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ABSTRACT

of the dissertation for the degree of Doctor of Science

DEVELOPMENT OF ENERGY-RESOURCE-SAVING AND ECOLOGICAL CLEANING TECHNOLOGIES FOR OIL AND GAS PRODUCTION PROCESSES BASED ON ALTERNATIVE ENERGY SOURCES

Speciality: 2525.01 - «Oil and gas fields development and exploitation»

Field of science: Technical sciences

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GENERAL FEATURES OF WORK

Relevance of the topic. In the last decade, due to the unstable state of prices for “black gold” on the world market and the “greenhouse effect” created by emissions of flue gases into the atmosphere after burning traditional fuels, which undoubtedly affects climate change on the planet, the demand for use of alternative and renewable energy sources. Recently, the rejection by countries of the world of “harmful energy” in favor of renewable energy has spread from international organizations. In this sense, despite the tragedies at the Chernobyl and Japan nuclear power plants, which entailed great human and material losses, the same trend continues. After the tragedy at the Fakusima 1 nuclear power plant in Japan, one of the most developed countries in the world - Germany, decided to stop all nuclear power plants in the country, until 2020.

In Azerbaijan, the main part of environmental pollution and the formation of harmful gases, creating a “greenhouse effect”, falls on the share of energy. The emission of greenhouse gases per person in Azerbaijan is 6-7 tons. According to forecasts, by 2020-2030 these indicators will be 9-10 tons. This growth rate is associated with the exploitation of oil (40-50%) and gas (35-45%). Prevention of future environmental problems and the energy crisis will be possible only through alternative and renewable energy sources. Thus, the replacement of the existing fuel and energy complex with a renewable energy sector will cause the improvement of the environment, flora, fauna, and the person’s involvement in a healthy lifestyle, including. Given the fact that a large part of the population of Azerbaijan lives on the territory of Absheron and the adjacent territory, as well as the fact that oil and gas have been produced here for the past 200 years, the use of environmentally friendly energy resources is important. Over the periods, both within the former Soviet Union and after gaining independence, our republic has joined 27 different international conventions covering 20 environmental areas.

The protocols signed under this convention pose a number of important obligations to states. At the first stage, the preparation of the National Action Plan and the creation of relevant State Programs, the approval of laws and orders, determines the fulfillment of these obligations in the future.

Thus, the conventions in which our country has joined can be divided into two stages from a chronological point of view. The first stage is the stage within the USSR, and the second is these conventions and protocols after independence.

On December 6, 1993, our republic joined the "Convention for the Protection of the World Cultural and Natural Heritage".

In 1995, the Republic of Azerbaijan joined the UN Framework Convention on Climate Change, and on July 18, 2000, it joined the Kyoto Protocol, which was later included in the Convention. On October 28, 1999, the Republic of Azerbaijan joined the "Convention on the Protection of Wild Fauna and Flora and Natural Habitats in Europe", which was signed in the city of Bern on September 19, 1979. Our Republic acceded to the "Convention on Access to Information, Public Participation in Decision Making and Access to Justice in Environmental Matters" signed on June 25, 1998 in Aarhus, on November 9, 1999. The Republic joined the Montreal Protocol "Substances that Deplete the Ozone Layer", signed on September 15-17, 1997, on July 18, 2000. Our Republic acceded to the "Convention on Biological Diversity" of June 5, 1992, March 14, 2000.

Also, on December 9, 2003, the republic joined the Stockholm Convention on Persistent Organic Pollutants, signed on May 22, 2001. The Republic of Azerbaijan joined the Convention "On the Transboundary Effects of Industrial Accidents" of March 17, 1992 (the city of Helsinki) on May 4, 2004. Azerbaijan joined the "International Convention on Preparedness for Oil Pollution, Combating and Cooperation" in 1990, as well as the 1969 International Convention on Civil Liability for Oil Pollution Damage, June 18, 2004. The Republic of Azerbaijan joined the Framework Convention on the Protection of the Marine Environment of the Caspian Sea, signed in Tehran on November 4, 2003, on April

4, 2006. On June 24, 2011, Azerbaijan acceded to the "European Convention on Landscapes" (Florence) of October 20, 2000. Signed on August 12, 2011 in Aktau, the Protocol on Regional Preparedness, Response, and Cooperation in the Event of Oil Pollution Incidents to the Convention for the Protection of the Marine Environment of the Caspian Sea: Azerbaijan joined it just a year later, on December 21, 2012 . The above and other international conventions, as well as the protocols signed within their framework, impose serious obligations on the republic to protect the environment and rational use of natural resources. In order to reduce harm to the environment, the proper use of environmentally friendly and cost-effective sources of energy, respectively, takes the main place among the obligations.

All protocols included in these conventions of the last twenty years reflected the widespread use of alternative and renewable energy. The states that joined the protocol provide for the search for potential energy sources, their widespread use in the fields of life and industry.

The tasks listed above should be implemented within the framework of the National Action Plan of the Republic. According to this action plan, a number of State Programs were approved. In this regard, the use of alternative energy sources in Azerbaijan, for the first time at the state level, was noted in the Decree of the President of the Republic of Azerbaijan "On Measures to Accelerate Socio-Economic Development in the Republic of Azerbaijan" dated November 24, 2003 and the Order of the President of the Republic of Azerbaijan on approval of the State Program "On the Use of Alternative and Renewable Energy Sources in the Azerbaijan Republic" of October 21, 2004.

Renewable energy sources are used in solving environmental, economic, social, international, scientific issues and addressing security issues. The use of renewable energy sources also creates conditions for reducing emissions of harmful substances into the atmosphere and the greenhouse effect, and eliminating the shortage of traditional fuel used.

Along with this, the use of partially renewable energy will contribute to saving hydrocarbon reserves, as well as improving the living standards of the population and the ecological state of the country.

In this sense, the use of autonomous, reliable, sustainable, modern, environmentally friendly alternative energy sources that allow saving fuel of one of the main industries in the industry - oil and gas companies, is quite relevant and indispensable.

Objective:

Development of scientific and practical fundamentals of energy saving and the use of environmentally friendly technologies in order to increase the efficiency of work on reserves of hard-to-reach oil and gas fields based on alternative energy sources.

To achieve this goal, the following tasks were completed:

- The potential of solar and wind energy, the wave energy potential of the Caspian coast of the Absheron peninsula of the Republic of Azerbaijan;
- alternative energy installations developed in the conditions of the Absheron Peninsula and the technical and energy base for their operation have been developed;
- mounted installations of various designs based on solar and wind energy, and their other elements;
- theoretical and experimental study of heat power parameters for each power plant separately;
- Technological workflows of various variations have been developed for applying the thermal method to reserves of hard-to-reach deposits using alternative energy plants;
- experimentally investigated the process of exposure to steam and heat from solar power plants for efficient heating of the oil reservoir and the bottom-hole zone;
- to influence the bottom-hole zone with a thermoelectric heater, a technological scheme consisting of a wind engine and a heat pipe was developed and investigated;
- in order to increase the efficiency of oil production, to prepare “alien” water, two different power plants and systems have been developed;

- to ensure reliable and continuous operation of wells in difficult mining conditions, a hybrid energy storage system was developed;
- based on the proposed methodology, a reduction in the cost of salable petroleum products from an economic and environmental point of view has been substantiated.

Scientific novelty:

- For the first time, solar and wind energy potentials of Azerbaijan and the Absheron peninsula were developed, and corresponding maps were compiled;
- experimentally measured the speed and direction of the wind at an altitude of 3, 5, 40, 60 and 80 meters on the territory of the Absheron Peninsula; the average annual speed is set and a wind rose is built; based on the Weibull distribution, the wind distribution speed in the specified territory is determined;
- the wave energy potential of the Caspian coast of the Absheron Peninsula was investigated, the corresponding maps were compiled, the average annual energy production for the respective territories was determined;
- for technological processes in the oil industry, alternative power plants for various purposes have been developed and tests have been conducted in natural conditions;
- studied the technical, energy and design parameters of solar and wind power plants; in order to ensure safety and increase efficiency, digital control systems have been developed;
- alternative power plants were used in the development of hard-to-recover reserves of oil and gas fields, and the average annual, monthly, average seasonal production of steam, hot water and electric energy was determined;
- in order to influence heat on the formation and the bottom-hole zone, for various conditions, highly efficient, autonomous and new constructive power plants have been developed and investigated;

- To compress residual oil and increase well productivity, a technology has been developed to generate “alien” water at new solar power plants;
- to ensure the reliability and autonomy of the oil production process, a hybrid energy system has been developed and applied;
- in order to ensure a long-term and uninterrupted mode of operation of solar power plants, a universal system of helioreactor accumulation based on phase heat-accumulating materials was developed and investigated;
- Ecological and economic foundations of reducing the cost of petroleum products through alternative power plants have been studied.

The practical value of the work.

- The results of the research will be widely used both in the oil industry and in all areas of the national economy, including the fields of energy, agriculture, food light and heavy industry, transport, management, communications, household industry, etc .;
- in practice, the indicated potential of solar and wind energy can be used as a useful database for the creation and effective operation of large alternative power plants in the future;
- power plants created due to internal capabilities and local material guarantee the construction of factories and production facilities based on modern technologies;
- the use of alternative power plants in oil production can cause energy savings, reliability and strength, which will allow them to be used as a prototype in other industries;
- the developed hybrid alternative power plants provide an opportunity for uninterrupted and autonomous operation.

The author protects.

- Characterization of the distribution of alternative energy potential, measurement accuracy, analysis of the results, experimental study of the operation of power plants;

- development of alternative power plants, research of their technical and energy parameters, analysis of experimental results, generalization and analysis of the results obtained;
- theoretical and practical study of the use of alternative power plants in the development of hard-to-reach reserves of oil and gas fields;
- comparative analysis and generalization of the theoretical and practical results of energy-saving and energy-efficient technologies in order to increase the efficiency of the oil production technological process;
- environmental justification for the use of alternative power plants in oil production, using the discount coefficient, and analysis of environmental assessment;

Approval and publication of the research:

The main results of the dissertation work: "X World Renewable Energy Congress and Exhibition", Glasgow, Scotland 2008; Proceedings of the IV International Technical and Physical Problems of Energy, Piteşti, Romania 2008; At the conference dedicated to the 90th anniversary of the Azerbaijan State Oil Academy, Baku, 2010; “New technologies in the oil and gas industry at the II International Scientific and Practical Conference”, Baku, 2012; Proceedings of the scientific-technical conference “Development and operation of high-voltage oil and bitumen deposits”, Uhtta, 2012; Proceedings of the International Scientific Conference on the 85th Anniversary of Academician Azad Khalil oglu Mirzazhanzadeh, "Non-Newtonian Systems in the Oil and Gas Field", Baku, 2013; II International Conference of Young Researchers, dedicated to the 91st anniversary of national leader Heydar Aliyev, Baku, Caucasus University, 2014; "Actual Problems of Mathematics and Mechanics", International Conference on the 55th Anniversary of the Institute of Mathematics and Mechanics, Baku, 2014; Republican scientific conference "Classic and Musical Problems of Mechanics", dedicated to the 100th anniversary of the outstanding scientist of Azerbaijan, corresponding member of ANAS, doctor of physical and mathematical sciences, professor Yusif Aman oglu Amanzadeh, Baku, 2014; I International Scientific Conference of Young Scientists and Specialists, Baku, 2014; VII All-Russian Conference "Problems of Development of Hydrocarbon and Mineral Deposits", Perm, 2014; All-Russian Conference of Students, Postgraduate and Young Scientists, Materials and Technologies of the 21st Century, Kazan, 2014; "Caspian oil and gas" - 2014, Scientific and practical conference, Baku, 2014; I All-Russian Scientific-Practical Conference "Energy and Energy Saving, Theory and Practice", Kemerovo, 2014; 1st All-Russian Scientific and Practical Conference "Access to Energy", Kemerovo 17-19 November 2014, Conference dedicated to Academician AXMirzadzanzadeh Ufa, 16-18 November 2016, Conference on Modern Technologies in Oil and Gas Fields, Makhachkala 2016, COIA-2018 11-13 July Baku was presented and discussed at the conference.

The main results of the dissertation were published in 65 scientific works, including 1 monograph, 5 patent documents of the Republic of Azerbaijan, 1 chapter, articles, theses, collections of international and local conferences.

Application of research:

Works, new constructive solutions, methods and substantiations reflected in the dissertation work are used in the teaching process of ASOIU, wells 108, 193, 1151, 1413 of the OGPD by name A. Amirov, wells of Binagadi Oil Company No. 252659, 252783. It has been used by Alten Group LLC in various industrial and catering facilities. Relevant Acts have been issued. As a result of the aforementioned activities, great economic benefits were achieved.

Structure and scope of research:

The dissertation consists of an introduction, 6 chapters, main results, a list of 307 titles and appendices. The volume of the work consists of 131 drawings, 45 tables and in total the dissertation is 428683 characters.

The author expresses deep gratitude to the follower of the school of the Honored Teacher, Great Scientist, Academician Azad Khalil oglu Mirzadzhanzade - corresponding member of ANAS, Academician of the Russian Academy of Natural Sciences (RANS),

Honored Worker of Science, Doctor of Technical Sciences, Professor T.Sh. Salavatov for the assistance provided in the formation of a scientific direction, formulation and finding ways to solve the problem; for valuable advice and recommendations at the time of discussion of the results; as well as in conducting experiments on modern plants and equipment.

THE CONTENT OF THE WORK

In the introduction, the relevance of the research topic is given; her goal; questions posed to achieve the goal; scientific novelty; practical value of the work; provisions to be defended; implementation of work and some tasks.

The first chapter provides a general literature review, the total generating capacity of Azerbaijan is expressed by statistical data, the dynamics of energy production and consumption for many years, detailed information on fuel consumption in the energy sector and other indicators. In addition, in Azerbaijan, implemented to date, projects in the field of alternative and renewable energy are presented in chronological order. An assessment of each alternative energy source separately is given, information is provided on the work done in this area in the world and on the research of influential scientists. Thoroughly analyzed: technological processes of oil production, work performed on the methods of influence of heat on the reservoir and bottomhole zone; To this end, the prospects of using alternative power plants have been investigated.

The second chapter measures the energy potential of alternative energy sources of the sun, wind and sea wave; an assessment of the results obtained; maps of energy potentials are made. The measurement of solar radiation was carried out, and mathematical methods of calculation were considered. A method for calculating the direct, scattered, reflected distribution of total radiation and radiation balance along with the thermal balance of the earth's surface is presented, and the corresponding mathematical calculations are performed. The methodology for calculating the direct, scattered, reflected distribution of the total radiation; radiation balance and heat balance of the earth's surface; corresponding mathematical calculations have been carried out. Information is provided on the operating principle of the actinometer used to measure types of solar radiation.

Maps of energy potentials are compiled, reflecting the intensity of solar radiation and covering all regions of Azerbaijan. In addition, the table shows the distribution potential of solar energy in some areas of the country. Also, separately for the Absheron Peninsula, which is rich in oil and gas potential, a map is compiled for the potential of solar energy (Fig. 1). For the first time, a nomogram was compiled for solar power plants located on the 40th North Ring of the Absheron Peninsula to determine the angle of incidence of sunlight during the day, depending on the months of the year and the height of the sun above the horizon (Fig. 2).

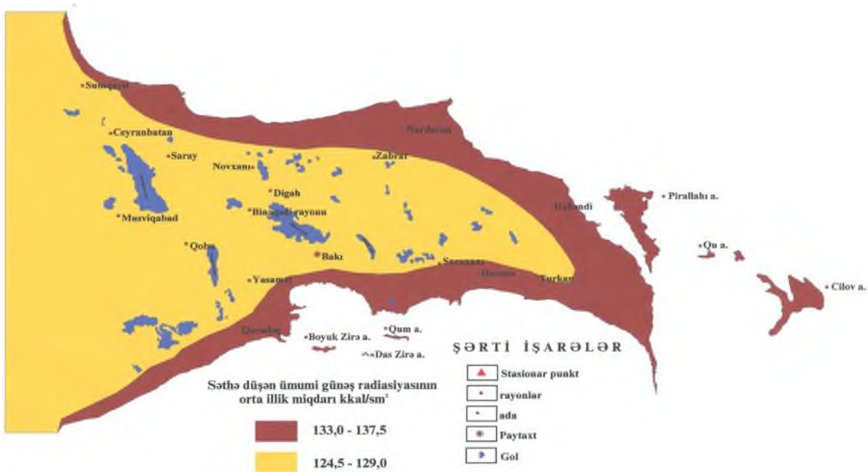


Fig 1. Map of the total potential of solar energy of the Absheron Peninsula

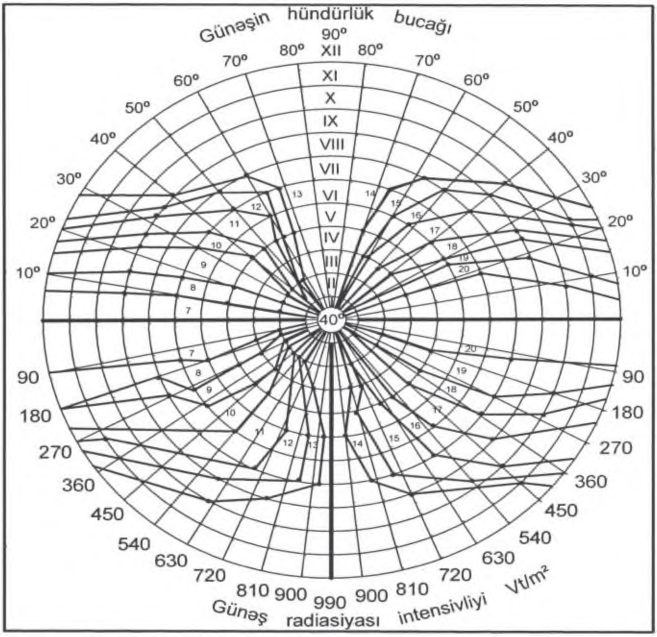


Figure 2. Nomogram for determining the angle of incidence of sunlight during the day, depending on the months of the year and the height of the sun above the horizon

As for the energy potential of the wind, for the full coverage of the Absheron Peninsula, the wind speed and direction for the period 2011-2015 were determined. for different wind heights, and the results are presented. For the first time, a map of the energy potential of the Absheron Peninsula wind was compiled at a height of 80 meters (Fig. 3). In addition, the results of monthly and annual average wind speeds for various regions of the Absheron Peninsula at an altitude of 80 meters are presented. The monthly average wind speed for the city of Baku at a height of H = 3 m and H = 5 m is presented (table 1).

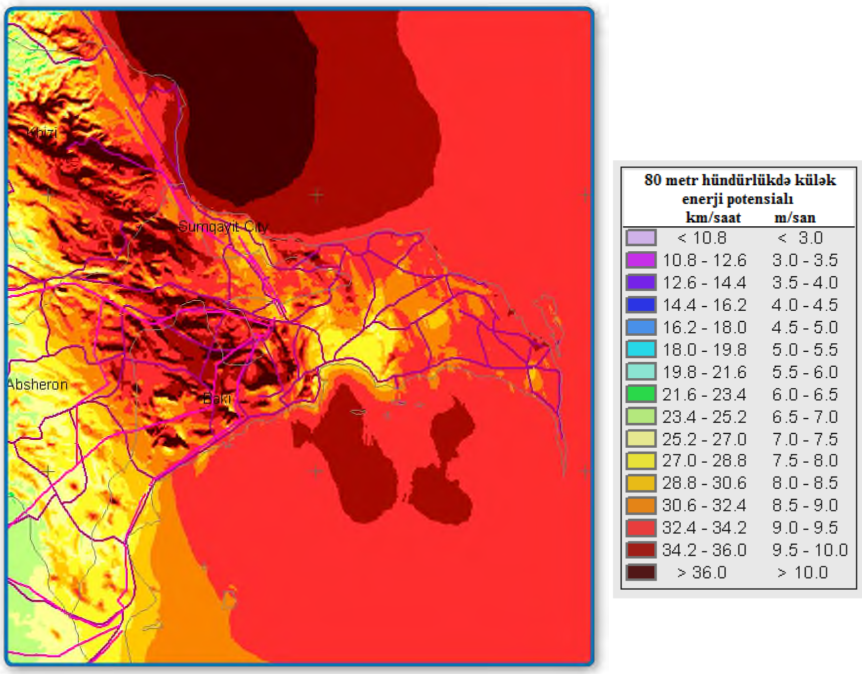


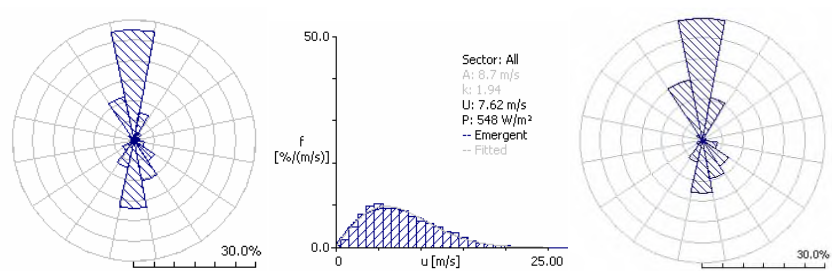
Fig. 3. Map of the wind energy potential of the Absheron Peninsula at an altitude of 80 meters

In order to determine the characteristics of the distribution of wind speed, the Weibull distribution was used. At the same time, an analysis of the Rayleigh distribution is carried out. The repeating speed (%) and wind direction are determined for the minimum and maximum values. The principle and conditions of installation and operation of wind turbines with high power are considered, and optimal options are proposed. The technical characteristics and operation principle of the Gamesa G8X-2.0 MW wind turbine, operated in accordance with the climatic conditions of the Absheron Peninsula, are considered.

Table 1

The average monthly wind speed of the city of Baku for 2011-2015. (H = 3 m, H = 5 m)

Month	Years									
	2011		2012		2013		2014		2015	
	Average wind speed, m/sec									
	H=3	H=5	H=3	H=5	H=3	H=5	H=3	H=5	H=3	H=5
January	1.90	2.93	4.03	5.11	3.06	4.21	3.74	4.81	3.03	4.21
February	2.00	3.04	3.96	5.01	2.53	3.76	4.07	5.18	4.82	6.02
March	2.45	3.56	4.02	5.00	4.93	6.07	5.32	6.48	4.45	5.64
April	2.80	3.91	3.96	4.98	3.16	4.28	4.06	5.21	4.73	5.91
May	1.38	2.51	2.67	3.79	2.32	3.46	3.80	4.92	3.45	4.54
June	2.20	3.58	3.40	4.51	2.93	4.21	4.33	5.54	4.06	5.22
July	2.25	3.44	3.25	4.38	3.83	5.02	3.61	4.79	4.58	5.81
August	2.16	3.39	3.29	4.41	2.77	3.98	3.61	4.78	3.54	4.74
September	1.63	2.92	2.90	4.01	4.70	5.92	3.73	4.88	3.33	4.46
October	2.00	3.21	2.90	4.02	3.87	4.99	3.90	4.99	4.03	5.26
November	1.56	2.74	2.30	3.51	3.26	4.41	3.00	5.11	3.66	4.91
December	1.64	2.98	2.32	3.56	4.06	5.24	5.03	6.12	3.54	4.82
Average	**1.99**	**3.18**	**3.25**	**4.35**	**3.45**	**4.62**	**4.01**	**5.23**	**3.93**	**5.12**



a) **b)** **c)**

Fig. 4. Definition of a wind rose on a meteorological tower 40 meters high for the period 2011-2012.

To determine the direction of the wind and compile the schedule, the wind rose of the Absheron Peninsula for 2011 and 2012 was determined. In fig. 4 presents a graphical form of a wind rose, compiled on the basis of the results. In fig. 4 a) wind direction, b) Weibull distribution, c) wind speed. Wind speed and direction were calculated taking into account a utilization rate of 30%. As can be seen from the Weibull distribution, during the measurement at a height of 40 meters, the average annual wind speed was 7.62 m / s, which is 548 W / m2, respectively. There is great potential for the use of sea wave energy on the coastline of the Caspian Sea and, mainly, on the coast of the Absheron Peninsula. The average annual wave height on the south coast of Absheron is 1-2 m, and on the north coast is 1.5-2.5 m. The average annual wave height across the coast in Azerbaijan is 1-1.5 m. Sometimes, during a strong wind , this figure can reach 8-10 meters. For the first time, when assessing the territory of the Caspian coastline of the Absheron Peninsula with the wave energy potential, a corresponding map was compiled (Fig. 5) and a sea wave power plant with a Wales turbine adapted to natural conditions was studied (Fig. 6).

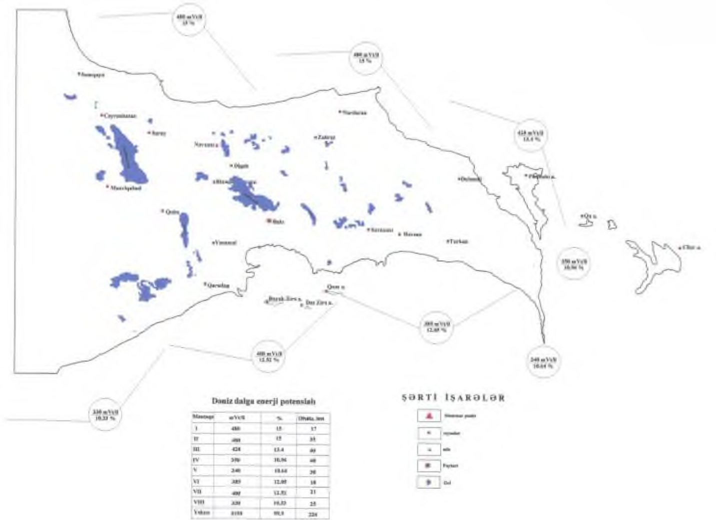


Fig. 5. Map of the average annual energy potential of the wave of the Caspian coast of the Absheron peninsula

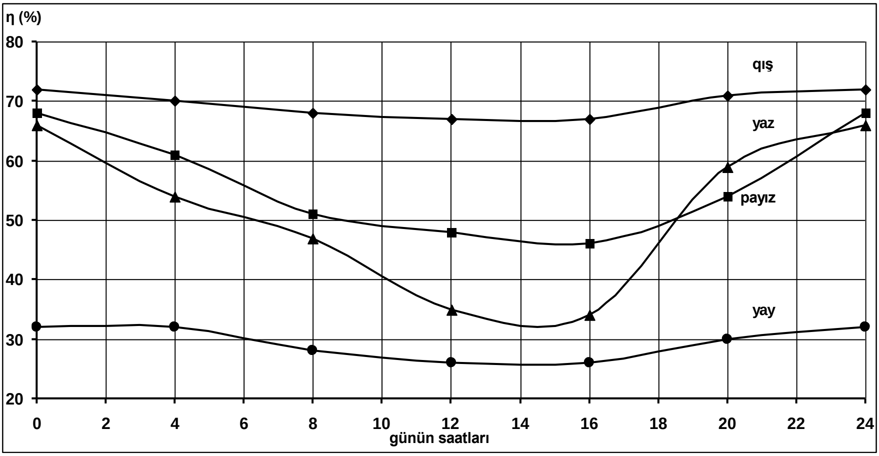


Fig 6. The dependence of the seasonal efficiency of the Wales turbine on the time of day

The construction of stationary installations of simple design with its subsequent operation on the coast of the Caspian Sea, from a technical point of view, is the most favorable. An example of such an installation is the Wales turbine, which during the movement of the wave forward and backward ensures the rotation of the blade in only one direction, has high aerodynamic qualities; high resistance to any weather conditions, when studied in accordance with the natural climatic conditions of the Caspian coast, is of interest as an effective energy converter. To date, many experiments have been conducted on the practical testing and improvement of the Wales turbine. Thus, according to the results of research, experimental work on the use of the Wales turbine is ongoing on the North Sea coast, including in England, Denmark, Germany and other European countries.

In the third chapter, for the first time in this research work, solar and wind power plants of various purposes and structures are designed for power supply systems in oil production processes; investigated their technical and energy parameters. Solar power plants consist of a high-potential parabolic concentrator (Fig. 7), parabolic cylindrical concentrator (Fig. 8), solar reactors of various designs, flat solar collectors (Fig. 9), solar desalination plants, a solar air heater, a solar heat accumulator, and a combined solar air heater.

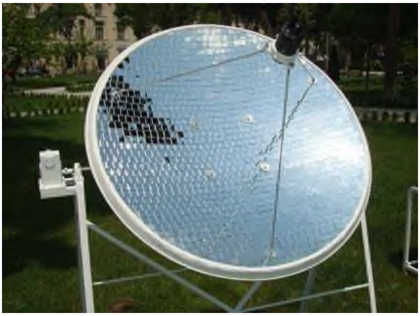


Figure 7. The main view of a solar power plant with parabolic concentrator.

Figure 8. The main view of a solar power plant with parabolic cylindrical concentrator.

Fig 9. General view of a flat solar collector

For each power plant individually, using a polishing machine, a very smooth surface is obtained on the ray-absorbing surfaces of solar reactors and absorbents. Then, after storage in a special furnace at 60-800 C, it was cooled for 30-50 minutes. Using special equipment (SC-400 Precise Coat), in the pollination mode, a selective layer was isolated. The thickness of the selective layer consisting of Cu + Ni + SiO2 and Cu + Ni + ZnS was 0.013-0.058 nm.

Table 2 presents the results of the experiments for July-August 2011. Measured and presented: solar radiation, average air temperature, average wind speed and the temperature of the selective layer of the solar reactor for months on different days. Based on the results obtained, the efficiency of the solar reactor is calculated.

Table 2

Results of Natural Testing of a Selective Solar Reactor surface for July-August 2011

Date	Direct solar radiation, W/m^2	Average temperature of air, °C	Average wind speed, m/sec	Selective surface temperature, °C	Efficiency %
July 2011					
1	853	36	2,1	381	0,82
5	879	38	2,8	386	0,84
10	897	38,1	3,5	389	0,84
15	934	39	2,0	392	0,85
20	955	39	1,2	399	0,86
25	968	41	1,1	401	0,87
30	913	40,4	1,5	390	0,85
Aigust 2011					
1	889	39,6	1,4	388	0,84
5	888	39,5	2,0	388	0,84
10	835	39	1,8	380	0,82
15	802	38,6	2,4	378	0,81
20	754	36	3,3	375	0,79
25	721	35,8	3,8	372	0,79
30	695	33,7	3,5	369	0,77

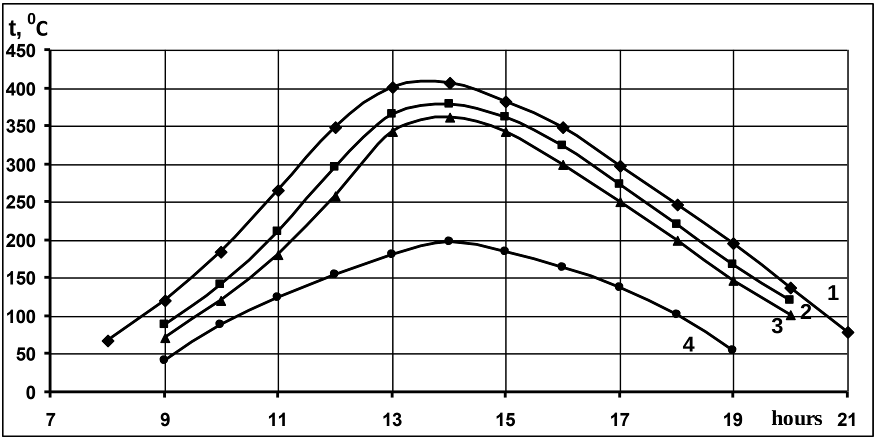


Fig. 10. The dependence of the seasonal change in the solar reactor temperature of the selective nanosurface depending on the time of day.
Seasonal curves are shown: 1 - summer, 2 - autumn, 3 - spring, 4 - winter.

To achieve high performance at each of the solar power plants, it is important to equip the mechanisms with mechanical transmission systems with a solar control system. This system, most needed for focusing mirrors, moving along the azimuthal and zenithal planes, provides a constant directivity of the mirror surface perpendicular to the sun. To this end, in focusing solar structures, flat solar collectors and PV panels, this system is installed and tested in the natural climatic conditions of the Absheron Peninsula. The results of experiments performed on PV panels are presented in table 3.

In order to obtain electric energy, as part of the research work, two different designs of vertical-axis wind turbines were developed in the period 2010-2014. passed tests in the conditions of the landfill. The appearance of the installations is shown in Fig. 11 and 12.

Table 3.

Output indicators of the main energy parameters (U, V and I, mA) solar panels throughout the day

Day hours	Movement on azimuthal and zenithal normal		Stationary state	
	U, V	I, mA	U, V	I, mA
8^{00}	21.10	96	8.87	48
8^{30}	21.22	158	10.63	99
9^{00}	21.74	221	12.08	196
9^{30}	21.68	248	14.12	212
10^{00}	22.34	261	16.58	233
10^{30}	22.58	281	17.01	259
11^{00}	22.84	324	17.26	311
11^{30}	23.18	384	18.35	376
12^{00}	23.54	418	20.41	401
12^{30}	23.36	435	21.18	429
13^{00}	24.77	464	22.13	446
13^{30}	26.20	488	24.90	465
14^{00}	25.91	471	23.39	451
14^{30}	23.65	438	22.51	423
15^{00}	22.98	409	21.36	389
15^{30}	23.05	388	20.79	328
16^{00}	22.51	356	18.36	248
16^{30}	21.35	324	17.04	205
17^{00}	21.01	301	16.23	164
17^{30}	18.62	271	14.31	131
18^{00}	15.11	256	12.20	99
18^{30}	12.32	192	10.88	74
19^{00}	10.58	101	8.21	51

In addition to these structures, taking into account the instability of the wind flow, a new design of a three-pole planetary gear reduction wind turbine has been developed. Operation of a wind turbine with such a design, i.e. the absence of idle rotational motion at the time of decrease and increase, as well as low wind speeds, the creation of conditions for replacing a low rotational speed with a higher one, and by combining three separately working axes into one single mechanism, a more efficient system was obtained from a mechanical, energy, and structural point of view.

Figure 11. The main view of the multi-blade vertical wind turbine

Figure 12. The main view of the multi-blade vertical wind turbine

The developed wind power plants with a capacity of 500 and 2500 W were tested both on the earth's surface and at an altitude of 6 and 9 meters from the ground. Silent during operation and the ability to move at low wind speeds - their positive quality.

In the fourth chapter, saving energy spent during the development and operation of oil fields, developing new methods to increase well productivity, using the capabilities of modern plants and equipment, in addition to technological advantages, is of great importance from an environmental and economic point of view. Here we consider the physical impact on the formation and the bottom-hole zone, in turn. In order to provide a method of applying heat to the formation, using alternative power plants, a technological scheme for producing and transferring steam and hot water to the system was developed and experimentally studied in a mine environment (Fig. 13).

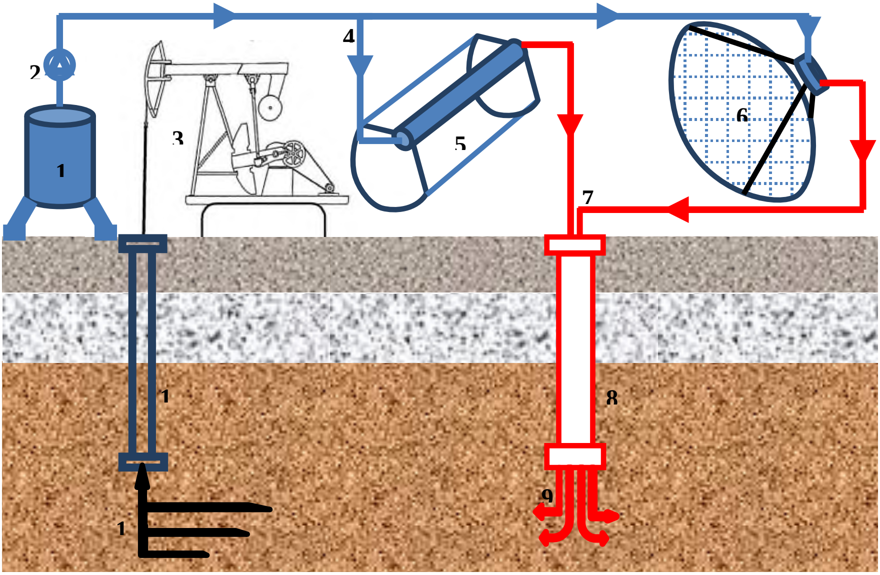


Figure 13. The technological scheme of the heated steam during the development of oil deposits using solar power plants

Where 1 is a cold water tank, 2 is a water pump, 3 is a rocking chair, 4 is a cold water line, 5 is a parabolic cylinder, 6 is a parabolic concentrator, 7 is a heating steam line, 8 is an shock pipe, 9 is a heating steam outlet, 10 - repair pipe, 11 - oil flow.

Table 4, in order to obtain heating steam, gives the efficiency and productivity of high and low temperature solar power plants for the months of the year.

Table 4

The results of the experiments of parabolic and parabolic cylindrical concentrators by month of the year

Month	Total solar radiatio	Average temperatu re of air,	Productivity of plant kg/m2 month	Efficiency of plant

	n, MC/m^2	°C	Parabolic	Parabolo trough	Parabolic	Parabo lo trough
I	305	3,9	58	47	0,147	0,118
II	370	4,1	86	66	0,18	0,14
III	555	6,3	128	101	0,21	0,222
IV	639	11,2	369	189	0,278	0,285
V	756	17,7	587	305	0,354	0,354
VI	769	22,6	758	498	0,425	0,389
VII	745	25,7	766	685	0,485	0,412
VIII	672	25,7	702	652	0,463	0,398
IX	556	21,8	655	502	0,384	0,311
X	443	16,6	565	425	0,31	0,235
XI	307	11,1	403	301	0,246	0,18
XII	267	6,8	191	98	0,165	0,13

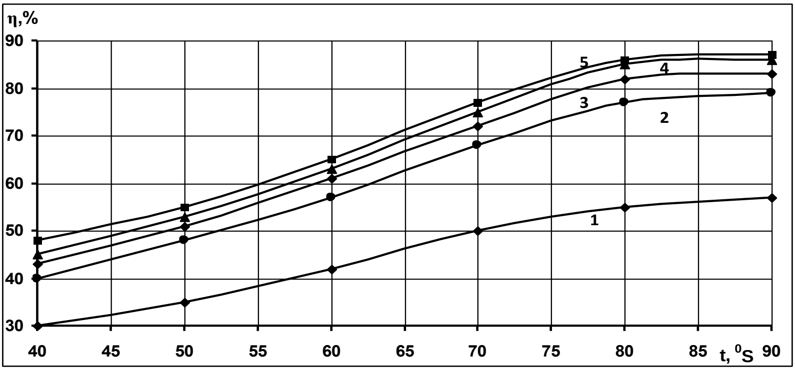


Fig. 14. Dependence of the coefficient of the oil pumping station on temperature. 1 - anhydrous oil production, 2 - oil production with a water content of 15-17%,3 - oil production with a water content of 25-30%, 4 - oil production with a water content of 35-40%, oil production with a water content of 45-50%.

The performance and efficiency of parabolic and parabolic cylinders, which depend mainly on the intensity of sunlight, vary depending on the curve of the parabola. The highest rates are observed in the summer, the average - spring and autumn, the minimum indicators - in the winter months, respectively.

As follows from fig. 14 coefficients of temperature increase and oil production are moving at a fast pace. The productivity of oil heated to 80-900 C is 35-40% higher than the performance of oil heated to a temperature of 50-60^0 C.

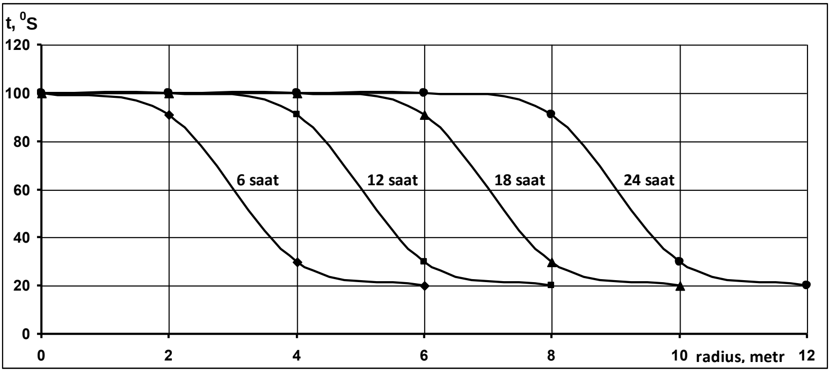


Fig. 15. Distribution of temperature along the radius of the coolant well with a temperature of 100^0 C for various times (6, 12, 18, 24 hours)

As can be seen from fig. 15 the coolant with a temperature of 100^0 C for 6 hours acts on a radius of 6 meters, and within 12 hours on a radius of 12 meters is cooled to a minimum temperature.

During exposure to heat transfer fluid to the well, temperature distribution - one of the main problems is the study of heat and mass transfer, which allows you to calculate the temperature distribution in the well when exposed to heat transfer fluid. In this case, the time dependence of the coolant supplied to the well is calculated and a distribution curve is constructed. In general, the experimental work on studying the process of oil production by heating with the help of a coolant consisted of two stages. At the first stage, the study of various factors affecting this process is provided. At the second stage, during the technological process, the study of the influence of all factors simultaneously possible is provided. In the first case, in the provided model of the system, the required temperature was provided. By transferring the heated coolant to the fabricated model of the system, an oil production process was created. Those. during the first experiments, the process was carried out in isothermal, and in subsequent stages - non-isothermal mode.

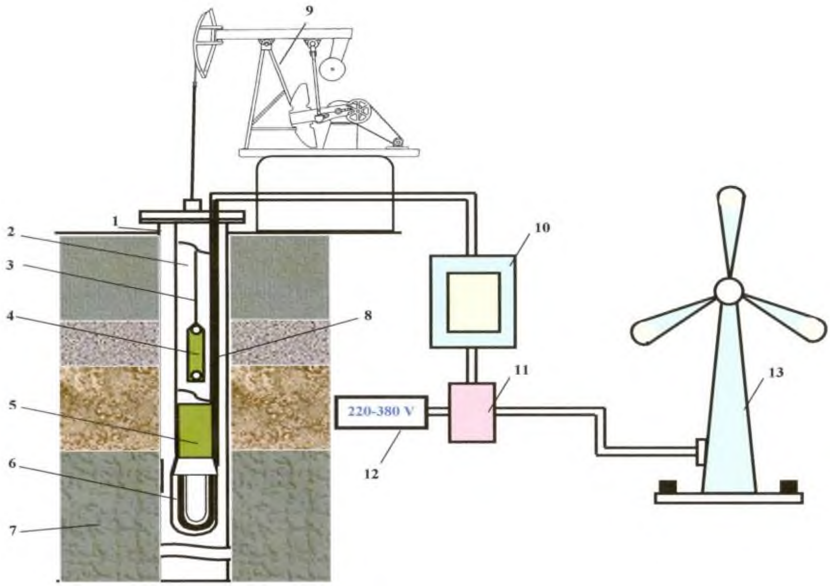


Fig. 16. Schematic diagram of the heating of the bottom-hole zone with the help of electric energy received from a wind engine.

Where 1 is the wellhead, 2 is the well, 3 is the rod, 4 is the pump, 5 is the dielectric mass, 6 is the thermoelectric heater, 7 is the formation, 8 is the electric cable, 9 is the rocking chair, 10 is the control panel, 11 is the transformer, 12 - auxiliary electric network, 13 - wind engine.

During the development of oil fields, interval intake and release of a thermoelectric heater into the well, some cooling occurs in the formation, which causes a violation of the stationary mode. To find out the amount of heat needed during interval heating, the formation cooling process was first experimentally studied. With this approach, during treatment by the electro thermal method, when the formation and the bottom-hole zone are heated, taking into account inertness, along with studying the temperature distribution, in order to increase the efficiency of the technological process, energy-saving technologies were applied. As a source of electrical energy, using the method of electro thermal treatment of the bottom-hole zone, a wind engine was used (Fig. 16).

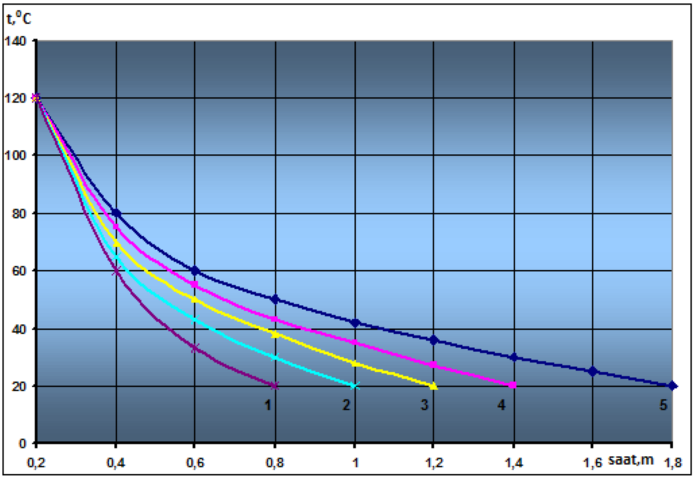


Figure 17. The temperature dynamics of the reservoir at a constant temperature (t = 1200 C) in the bottom-hole zone
1 - heating temperature T = 1000 C; 2 -T = 1100 C; 3 -T= 1200 C.

To obtain high productivity during experiments, regardless of the type of thermal method applied to the formation or well, the dynamics of heat distribution was also determined theoretically and practically. Knowing the equipment and types of rocks used in the wells, the possibility of determining the temperature distribution based on the heat equation was shown.

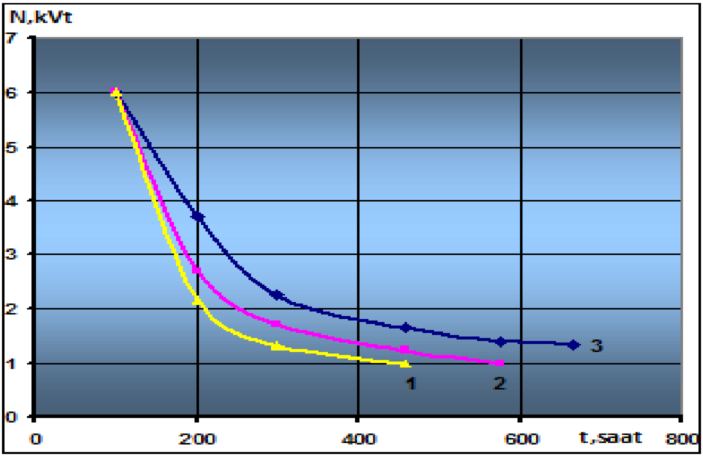


Figure 18. Time-dependent dynamics of thermoelectric heater strength. 1 – heating temperature T=100^{0}C; T=110^{0}C; T=120^{0}C;

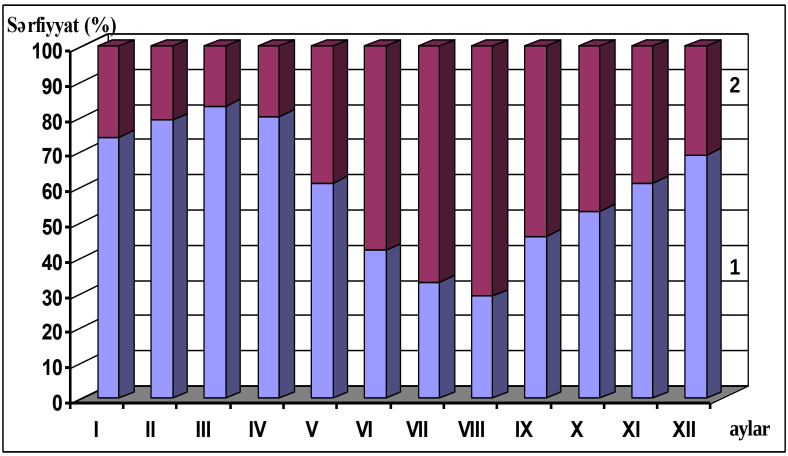


Fig. 19. Dependence of the energy consumption of the operated well with the help of a mains and a wind engine from the months of the year.

Where 1 is 8 kW electric energy received from a vertical axis wind engine, 2 is electric energy from a common network.

As can be seen from fig. 19, a vertical-axis wind turbine with a power of 8 kW generates the maximum amount of energy, mainly in February-April, and in July-August, these figures reach a minimum. From laboratory studies, it becomes clear that while using the method of thermoelectric heating, used in some dry fields, oil, in the reservoir, behaves as a viscoplastic fluid. But, as you know, during an increase in oil temperature, a change in the physical state occurs and the viscoplastic properties of the oil disappear.

Thus, the performed field studies showed that the maximum temperature is formed at the location of the thermoelectric heater. And, as a result, it is impossible to clean the well of resinous substances that fill its entire depth. Therefore, it becomes necessary to heat all parts of the formation to equal temperatures.

From the performed calculations and the obtained dependencies, it can be seen that the efficiency of the thermoelectric heater used is quite high, and the required power is 6 kW. To obtain such power, it is advisable to operate a wind engine with a rated outgoing power of 8 kW.

For the purpose of electro thermal treatment of the bottom-hole zone, a heat pipe has been developed (Fig. 20), which has internal heat resistance, the principle of its operation and a number of calculated data are given.

For the evaporation-condensation process, each of both ends of the heat pipe (1/3 of the internal volume consists of water) of the thermoelectric heater is a hermetically sealed cylindrical tube. Since the heat pipe of the thermoelectric heater in the U-form is 1/3 filled with water, the remaining 2/3 of the pipe is forced to more actively separate the heat. To increase the heat transfer coefficient, to ensure a continuous heating-cooling process and the effective operation of the installation, thin-walled ring-shaped ribs are welded along the entire surface of the outer wall.

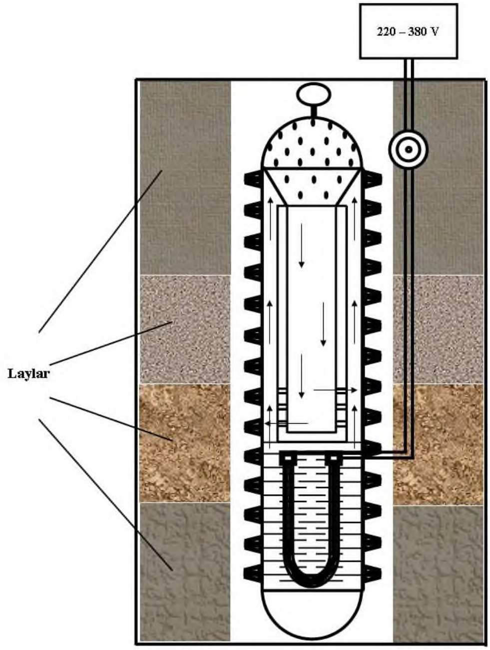


Fig. 20. Layout of a heat pipe with heat resistance in a well.

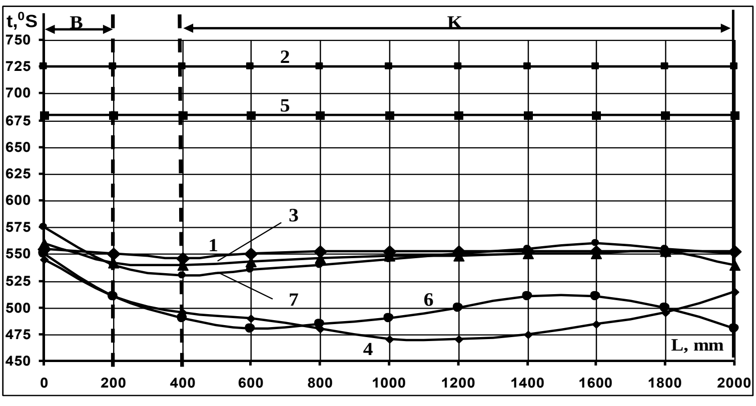


Figure 21. Temperature distribution along the entire length of the heat pipe.

Where 1 - 350 W, 2 - 520 W, 3 - 630 W, 4 - 670 W, 5 - 710 W, 6 - 735 W, 7 - 1500 W, And is the evaporation area, K is the condensation area

Table 5

Dynamics of temperature changes in the zones of evaporation, adiabat and condensation, depending on the voltage supplied to the heat pipe

Voltage, V	Evaporation Zone, °C	Adiabatic Zone, °C	Condensation Zone, °V
200	175	173	155
400	254	255	231
600	311	309	284
800	429	428	398
1000	562	560	535
1200	654	654	626
1500	742	740	708

Water lowered into the well and heated by a thermoelectric heater in a heat pipe, turning into steam, moves along the entire length of the pipe. Transferring its heat through the wall of the pipe, it becomes the reason for the necessary heat along the height of the well.

As can be seen from fig. 21, in curves 1, 3 and 7, when the power in the heat pipe reaches 350, 630 and 1500 W, the minimum value of the vapor pressure occurs at the beginning of the condensation area. But on curve 6, the vapor pressure at the beginning of the condensation area is minimal. On the curve, 4 pairs at the beginning of the condensation area moves with sufficient inertness. And, as can be seen, on curves 2 and 5 the process moves stably.

Table 5 shows the results of tests on a heat pipe, as well as the dependences of the temperature of the thermoelectric heater of the evaporation zones, adiabat and condensation on the voltage value.

The fifth chapter explores the efficiency of using alternative energy in oil production processes, as well as the use of energy-saving technologies. To this end, to inject “alien” water into the reservoirs, a new design of a solar desalination plant was developed and tested (Fig. 22).

Fig 22. The main view of the solar desalination plant

Table 6

Natural desalination plant test results Absheron Peninsula (July 20, 2011)

Day hours	Total solar radiation kcal/m^2 day	Temperature^{0}C						Amount of distillate l/m^2 hour	Efficiency. %
		Salt water	Vapour	Condensation surface	Out surface of glass	Bottom of plant	Side walls		
6	80	23	25	23	22	24	24	0,009	62 – 66
7	110	27	34	28	27	34	33	0,021	
8	193	43	48	44	43	47	45	0,068	
9	299	56	60	58	56	64	62	0,121	
10	405	68	73	69	67	71	60	0,298	
11	601	74	80	75	74	77	76	0,426	
12	758	80	86	79	77	80	78	0,503	
13	885	82	89	80	79	83	81	0,565	
14	833	81	88	80	78	85	82	0,532	
15	726	78	84	79	77	81	80	0,501	
16	504	75	80	77	76	76	75	0,476	
17	400	70	76	72	71	72	71	0,388	
18	313	66	71	67	66	66	64	0,362	
19	261	62	67	63	62	63	60	0,334	
20	132	55	61	57	55	56	53	0,302	
21	98	46	52	47	45	46	42	0,292	
22	55	42	44	42	41	42	36	0,285	

To obtain “alien” water, experiments were also carried out at other power plants. So the process of purification of formation or oil water (evaporation) was carried out. The data obtained are shown in table 7.

Table 7

Indicators of the purification of oil-water samples at various temperatures

20 – 80 % oil - water sample								
Temperature, ^{0}C	30	40	50	60	70	80	90	100
Cleaning %	31	36	42	48	55	62	69	78
50 – 50 % oil - water sample								
Temperature, ^{0}C	30	40	50	60	70	80	90	100
Cleaning %	23	26	30	34	39	45	51	58
80 – 20 % oil - water sample								
Temperature, ^{0}C	30	40	50	60	70	80	90	100
Cleaning %	18	22	25	29	32	36	40	45

Although the potential of the devices used during the experiment is higher, based on preliminary results, almost all of the three devices can be evaporated and can be used for desalination. However, a new and perfect design has been developed to make the sweetening process more efficient.

The purpose of designing such a design is to protect seawater from various salinity levels of the technologically and economically cost-effective selective layer used to effectively absorb the sun's rays in the receiver of the unit.

The problem is solved by the fact that, instead of a regenerative linear solar thermal device with a dark surface, directly in contact with the seawater, the thermal conductivity of the thermal conductive tubes and the thermal tubes, Pipe casing with perforated bathroom transparent glass plate in accordance with layout projection, vacuum environment with vacuum environment between the sides of the tube and the receiver with hermetically sealed glass sheets.

In the solar sweetener unit, only the direct contact with transparent glass sheets and small-scale heat pipes do not spoil the selective surface and prevent the high temperature caused by the heat generated by the vacuum between the transparent glass plate and the boiler.

High-temperature thermal conductivity with salty water, glass coating, tubular transparent glass tube casing, fresh water output, hose, thermal insulation on the inner surface of the body, high-selective thermal conductivity with a selective surface. welders that combine thermal boilers, pipes that connect the heat pipes to the pipe casing with a transparent glass layer, vacuum distance, salt water inlet, rear heat insulation and mirror reflecting solar rays.

The unit has a transparent glass-shaped tube casing with a high heat transfer capability and a selective surface capacity 6, which are interconnected with each other. High-throughput heat-insulated pipes with a chessboard shape are tightly coupled to a tub-shaped glass cage and also welded to a selective surface. The bottom and top of the floor are welded together with a tub-shaped transparent glass tube casing with high heat transfer capability in order to prevent salty water leaking over the tub of transparent glass tubes. The vacuum distance between the tubular cage and the selective surface of the bath-shaped transparent glass layer prevents heat loss. The selective surface absorbs both the direct sunlight and the reflection of the sun's rays, reflecting the sun's rays. With the introduction of salt water on the unit, the output of fresh water is attached to the body. The glass cover is attached to the base of the unit at 30^0 degrees.

The principle of operation of the device is the same.

If the device is small and mobile, it should be equipped with a solar tracking system, or if it is stationary, it should turn south. Firstly, a certain amount of salt water is injected into it through the inlet. The sun's rays penetrate through the glass cover of the rig, salt water, and a transparent glass-shaped tube casing, and the temperature is achieved by concentrating on the selective surface capacity. The temperature generated on the surface of the selective surface heat capacity moves through the thermal tubes with a high thermal conductivity of 6 on the surface to a cooler environment, that is, salty water. The chess-shaped welding of small-sized high-heat transfer pipes in the form of a chessboard aims to distribute the heat evenly across the field. This distribution of heat leads to an effective evaporation by completely covering the salt water, which in turn causes the device to rise and achieve a positive result. The tub-shaped glass casing, in turn, holds saline water, which is a bathtub function, and can be used to create heat from the thermal tubes, which have a high thermal conductivity in the form of chess through these holes. In addition, the choice of the distance between the holes in the tub-shaped transparent glass tube is based on the fact that the heat released from the thermal tubes in the form of chess shaped shapes will remain constant at this intermediate distance. On the other hand, the perforation of a tub-shaped glass tube cage results in the transfer of heat from the tubes, which have a high thermal conductivity in the form of a chess form, through the conductivity of the tub by the transparent glass tube. The salted water directly in contact with the upper part of the high-temperature thermal conductors in a chess form is evaporated and condensate in the bottom of the glass cover. Here, the droplets slip downwards through the lower surface of the glass coil due to the force of gravity and are removed from the fresh water. Salt water located above the tub-shaped glass casing on the unit does not flow downstream due to the bottom and upper couplings that connect the tubes to the tub-shaped transparent glass tube with high thermal conductivity. In order to increase the efficiency of the unit, the distance between the selective surface capacity and the bathtub transparent glass tube casing was vacuumed to avoid heat losses. To increase the intensity of solar rays falling on the selective surface capacity, a mirror reflecting solar radiation was placed on the rear wall of the unit. Directing the sun's rays, which fall parallel, causes additional heat energy on the surface of the capacity. The intensity of salt water evaporation increases as a result of the reflection of the sun's rays. The mirror, reflecting the sun's rays, has a flat surface and increases the efficiency of the device. Thermal insulation is placed between the hull and the inner surface to prevent the heat generated inside the unit.

Thus, the selective surface, which is technologically and economically costly to use when operating this unit, is long-lasting and effective because it does not have direct contact with salt water. Reflecting the solar radiation applied to the device, it also increases the solar intensity, but also increases the physiology of the vacuum distance between the selective surface receiver and the transparent glass tube cage.

Besides:

The materials used in the development of the device are both easy to find and economically inexpensive. The use of these materials fully meets sanitary and hygienic requirements and can be used in the food industry.

As the third phase of the study, we have developed a solar-cooling unit to carry out the process of desalination of sea water using solar energy. This unit is the first test model in the country and has been tested for months in 2010 and 2011.

The device consists of a wooden case (9mm thick), a black selective solar radiation receiver, a glass lid, access to salt water, an access to sweet water and an internal thermometer. The total weight of the sweetener (in the case of thirst) is 7 kg. The optimal capacity for salt water is about 1.3 - 1.5 liters. To determine the internal surface temperature of the receiver, the lower and upper parts of the surrounding walls and the cooling unit are equipped with thermocouples. The amount of solar radiation (direct radiation actinometer and diffuse radiation pyranometer and compatible galvanometer), wind speed anemometer, temperature and humidity were recorded during the tests. In addition, with the help of thermocouples, the temperature of the condensate, the vapor-air mixture, and the condensation surface in the upper and lower bottles of the lid were measured. It has been installed in accordance with the geographical location of the refrigeration unit to obtain maximum temperature. Here salt water is supplied to the sweetener from a 15 liter tank. Due to the difference in levels of the seawater and the boiler, the salt water enters the unit with its own flow. The solar energy that passes through the glass lid is almost absorbed by the radiation surface of the device, and the water on it is heated. The water vapor is then lowered to the bottom of the glass lid, where condensation occurs. The condensate obtained is flowing to the surface of the glass surface. The process of heating in the condensation system is very complex. For this purpose it is necessary to take the process in stationary mode when studying the solar sweetener.

For the first time we have developed and tested hybrid solar and wind energy systems to obtain stable electrical energy and in unsuitable places, in mining conditions, in energy saving systems.

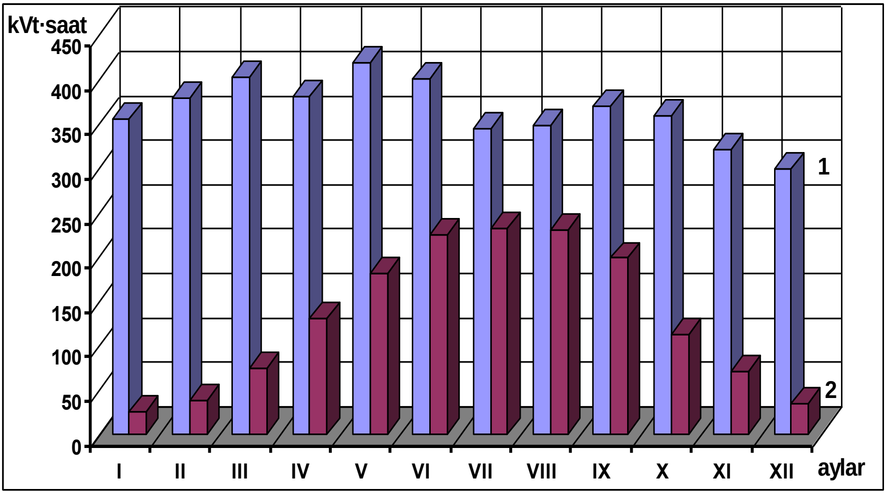


Figure 23. The amount of electrical energy received from the hybrid system for the year.

where 1 is the amount of electric energy received from the wind engine per year, 2 is the amount of electric energy received from solar panels per year.

Based on theoretical calculations and experiments, we can conclude that the combined use of solar and wind energy, the possibility of accumulation of this energy seem more favorable. We have implemented the full functioning of such a system at the training ground of the city of Baku and ensured continuous operation for 6 years. Part of the results obtained during the operation of the combined system are shown in table 8.

Table 8

The generating capacity of a solar and wind power plant with a total capacity of 11 kW for 2008-2014. by seasons of the year and time of day

Day hours	Generating energy, W			
	Spring	Summer	Autumn	Winter
0-1	3415	4512	3256	4250
1-2	3452	3804	3255	4420
2-3	3500	3215	3255	4810
3-4	3510	2925	3000	4804
4-5	3512	2700	2982	4800
5-6	3425	2700	2980	4800
6-7	3397	2865	2980	4810
7-8	3360	3205	2980	4830
8-9	3220	3600	2878	4840
9-10	3005	4210	3015	4863
10-11	3010	4320	3058	4878
11-12	3058	4550	3120	4880
12-13	3128	4550	3480	5010
13-14	3245	4562	3520	5112
14-15	3232	4530	3510	4759
15-16	3200	4302	3500	4621
16-17	3190	4300	3250	4250
17-18	3190	4105	3220	4015
18-19	3215	4620	3215	3854
19-20	3296	4709	3215	3800
20-21	3374	4710	3005	3980
21-22	3388	4622	3000	4025
22-23	3401	4620	3089	4087
23-24	3410	4601	3132	4112

As follows from table 8, the generating power of a solar and wind power plant with a capacity of 11 kW reaches a minimum of 2700 W in the summer, and a maximum of 5112 W in the winter, respectively.

Received from the hybrid system, the average daily, annual average and seasonal seasonal indicators of electrical energy of the experiments performed were processed using the computer program SWPMP of the SCADA system. Theoretically, in order to obtain more accurate results, daily average, monthly average, annual and average seasonal calculations were performed, and the obtained values were compared with the values obtained under natural climatic conditions.

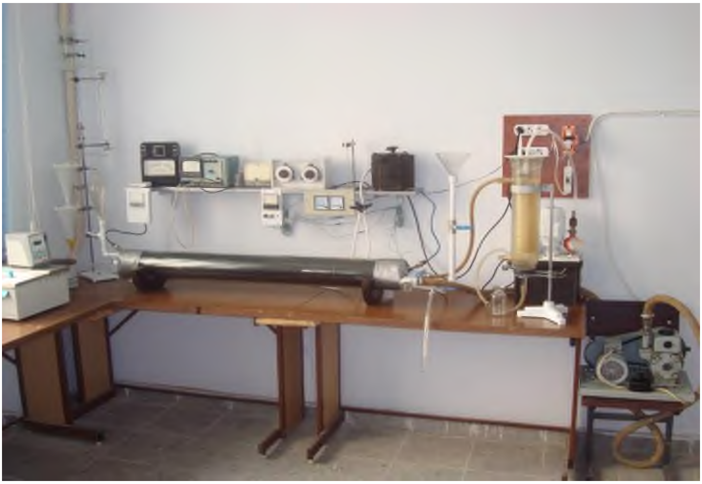


Fig. 24. General view of the laboratory installation of the storage system: solar heat exchanger - helioreactor

Technological processes for various purposes on new universal solar reactors have been completed. Here, mainly heat storage material with a different phase transition was used. A laboratory universal helioreactor was manufactured and experiments were performed (Fig. 24), which took a long time.

And at present, the accumulation of heat in solar thermal energy systems, also using various methods and means, is the accumulation of heat in solar energy systems. Such methods are most often used in high power solar thermal power plants. When choosing an accumulating material, it is important to know what is the change in its thermophysical properties in the range of medium and high temperatures and pressures. Heat-accumulating materials, consisting of river and rocky stones, are used to retain thermal air, as well as to heat hot water or other heat carrier, consisting of various liquids, having a high heat capacity.

In this study, at all times of the day, including night hours, during changes in the compression of the flow of sunlight and the ambient temperature, heat storage materials (paraffin, wax, transformer oil, industrial oil) were used to ensure the required temperature in the technological processes for producing hot water and steam oil, etc.) with stable thermal properties.

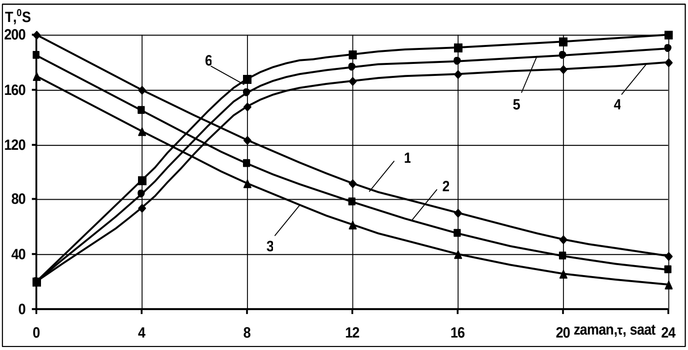


Figure 25. Dynamics of temperature change depending on time. in a heat storage system

In fig. 25 the dependence of the cooling system of the air stream heated at speeds of 1; 1.5; 2 m / s, from time shown on curves 1, 2 and 3, respectively. Dependence of an airflow system heated at speeds of 1; 1.5; 2 m / s, from the time of transition to the stationary mode is shown on curves 4, 5 and 6, respectively.

As can be seen from fig. 25 the system warms up to a maximum of 2000 C. After reaching the stationary mode, the air flow, at 3 different speeds, is moved along the inner pipe. Over time, cooling dynamics occur. On the other hand, both the time for ensuring the movement of the air flow through the inner pipe and the time the unit is in stationary mode are determined.

Development and operation of heliosystems with stable output to ensure continuous operation of technological preconditions in mining conditions are key. For this purpose, a thermally charged solar collector, which is a more energy efficient and constructive system, has been developed to maintain the heat flux in the unit during the interruption and reduction of solar radiation in semi-arid weather conditions.

The issue presented here is that the heat accumulated solar collector is placed inside the general body, with heat insulation absorbed by the sun's rays, absorber for heating of the heat exchanger, solar panels for the solar panels. cylinder tube with a high thermal conductivity for moving the collector in place of the collector instead of the collector, long-term heat retention and high heat transfer to the overall system, which is a box with a reflective box, In addition, cover the bottom of the unit with flat mirrors on the 4 sides has moved. Zenith stairs are mounted on the racks to allow the perforated glass beams and flat mirrors to be perpendicular to the sun's rays.

In this design, the temperature of the heated heater in the tube is enhanced by the fact that the thermal accumulator is stable to the black fluid hemisphere;

The thermal accumulating black liquid is mainly paraffin, wax, oil or binary mixture with a temperature of 160 ÷ 450, 132 ÷ 355, 165 ÷ 180 kC / kg, respectively.

The unit operates 14 interconnected air exhaust pipes 13 connected to the air outlet tube with 6 of the thermal accumulator inlet 6 to fill the thermal accumulator 10 inside the transparent glass box. The transparent glass box is equipped with 11 extensor jugs, taking into account the thermal accumulation coefficient of 10 in the interior of the box. The 4 flat mirrors attached to the base of the device reflect 16 of the thermal accumulator inside the transparent glass box, as 16 additional auxiliary areas. The thermal accumulator 10 and the welded pipe 3 are in direct contact. Thanks to this connection, any liquid or gas can be heated to a long-term fixed temperature by passing through the 3 inlet of the welded pipe. In addition, interoperability joints 7 achieve greater productivity by providing the sun's perpendicularity to the rig using the 18th angle of the rod, 18 on the rod.

The principle of operation of the device is the same.

First, the inlet of the thermal accumulator is opened by opening 5 and filling the thermal accumulator 10 inside the transparent glass box. At the same time, the ventilator of the air outlet pipe is kept 14 open. After filling is completed, the valves 5 and 14 are closed. The rods are then positioned in one of the 17 steps of the anti-aircraft axis, according to the sun's monthly zenith angle with 7 of the 18 joints. This is mainly intended for sun rays to perpendicular to the device. The sun's rays falling on the device pass through the glass cover1 and begin to heat up the heat accumulator in the inside of the transparent glass box 10. At the same time, the coil-shaped tube in 10 parts of the heat accumulator is 3 heated. In accordance with the coefficient of thermal accumulation of 10 heat, there are 11 expansion boards. The heater moves 4 through the inlet and 3 inside the wrapped tube, moving 12 where it is required, excluding the heat exchanger 12. The flat mirrors on the four sides of the rig provide additional power flow to the unit. The reflective plate 8 attached to the back of the transparent glass box 8 is designed to prevent the rays from falling onto the device, that is, to prevent radiation loss. The box 2 is placed in vacuum cavity 15 on each side to prevent the heat generated from the heat accumulator inside the inside of the 2 inside the transparent glass box. When heating the heat of the unit through solar energy, it is possible to achieve a constant output temperature of 15-60 minutes and a temperature of 200-4000C, depending on the type of heat accumulator.

Thus, using the proposed design, solar radiation is the only source of environmentally friendly energy that can be absorbed into the single site by providing a higher density of solar radiation, without heat loss, and avoiding solar radiation from the clouds, mobile or stationary. Liquid and gaseous heaters are heated to high temperatures (maximum 400^0C).

The sixth chapter discusses the economic, environmental, and sociological feasibility of using alternative energy sources in oil production processes. We consider the reduction of prices for thermal and electric energy, affecting the price of oil produced, to a minimum due to the installation of alternative energy. The amount paid for both fuel combustion and atmospheric pollution is directly dependent on oil production. In order to solve this problem in oil production processes, considering the technical and economic aspect of the use of alternative energy plants in the framework of environmentally friendly and energy-saving technologies, it can be noted that for any such project, the proposed investment, taking into account the discount coefficient, is 5- 6 years. The implementation of projects of this type is most effective on the Absheron Peninsula and adjacent territories, which are the most profitable both in oil and gas potential and in alternative energy resources.

So, according to the results of calculations, taking into account current market prices, each of the alternative energy plants with a capacity of 1 MW per year brings economic benefits, on average, in the amount of 500,000 AZN. Obtaining such an economic effect is based on saving all types of fuel during oil production, with a new approach, through the use of alternative energy plants. At the same time, capital investments in such plants pay for themselves, on average, in 3.5 years. And the operating time of alternative energy plants, on average, is 20-30 years. During this period of time, these installations require low maintenance costs. The main repair costs are required every 10-12 years.

To carry out these calculations, one of two options must be taken into account - either in real mode, i.e. without the influence of inflation; or in nominal mode - taking into account inflation. Since these projects are long-term and conducive to the future development of the energy sector, in most cases inflation is taken into account.

In the eco-economic assessment of the project, taking into account the special criterion of discounted benefits, it can be noted that the use of alternative energy plants is significantly superior compared to traditional mining equipment.

Thus, the calculations performed during the development of the project allow the project to receive long-term benefits. This project, which can be operated for 25 years, taking into account current market prices, is able to return the investments made in it within 5.4 years. On the most advantageous, both in oil and gas potential, and in alternative energy resources, in areas on the Absheron Peninsula and adjacent territories, the implementation of this project would be most effective. The implementation of the project is accompanied by great benefits, from an environmental point of view. Thus, this project will prevent the release of 25 million m3 of carbon dioxide per year.

Given the above, it can be noted that this project, from the point of view of using alternative and renewable energy sources in Azerbaijan, is important, and from an environmental and economic point of view, it is a successful project.

Given that the world's conventional fuel resources are depleted, so far, the use of alternative energy sources, which is the energy of the future, for the "green world."

Of course, the use of alternative energy installations in energy-intensive processes in mining conditions is unequivocally and environmentally superior, but at first glance, investors may seem at risk of investing. To do this, we need to determine the cost-effectiveness of the installation and commissioning of alternative energy facilities, based on the evaluation of economic performance of the abovementioned investment projects and the indicators obtained. To this end, let's take a look at the feasibility study that describes the comparative analysis of traditional mining equipment, alternative energy installations and their costs, as defined below:

While the difference in capital investment between conventional mining equipment and alternative power plants may seem small at first glance, it will save up to 5,662,280 AZN a year thanks to the use of alternative power installations. The payback period for installing and commissioning alternative power plants is 5.4 years. As mentioned, the project is designed for long-term operation. With that in mind, let's take a look at international practice assessment techniques to determine how eco-economically viable the project is based on the indicators:

Two approaches can be used for the eco-economic assessment of such a project for the oil and gas industry.
1. Expenses - Income.
2. Expenses - efficiency.
During the eco-economic assessment of a project, the following key economic criteria should be used to identify each of these approaches:
• Net Discounted Income or Integrated Profit (XDG)
• Internal rate of return or internal rate of return (DGN)
• The profitability index or the profitability index (GI)
• Cost and Income Difference (XGF)
• Maturity Period (OM)
Determining the net present value of the project's environmental costs and revenues, or its integrated benefits, can only be done by calculating the discount rate of environmental costs and revenues in accordance with the economic performance of the project:

$$XDG = \sum_{t=0}^{T} \frac{Be_t - Ce_t}{(1+r)^t} \quad \text{or} \quad XDG = \sum_{t=0}^{T} \frac{Be_t}{(1+r)^t} - \sum_{t=0}^{T} \frac{Ce_t}{(1+r)^t}$$

Here,
Be_t - environmental and social income;
Ce_t - environmental and social costs;
t - project evaluation year;
r - discount rate;
T - time required for project implementation.
If the use of natural resources envisaged during the project is increasing, then the following calculation can be used.

$$XDG = \sum_{t=0}^{T} \frac{Be_t}{(1+r)^t} - \sum_{t=0}^{T} \frac{Ce_t}{(1+r)^t} - Vr$$

Here is Vr the value of the natural resources used, which are discounted for an infinite period of time, and this quantity is definitely included in the list of environmental and social costs and is defined as:

$$Vr = \sum_{t=0}^{T} \frac{Ce_t}{(1+r)^t}$$

In this calculation, the indexes of environmental and social expenditure lists can be derived from the literature.
To determine the net profit and general eco-economic assessment included in the calculation of the economic efficiency of the project, its environmental benefits, discounted environmental costs:

$$XDG = \sum_{t=0}^{T} \frac{(Bk_t - Ck_t) + (Be_t - Ce_t)}{(1+r)^t}$$

Here,
Bk_t - commercial profit;
Ck_t - commercial delays.
To make such a calculation, one must definitely take into account one of the two options, either in real terms, without the effect of inflation, or in the nominal terms. Because such projects contribute to the development of long-term and future energy, inflation is often taken into account.

Looking at the graphical dependence of the project on the eco-economic assessment of the project, it can be seen that the use of alternative energy facilities is much higher than that of traditional mining equipment.

As is the case in various industries today, the oil extracting and refining industries are causing environmental pollution by releasing pollutants into the atmosphere. The profile of the oil refining facility, the depth of the technology for the production of products, the technical, technological equipment and facilities used for the determination of the damage. and socio-environmental and economic assessments of operating indicators, the amount of fuel and electricity consumed, the range, volume of commodity oil, water used for industrial purposes, and torpedo fields. To make such an assessment, it is first necessary to consider the requirements of the existing ecosystem. That is, at each stage during the production process, in the processing and preparation of consumer goods, including oil products, the requirements of environmental standards must first be met. So far, the law of the Republic of Azerbaijan on protection of the environment of the Republic of Azerbaijan "Law of the Republic of Azerbaijan on environmental safety", "Law of the Republic of Azerbaijan on environmental protection" dated March 27, 2001" and so on. Laws were adopted, 2010 was declared the Year of Ecology by the decree of the President of the Republic of Azerbaijan Ilham Aliyev.

Since the 19th century, the intensification of the industrialization period has led to a significant increase in environmental pollution on Earth, particularly in greenhouse gases CO_2, NO, and so on. Has caused an increase in the as a result of the increase in greenhouse gases, the amount of air absorbed by the infrared radiation from the sun has also increased. In addition, the average temperature and atmospheric CO_2 concentration in the Earth also increased.

A large number of fuel-burning facilities emit CO_2, CH_4 and N_2O, the main greenhouse gases. The amount of CO_2 emitted from such facilities is 1/3 of total CO_2. Carbon dioxide (CO_2) is one of the most detrimental to products released from combustion of organic fuel. Due to the high level of this indicator in liquid fuels, only gas fuels have been used at thermal power plants in our country over the past few years.

The requirements of environmental standards for the oil industry considered in this study can be summarized as follows: consumer products should not cause harm to humans and other living organisms from harmful substances; the harmful substances contained in the products must be completely removed; production waste should not violate the ecological balance of the environment; production products should be prepared in such a way as to prevent ecosystem degradation and so on. Based on these indicators, almost the oil industry has the use of environmentally friendly and economically viable renewable energy resources for both the production of the final commodity and for the treatment of water, air and soil that is exposed to environmental pollution during production the problem will be solved.

RESULTS

1. For the Republic of Azerbaijan and the Absheron Peninsula, the characteristics of direct, diffuse, albedo (reflected) and average annual, monthly, average daily distribution of total solar radiation were determined and a map was compiled; compiled a nomogram showing the dependence of the intensity of solar radiation on the height of the sun above the horizon.
2. The average annual wind potential in the Republic of Azerbaijan has been determined and a corresponding map has been drawn up; wind speed and direction were determined at an altitude of 3, 5, 40, 60 and 80 meters above the ground; Based on the results obtained, maps of the average annual speed were compiled and a wind rose was built.
3. The energy potential of the wave of the Caspian coastline of the Absheron Peninsula was determined and a corresponding map was compiled; the average annual energy production over the territories was determined and, corresponding to this potential, the marine wave power plant with the Wales turbine was investigated; The main energy indicators were obtained.
4. The power generation indicators and the efficiency of using a G8X-2.0 MW wind turbine operated in natural conditions have been practically proved and implemented. The optimal options for the operation and placement of new wind turbines of this type were proposed.
5. In order to influence the formation with heat to produce hot water and steam, solar power plants have been developed - high temperatures (1300^0 C), medium (500^0 C) and low (200^0 C). The installations were tested at solar radiation indices of 200-1000 W / m2; The average annual, monthly average and seasonal seasonal values of the test results were obtained.

6. To supply hot water to the reservoir and well, a new design solar collector has been developed and practically investigated. This solar collector, in comparison with analogs, is 3 times more efficient and long-term in operation.
7. To ensure autonomous operation of the system for providing general electric energy and field equipment, a new wind engine with a planetary gearbox has been developed and tested.
8. An innovative, practical and theoretical justification in the field was given of methods for influencing the formation and bottomhole zone with thermal and electric energy received from alternative energy plants.
9. In order to increase the efficiency of the bottom-hole zone and expand the scope of the impact methods, a heat pipe with a new storage system, powered by a wind engine, has been developed.
10. To compress residual oil and purify oil water, in order to produce "foreign" water, a solar desalination plant and a laboratory oil water purification plant have been developed.
11. In order to ensure the stability and stability of the method of exposure to heat, a heat storage helioreactor is developed - a system that changes heat.
12. In order to heat and maintain a constant temperature range of the air supplied to the reservoir, a solar air collector and a heat storage unit have been developed.
13. In order to provide autonomous and stable electricity in mining conditions, a system for generating electric energy and hybrid type accumulation has been developed and implemented.
14. The use of alternative plants and energy sources in the oil industry is economically and environmentally sound.

List of published works on dissertation topic

1. Mammadov F.F. Solar energy application for purification and treatment of waste in oil fields / Tenth World Renewable Energy Congress and Exhibition: Glasgow, Scotland, 2008, p. 1992-1994

2. Mammadov F.F. Possibility of Solar and Wind Energy Plants' Application in Proceedings of the 4th International Conference on Technical and Physical Problems of Power Engineering, Pitesti University, Pitesti, Romania, 2008, pp.VII-17-19

3. Mammadov F.F. Ecological benefits of solar and wind energy application in oil fields / Petroleum Geology & Hydrocarbon Potential of Caspian and Black Sea Regions, 6 - 8 October 2008, Baku, pp. 18-21

4. Mammadov F.F., Samadova U.F. Experimental results of using a parabolic trough solar collector for thermal of crude oil // Journal of Energy in Southern Africa, 2008, v.19. pp .. 70-76.

5. Salavatov T.Sh, Mammadov F.F. Development strategy of alternative energy sources in the field of science and education in ADNA / Scientific conference dedicated to the 90th anniversary of the Azerbaijan State Oil Academy, 2010. p. 36–37

6. Salavatov TS, Mammadov F.F, Panahov E.A. Possibilities of using alternative and renewable energy sources in technological processes of oil production // Azerbaijan Oil Industry, 2011, № 6-7, p.46-49

7. Mammadov F.F. Solar Energy Utilization and Modern Solar Energy Facilities in Azerbaijan. Baku: Progress, 2011. 204 p.

8. Mammadov F.F. New universal helioactor with recuperative type heat exchangers with heat accumulation in solar power plant // Problems of Energy 2011, №4. pp.52-57

9. Mammadov F.F. Estimation of flat plate solar collector productivity // International Journal of Technical and Physical Problems of Power Engineering, 2012, v.4, pp.35 - 40

10. Mammadov F.F. Solar Energy Application for Desalination of Caspian Sea Water // International Journal of Environment and Sustainability, 2012, v.1, pp.34-42

11. Mammadov F.F. Selective Surface Study of Solar Heat Receiver // International Journal of Energy Engineering, 2012, v.2, pp.138-144

12. Salavatov T.Sh, Mammadov F.F. Possibility of using alternative energy installations to increase oil deliveries of lye / II International Scientific and Practical Conference on New Technologies in Oil and Gas, Baku: 2012, p.155-157

13. Mammadov F.F. Renewable Energy Policy and Production of Solar and Wind Energy Plants in Azerbaijan // Engineering Science Letters, 2012, v.1, p.25-31

14. Mammadov F.F. Development of solar water collector and solar thermal accumulator // Energy Problems, 2012, №4. pp. 38-45.

15. Salavatov T.Sh., Mammadov. F.F. Guseinova A.V. The use of solar energy in subcontracting and transport oils / "Problems of exploitation of oil and bitum oil and bitum". 2012, Ukhta, pp. 193-197

16. Mammadov F.F. Development of Equipments for Renewable Energy Sources: Case study in Azerbaijan. // Advances in Energy Research. Energy and Power Engineering. NOVA Publishers, New York, 2013. Chapter 21, pp. 533–555.

17. Mammadov F.F. Thermo technical calculation of heat exchanger for solar energy plants // Science and Technology, 2013, v.3, pp.55-60

18. Mammadov F.F. Technical and economic feasibility study of combined solar-fuel energy plant // Resources and Environment, 2013, v.3, pp.20-23

19. Mammadov F.F. Yearly Average Maps of Solar Radiation in Azerbaijan // Energy and Power, 2013, v.3, pp. 44-50

20. Mamedov FF Solar power tools and insulation or thermal characteristics // Journal of Energy, 2013, No. 5, pp. 40-43

21. Salavatov T.Sh, Mammadov F.F. Researches on Residual Oil Extraction through Heat Insulation at Solar Energy and Energy Fields // Proceedings of the 85th Anniversary of Academician Azad Khalil oglu Mirzazhanzadeh, "Non-Newtonian Systems in the Oil and Gas Field", 31, 2013, Baku. 232.

22. Mammadov F.F. Technical and economic aspects of wind energy application in Azerbaijan // International Journal of Energy Engineering, 2014, v.4, pp. 1-4

23. Mammadov F.F. Investigation of energy parameters of cylindrical helioreactor of facet type parabolic and parabolosylindrical concentrator // Ganja branch of ANAS, 2014, № 55, pp. 120-128
24. Mammadov F.F. Ecological and economic importance of using modern alternative energy technologies in Azerbaijan / II International Conference of Young Researchers, dedicated to the 91st anniversary of national leader Heydar Aliyev, 2014, Caucasus University, Baku, p.648
25. Salavatov T.Sh, Mammadov F.F. Investigation of Temperature Distribution during Electrothermal Processing of Oil Fields / Actual Problems of Mathematics and Mechanics. International Conference on the 55th Anniversary of the Institute of Mathematics and Mechanics, 2014, Baku, pp. 313 - 316
26. Mammadov F.F. Ways to Increase the Effectiveness of Focusing Solar Energy Facilities / "The classic and modern problem of mechanics", dedicated to the 100th anniversary of the birth of prominent scientist of Azerbaijan, corresponding member of ANAS, doctor of physical and mathematical sciences, professor Yusif Aman oglu Amanzade 2014 , Baku, pp. 109-199
27. Mammadov F.F. Esperimental study of steam-generating solar power plant in natural climatic conditions of the Absheron peninsula // Ecology and Water Resources, 2014, № 2, p. 84-89
28. Salavatov T.Sh, Mammadov F.F. Investigation of thermal effects on the layout and borehole zone using wind energy // Azerbaijan Oil Industry, 2014, No. 5, p.41-46
29. Salavatov TS, Mammadov F.F. Investigation of use of flat solar collectors to increase oil supply ratios // News of Azerbaijan Technical University, 2014, No. 3, pp. 30-34
30. Mammadov F.F. Development and study of hybrid solar and wind energy systems // Review of Energy Technologies and Policy Research, 2014, v.1, pp.9-19
31. Mammadov F.F. Investigation of thermal tube with internal heat // Ecoenergetics, 2014, № 2, pp.10-13
32. Salavatov T.Sh, Mammadov F.F. Experimental study of the use of high-capacity solar installations in the thermal development of oil

fields // News of the Azerbaijan National Academy of Sciences, 2014, №1, 2 pp. 85-88

33. Mammadov F.F. Investigation of the heating effects of layers through the solar and wind vapor generator // Energy Problems, 2014, # 1, pp.54-59

34. Mammadov F.F. Theoretical and experimental study of seasonal use of alternative energy facilities / 1st International Scientific Conference of young scientists and specialists. The role of a multidisciplinary approach in addressing the actual and fundamental problems of earth and earth (technical, chemical and chemical), 2014, Baku, p. 86-88

35. Mammadov F.F. The Effective Process of Wattening Oil Fueling Methods / "The Problems of Hemorrhagic Carbohydrate and Ore Carrying Out", Proceedings of the VII Verkhovsky Conference, 2014, Perm, pp.242-244.

36. Mammadov F.F. Mobile Solar Parogenerator for Heating in Oil / Vertical Skills / Conference Students, Post-Graduate Students and Scholars "Materials and Technology XXI Veca", 2014, Kazan, p.119

37. Salavatov T.Sh, Mammadov F.F. Determination of the economic efficiency of the use of alternative energy sources in oil and gas extraction / Caspian Scientific-Practical Conference, 2014, Baku, p.

38. Mammadov F.F. Thermal-energy analysis of helioreactor-heat exchanger system of solar energy facilities // SRI "Geotechnical problems of oil and gas and chemistry", Proceedings XV, 2014, p. 232–240

39. Mammadov F.F. Distribution Characteristics of Solar Radiation in Azerbaijan // Journal of the Caucasus University - Mechanical and Industrial Engineering 2014. v.2, pp.159-166

40. Mammadov F.F. Experimental Resonance Fluid or Fluid Fluid in Fluids with Solar Energy Utilization in Memory Methods / I Vertical Research Conference "Energy and Energy: Theory and Practice" 3-5 Decemder.

41. Mammadov F.F. Elevated thermal power parameters of the solar collector / I Versossian labor-practical conference "Welcome to Power" December 17-19, 2014, Kemerovo.
42. Mammadov F.F. Ecological and economic evaluation of the use of alternative energy facilities in technological processes of oil industry // News of Azerbaijan Engineering Academy. 2015, No. 1, pp. 95-101
43. Mammadov F.F. Ecological and economical estimates of the exploitation of energy sources in oil and gas processes // Journal of Energy Energy, 2015, No. 12, p.57-59
44. Mammadov F.F. Investigation of geometric, optical and energy parameters of helio-reactor systems with a focusing solar concentrator // Energy Problems, 2015, №4, p.57-62
45. Mammadov F.F. The Wind Energy Potential of the Absheron Peninsula // Journal of the Caucasus University - Mechanical and Industrial Engineering 2015, V 3, No.2, pp.175-182
46. Salavatov T.Sh, Mammadov F.F, Guseinova A.V. Perspectives on the use of alternative sources of energy in the oil production. International scientific-technical conference, academician A.H. Mirzazhanzadeh. Ufa, 16-18 November 2016. c 51-55
47. Salavatov T.Sh, Mammadov F.F, Guseinova A.V. Temperature regimes in volatile thermal insulation method. The Virtual Business Conference on Modern Technology in Oil and Gas Industry. Makhachkala 2016. c. 188-189
48. Mammadov F.F. Solar Energy Plants 'Sun Tracking Systems' Experimental Results and Energy Calculation // International Journal of Energy Engineering. 2017, 7 (1): 28-31.
49. Mammadov F.F. Solar Reactor Storage Systems Based Study on Phase Transition Material // International Journal of Energy Engineering. 2017, 7 (3): 74-78.
50. Mammadov F.F. Wave Power Plant Analysis on the Northeast Coast of the Absheron Peninsula // American Journal of Modern Energy. 2017; 3 (4): 84-89.

51. Mammadov F.F. Justification of conditions and requirements for installation and operation of wind turbines // Energy Problems, 2017, # 1, p.85-90

52. Mammadov F.F. Investigation of the influence of the electric field on the layout system on the basis of alternative energy sources // Azerbaijan Petroleum, 2017, No. 6, p.62-65

53. Mammadov F.F. Investigation of heat distribution in the solar sweetener facility // Ecology and Water Management, 2017, №5, p.21-24

54. Salavatov T.Sh, Mammadov F.F, Guseinova A.V. Economic Evaluation of the Use of Renewable Energy Sources in Mining // News of Azerbaijan Higher Technical Schools, 2018, No. 4, pp.25-29

55. Mammadov F.F. Experimental study of solar sweetener in natural climate of Absheron peninsula. Azerbaijan Engineering Academy News, 2018, # 2, p. 119–124

56. Salavatov T.Sh., Mammadov F.F. Solar power plant application in thermal effects of the oil reservoir process. The 6th International Conference on Control and Optimization with Industrial Application, July 11-13, 2018, Baku, Azerbaijan. pp. 327-329

57. Mammadov F.F. Three-axis planetary reducer wind generator. A2013 0082. Patent and Trademark Examination Center of the Azerbaijan Intellectual Property Agency. Notification of positive result of preliminary examination.

58. Salavatov TS, Mammadov F.F. Equipment for thermal treatment of wells. A2013 0088. Patent and Trademark Examination Center of the Azerbaijan Intellectual Property Agency. Notification of positive result of preliminary examination.

59. Mammadov F.F. Solar collector with heat accumulator. U 2016 0002. Patent and Trademark Examination Center of the Azerbaijan Republic Intellectual Property Agency. Utility Models in Industrial Property (Monthly Official Bulletin), No. 8, Baku - 2019. p.13

60. Mammadov F.F. Solar Energy Installation.U 2016 0003. Center for Examination of Patents and Trademarks of the Azerbaijan

Republic Intellectual Property Agency. Utility Models for Industrial Property (Monthly Official Bulletin), No. 8, Baku - 2019. p.12
61. Mammadov F.F. Solar still. U 2016 0004. Patent and Trademark Examination Center of the Azerbaijan Intellectual Property Agency. Utility Models for Industrial Property (Monthly Official Bulletin), No. 8, Baku - 2019. p.12
62. Mammadov F.F. Solar energy plant application in thermal effect of oil reservoir // Petrochemistry and Refining Processes. 2019, Vol.20, No.2, pp.116-124.
63. Salavatov T.Sh., Mammadov F.F. Thermal effects on the mud and wells and the prospects for using alternative power plants for this purpose // Azerbaijan Petroleum, 2019, No. 4, pp. 37-39.
64. Mammadov F.F. Fuzzy Logic Controller Application in Hybrid Solar and Wind Energy System / International Artificial Intelligence and Data Processing Symposium (IDAP). 2019. pp. 00-00
65. Mammadov F.F. Increasing the efficiency of the oil process formation by heat methods // Processes of Petrochemistry and Oil Refining. 2019, Vol.20, No.4, pp. 373-382

Personal contribution of the researcher in the published works:

[1,2,3,7,8,9,10,11,13,14,16,17,18,19,20,22,23,24,26,27,30,31,33,34,35,36,38,39,40,41,42,43,44,45,48,49,50,51,52,53,55,57,59,60,61,62, 64, 65] cases are free;
Carrying out of patent searches on cases [57,58,59,60,61];
Issue of cases [4,5,6,12,15,21,25,28] issue, conduct and analysis of results in experimental studies;
Conducting investigations, summarizing and systematizing the results of the cases [29,32,37,46,47,54,56,63].

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