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МАЗМҰНЫ

generator system were identified when using it from a source of waste heat. The introduction of this power generation system will reduce the need for small and medium-sized boiler houses to supply their own needs with the issuance of excess electricity to the centralized power grid, reduce dependence on energy fuel, and ensure an increase in energy capacity.

The issues of energy efficiency of the turbine-generator system are considered. There is a slight decrease in the efficiency of the turbine generation system due to an increase in the temperature of the ambient outside air (1-2%), as well as the estimated specific consumption of reference fuel, which amounted to 0.01-0.05 kg/kW•h with changes in the ambient temperature by 5-7 0C. It has been proven that the system is efficient and can generate enough energy during operation, which will cover the costs of electricity consumption for the boiler house's own needs, reduce the load on the climate, and ensure the reliability and uninterrupted power supply.

Ключевые слова: secondary energy resources, boiler, steam turbine, turbogenerator, mechanical energy, electrical energy, boiler house

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AUTONOMOUS POWER SUPPLY ON SOLID FUEL AND BIOGAS

The article considers two options for autonomous power supply using both traditional and non-traditional fuels.

The efficiency of using renewable energy sources is described depending on the climate, geographical location and method of energy production.

The relevance of this topic is caused by increasingly high environmental requirements for production. Moreover, decentralization with the use of unconventional sources allows the energy system to be more flexible in an autonomous mode, taking into account the time of day, the intensity of solar, wind and hydropower. The use of renewable energy sources is also possible in combination with solid, liquid and gaseous fuels. Combined systems are very convenient for power supply of small objects. These can be settlements remote from centralized power supply, autonomous industrial facilities, peasant farms, livestock farms.

One of the energy supply options is more suitable for the northern region of the country with a long cold period and the presence of large coal reserves, there is an opportunity for the consumer to receive gas, as well as heat and electric energy when using coal as a feedstock, a kind of local gas network. The second method will ensure the disposal of animal waste and organic waste.

Keywords: alternative energy sources, biogas, gaseous fuel, coal processing, autonomous power supply.

Introduction

To date, alternative energy sources are increasingly being considered as an opportunity to reduce the cost of energy. In world practice, there is a successful experience in improving energy efficiency through the introduction of renewable

energy sources (RES) for energy supply of remote facilities. But with such methods, it is necessary to take into account climatic conditions and the economic feasibility of their use.

So, when choosing the method of production of various types of energy, they are primarily based on the technological justification for optimizing production costs. Kazakhstan has committed to increase the share of alternative energy in the total amount of energy produced from 1 % to 50 % by 2050. But, it is worth noting that the cost of electricity generated, for example, by solar panels, at Astana Solar LLP, in 2018 was 71 tenge per 1 kW/h. Whereas Ekibastuz GRES-1, which runs on coal, is ready to sell its products for 6 tenge per 1 kW/h.

Electricity production using renewable sources in our country in 2017 amounted to 1,2 %. According to the Statistics Committee of the Ministry of National Economy of the Republic of Kazakhstan on renewable energy sources, as of 01.04.2019, 11210. 2 million kWh were produced by hydroelectric power plants in 2017. Hydroelectric power generation is in the first place. In second place is wind energy – 339,840 thousand kV/h, in the next place is solar 93,038.8 thousand kW/h, and in last place is energy production using biofuels 200 thousand kW/h.

The use of alternative sources in the creation of modern sustainable energy systems is a priority. Investments aimed at the development of the «Green Economy» contribute to the further growth of clean technologies. But today renewable energy is more expensive. There are also plans for gasification of a number of regions of the country, however, the coal industry occupies a large share in the energy balance of the republic. It provides 78 % of electricity, as well as a full load of coke production. But the use of coal as a fuel in the form that it is happening now has many disadvantages. In terms of calorific value, coal is less efficient than gas, and when generating 1 kV/ h of electricity, about 1 kilogram of CO2 is emitted into the atmosphere.

Solar panels used over the past decade have fallen in price, which makes solar energy much more attractive, but it is not enough for the payback period to reach 2–3 years, and given the specifics of operation, it can be assumed that before it expires, it may be necessary to change the panel or other equipment (wires controllers, inverters, batteries). The panels themselves are subject to wear, they need to be cleaned, the absorbing surface is covered with dust and dirt in bad weather, even a small damage can reduce the quality of the reflective coating. A prolonged solar season is typical for the southern regions, that is, the intensity of solar radiation required for energy conversion in other regions will be seasonal.

Solar energy is not just a fashion trend, but a promising direction in the production of electricity, supported by government policy. By the current SES in 2020, it is planned to launch 4 more solar power plants with a capacity of 77 MW. Every year, about 30 GW of solar-powered generating capacity is connected to

the grid in the world. Moreover, according to the results of 2018, Germany was not too sunny, where 7.6 GW was installed. The production of equipment for such SES on the territory of the country is possible and would reduce the cost of this type of energy, but still traditional energy is still out of competition. In the northern regions, the flow of solar radiation from mid-April to early October can satisfy a partial demand for electricity. But it is also necessary to take into account cloudy days when the sun's rays do not have direct access to the panel. Dependence on the season and time of day, the high cost of construction, the features of the operation of such equipment are the main drawbacks affecting the choice of energy supply technology. And the long winter period, accompanied by prolonged low temperatures in most of our republic, suggests that the use of renewable energy is generally unprofitable.

Wind energy as an alternative to traditional energy is already being used in some regions. The wind speed in the vast expanses of our country varies from moderate to strong, with such production there are no expenses for the purchase and transportation of fuel, the cost of equipment decreases every year. But again, such sources are unreliable, as in the previous case, they depend on the weather and the time of year. The peculiarities of operation in general make such sources not permanent. Icing can disrupt the operation of a wind farm, weather conditions change the amount of energy generated. The station operates at full capacity only 10 % of its time. And most likely such a source is applicable only as an additional one, because at low temperatures the energy received is not enough for heating. So far, solar and wind energy is much more expensive than using traditional sources.

Underground gasification can be used as an alternative source, using such technology Kazakhstan may be in the first place in the production of combustible fuel. This is a more environmentally friendly and safe way, since there is no need for expensive equipment used for the safety of miners (coal harvesters, lifts, trolleys and other equipment for transportation). All the ash remains in the mines, and not carried by the wind. Many countries of the world are interested in underground gasification. The place and role of decentralized energy in the energy supply of Kazakhstan, the ways of its implementation with the help of hybrid power generating plants have been described more than once.

Materials and methods

Given the climatic conditions, geographical location, as well as the location of the fuel resources of our country, decentralized energy supply is preferable, in particular for dispersed settlements where coal is the only available type.

Decentralization of energy supply is one of the options for providing various types of energy to remote settlements, which will primarily affect the reduction in the cost of electricity, as well as more comfortable living conditions in places where centralized heating of fuel has not been introduced.Вариант получения

из твердого топлива газообразное с избыточным давлением и высокой температурой и наряду с этим, твердого кокса может быть использован для обеспечения газо- и энергоснабжения малых населенных пунктов.

The increased pressure and temperature of gases can be triggered in an electric power generation unit (gas turbine), and then directed to the household needs of the population. By burning solid coke residue, hot water will be obtained for heating the population. In addition, gaseous fuel can be used for household needs.

The location of such remote settlements allows them to be supplied with cheaper fuel – coal. As is known, coal contains a sufficient amount of substances that, when heated, are released as a combustible gas with an acceptable heat of combustion, the released gas is suitable for use as a gaseous fuel, as well as for cooking. The supply of settlements with gas for domestic needs, as well as electric and thermal energy can be carried out according to the scheme shown in Figure 1.

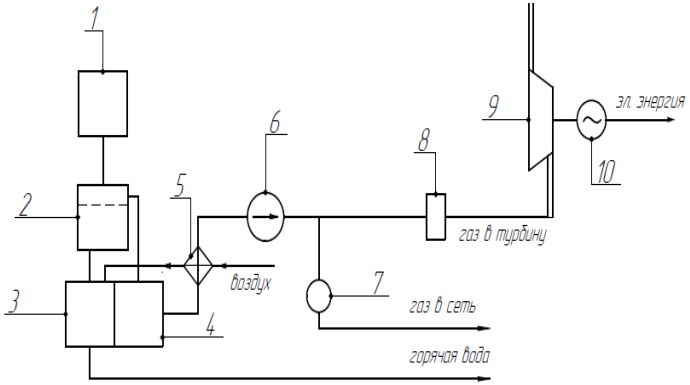

Figure 1 – a source of autonomous gas and power supply to a remote settlement when using coal as a feedstock

The proposed autonomous source of gas and energy supply to a remote settlement works as follows: ordinary coal from the warehouse (1) is fed to the classifier (2), in which the small part is removed. The fine particles removed from the coal are sent to the boiler unit (3), in which the pyrolyzer is simultaneously heated and the water intended for further supply to the heat supply network is heated. The classified coal enters the pyrolyzer chamber (4) without oxygen access. The gas released during heating through the cooler (5) with the help of a fan (6) enters the main gas pipeline, where it is divided into two streams, one of

which enters the receiver (7). The presence of the receiver allows you to vary the performance quite widely due to volume changes. The gaseous fuel accumulated in the receiver is supplied to the local gas network before entering the houses. Another flow of gaseous fuel goes to the gas distribution point (8) and then to the gas turbine unit (9), where the gaseous fuel energy is converted into electrical energy in the electric generator (10).

From the pyrolyzer chamber (4), the coke residue formed after the removal of volatile, together with coal is fed for combustion into the boiler unit (3), in which the pyrolyzer is simultaneously heated and the water intended for further supply to the heat supply network is heated.

The cooler (5) is designed to cool the pyrolysis gas and use the resulting heat to heat the air sent to the boiler.

The proposed autonomous source of gas and power supply to a remote settlement involves switching to a single-fuel power supply system, which is an advantage in regions where coal is the only source of energy, excluding the use of hydrocarbon gas and liquid fuel. The introduction of this patent will make it possible for the consumer to obtain gas, as well as heat and electric energy when using coal as a feedstock, excluding the use of hydrocarbon gas and liquid fuel. The result is achieved by transferring: electric energy generated by a gas turbine installation over the network; hot water obtained using a hot water boiler over thermal networks; gas obtained in a pyrolyzer chamber without oxygen access through a local gas network.

Results and discussion

If biogas is used as fuel, a special biogas plant can be used for the production of various types of energy: heat, electricity and fuel for cars, the product of which is an environmentally friendly gaseous fuel. Simply put, a biogas plant is an aggregate consisting of a complex of technical structures and devices combined into a single technological cycle. The configuration of a biogas plant can be different, depending on its capacity, the type of raw materials and the final product obtained in the form of thermal or electrical energy, both types of energy or only biogas used in household gas stoves and as fuel for cars.

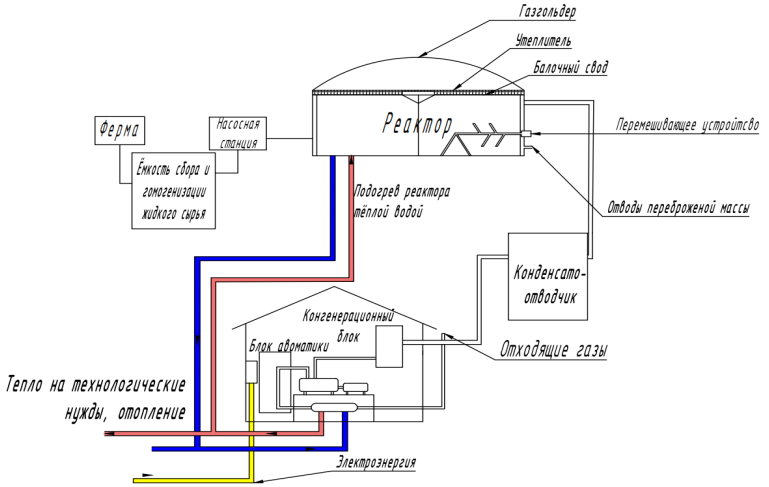

Figure 2 – Configuration of a biogas plant

The standard installation consists of several units and aggregates. This is a storage tank in which raw materials used to produce biogas are accumulated, mixers and mills of various designs dividing large fractions of raw materials into smaller ones, a gas tank, a hermetically sealed container that serves as a storage of the resulting gas. The heart of the installation is a reactor, a tank or a reservoir in which the process of biofuel formation takes place. The systems for supplying raw materials to the reactor of the installation and the system for transferring the received fuel from the reactor and the gas tank are used at the stage of processing and conversion into other types of energy. The plant is controlled by an automation system with protection and control over the processes of production of gas and its processed products.

For smooth operation, it is necessary to prepare raw materials. As raw materials, products of the vital activity of farm animals (manure), waste from food and other industries (timber processing) can be used, which enter storage tanks, after which the raw materials are crushed and transported using pumps. The prepared raw materials enter the bioreactor, which must be durable, acid-resistant and hermetically sealed, which determines the process of biogas production.

In order to create optimal conditions for the decomposition of the prepared raw materials and accelerate the fermentation process, devices are usually installed in the reactor to provide additional heating and mixing of decomposition products. The optimal temperature regime for the operation of the bioreactor plus 40 ° C. As a result of decomposition and fermentation, after a certain period of time, which

depends on the raw materials and technical capabilities of a particular installation, biogas and biofertilizers are formed. Biogas accumulates in a gas tank, which can be detached from the bioreactor, or mounted in a single housing with it. Biofertilizers accumulate in the capacity of the bioreactor itself and after the fermentation process is completed, they are removed for further use. Biogas, under the pressure created in the gas tank, enters the purification system, after which it is used by consumers to obtain electrical, thermal energy and for household consumption. Biofertilizers enter the storage tank, then by separation, are divided into solid and liquid, after which they are used for their intended purpose.

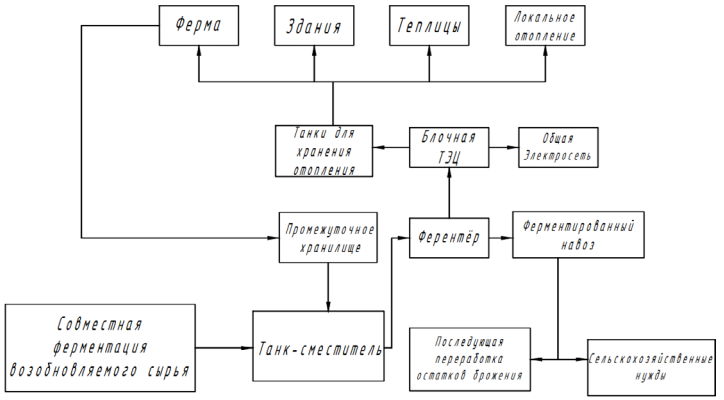

Figure 3 – Biogas production technology

The peculiarity of such an installation is that in a cold climate, most likely, the use will be ineffective. When studying this direction, the following advantages and disadvantages of a biogas plant were highlighted. First of all, from the point of view of ecology, when installing such installations near enterprises that are suppliers of raw materials, the protective sanitary zone around them decreases. Emissions of harmful substances into the atmosphere are reduced. From an energy point of view, we get affordable raw materials at minimal prices, and sometimes without it, as a result, the consumer receives various types of energy and fuel with low cost. From an economic point of view, the installation of biogas plants avoids the construction of sewage treatment plants, barrier devices, and waste disposal costs. Which depends on the availability of various types of raw materials used as fuel. Waste can be considered as an inexhaustible source of raw materials, provided by the growth of agricultural production and the volume of food industry products.

Conclusion

The proposed autonomous sources of gas and energy supply provide for the transition to a fuel system preferred for the region, depending on climatic conditions and territorial locations. The first option is preferred in regions where coal is the only source of energy. This is typical for the Northern region of the country with a long cold period and the presence of large coal reserves, where it is possible for the consumer to obtain gas, as well as heat and electricity when using coal as a feedstock, excluding the use of hydrocarbon gas and liquid fuel. The result is achieved by transferring: electric energy generated by a gas turbine installation over the network; hot water obtained using a hot water boiler over thermal networks; gas obtained in a pyrolyzer chamber without oxygen access through a local gas network.

The second method will ensure the disposal of animal waste and organic waste, while it is necessary to take into account the territorial dependence of the installation location on the area where the sources of raw materials are located (large livestock complexes, processing enterprises and agricultural production facilities), this will affect the cost of energy generated.

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АВТОНОМНОЕ ЭНЕРГОСНАБЖЕНИЕ НА ТВЕРДОМ ТОПЛИВЕ И БИОГАЗЕ

В статье рассмотрены два варианта автономного энергоснабжения с использованием как традиционного, так и нетрадиционного топлива.

Описана эффективность использования возобновляемых источников энергии в зависимости от климата, географического расположения и способа производства энергии.

Актуальность данной темы вызвана все более высокими экологическими требованиями к производству. Причем децентрализация при использовании нетрадиционных источников позволяет быть энергосистеме более гибкой в автономном режиме с учетом времени суток, интенсивности солнечной, ветровой и гидроэнергии. Использование возобновляемых источников энергии возможно и в сочетании с твердым, жидким и газообразным топливом. Комбинированные системы очень удобны для энергообеспечения небольших объектов. Это могут быть удаленные от централизованного энергоснабжения населенные пункты, автономные промышленные объекты, крестьянские хозяйства, животноводческие фермы

Один из вариантов энергоснабжения больше подходит для Северного региона страны с длительным холодным периодом и наличием больших запасов угля, там есть возможность получения потребителем газа, а также тепловой и электрической энергии при использовании в качестве исходного сырья угля, рода по локальной газовой, сети. Второй способ обеспечит утилизацию отходов жизнедеятельности животных и органического мусора.

Ключевые слова: альтернативные источники энергии, биогаз, газообразное топливо, переработка угля, автономное энергоснабжение.

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ҚАТТЫ ОТЫНМЕН ЖӘНЕ БИОГАЗБЕН ДЕРБЕС ЭНЕРГИЯМЕН ЖАБДЫҚТАУ

Мақалада дәстүрлі және дәстүрлі емес отынды қолданатын автономды энергиямен жабдықтаудың екі нұсқасы қарастырылған. Жаңартылатын энергия көздерінің тиімділігі климатқа, географиялық орналасуына және энергия өндіру әдісіне байланысты сипатталған. Бұл тақырыптың өзектілігі өндіріске қойылатын экологиялық талаптардың артуына байланысты. Сонымен қатар, дәстүрлі емес көздерді пайдалану кезінде орталықсыздандыру энергия жүйесіне тәулік уақытын, күн, жел және гидроэнергияның қарқындылығын ескере отырып, офлайн режимде икемді болуға мүмкіндік береді. Жаңартылатын энергия көздерін пайдалану қатты, сұйық және газ тәрізді отынмен бірге мүмкін. Біріктірілген жүйелер шағын нысандарды энергиямен қамтамасыз ету үшін өте ыңғайлы. Бұл орталықтандырылған энергиямен жабдықтаудан шалғай елді мекендер, автономды өнеркәсіптік объектілер, шаруа қожалықтары, мал фермалары болуы мүмкін.

Энергиямен жабдықтау нұсқаларының бірі ұзақ суық кезеңі бар және көмірдің үлкен қоры бар елдің солтүстік аймағы үшін қолайлы, тұтынушының газды, сондай-ақ көмірдің бастапқы шикізаты ретінде пайдаланған кезде жылу және электр энергиясын алу мүмкіндігі бар, жергілікті газ желісі бойынша. Екінші әдіс жануарлардың қалдықтары мен органикалық қоқыстарды жоюды қамтамасыз етеді.

Кілтті сөздер: баламалы энергия көздері, биогаз, газ тәрізді отын, көмірді қайта өңдеу, автономды энергиямен жабдықтау.

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PROMISING TECHNOLOGIES FOR COMBUSTION OF USED OIL IN BURNERS

Emissions of pollutants are of great public concern due to their impact on the environment and human health. There is an acute issue of saving energy resources while reducing harmful emissions during the combustion of various types of fuel. Used oil, which consists mainly of hydrocarbons, is an excellent alternative for partial or complete replacement of typical design fuels does not contain the heavy residual fraction characteristic of heavy fuels.

This article provides an overview of alternative fuel combustion technologies. The review focuses on the principles of operation, key technologies in the field of used oil combustion. As an alternative to existing technologies on the market, an innovative design of a swirl burner for burning various types of fuel is presented in comparison with the closest analogue in terms of design and characteristics. The main advantages of using the innovative design of the burner are substantiated. The conducted literature review and analysis will be useful for further study of the efficient combustion of used oil.

Keywords: combustion, vortex burner, fuel-air mixture, vortex, alternative fuel, used oil.

Introduction

The high rate of fossil fuel depletion is the main cause of the energy crisis and pollution dilemma [1]. There is an acute issue of environmentally safe combustion of heavy hydrocarbons and substandard fuel for cheap energy production [2]. The industry is gaining attention due to worldwide concerns about greenhouse gas, carbon dioxide (CO_2), nitric oxide (NOx), sulfur oxide (SOx) and soot emissions. For example, the Intergovernmental Panel on Climate Change has provided

evidence that CO_2 emissions increased by 3 % per year between 1990 and 2010 and will continue to rise [3]. Burning used oil as a heating fuel is underutilized due to the challenges of cleaning up contaminants found in the oil and overcoming its high viscosity and density to properly atomize into a fine stream and effectively mix the fuel with air [4]. In external combustion devices such as oil burners, the combustion and ejection characteristics of viscous fuels are improved by using heaters to reduce the high viscosity of the oil and swirlers to supply turbulent secondary air in a swirl form to the combustion zone in order to provide efficient atomization and mixing characteristics [5], [6]. Although the re-refining and recycling of used oil is considered more environmentally friendly, its combustion, which meets the quality requirements for heat recovery, is a fairly environmentally and economically viable option [7]. Used oil is used as an individual fuel or mixed with others for many heating systems. In ceramic kilns, used oil is used as a fuel during hardening and glazing under reducing firing conditions [8], [9]. Household heaters, foundries and, more importantly, cement kilns use used engine oil as an additional or replacement heating oil [10].

Used oil burners are justified where there are sufficient volumes of «own-made» testing – auto enterprises, service stations, car garages, heavy equipment repair enterprises. For them, it is not only waste disposal, but also cheap heat for their own needs. Greenhouses can also achieve savings when using used oil boilers. The advantage is that there is no need for gas supply lines, which leads to less risk during interruptions in gas supplies. Small enterprises, farms, livestock complexes can easily solve the issue of heating with the help of mining boilers.

Literature review

At the present stage of development of science and technology in the world, developments in the field of used oil combustion are being actively carried out. The issue is especially relevant due to the increasing price of traditional energy carriers.

Studies conducted on the incineration of used oil have reported high spray, combustion, and impressive heating values [11], [12], [13].

In the EU and the USA, systems for the disposal of used oils have long been developed. Used oil burners from the following manufacturers are popular: USA (EnergyLogic; Omni; Clean Burn), Canada (CAEQ), Germany (Kroll; Euronord EcoLogic; Giersch), Italy (Ecoflam), Finland (Danvex), South Korea (Olympia AL), China (Smart Burner; NORTEC WB), Poland (Hiton; Master MB).

The equipment requires regular maintenance – cleaning the combustion chamber, checking the filter and removing contaminants from it is required at least once a month. When it comes to used oil burners, the quality of American and Canadian products is unbeatable. German and Austrian modules are traditionally distinguished by high quality and reliability. Korean burners are multifunctional