2)(t-t_0-\tau/2)+S_2^{''}(t_0+\tau/2)\frac{(t-t_0-\tau/2)^2}{2}\geq H_0.$$

,

here $S_1^{'}(t)$ and $S_2^{'}(t)$ – are first derivations of the $S_1(t)$ and $S_2(t)$ respectively, $S_1^{''}(t)$ and $S_2^{''}(t)$ – are second derivations of the $S_1(t)$ and $S_2(t)$ respectively.

We can simplify the expression (3) taking into account the equality $S_2(t_0+\tau/2)=S_1(t_0)$, the condition that the time characteristics of $S_1(t)$ and $S_2(t)$ impulses are same and $S(t_0)=2H_0=h$:

$$\frac{\Delta t_1^2+(\Delta t_2-\tau/2)^2}{2}S_1^{''}(t_0)+(\Delta t_1+\Delta t_2-\tau/2)S_1^{'}(t_0)+2S_1(t_0)\geq H_0.$$

Using this expression, we can find the allowable limit of variation of clock moments. For example, knowing that the component of cosine square pulses has a time characteristic $S(t)=h\cos^2\frac{\pi}{\tau}t$ in time interval $\left[-\frac{\tau}{2}\leq t\leq\frac{\tau}{2}\right]$, we find its first and second order derivatives:

$$S^{'}(t)=-\frac{2\pi}{\tau}h\cos\frac{\pi}{\tau}t\sin\frac{\pi}{\tau}t \quad ;$$

$$S^{''}(t)=\frac{2\pi^2}{\tau^2}h\left(\sin^2\frac{\pi}{\tau}t-\cos^2\frac{\pi}{\tau}t\right). \qquad (5)$$

For $t=t_0$ we can calculate: $S^{''}(t_0)=-\frac{2\pi^2}{\tau^2}h$. From here in special condition when $\Delta t_1=\Delta t_2=\Delta t$ by using the expression (4), we calculate the allowable limit of the change of clock moments:

$$\Delta t_{bur}=\frac{\tau}{4}+\frac{0{,}73\tau}{2\pi}.$$

Note that we can perform this report for other pulses that are widely used in practice. A change in the clock moments that exceeds the allowable limit leads to incorrect recognition of the pulse. Here, we have calculated the allowable limit of the variation of the clock moments, provided that two consecutive pulses are transmitted with overlap each other. If the clock moments are greater than the calculated limit, the condition (2) is violated. We considered the occurrence of a change in the clock moments and their equality for both pulses. Theoretically, the shifts that occur in two pulses can be different, or the shift can occur in only one pulse. However, experiments have shown that the causes leading to a clock shifting are generally continuous and therefore involves many pulses in succession. In addition, most of the reasons that cause changes in clock times have the same degree of influence. Therefore, it is practical to apply the change of clock moments to several pulses and choose their level equal or nearly equal.

Here, the deterministic model of change of tact moments was considered. In practice, the effect of both noise and interferences should be taken into account. It is clear that the fluctuation of tact moments may occur in the case of noise and interferences, and therefore the value of this drift should be evaluated with its probable characteristics. Thus, when two consecutive pulses are transmitted, the total signal $S_\Sigma(t)$ at the input of the decision device consists of the sum of a deterministic signal and a random process (noise and (or) interference). This sum itself is a random process [8-9]. Therefore, in order to determine the general signal recognition conditions, it is necessary to determine its probability density and mean value.

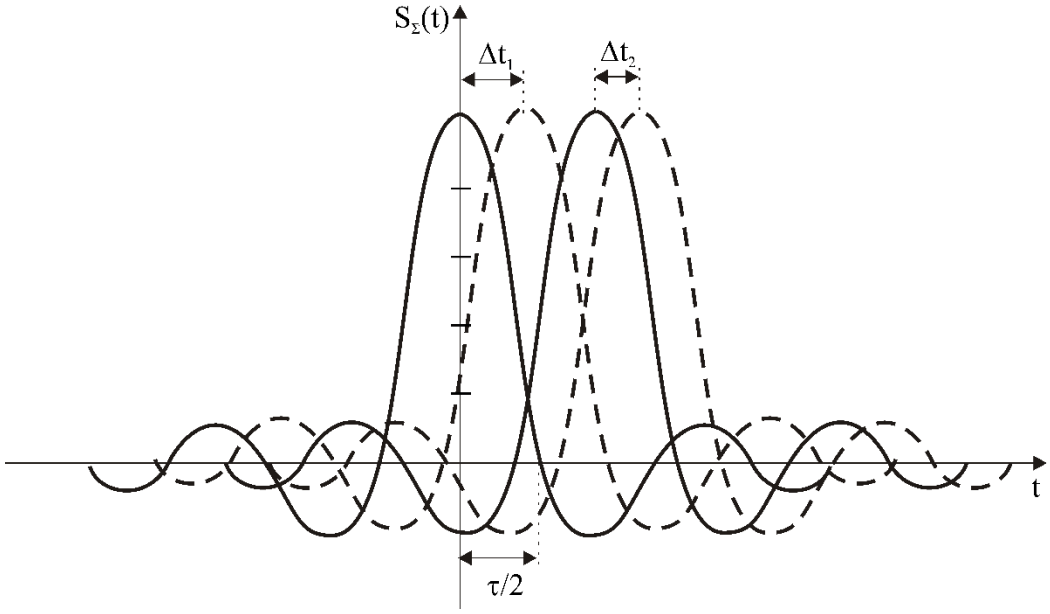


Figure 2. Shifting of clock moments in over-lapping transmission of two pulses

3. Conclusion

In digital transmission systems, the variation of the clock moments of pulses exceeding the allowable limit caus-es the pulse to be incorrectly recognized at the receiver. When this shift is small, its allowable limit can be calcu-lated by decomposition the analytical expression of the pulse sequence.

References

1.I.R.Mamedov, Transfer of still and graphic images. Moscow: Radio and communication, 128 p. 1999.
2.M.Ku, W.Chen, C.Huang EM-Based Iterative Receivers for OFDM and BICM/OFDM Systems in Doubly Selective Channels// IEEE Transactions on Wireless Communications, vol.10, No.5, pp.1405-1415, 2011.
3.V.Jiménez, Y.Jabrane, A.Armada, B.Said, A.Ouahman, Reduction of the Envelope Fluctuations of Multi-Carrier Modulations using Adaptive Neural Fuzzy Inference Systems// IEEE Transactions on Communications, vol.59, No. 1, pp. 19–25, 2011.
4.P.Rabiei, W.Namgoong, N.Al-Dhahir, On the Performance of OFDM-Based Amplify-and-Forward Re-lay Networks in the Presence of Phase Noise// IEEE Transactions on Communications, vol. 59, No.5, pp.1458–1466, 2011.
5.I.R.Mamedov, I.D.Akhadov, A.M.Sharifov, M.G. Abbasov, Digital Television: Signal Formation and Transmission (monograph). Baku: Azerneshr, 150 p., 2010.
6.I.D.Akhadov, Methods and means of increasing frequency and information efficiency in TV broadcasting systems. Abstract of diss. for an apprenticeship degree cand. tech. Sciences. Baku, 23 p., 2006.
7.Ya.A.Fomin, Theory of emissions of random processes. M.: 216 p., 1980.
8.V.I.Tikhonov, Nonlinear transformations of random processes. Moscow: Radio and communication, 296 p., 1986.
9.B.R.Levin, Theoretical Foundations of Statistical Radio Engineering. AT 3 books. Book one. M.: Soviet radio, 550s., 1974.

Power quality control for bitumen production

T.M.Maharramova, E.A.Melikov

Azerbaijan State Oil and Industry University, Baku, Azerbaijan

Abstract: Bitumen production has continued to increase every year compared to previous years, naturally due to the demand to build more roads every year. Bitumen is the most produced product in the road construction industry. Bitumen is purchased at the ELOU-AVT technological facility. The bitumen processing plant consists of tanks, pumps, heat exchangers, reactors, tanks, coolers and furnaces. One of the main issues in this device is to adjust the technological parameters in the environment where the reaction takes place. The main reason for this is the purchase of high-quality bitumen and the management of energy quality in its production.

Keywords: Road construction, Energy quality, Energy saving, Residual tar, Bitumen production, Quality management.

1.Introduction

The growth of the world population and the development taking place in the world, construction of quality roads is the main direction. Bitumen is one of the organic compounds used in road construction. According to its physical appearance, bitumen is a black and soft substance. Bitumen can be divided into two types, natural and artificial. Natural bitumen is used to fill all the cracks on the earth's surface. Fuel oil is vacuum distilled to obtain artificial bitumen, that is, residual tar. More than 95% of bitumen used is considered artificial bitumen [1-18].

Energy quality in the purchase of bitumen is the efficient and low loss of energy in the production of the targeted product. Researchers make a number of suggestions for saving energy in the bitumen production process. The following methods are proposed for the efficient use of energy in the technological process of bitumen production:

1) the temperature of the product can be reduced to a certain extent when changing the properties of bitumen;

2) it is possible to save energy in the purchase of bitumen, freeing from unnecessary energy consumption;

3) purposeful equipment can be used.

Bitumen is used for laying asphalt due to its strength-giving properties. It is a convenient way to save energy by changing the properties of bitumen. In order to improve the properties of bitumen, scrap rubber tires, polymer and nylon waste, and plastic bottles are added to the residual tar. When research is conducted, it is shown that bitumen production by this method reduces the temperature to a certain extent.

For the purpose of energy saving, when mixing polyurethane foam and residual tar with a certain percentage, the technical indicators are shown in table 1.1, and how its graphical schemes change in the MS Excel software package is shown in figure 1.1.

Another effective and cheaper method is to add polyurethane foam to the residual tar. By adding polyurethane foam to the bitumen mixture, it is possible to keep the completion time of the process stable by burning less fuel.

When mixing sulfur and residual tar with a certain percentage, the technical indicators are shown in table 1.2, and how its graphical schemes change in the MS Excel software package is shown in figure 1.2.

Table 1.1. Use of residual tar with polyurethane foam for energy saving

	Polyurethane foam	Residual tar	Melting temperature (T)	Fuel used (F)	Energy saving
1	2	3	4	5	6
1	0%	100%	250	0.200	-
2	10%	90%	247	0.190	5%
3	20%	80%	243	0.184	8%

1	2	3	4	5	6
4	30%	70%	238	0.180	10%
5	40%	60%	234	0.166	17%
6	50%	50%	223	0.160	20%

Table 1.2. Use of residual tar with sulfur for energy saving

	Sulphur	Residual tar	Melting temperature (T)	Fuel used (F)	Energy saving
1	4%	96%	250	0.200	-
2	5%	95%	245	0.198	1%
3	7%	93%	240	0.187	6.5%
4	8%	92%	235	0.184	8%
5	10%	90%	230	0.178	11%
6	12%	88%	220	0.172	14%

2. Experimental details

Bitumen contains nitrogen, oxygen, hydrocarbon compounds and sulfur. 90% of such compounds are hydrocarbon compounds, up to 4% are sulfur, and the rest are oxygen and nitrogen. In order to change the properties of bitumen, it is important to increase the amount of sulfur in its content. In the process inside the reactor, the temperature drops during the bitumen production.

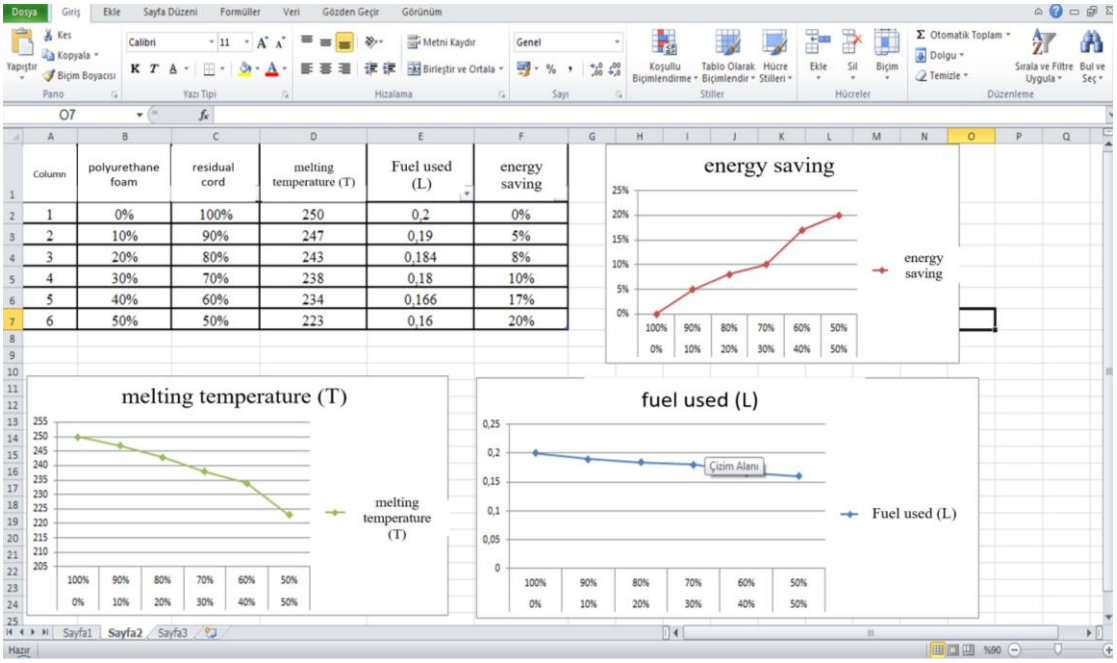
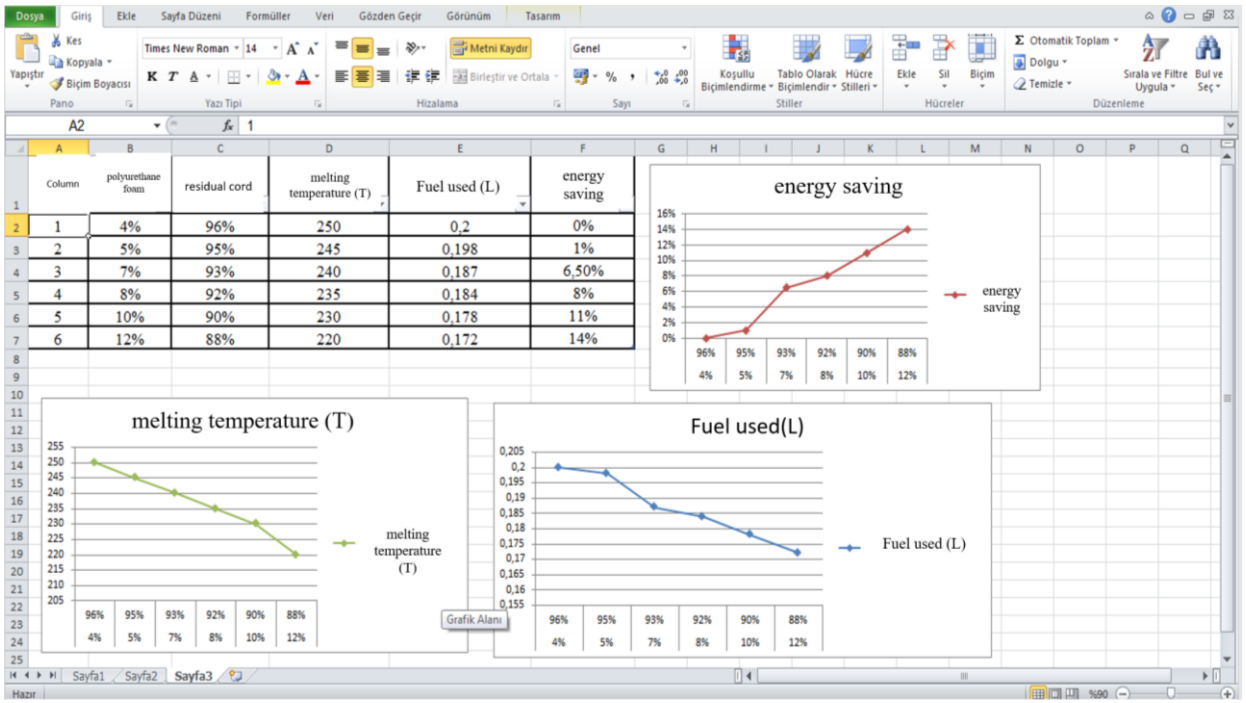


Figure 1. Graphs of energy savings, melting temperature and fuel used (when residual tar and polyurethane foam are mixed)



Column	polyurethane foam	residual cord	melting temperature (T)	Fuel used (L)	energy saving
1	4%	96%	250	0,2	0%
2	5%	95%	245	0,198	1%
3	7%	93%	240	0,187	6,50%
4	8%	92%	235	0,184	8%
5	10%	90%	230	0,178	11%
6	12%	88%	220	0,172	14%

Figure 2. Graphs of energy savings, melting temperature and fuel used (when residual tar and sulfur are mixed)

3.Conclusion

In the considered technological process, bitumen, which is the target product, transfers its energy to residual tar, which is a raw material. In a special software package, energy savings, melting temperature and fuel used are plotted against each other. Energy saving has been achieved by changing the properties of bitumen.

References

1.I.R.Efendiyev, I.A.Mustafayev, S.A.Musayev, T.M. Maharramova Development of algorithms for adaptation of mathematical models in management systems. Azerbaijan Airlines State Concern National Aviation Academy. Scientific Collections Vol.4. №2., pp.31-38, 2002.

2.M.A.Mammadov, Modern automatic control systems in oil refineries. Baku. Science, 268 p., 2013.

3.E.A.Melikov, T.M.Magherramova, A.I.Ibragimov, Synthesis of a fuzzy adaptive control system for the process of propylene glycol production. Proceedings of the 14th International Scientific Conference Mathematical methods in technology and technologies MMTT-14, Smolensk - 2001, vol.6, pp.111-113, 2001.

4.E.A.Malikov, T.M.Maharramova, Z.Q. Gurbanov, Management of modern chemical-technological systems. EKOENERGETIK scientific and technical magazine, No.4, pp.81-84, 2012.

5.T.M.Maharramova, E.A. Melikov, Energy saving system in vacuum unit. Ekoenergetics, №3, Baku, pp. 8-12, 2022.

6.A.A.Safarova, E.A.Melikov, T.M.Maharramova, Optimization in the form of a stochastic programming problem. Proceedings of the 8th International Conference on Control and Optimization with Industrial Applications, August 24-26, vol.1, pp.381-383, 2022.

7.M.S.Aliev, T.M.Maharramova, E.A.Melikov Changes in world energy consumption. Ecoenergetics, No.1, Baku, pp. 46-49, 2022.

8.R.G.Abaszade, A.G.Mammadov, V.O.Kotsyubynsky, E.Y.Gur, I.Y.Bayramov, E.A.Khanmamadova, O.A.Kapush, Photoconductivity of carbon nanotubes, International Journal on Technical and Physical Problems of Engineering, Vol.14, №3, pp.155-160, 2022. http://www.iotpe.com/IJTPE/IJTPE-2022/IJTPE-Issue52-Vol14-No3-Sep2022/21-IJTPE-Issue52-Vol14-No3-Sep2022-pp155-160.pdf

9.R.G.Abaszade, Synthesis and analysis of flakes graphene oxide, Journal of Optoelectronic and Biomedical Materials, Vol.14, №3, pp.107–114, 2022. https://doi.org/10.15251/JOBM.2022.143.107

10.O.A.Kapush, I.O.Mazarchuk, L.I.Trishchuk, V.Y.Morozovska, S.D.Boruk, S.I.Budzulyak, D.V.Korbutyak, B.N.Kulchitsky, O.G.Kosinov, R.G.Abaszade, Influence of the nature of the dispersion medium on the optical properties of CdTe

nanocrystals during sedimentation deposition, Chernivtsi University Scientific Herald. Chemistry (819), pp.7-11, 2019
https://doi.org/10.31861/chem-2019-819-01
11.O.A.Kapush, I.O.Mazarchuk, L.I.Trishchuk, V.Y.Morozovska, S.D.Boruk, S.I.Budzulyak, D.V.Korbutyak, B.N.Kulchitsky, O.G.Kosinov, R.G.Abaszade, Influence of the nature of the dispersion medium on the optical properties of CdTe nanocrystals during sedimentation deposition, Chernivtsi University Scientific Herald. Chemistry (819), pp.7-11, 2019
https://doi.org/10.31861/chem-2019-819-01
12.R.G.Abaszade, A.G.Mamedov, I.Y.Bayramov, E.A.Khanmamadova, V.O.Kotsyubynsky, O.A.Kapush, V.M.Boychuk, E.Y.Gur, Structural and electrical properties of sulfur-doped graphene oxide/graphite oxide composite, Physics and Chemistry of Solid State, Vol.23, №2, pp. 256-260, 2022.
DOI:10.15330/pcss.23.2.256-260
13.R.G.Abaszade, A.G.Mammadov, V.O.Kotsyubynsky, E.Y.Gur, I.Y.Bayramov, E.A.Khanmamadova, O.A.Kapush, Modeling of voltage-ampere characteristic structures on the basis of graphene oxide/sulfur compounds, International Journal on Technical and Physical Problems of Engineering, Vol.14, №2, pp.302-306, 2022.
http://www.iotpe.com/IJTPE/IJTPE-2022/IJTPE-Issue51-Vol14-No2-Jun2022/37-IJTPE-Issue51-Vol14-No2-Jun2022-pp302-306.pdf
14.R.G.Abaszade, S.A.Mamedova, F.H.Agayev, S.I.Budzulyak, O.A.Kapush, M.A.Mamedova, A.M.Nabiyev, V.O.Kotsyubynsky, Synthesis and Characterization of Graphene Oxide Flakes for Transparent Thin Films, Physics and Chemistry of Solid State, Vol.22, №.3, pp.595-601, 2021.
DOI: 10.15330/pcss.22.3.595-601
15.R.G.Abaszade, O.A.Kapush, A.M.Nabiyev, Properties of carbon nanotubes doped with gadolinium, Journal of Optoelectronic and Biomedical Materials, Vol.12, №3, pp.61–65, 2020.
https://www.chalcogen.ro/61_AbaszadeRG.pdf
16.R.G.Abaszade, O.A.Kapush, S.A.Mamedova, A.M.Nabiyev, S.Z.Melikova, S.I.Budzulyak, Gadolinium doping influence on the properties of carbon nanotubes, Physics and Chemistry of Solid State, Vol. 21, No. 3, pp. 404-408, 2020.
https://doi.org/10.15330/pcss.21.3.404-408
17.S.R.Figarova, E.M.Aliyev, R.G.Abaszade, R.I.Alekberov, V.R.Figarov, Negative Differential Resistance of Graphene Oxide/Sulphur Compound, Journal of Nano Research Submitted, Vol.67, pp.25-31, 2021.
http://dx.doi.org/10.4028/www.scientific.net/JNanoR.67.25
18.A.G.Mammadov, R.G.Abaszade, E.A.Khanmamedova, I.Y.Bayramov, H.D.M.Muzaffari, Optoelectronic information processing devices, Ecoenergetics, №3, pp.23-25, 2021.
http://ieeacademy.org/wp-content/uploads/2022/01/Ekoenergetic-journal-2021.-1.pdf

S.M.Askerzadeh, İ.A.Khudiyeva, M.N.Javadova, S.H.Eldarova,
O.B.Urban, N.E.Mammadov, F.N.Azizova, Ecoenergetics, №4, pp.43-47, 2022

Comparative analysis of the effect of different oxygen-containing additives obtained on the basis of C3-C4 gases on gasoline production

S.M.Askerzadeh, İ.A.Khudiyeva, M.N.Javadova, S.H.Eldarova,
O.B.Urban, N.E.Mammadov, F.N.Azizova

Y.H.Mamedaliyev İnstitute of Petrochemical Processes, Baku, Azerbaijan,
askerzade.saadet@gmail.com, ilhama.xudieva@gmail.com ,
mjavadova@gmail.com, sabina1983aziz@gmail.com,
urbano@live.ru, niyazi2002@gmail.com,
fidan_azizovah@hotmail.com

Abstract: In order to organize the production of gasoline in accordance with environmental requirements, the article compares a mixture of gasoline components produced on the technical basis of our country and various high-octane oxygenates (methanol, ethanol, MYUBE, DIPE), and analyzes the environmental and economic properties of the resulting gasoline

Keywords: Oxygenates, Alcohols, Ethers, Octane number.

1.Introduction

Car gasoline occupies a special place in the development of the oil refining industry of our country and in the formation of the budget. Their share in the enterprise's production is 40%, and their share in the formation of economic indicators of enterprises is 35-40% [1].

It is known that, the aggravation of environmental problems imposes strict requirements on the composition of oil refining products, including automobile gasoline, and their production technologies.

The use of oxygenates is necessary in order to reduce the environmental stress and improve the ecological properties of the produced gasoline. Among them, various alcohols (methanol, ethanol, IPA) and ethers produced on the basis of liquefied gases (MTBE, ETBE, DIPE) can be mentioned [2-4].

Recently, there has been no production of oxygenate in our country except DIPE, which is received as a by-product in the production of IPA.

In the conditions of limited investments, the improvement of the quality of gasoline creates the need to import oxygenates from outside. Various technical and economic studies have been conducted in order to determine the ecologically and economically efficient option from oxygenates used in oil refining.

2. Experimental details

The presented studies were conducted on the basis of gasoline produced on the basis of the current technical base of our country for oil refining. In order to determine the quantitative and qualitative indicators of that gasoline, calculations were made for the complex processing of oil, which ensures its production:

The mixture of Azerbaijani oils corresponding to the complex scheme presented in Fig. 1 enters the CDU/VDU unit after preliminary cleaning (dehydration, desalination, etc.) and is separated into fractions.

The obtained dry gas is sent to the fuel system of the plant, and liquid gas (C3-C4 fraction) is sent as a raw material to the petrochemical field. Primary processing gasoline, together with gasoline obtained from the hydrotreating process of diesel fuel, is fed to the re-expulsion unit of the CDU/VDU unit and separated into light (IBP-850C) and heavy (850C-EP) gasoline fractions.

The light gasoline fraction is directed to gasoline compounding, and the heavy gasoline fraction to the catalytic reforming unit. The kerosene fraction (140-2400C) is sent to the “Merikem” block, and then to the commodity park.

The diesel distillate (200-3500C) received at the CDU/VDU unit is processed in the hydrotreatment unit of the catalytic cracking complex together with gasoline and light phlegm of coking.

Vacuum gas oil is supplied as raw material to the catalytic cracking block of the catalytic cracking complex together with the heavy phlegm of coking.

Part of the goudron is directed to the bitumen production unit, and the rest to the delayed coking unit together with the heavy gas oil of the catalytic cracking.

The platformate produced in the catalytic reforming unit is used for gasoline compounding, the liquid gases are used in the petrochemical field, the balance

of hydrogen-containing gases is used in the hydrotreating of diesel fuel, and the rest is used as fuel. The liquid gases received in the catalytic cracking and delayed coking unit enter the gas fractionation block

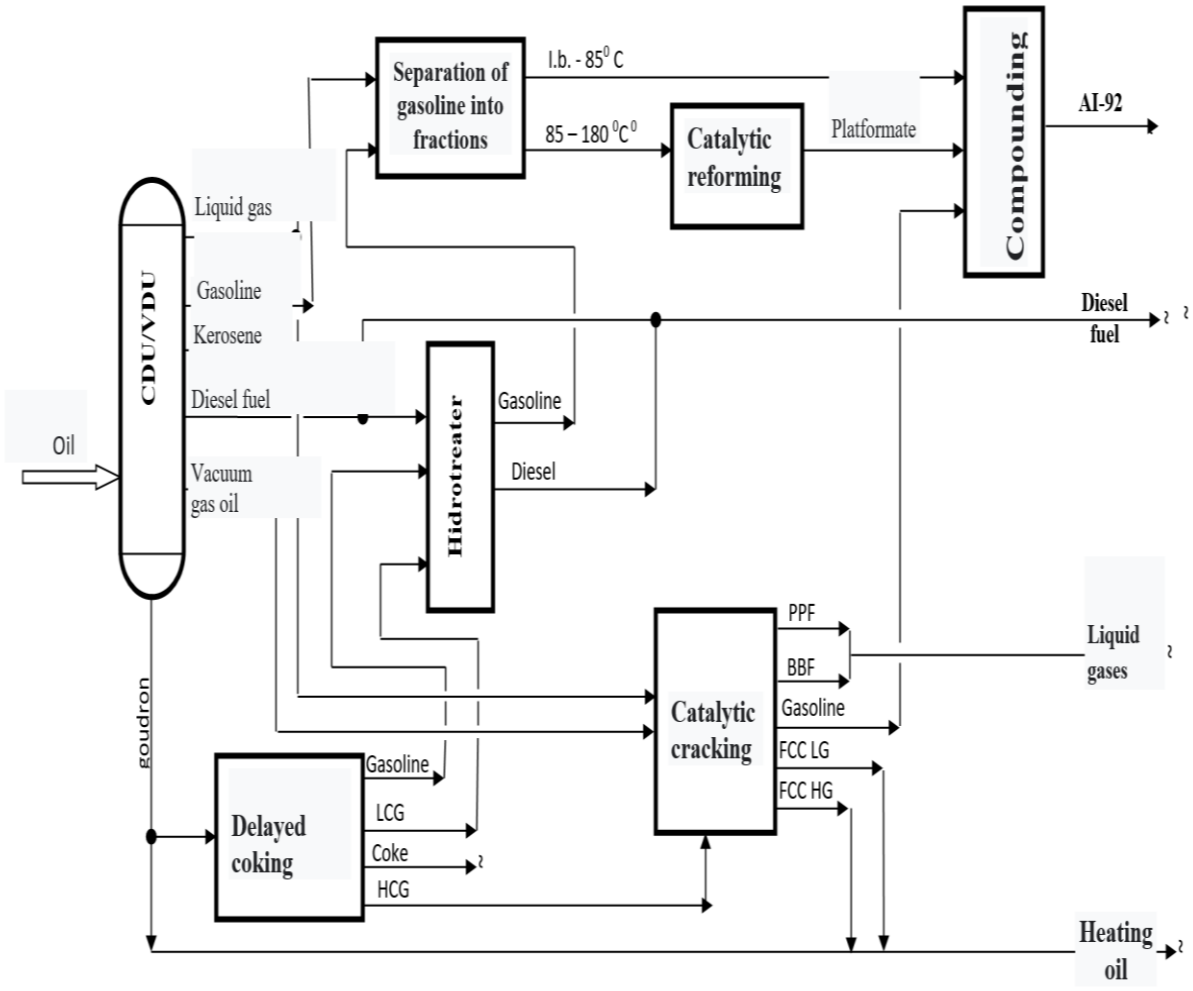


Figure 1. The scheme of the refinery operating in the fuel direction

of the catalytic cracking complex, where they are separated into propane-propylene and butane-butylene fractions and directed to the petrochemical field.

The total octane number of the gasoline stock produced according to the presented technological It is necessary to add oxygen-containing high-octane additives to gasoline to produce automobile gasoline that meets Euro-5 standards by increasing the amount of oxygen. For this, studies were conducted also on the use of oxygen-containing alcohols and ethers (including those produced in the country) in gasoline and their efficiency was analyzed.

For comparison, the amount of gasoline (1964920 t/year) and quality were taken as constant.

scheme is around to 84.13. Therefore, on its basis, production of 1408.3 K t/year AI-92, 556.6 K t/year AI-95 gasoline can be organized.

The quality of produced gasoline meets EURO-4, 5 international requirements for all indicators, except oxygen number.

As oxygenates, alcohols (methanol and ethanol), ethers (MTBE), which are widely used in world oil refining, and DIPE, which is a by-product in the production of isopropyl alcohol at Sumgait Petrochemical Complex, were taken. The technical and economic indicators of those components are given in table 1.

Table 1.The quality of oxygenates used in the production of motor fuels

Components	The amount of oxygen, % (mass)	Octane number
Methanol	50.0	105
MTBE	18.2	101
Ethanol	36.0	106
DIPE	16.0	99

As can be seen from the table, oxygenates differ sharply in terms of octane number, price, and oxygen share. As the molecular weight of alcohols increases, their "oxygen capacity" decreases from 50% to 36%. Therefore, among the alcohols, methanol is the most advantageous for oxygen, because its use requires both low cost and low resources to make the oxygen content of the total gasoline stock 2.7%.

However, since methanol is a toxic substance, it can create an environmental hazard during operation, so its use as an additive to gasoline is limited [5].

Ethers have better mixing and burning characteristics than alcohols. The main advantage of ethers compared to alcohols is low vapor pressure. The high pressure of alcohols in the mixture is due to the fact that they form low-temperature boiling azeotropic mixtures with some hydrocarbons of gasoline. Ethers form much less azeotropes, and those formed do not increase the vapor pressure, but rather decrease it [5].

Gasoline produced on the basis of the existing technical base and taken as the basis does not contain oxygenates.

Among the oxygenates (alcohols and ethers) used in world practice, both their technological properties (share of oxygen) and their price were analyzed in order to choose the most efficient one. It was determined that the amount of oxygenates (alcohols and ethers) changes sharply, required to ensure the amount of oxygen around 2.7% in the total gasoline stock corresponding to the prospective requirements (table 2). As can be seen from the table below, the required volume of different oxygenates varies from 106.1 to 338.2 thousand tons, depending on the content of oxygen.

In the comparison of oxygenates, both their ecological and economic indicators were taken into account (table 3). For this reason, a mixture of the same base gasoline and different oxygenates was prepared and the octane number, oxygen number and cost of the obtained gasolines were determined.

Table 2.Amount of various oxygenates added to produced gasolines

Name	I	II	III	IV
Gasoline components	1964920	1964920	1964920	1964920
Oxygenates:				
Methanol	112162	–	–	–
MTBE	–	342276	–	–
Ethanol	–	–	165274	–
DIPE	–	–	–	408099
Total gasolines	2077082	2307196	2130194	2373019

Table 3.Technical and economic evaluation of gasoline compositions

Indicators	**Gasoline**	**Gasoline compositions:**			
		Methanol + Gasoline	**MTBE + Gasoline**	**Ethanol + Gasoline**	**DIPE + Gasoline**
Octane number	84.13	85.3	86.6	85.8	86.7
Oxygen number	-	2.7	2.7	2.7	2.7
Share of oxygenates in the mixture, in %	-	~5.4	~14.8	~7.8	~17.2
Cost , AZN/t	185.38	186.17	342.73	250.14	429.18

The price of the oxygenates taken during the calculations was determined based on the information obtained from the websites, taking into account the relevant dollar/manat exchange rate (since the delivery costs can be specified on the basis of the contract in most cases, the prices are included in the account, as on the website, without taking into account the delivery costs) [6,7,8].

The analysis of the conducted studies shows that gasoline compositions with the use of methanol have the lowest cost (~186.13 man./t). Considering the technological and environmental properties of methanol, the preference of MTBE and ethanol can be shown. To increase the amount of oxygen in the total gasoline stock to ~2.7%, 342.3 thousand t/year of MTBE, or 165.3 thousand t of ethanol is required (table 2).

By comparing the amounts required for the purchase of that amount of MTBE and ethanol, ethanol is preferred from an economic point of view. According to that account, the purchase of MTBE and ethanol in the specified amount respectively costs 426,475.9 and 168,579.5 thousand manats.

3. Conclusion

The addition of MTBE and ethanol to gasoline creates a basis for improving the quality of gasoline and increasing the share of high-quality and high-priced AI-95 gasoline in the general gasoline fund. At this time, a ~10-15% increase in the volume of commodity products is observed. Thus, the use of oxygenates exhibits both environmental and economic advantages.

The choice of indicated oxygenates depends on the requirements of a specific enterprise. At this time, based on local raw materials, production, price, export potential, etc. selection was made in the presented studies depending on the indicators. Taking into account the raw material potential and technological capabilities of our country, in the presented article preference is given to oxygenates (MTBE and DIPE) produced on the basis of available gases (C_3-C_4).

It is known that the production of isopropyl alcohol operates within the Petrochemical Complex of our country. A cubic residue containing 80% diisopropyl ether is obtained in the unit together with isopropyl alcohol of high purity (99.99%). High-octane isopropyl alcohol (98 p. motor method) and diisopropyl ether (98 p. motor method) can be added to gasoline in the amount of 10-15% according to EN 228 European standards.

As a result of the researches, it was determined that (table 3) the addition of oxygenates (10-15%) produced in our country to base gasoline components (catalytic cracking, catalytic reforming gasolines, fraction of primary processing gasoline (IBP-85°C), etc.) produced in our country (H. Aliyev Refinery) will create the basis for the production of AI-92 and AI-95 brand gasoline according to prospective requirements.

Technologies for the production of oxygenates are mainly related to the processing of liquefied gases and are limited to the production volume of C_3-C_4 gases. Profits from the sale of environmentally safe high-octane gasoline received as a result of the actions presented in the domestic and foreign markets can be

directed to the implementation of wider and more complex technologies and projects.

References

1.Energy of Azerbaijan (Statistical compilation), Baku, Az. State Statistics
2.Committee of the Republic of Azerbaijan, small enterprise №. 9, 161 p., 2013.
3.https://www.stat.gov.az/source/balance_fuel/
4.B.Kh.Borzaev, S.A.Karpov, V.M.Kapustin, "Multifunctional additives to automobile gasolines", Chemistry and technology of fuels and oils, №2, pp.18-20, 2007.
5.https://link.springer.com/article/10.1007/s10
6.S.N.Onoichenko, "The use of oxygenates in the production of perspective automotive gasolines", M.:Tekhnika, TUMA GROUP LLC, 64 p., 2003.
7.https://www.nitu.ru/texnika/book21.htm
8.A.V.Tsarev, "Improving the environmental and performance characteristics of motor gasoline by introducing oxygenates", Chemical technology (organ of the Scientific Council of the Russian Academy of Sciences on the scientific basis of chemical technology) // 2007. №7, pp. 324-328.
9.V.M.Abbasov, H.C.Ibrahimov, S.R.Hajiyeva et al., "Chemistry and technology of oil and gas processing processes" Baku: Elm, 408 p., 2014.
https://russian.alibaba.com/product-
10.https://russian.alibaba.com/product-detail/price-ethyl-alcohol-60268492059.html?spm=a2700.8699010.normalList.74.994033de3Qpke3
11.https://www.alibaba.com/trade/search?fsb=y&IndexArea=product_en&CatId=&SearchText=methyl+tert-butyl+ether&viewtype

Volts-ampere characteristics of carbon nanotubes doped 10 percent gadolinium

R.G.Abaszade

Azerbaijan State Oil and Industry University, Baku, Azerbaijan,
abaszada@gmail.com

Abstract: The presented article is devoted to the volt-ampere characteristic of carbon nanotube doped with 10 percent gadolinium. Thus, the volt-ampere characteristic of the carbon nanotube shaped into a rectangular parallelepiped was determined and the opposite differential effect was observed at certain voltage values. The observed effect is additive is more intense in carbon nanotubes, which is because of doping.

Keywords: Carbon nanotube, Volt-ampere characteristic.

1.Introduction

The rapid development of science and technology has increased the urgency of enriching nanoelectronic devices with new modifications [1-10]. This, in turn, began to be observed with revolutionary innovations in the field of device manufacturing. For the first time in 1991, the Japanese scientist S. Iijima bought carbon nanotubes, and it was determined that they have important properties [11].

As is known, the study of volt-ampere characteristics of nanostructures is of great importance both experimentally and theoretically. So, as a result of these studies, the generation of cargo carriers, assists in obtaining the necessary information for the study of recombination and transfer events. In addition, it is possible to achieve new achievements in the direction of device manufacturing by studying the volt-ampere characteristic. During the investigation of the theoretical and experimental electrical and magnetic properties of carbon nanotubes, relevant effects related to the quantum nature of charge carriers were observed. The results of the conductivity spectrum and VAX analysis show that carbon nanotubes exhibit ballistic conductivity, tunnel and stepwise (jump) conductivity [11-18]. Currently, it is possible to create new types of transistors based on carbon nanotubes [18].

The purpose of the presented article is to study the volt-ampere characteristics of carbon nanotubes made in the form of a rectangular parallelepiped compressed under a pressure of 25 MPa.

2. Experimental details

Pure carbon nanotubes and carbon nanotubes doped with 10 percent gadolinium were filled into a rectangular parallelepiped cavity with a length of 12 mm, a width of 4 mm, and a depth of 4 mm and kept under a compressive pressure of 25 MPa for 10 minutes. Contacts placed parallel to each other were placed on the sample, taking into account that the resistances were R=0.3kOm and R=0.4kOm, the volt-ampere characteristics were determined and graphs were obtained in the following figure.

3. Conclusion

It can be seen from Figure 1 that the current strength is linear up to the voltage value of 1.3V. U=1.3 when there is a quadratic increase in voltage with increasing current intensity. This increase results in a maximum at U=1.5, and starts to increase linearly again at 1.6V. This process is stressful 1.65÷1.7V; 1.8÷1.9V; 1.95÷2.05V; 2.05V÷2.1V; 2.2V÷2.3V; 3.1V÷3.24V; 3.9V÷4.07V; Occurs at values of 4.12V÷4.3V. It can be seen from Figure 2 that the current strength is linear up to the voltage value of 0.23V. When U=0.23V, the voltage is 1.85÷2.07V with increasing current; 2.3V÷2.4V; 4.1V÷4.3V with a gradual increase in the values of 3.05V÷4.3V; At the values of 4.85V÷5.01V, peaks are observed. The fact that the voltage undergoes such changes with the increase of the current intensity can be explained by the occurrence of the opposite differential effect, which in turn is considered to be one of the most important features from the point of view of the application of low-dimensional systems. This is due to the change in the diameter of the nanotube and the appearance of the tunnel current. The results of the comparative analysis of the volt-ampere characteristics of the carbon nanotube and the carbon nanotube doped with gadolinium allow us to say that the opposite

differential effect is more observed due to the addition. This, in turn, makes their use as smart materials in the creation of devices for modern electronics even more relevant. This increase results in a maximum at the value of U=0.47, and starts to increase linearly again at 0.47V. This process voltage is 0.68÷0.8V; 1.1÷1.22V; 1.85÷2.07V; 2.3V÷2.4V; 4.1V÷4.3V with a gradual increase in the values of 3.05V÷4.3V; At the values of 4.85V÷5.01V, peaks are observed. The fact that the voltage undergoes such changes with the increase of the current intensity can be explained by the occurrence of the opposite differential effect, which in turn is considered to be one of the most important features from the point of view of the application of low-dimensional systems. This is due to the change in the diameter of the nanotube and the appearance of the tunnel current. The results of the comparative analysis of the volt-ampere characteristics of the carbon nanotube and the carbon nanotube doped with gadolinium allow us to say that the opposite differential effect is more observed due to the addition. This, in turn, in the creation of devices for modern electronics makes its use as smart materials even more relevant.

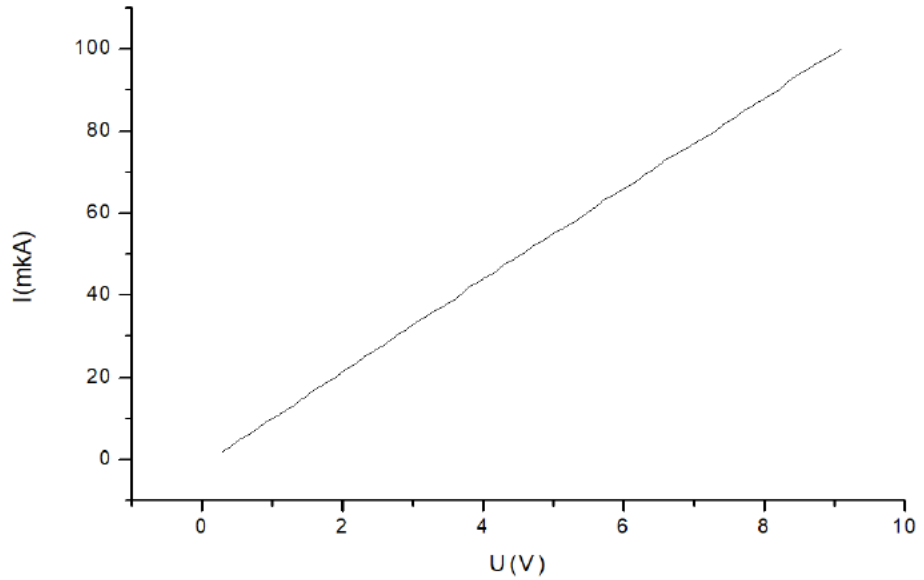


Figure 1. VAX of carbon nanotube obtained by electric arc method and compressed under 25 MPa pressure.

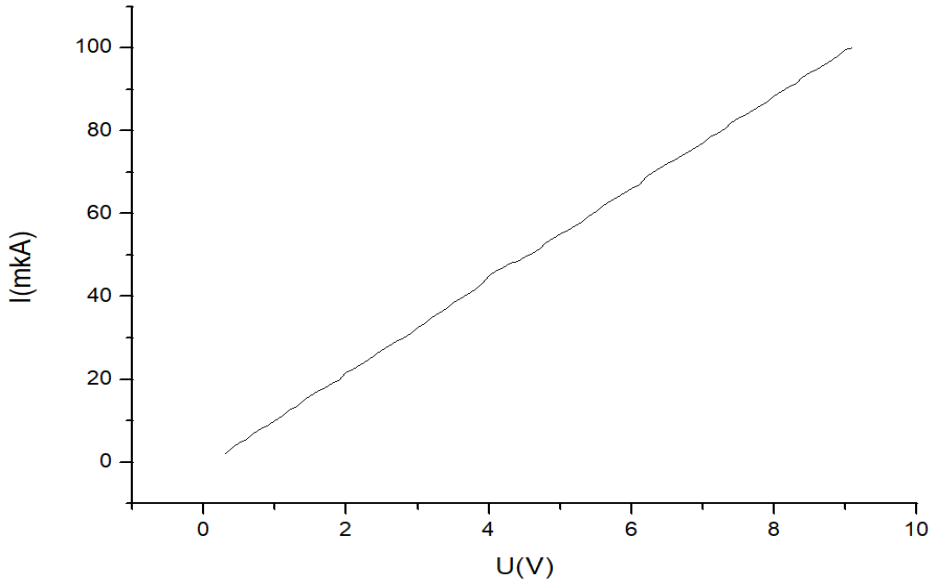


Figure 2. VAX of carbon nanotube doped with 10% gadolinium and compressed under 25MPa pressure.

References

1.S.R.Figarova, E.M.Aliyev, R.G.Abaszade, R.I. Alekberov, V.R. Figarov, Negative Differential Resistance of Graphene Oxide/Sulfur Compound, Journal of Nano Research Submitted, Vol.67, pp.25-31, 2021.
http://dx.doi.org/10.4028/www.scientific.net/JNanoR.67.25

2.R.G.Abaszade, O.A.Kapush, S.A.Mamedova, A.M.Nabiyev, S.Z.Melikova, S.I.Budzulyak, Gadolinium doping influence on the properties of carbon nanotubes, Physics and Chemistry of Solid State, Vol.21, №.3, pp.404-408, 2020.
https://doi.org/10.15330/pcss.21.3.404-408

3.R.G.Abaszade, O.A.Kapush, A.M.Nabiyev, Properties of carbon nanotubes doped with gadolinium, Journal of Optoelectronic and Biomedical Materials, Vol.12, №.3, pp.61–65, 2020.
https://www.chalcogen.ro/61_AbaszadeRG.pdf

4.R.G.Abaszade, S.A.Mamedova, F.H.Agayev, S.I.Budzulyak, O.A.Kapush, M.A.Mamedova, A.M.Nabiyev, V.O.Kotsyubynsky, Synthesis and Characterization of Graphene Oxide Flakes for Transparent Thin Films, Physics and Chemistry of Solid State, Vol.22, №.3, pp.595-601,2021.
https://doi.org/10.15330/pcss.22.3.595-601

5.R.G.Abaszade, A.G.Mammadov, V.O.Kotsyubynsky, E.Y.Gur, I.Y.Bayramov, E.A.Khanmamadova, O.A.Kapush, Modeling of voltage-ampere characteristic structures on the basis of graphene oxide/sulfur compounds, International Journal on Technical and Physical Problems of Engineering, Vol.14, №.2, pp.302-306, 2022.
http://www.iotpe.com/IJTPE/IJTPE-2022/IJTPE-Issue51-Vol14-No2-Jun2022/37-IJTPE-Issue51-Vol14-No2-Jun2022-pp302-306.pdf

6.R.G.Abaszade, A.G.Mamedov, I.Y.Bayramov, E.A.Khanmamadova, V.O.Kotsyubynsky, O.A.Kapush, V.M.Boychuk, E.Y.Gur, Structural and electrical properties of sulfur-doped graphene oxide/graphite oxide composite, Physics and Chemistry of Solid State, Vol.23, №.2, pp. 256-260, 2022.
https://doi.org/10.15330/pcss.23.2.256-260

7.R.G.Abaszade, R.Y.Safarov, Growth of graphene and applications of graphene oxide, Ecoenecgetics, №2, pp.9-15, 2022.
http://ieeacademy.org/wp-content/uploads/2022/06/Ecoenergetics-N2-2022-papers.pdf#page=10

8.R.G.Abaszade, Analysis of carbon nanotube doped with five percent gadolinium, III International scientific and theoretical conference, Theory and practice of modern science, April 1, Kraków, Poland, pp.82-83, 2022.
https://previous.scientia.report/index.php/archive/article/view/21

9.R.G.Abaszade, Synthesis and analysis of flakes graphene oxide, Journal of Optoelectronic and Biomedical Materials, Vol.14, №.3, pp.107–114, 2022
DOİ:10.1525/JOBM.2022.143.107

10.R.G.Abaszade, Photoconductivity of carbon nanotube obtained by arc discharge method, International scientific journal Grail of Science, №17, pp.248-250, 2022.
https://archive.journal-grail.science/index.php/2710-3056/article/view/446/451

11.S.Iijima, Synthesis of Carbon Nanotubes, Nature, 354, 1991, pp.56-58.

12.Poncharal Ph. J. Berger, Yi Yan, Z.L. Wang, W.A. de Heer. J. Physical Chemistry, Vol.106. pp. 121004–121029, 2002.

13.J.Karamdel, M.T.Ahmadi, M.Damghanian, B.Y. Majlis, C.F.Dee, R.Ismail. Materials Research Innovations, vol.13 (3), pp.211–213, 2009.

14.Y.Chiu, V.V.Deshpande, H.W.Ch. Do not post. Phys. Rev. Letters, Vol.95, pp.226101–226104, 2005.

15.A.A.Zakharchenko, B.K.Petrov, S.I.Kurgansky, A.F.Klinskikh. Vestnik VGU, №.1, pp.29–34, 2008.

16.M.A.Grujicic, G.Gao, W.Roy. Journ. Of Materials Science, Vol.39, pp.4441–4449, 2004.

17.S.V.Bulyarsky, Yu.V.Rud, L.N.Vostretsova, A.S.Kagarmanov, O.A.Trifonov. FTP, 2009, Vol. 43, №4, pp.460–466, 2009.

18.A.Srivastava, J.M.Marulanda, Y.Xu, A.K.Sharma, Carbon-Based Electronics, Transis-tors and Interconnects at the Nanoscale, Taylor & Francis Group LLC, 140 p., 2014.

The role of solar panels in energy production

R.A.Namazov, X.M.Popal

Azerbaijan State Oil and Industry University, Baku, Azerbaijan,
resadnamazov852@gmail.com,
popal.xp@gmail.com

Abstract: The article provides information about solar panels and energy systems. Static and dynamic data were collected and analyzed here. General information about renewable energy systems has been collected and the work done has been analyzed. The work done and the direction of this system in the past and in the future are indicated.

Keywords: General information about solar panels, Energy systems, Working principle of renewable energy systems, Reduction of unused energy sources.

1.Introduction

Among the ALTERNATIVE energy sources that can be used in Industrial Energy Systems, solar energy can offer practical, functional and economical solutions. The choice of renewable energy technology, which can be used in industrial and laboratory production processes, mainly depends on the type of energy, renewable energy source and potential, and physical/technical infrastructure capabilities. The total energy stored in the world's coal, oil and natural gas reserves is equal to the energy of 30 days of sunlight. The sun is used to produce light, heat and energy in agricultural fields. Solar energy; Electric fences lighting, drip irrigation and their automation devices can be a suitable alternative energy source for its operation. With an average of 2,609 hours of sunshine per year, Azerbaijan is a country that spends about 30% of the year in sunlight. Solar energy is an environmentally friendly source of energy that comes from the sun and has no operating costs. In our world, which is already exposed to the sun's rays all day, compared to the energy obtained from fossil fuels no pollution and no wastage. Solar energy plays an important role in agriculture and animal husbandry, as well as in industry. Irrigation is one of the most efficient areas where solar energy is used, and considering that wells and other water resources are located in rural areas far from urban centers, the demand in this area is increasing day by day due to the high cost of electricity. The most important advantage of solar water pumping systems is their ease of use and longevity. Solar energy panels collect direct sunlight and use these rays to produce heat or electricity. The source of this energy is fusion reactions that occur during the conversion of hydrogen into helium on the surface of the Sun. The intensity of solar energy outside the Earth's atmosphere is approximately constant at 1370 W/m², but varies between 0 and 1100 W/m² on Earth. The greatest characteristic of the energy reaching the Earth from the Sun is that it is boundless. Solar energy is evaluated in the form of light, heat and electricity. Photovoltaic (PV) systems convert solar energy directly into electricity and can be installed on building roofs, appliances, and even cars. Solar thermal collectors, which are widely used in our country, are used for heating water. Solar energy is an important energy alternative in countries that receive a lot of sun, such as Azerbaijan. This technology is especially useful for off-grid electricity generation in rural areas. The biggest drawback of this technology is that it cannot be produced at night. Due to the fact that the Earth's energy reserves will be exhausted in a short time, fuel prices are increasing day by day. In 2025, it is estimated that the price of a barrel of fuel oil will be around 60 dollars. Solar panels are the only inexhaustible source of energy that does not produce smoke, carbon monoxide and radiation. It also provides alternative system solutions for various types of applications with low operating costs. Because solar energy does not depend on foreign countries, economic and political crises do not affect solar energy. In a

country like Azerbaijan, where the total solar radiation is approximately 15-16 Mjtm2 days, convenient solar panels will be an important factor for the development of our countries [1-16].

2.Experimental details

Basically, a solar panel uses photons to separate electrons from atoms. The process of removing electrons from atoms also creates electricity. Solar panels contain photovoltaic cells made of silicon that convert sunlight into electricity instead of heat. In these solar cells located on the panels, a direct current is generated due to the sun's rays. The amount of energy received is measured according to the location or the season of use, and a series or parallel mechanism is established and connected to homes or workplaces.

A photovoltaic system is a system that uses solar energy and converts it into energy. A photovoltaic system is created by combining many procedures and absorbs sunlight with solar panels, then converts it into electricity. A solar inverter converts electricity from direct current to alternating current. After that, the connection, wiring and installation of other electrical devices form a

working system. At the same time, this system increases its overall performance with a solar tracking system, and can also include a built-in battery solution. Photovoltaic module is shown below (picture 1.).

Figure 1. Photovoltaic module

Photovoltaic cells convert light directly into electricity and then cool it.

Photovoltaic elements are small-range systems of several kW installed on objects or consists of power plants. Today, many photovoltaic systems are connected to the grid.

Solar panels use photons to separate electrons from atoms. This process also creates electricity. Solar panels contain photovoltaic cells made of silicon that convert sunlight into electricity instead of heat. This is how we can flow solar panels to generate

electricity. First, the solar panels absorb the heat, then the photovoltaic

cells receive the light (photons) and convert the light into electricity. When the heat hits the solar panel, the PV cells start working and generate direct current electricity.

We can divide solar panels into 2 parts:

Polycrystalline solar panels and monocrystalline solar panels

Polycrystals are cheaper than single crystals because they do not require a crucible drawing process. Here, raw silicon is melted and converted into square cells. Monocrystalline solar panels are high It is made of high-grade silicone. Although it is a little expensive, it is widely used due to its useful work coefficient. It is used in stations and high-tech facilities, because it is high-quality and efficient, and at the same time long-lasting.It was mentioned above that solar cells differ from each other in

terms of efficiency. Solar cell efficiency it is denoted by (η).

$$\eta = \frac{P_{max}}{I \times A_c}$$

Pmax, maximum power; I, Shows light irradiation on cell

If more graphene is processed, solar panels are made from other elements. Table 1 shows the characteristics of the elements.

Parameters	InAs	GaAs	$In_xGa_{1-x}As$
b (eV)	-1.8^c	-1.7^c	$-1.7-0.1x$
a_c(eV)	-5.08^a	-7.17^a	$-7.17+2.09x$
a_v(eV)	1.0^c	1.16^c	$1.16-0.16x$
m_e^r/m_0	0.04^b	0.067^b	$0.067-0.027x$
m_{hh}^r/m_0	0.035^a	0.112^a	$0.112-0.077x$
m_e^z/m_0	0.341^b	0.377^b	$0.377-0.036x$
E_g(eV)	0.419	1.519	$1.519-1.102x$

Table 1. Materials used in solar panels

3.Conclusion

Synthesis and Characterization of Graphene Oxide Flakes for The synthesis process of Graphene oxide is shown in the article entitled Transparent Thin Films. Here, thin
graphene oxide flakes were synthesized by the Hummer method.
Their suitability for the production of transparent nanocomposites was investigated.
Graphene oxide flakes were then thoroughly X-rayed and characterized by Scanning Electron Microscopy (SEM), Energy Dispersive X-ray analysis (EDX), Raman spectroscopy and Differential Scanning Calorimetry (DSC). Graphene oxide is widely used in manufacturing processes due to its high solubility properties, large scale and transparency. They can be very useful in solar panels, biomedical applications and electromagnetic interference (EMI) environmental protection. As a result, it uses dispersed graphite as a carbon source, modified by the Hummer method. synthesized large-scale, transparent, thin graphene oxide flakes.Concentrated thermal energy uses different types of mirrors to focus the sun's rays. These rays heat the liquid and then drive the turbine. As a result, it creates steam to produce electricity. Concentrated thermal energy is used to produce electricity in power plants designed with special technology. By early 2019, the global installed capacity of combined heat and power was approaching 8 GW, a five-fold increase between 2010 and 2019.

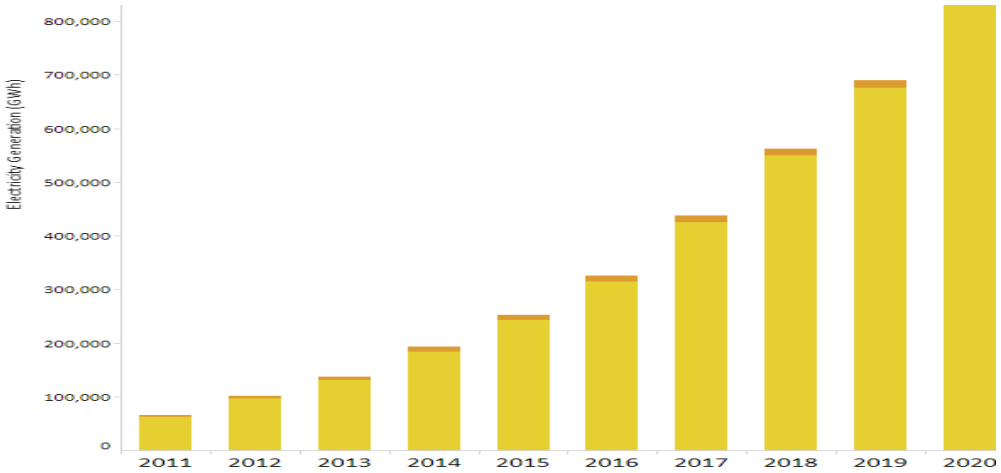


Figure 2.Electricity generation in renewable system.

The article provides information on renewable energy systems. Today and experience shows that the most used energy source for our future is the solar energy source. Solar cells differ in their efficiency and electrical conductivity. Studies show that solar panels made of graphene oxide are more affordable. Energy sources should not be a problem for countries to move forward economically. Oil, gas and other environmentally damaging non-renewable energy sources will eventually run out. In countries where the sun shines a lot, especially in Azerbaijan, the issue that needs to be focused on the most is that
solar panels should be worked on a lot. Solar panels should be controlled with remote control programs for easier use as an energy source in
agriculture, industries, and laboratory conditions. This will be discussed in our future research work and articles.

Reference

1.R.G.Abaszade, S.A.Mamedova, F.G.Agayev, S.I.Budzulyak, O.A.Kapush, M.A.Mamedova, A.M.Nabiyev, V.O.Kotsyubynsky, Synthesis and characterization of graphene oxide flakes for transparent thin films, Physics and Chemistry of Solid State, Vol.22, №3, pp.595-601, 2021. https://scholar.google.ru/citations?view_op=view_citation&hl=ru&user=rCtORvkAAAAJ&citation_for_view=rCtORvkAAAAJ:k_IJM867U9cC

2.R.G.Abaszade, O.A.Kapush, A.M.Nabiyev, Properties of carbon nanotubes doped with gadolinium, Journal of Optoelectronic and Biomedical Materials Vol.12, №3, pp.61-65, 2020. http://lib.pnu.edu.ua:8080/handle/123456789/ 3. R.G. Abaszade, O.A.

3.S.A.Kapush, A.M.Mamedova, S.Z.Nabiyev, S.I.Melikova, S.I.Budzulyak, Gadolinium doping influence on the properties of carbon nanotubes, Physics and Chemistry of Solid State, Vol.21, №3, pp.404-408, 2020.
https://scholar.google.ru/citations?view_op=view_citation&hl=ru&user=rCtORvkAAAAJ&citation_for_view=rCtORvkAAAAJ:qUcmZB5y_30 C

4.S.W.Glunz, R.Preu, D.Biro, Crystalline silicon solar cell: State of the art and future developments, in Comprehensive Renewable Energy, Vol.1, pp.353-387, 2012.
https://doi.org/10.1016/B978-0-08-087872-0.00117-7

5.W.Ch. Y.A.Oh, Modeling dyesensitized solar cell with grapheme based on nanocomposites
in the Brilliouni zone and density functional theory, Journal of the Korean Ceramic Society, Vol.58, pp.50–61, 2021.
https://link.springer.com/journal/43207/volumesand-issues/58-1

6.J.Szlufcik, S.Sivoththaman, J.F.Nijs, R.P.Mertens, R.V.Overstraeten, in McEvoy's Handbook of Photovoltaics (Third Edition), pp.129-158, 2018.
https://www.sciencedirect.com/topics/engineering/contact-solar-cell

7.S.W.Glunz, R.Preu, D.Biro, Crystalline Silicon Solar Cell: State-of-the-Art and Future Developments, in book: Comprehensive Renewable Energy, vol.1, preprint of chapter 1.16, 2012. https://doi.org/10.1016/C2009-0-19749-0

8.S.J.Fonash, in Solar Cell Device Physics (Second Edition), 354p., 2010.
http://www.fulviofrisone.com/attachments/article/403/solar%20cell%20device%20physics.pdffStephan

9.J.S.Kumari, Ch.S.Babu, Mathematical Modeling and Simulation of Photovoltaic Cell using Matlab-Simulink Environment, International Journal of Electrical and Computer Engineering (IJECE) Vol.2, №1, pp.26-34, 2012.
http://www.ijece.iaescore.com/index.php/IJECE/article/viev./5368

10.R.G.Abaszade, A.G.Mammadov,
V.O.Kotsyubynsky, E.Y.Gur, I.Y.Bayramov,
E.A.Khanmamadova, O.A.Kapush,
Photoconductivity of carbon nanotubes,
International Journal on Technical and Physical Problems of Engineering, Vol.14, №3, pp.155-160, 2022.
http://www.iotpe.com/IJTPE/IJTPE-2022/IJTPE-Issue52-Vol14-No3-Sep2022/21-IJTPE-Issue52-Vol14-No3-Sep2022-pp155-160.pdf

11.R.G.Abaszade, Synthesis and analysis of flakes graphene oxide, Journal of Optoelectronic and Biomedical Materials, Vol.14, №3, pp.107–114, 2022
https://doi.org/10.15251/JOBM.2022.143.107

12.S.R.Figarova, E.M.Aliyev, R.G.Abaszade, R.I.Alekberov, V.R.Figarov, Negative Differential Resistance of Graphene Oxide/Sulphur Compound, Journal of Nano Research Submitted, Vol.67, pp.25-31, 2021.
http://dx.doi.org/10.4028/www.scientific.net/JNanoR.67.25

13.R.G.Abaszade, Analysis of carbon nanotube doped with five percent gadolinium, III

International scientific and theoritical conference, Theory and practice of modern science, April 1, Kraków, Poland, pp.82-83, 2022.
https://previous.scientia.report/index.php/archive/article/view/21

14.R.G.Abaszade, A.G.Mammadov, V.O.Kotsyubynsky, E.Y.Gur, I.Y.Bayramov, E.A.Khanmamadova, O.A.Kapush, Modeling of voltage-ampere characteristic structures on the basis of graphene oxide/sulfur compounds, International Journal on Technical and Physical Problems of Engineering, Vol.14, №2, pp.302-306, 2022.
http://www.iotpe.com/IJTPE/IJTPE-2022/IJTPE-Issue51-Vol14-No2-Jun2022/37-IJTPE-Issue51-Vol14-No2-Jun2022-pp302-306.pdf

15.Kh.M.Popal, R.G.Abaszade, Research and modeling of hybrid energy systems (review), Ecoenergetics, №1, pp.65-69, 2022.
http://ieeacademy.org/wp-content/uploads/2022/05/ECOENERGETS-JOURNAL-No1.-2022.pdf#page=66

16.R.G.Abaszade, A.G.Mamedov, I.Y.Bayramov, E.A.Khanmamadova, V.O.Kotsyubynsky, O.A.Kapush, V.M.Boychuk, E.Y.Gur, Structural and electrical properties of sulfur-doped graphene oxide/graphite oxide composite, Physics and Chemistry of Solid State, Vol.23, №2, pp. 256-260, 2022.
DOI:10.15330/pcss.23.2.256-260

Influence of porosity on mechanical and tribotechnical characteristics of composite materials of copper-graphite type

A.V.Sharifova

Azerbaijan State University of Oil and Industry, Baku, Azerbaijan,
aynur.sh84@mail.ru

Abstract: The article considers the effect of porosity on the mechanical and tribological properties of copper-graphite and copper + copper-graphite powder composite materials used in friction units. It has been established that the Cu-C and Cu+ (Cu-C) materials obtained after sintering have the optimum value of hardness and impact strength at a porosity of 18%. The highest value of tribotechnical properties was obtained for the Cu+(Cu-C) material.

Keywords: Friction unit, Antifriction materials, Copper-graphite, Cold pressing, Sintering, Porosity, Physical and mechanical properties, Tribological properties.

1.Introduction

The relevance of the work. The first of the main operations of powder metallurgy is the production of powders. Known methods produce various powders with different properties. This makes it possible to manufacture parts from materials of various purposes and properties using powder metallurgy methods. In the production of products using new technology with the use of powders, its quality, economic efficiency and other high indicators. In this regard, there is a need for the production of copper-graphite powder, which has high tribotechnical and electrical properties, thermal conductivity, and arc-extinguishing properties. It is known that an increase in the amount of graphite in a copper-graphite composition leads to a sharp decrease in the mechanical properties of the resulting material [1]. Therefore, it becomes necessary to increase the amount of graphite in the composition without deteriorating the mechanical properties.

It should be noted that copper-based antifriction materials are widely used in friction units both in mechanical engineering and in electrical engineering, and the most interesting parameter that ensures their reliability is porosity. The study of the influence of porosity on mechanical and tribological characteristics makes it possible to estimate the limits of impact strength and hardness (according to Brinell) of copper and copper-graphite materials used in the work.

Purpose of the study. Influence of porosity on mechanical and tribological properties of copper-graphite and copper+copper-graphite powder composite materials used in friction units.

Methodical base of experimental works. In the course of the study, powders of the S11000 brand from copper smelting were used. Sedimentation analysis was used to determine the particle size distribution of S11000 copper powder. The basic principle of the sedimentation method is to determine the rate of settling of a particle of the dispersed phase, which depends on any viscous medium (liquid or gas). The theoretical substantiation and expression of this principle obeys the Stokes law.

Sedimentation analysis was performed on a Mastersizer-2000 instrument. Based on the results of the analysis, the average size for copper powders was calculated and determined to be 36 μm (α_{mav} = 36 μm) (Fig. 1, Table 1).

The other component, Cu-C, was obtained by electrochemical copper plating of graphite obtained from the carbon electrode (EG) used in the study. The copper plating process was carried out separately for different fractions of graphite powder.

For electrochemical copper plating of graphite, a special electrolysis plant-electrolyzer with a movable filling cathode was used, which ensures the economic efficiency of copper [2, 3].

Elemental analysis was carried out to determine the amount of copper in copper-graphite melts obtained by electrochemical methods. For elemental analysis, an MGA-915 atomic absorption device was used. The principle of operation of an atomic absorption device is based on the absorption of free atoms of elements by light energy.

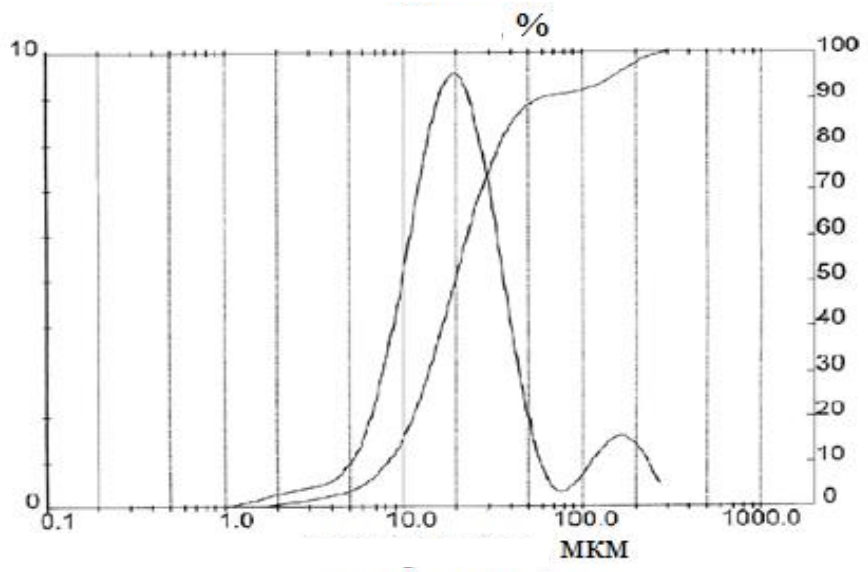


Figure 1. Sedimentation analysis of copper powder

Table 1. Granulometric composition of copper powder

Copper powder size (μm) and capacity (%)							
Size	capacity	size	capacity	size	capacity	size	capacity
1,06	0,02	4,88	3,48	22,49	58,80	103,58	91,94
1,24	0,08	5,69	4,54	26,20	67,55	120,67	92,92
1,44	0,18	6,63	6,15	30,53	75,09	140,58	94,23
1,68	0,36	7,72	8,58	35,56	81,08	163,77	95,75
1,95	0,60	9,00	12,12	41,43	85,41	190,80	97,29
2,28	0,92	10,48	17,00	48,27	88,22	222,28	98,61
2,65	1,29	12,21	23,34	56,23	89,79	258,95	99,54
3,09	1,72	14,22	31,07	65,51	90,55	301,68	100,00
3,60	2,19	16,57	39,91	76,32	90,93		
4,19	2,75	19,31	49,37	88,91	91,31		

The preparation of the charge composition, consisting of the above components, was carried out by mechanical mixing of copper-graphite powder obtained by electrolysis, and copper powder grade S11000. The amount of components in the charge - copper and copper-graphite powder (for each fraction of graphite) was 90 and 10% (by weight), respectively [4, 5].The mixture was mixed in a special device, in a mixing medium, by weighing the mass fraction of each component separately. After mixing for a predetermined period of time, the total mass of each sample is taken from the finished mixture for pressing; after pressing, the mass fraction and density of the pressed briquettes are determined.During the study, a mechanical press "Yosuzuka" was chosen for pressing prismatic samples and plain bearings. Pressing was carried out with a nominal force of 50 kN. Plain bearings (Fig. 2) with high density were obtained using a special mold at low pressure (100-250 MPa).

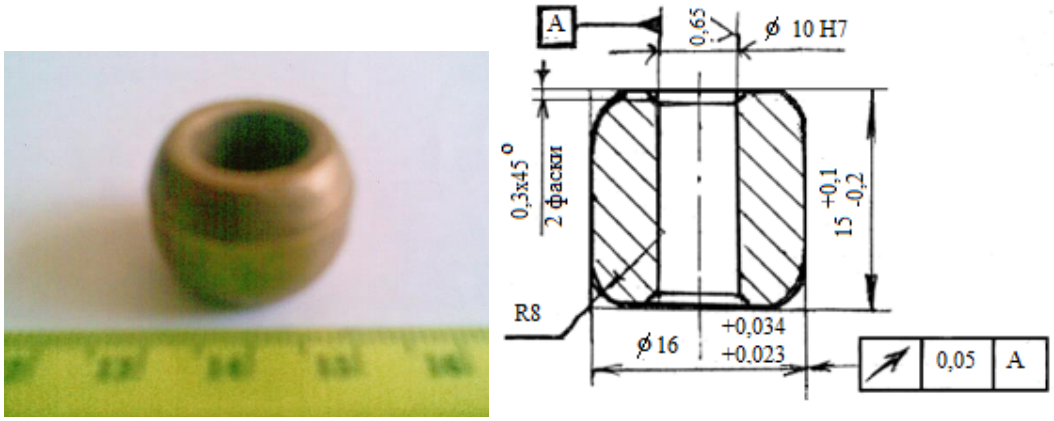


Figure 2.General view and working drawing of the plain bearing

To determine the density and porosity of sintered specimens, the mass of the specimen (in air) and the mass of the specimen impregnated with oil in water are determined. It should be noted that all of the above weighing operations are carried out on a weighing device equipped with special devices. The porosity and density of sintered samples and products is determined according to GOST-18898-73.The samples prepared for the study were sintered in a laboratory furnace of the SShOL-1.1.6/12 brand. The sintering temperature of samples from copper-graphite and copper+copper-graphite composition was 850-1000°C (from 1 to 4 hours).Calibration of sintered bearings and samples was carried out on a KD2128 calibration press using a special mold. One of the main requirements for calibration is the preservation of porosity on the inner friction surface.Also, in separate works, the influence of the dispersion of the components used on the structure of the composition was studied [4, 5, 7]. At the same time, the microstructure and shape of powder samples, as well as Cu-C and Cu+ (Cu-C) powders, were studied using a PME OLYMPUS TOKYO optical microscope made in Japan. After sintering and sizing, the bearings were tested for hardness and the compressive and tensile strengths were determined.The antifriction characteristics were studied on an MI-2 machine at a specific pressure of 0.08 MPa and a sliding speed of 2.0 m/s. The material of counter samples is steel 07X16H6.Results of the study and their discussion.

The selected technological modes and properties of the powders used in the charge made it possible to obtain samples with a porosity of 10 to 30%. Among samples with a porosity of more than 16%, the largest amount of shrinkage was in samples from pure copper powder. This can be explained by the fact that the powders have different fineness, and copper powder with fineness <70 μm is used. A relative increase in volume was observed during sintering of samples from Cu-C and Cu + (Cu-C) powders containing graphite powder with fractions of -250 + 160 μm and a porosity of <23%. Such an increase also occurred in the pure copper powder material. However, in samples from copper powder, the change in volume depending on porosity was ±1.2%, and in charge materials from powders of Cu-C and Cu + (Cu-C) ± 1.5%. It would be more correct to explain the reason for the increase in solubility and adsorption of gases in the powder. In addition, the formation of large water molecules during the reduction of copper oxide (with hydrogen) in copper powder can contribute to this.
The determination of the temporal strength in such materials, its theoretical substantiation has been sufficiently studied in various works [6, 7].When studying the dependence of hardness and impact strength on porosity, it was found that impact strength decreases as porosity increases in these materials (Fig. 3 and 4). This is due to a decrease in the contact area between the particles.

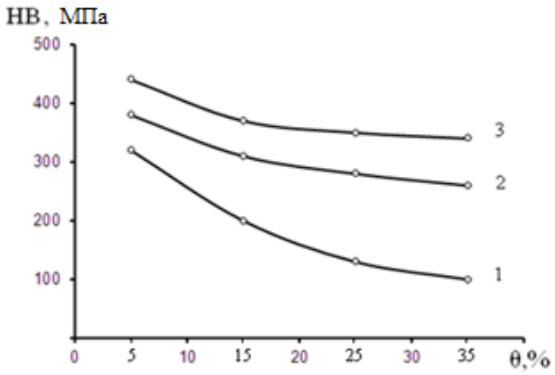


Figure 3. Dependence of hardness on porosity: 1 - copper powders, <70 microns;

2 - Cu-C, αg = (- 250 + 160) μm; 3 - Cu + (Cu-C), αg = (- 250 + 160) μm

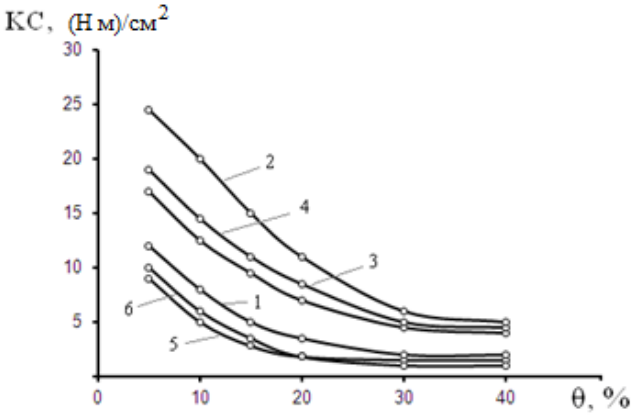


Figure. 4. Dependence of impact strength on porosity: 1 and 2 - copper powders; 1 - <70 μm, 2 - >70 μm; 3 and 4 - Cu-C and Cu + (Cu-C), αg = (- 250 + 160); 5 and 6 - Cu-C and Cu + (Cu-C),αg = (- 160 + 63)

2.Experimental details

From both graphs, it can be seen that the hardness and toughness are higher for samples made from coarse powders. Although the impact strength is high depending on the porosity, copper powder is characterized by a relatively low hardness value. It can be assumed that such a change in impact strength and hardness with porosity is due to structural features. Although the impact strength of materials made from copper-plated graphite and adding copper-plated graphite to a copper base is relatively low, they are superior in hardness to other materials. Achieving a high hardness value is very important for the surface friction layer.On Figure 5 shows the results of the fractographic analysis carried out after testing the samples on a TESCAN VGA3 electron microscope. As can be seen from the figure, the porous structure is expressed in all samples (especially in samples with large particles). The study of powders from copper and copper-graphite composite material shows that the internal and intergranular pores differ from each other.

Although such a difference is evident in large fractions, their areas of contact are larger. Large contact areas were found in Cu-C and Cu + (Cu-C) samples. The most optimal value was obtained as a result of copper plating of coarse-grained graphite obtained from graphitized carbon electrode material. The optimal option for adding Cu-C to the copper base was obtained in the amount of 20-25% copper-plated graphite. With a porosity (after sintering) of 18%, the impact strength and hardness of this powder material are considered to be more optimal.When determining the impact strength in copper samples (Fig. 5, a, b), in the process of refraction of the sample, micropores are formed, grow and appear in the form of voids in the areas of interparticle contacts. This process is fully confirmed by the presence of a break in the area of interparticle contact.In a Cu+(Cu-C) copper-based composite material, the presence of a copper base <70 μm, the addition of Cu-C-containing copper-graphite fractions, and a large particle contact area prevent the formation and development of this type of micropores.

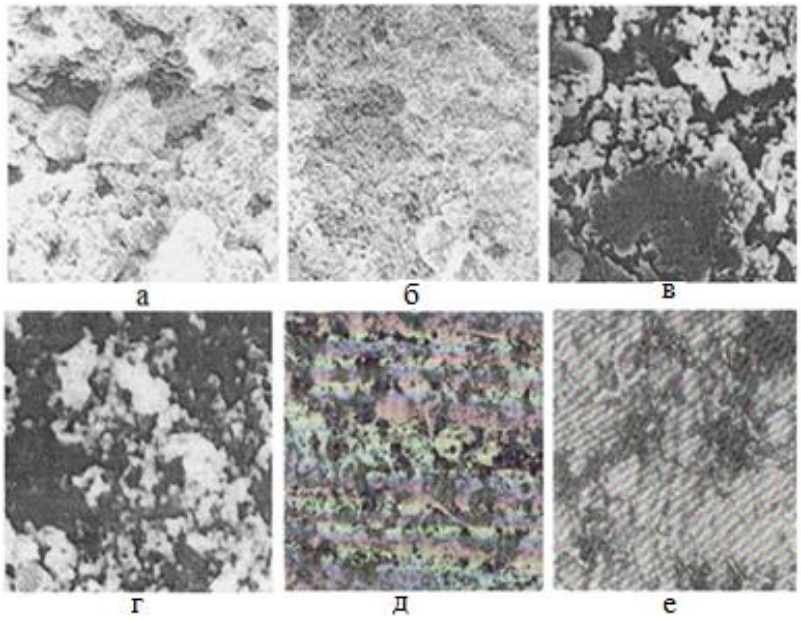


Figure. 5. Fractography of the fracture of copper (a, b) and powder composite materials based on copper (c, d, e, f) with a porosity of 18% (a, c, e) and 16% (b, d, f), x1500: a - >70 μm; b - <70 μm; c, d - αg = (-250 + 160) μm; e, f - αg = (-160 + 63) μm

The dependence of impact strength on the fractional size of copper-plated graphite and copper grains is explained by a larger area of interparticle contacts. Adding copper-plated graphite to the copper base solves the problem directly. When less porosity is obtained, the impact strength can be in the range of 20-25 Nm/cm2.The hardness of pure copper powder material does not depend on particle size distribution and decreases by several units as porosity increases.During friction, copper particles gradually move to the surface of the counter-sample and create adhesion. As a result, a dark black coating appears on the friction surface. The thickness of this layer is about 15 μm, taking into account the roughness. The appearance of the friction surface does not depend on the size of the abrasion and porosity.The surface finish of the counter sample is determined by the porosity of the copper powder material. The purity parameter (Rα) after friction of copper powder material with a porosity of 10 and 35% is 7.5 and 0.4, respectively. An increase in purity with a decrease in porosity on the surface of the countersample is probably associated with an increase in hardness.Studies of Cu-C and Cu+(Cu-C) composite materials during friction show that in these samples, similarly, what happened to the copper material at the beginning of the process was observed. During the process, copper-plated graphite in samples of Cu-C and Cu + (Cu-C) materials undergoes a number of changes after friction.As can be seen from fig. 6, there are sections of the copper layer that are destroyed and not destroyed by friction. The gradual presence of graphite in friction not only improves the anti-friction properties, but also makes it possible to produce stronger parts from the material. The formation of a lubricating layer on the surface of the countersample reduces the roughness and improves the cleanliness of the friction surface of the copper-graphite material. It was found that among these samples, the highest purity refers to the material Cu + (Cu-C).With an increase in the indicated particle sizes and porosity of more than 20%, the wear intensity increases in all three powder materials. The best results are obtained by a composite material containing Cu + (Cu-C) (Fig. 7).Particles that are a product of wear are formed as a result of the action of friction cracks and due to increased stress concentrators. The pore is also involved as a stress concentrator during copper friction. Although this principle remains valid at the beginning of friction, it cannot be strengthened by the action of graphite. To explain what is shown in Fig. 7 dependence, it would be more correct to study the structural transformations in the near-surface layers under the action of the friction force.

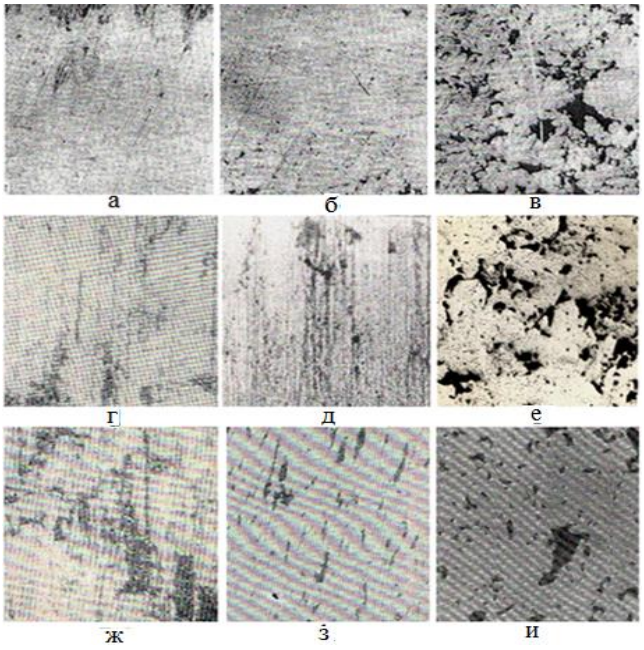


Figure. 6. Microstructure of the surface layer of samples (porosity 30%) of copper and copper-graphite composite materials based on copper after friction and wear, x400: a, b, c - copper powder, <70 μm; d, e, f - Cu-C, αg=(- 250 + 160) μm; g, h, i - Cu + (Cu-C), αg \u003d (- 250 + 160) μm; distance from the friction surface: a, d, g - 0–80 μm; b, e, h - 80-160 microns; c, f, i - 160–240 μm

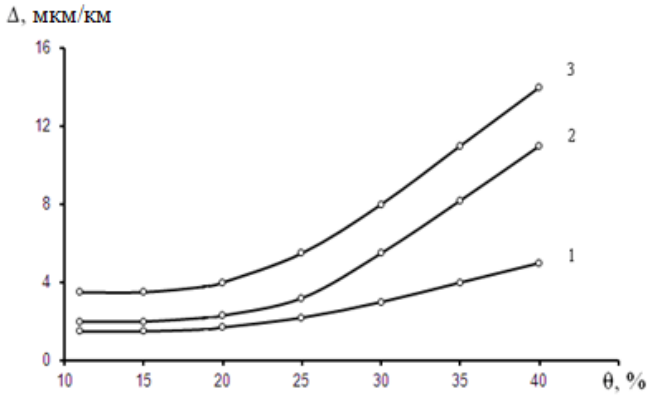


Figure. 7. Dependence of the wear rate of copper and copper-based powder materials on porosity: 1 - Cu+(Cu-C); 2 - Cu-C; 3 - copper powder

In order to study the structural transformation, a study of surface layers after friction and wear was carried out on a sample made from fractions -200 + 160 μm. Since an increase in the intensity of etching was observed mainly at a porosity value of 30%, microstructures were studied at various distances from the friction surface in a sample of this material. As a powder material, a copper-graphite material was used, which is considered more optimal. Copper-plated graphite was 25%. The surface friction of such a powder composite material indicates that the friction occurs under the action of weak plastic deformation compared to the copper powder material. However, the process of gradual closing of pores in the surface layer does not occur. As a result of deformation in samples taken from pure copper powder, the pores disappear or close. The degree of deformation increases as the area of the friction surface is approached. This is due to gradual shrinkage and a decrease in the number of pores. From this point of view, the cross-sectional area of the "steam channels" gradually narrows, causing the walls of the pores to meet and then turn into microcracks. The depth of the deformation zone of copper-graphite samples is 150 μm, while for copper samples this depth is 200-250 μm. Such a shallow depth of the deformation zone is due to the fact that the composition of the powder composite material Cu + (Cu-C) includes <70 μm of copper powder and copper-plated graphite.

A change in the porosity and fineness of a material containing Cu + (Cu-C) does not significantly affect the value of the friction coefficient, which varies within 0.09–0.18. The coefficient of friction was set at 0.30-0.45 for copper powder and 0.10-0.25 for copper-plated graphite (Cu-C). It can be concluded that the structure and composition of the outer surface layer should be taken as the main factor affecting the value of the friction coefficient.The dark black coating that forms on the surface during friction fills and evens out the roughness on the friction surface and has a certain interface with the copper base. This can be explained by the relatively high hardness on the surface of samples containing Cu-C and Cu+(Cu-C), low plastic deformation and the influence of graphite.Studies show that the coating layer on the surface contains copper, graphite, oxygen, iron, chromium, nickel (copper samples do not contain graphite). In some parts of the samples, the oxygen content is even increased to 36%. This confirms the presence of an oxide layer (Cu2O) on the surface in the form of a film. 36% oxygen content was found only in copper samples. The relatively high hardness in the surface layer of the samples can be due to the combined action of elements coming from the counter-sample and particles separated from the dispersed copper during sintering. In addition, during the formation of this oxide layer, the influence of high local temperature and pressure on the countersample and copper powder samples is strong. Compared to Cu-C and Cu+ (Cu-C) powder composites, it has been observed that the coefficient of friction of copper powder has a relatively high value regardless of porosity. It is shown that a very thin surface layer in the porosity range of 10-35% has a submicrocrystalline structure and does not differ in phase composition. Thus, since the porosity of the copper samples does not affect the structure of the surface layer, the coefficient of friction does not depend on the porosity.

3.Conclusions.

The use of samples from composite material Cu + (Cu-C) reduces the intensity of plastic deformation, which leads to the disappearance of pores in the surface layer. The inclusion of the resulting submicrocrystalline hard graphite, consisting of the main elements of friction pairs and oxygen, has a strong effect on the antifriction properties. It has been established that with an increase in porosity from 10 to 35%, the wear resistance of copper decreases and this does not affect the coefficient of friction. In other materials containing Cu-C and Cu+(Cu-C), wear resistance starts to decrease after 20% porosity and the coefficient of friction increases after 25% porosity. In general, the Cu+(Cu-C) material has the best tribological properties.

References

1.T.A.Bolsunovskaya, I.Yu., Influence of grade of graphite as a solid lubricant on the tribotechnical properties of a metal composite material. Composite materials, №7, pp. 69-77, 2018.

2.S.M.Mustafaev, A.A.Guliyev, S.A.Gasimov, Investigation of the technology for obtaining copper-graphite material by the electrochemical method, Bulletin of the Higher Technical Schools of Azerbaijan, ADNA, Baku, №4 (20), pp. 27-33, 2002.

3.A.V.Sharifova, Influence of modes of electrochemical copper plating of graphite on the structure of the composition. Modern problems of metal physics, materials of the II International Scientific and Practical Conference, Baku, pp.48-50, 2010.

4.S.M.Mustafaev, A.A.Guliyev, A.V.Sharifova, Formation of the structure of copper-graphite powder composition. News of higher technical schools of Azerbaijan, ADNA, N5 (81), 2012, p. 55-58

5.A.V.Sharifova, Formation of the structure and properties of a copper-graphite composition with a high content of graphite. Materials of the XVII Republican scientific conference of doctoral students and young scientists, Baku, p.127, 2013.

6.S.M.Mustafaev, A.V.Sharifova, A.A.Guliev, Research on the development of a copper-graphite composition with a high content of graphite. Progressive technology and engineering systems. International collection of scientific works, Donetsk, pp.187-191, 2013.

7.A.V.Sharifova, On the influence of dispersion of non-interacting components on the properties of a composite material. Equipment and technologies for the oil and gas complex. Scientific and technical journal. Moscow, №3, pp.28-30, 2014,

ECO

ENERGETIKA
ENERGETICS