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N N. Makhmudov
Tashkent State Technical University named after Islam Karimov

K M. Sulitanofu
Tashkent State Technical University named after Islam Karimov

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ELECTRICAL AND COMPUTER ENGINEERING

INTELLIGENT APPROACH TO POWER SYSTEM MANAGEMENT DURING WELL DRILLING IN TERMS OF ENVIRONMENTAL IMPACT

N.N. Makhmudov, K.M. Sulitanofu
Tashkent State Technical University
University st, 2 100095, Tashkent, Uzbekistan

Abstract*: An autonomous hybrid power system is an intelligent power installation that provides electricity to isolated consumers without being connected to the power grid. The introduction of autonomous hybrid power systems in the oil and gas industry is considered as an option to improve energy and environmental security. As a rule, oil and gas fields are located remotely and off the grid, and therefore electricity is generated using diesel generators. This article discusses the possibility of reducing emissions of pollutants into the atmosphere by using an autonomous hybrid installation as a source of electrical energy.*

Keywords: *Energy saving, energy efficiency, renewable sources, drilling, sustainable development, ecology, environmental friendliness.*

INTRODUCTION. The energy for drilling is often provided by diesel generators. On average, the need for diesel fuel for drilling and construction of conventional oil wells usually ranges from 70 to 100 tons or more. Renewable generation can reduce or eliminate the need for a generator, which can lead to significant fuel savings. Moreover, on the example of the construction of two different groups of wells (Kashkadarya region, Mubarek Oil and Gas Production Department (OGPD)) using diesel units and power lines (power transmission lines) as a source of electricity, when analyzing the dispersion of pollutants in the atmosphere, it was found that hydrocarbon emissions were reduced and greenhouse gas emissions - carbon monoxide, nitrogen oxides, sulfur dioxide, as well as soot and formaldehyde (Figures 1,2).

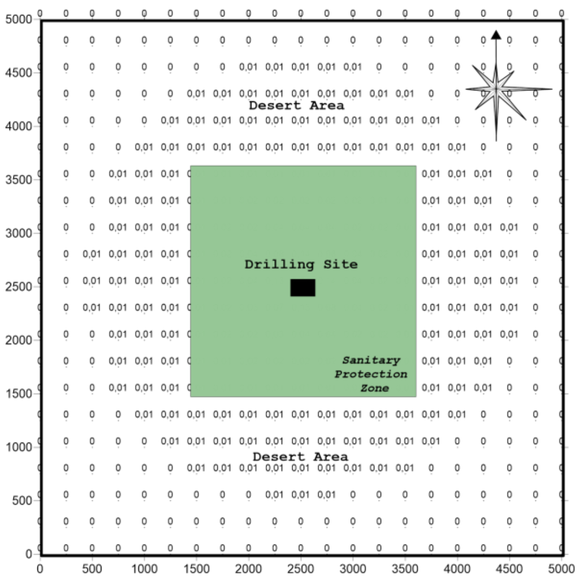

Fig. 1. Dispersion of NO2 emissions during diesel-driven well construction

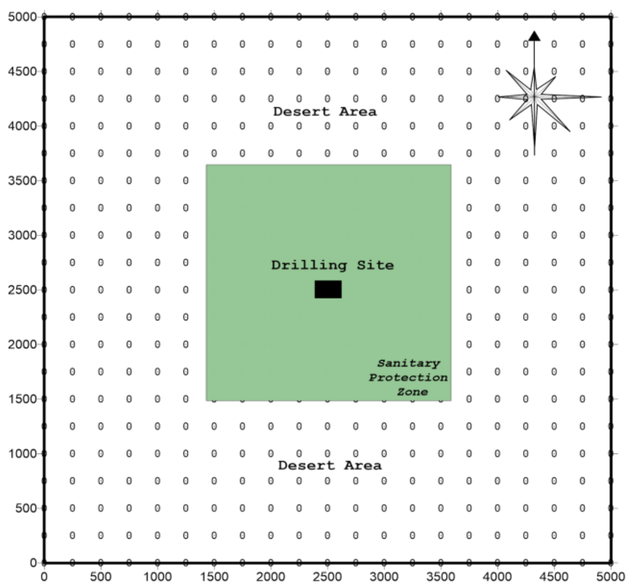

Fig. 2. Dispersion of NO2 emissions during well construction using power lines

Table.1

Lithological and stratigraphic characteristics of the well

Stratigraphic unit	Depth, m		Standard description of the rock: full name, characteristic features (structure, texture, mineral composition, etc.)
	from (roof)	to (bottom)	
1	2	3	4
Neogene + Quaternary	0	~150	Variegated continental clays, loams, limestone, sands, sandstones
Paleogene:	150	~300	
Suzak layers	150	~210	White clays, layered sandstones
Bukhara layers	210	~300	Cavernous light gray limestone
Cretaceous:	300	~1400	
Upper Cretaceous Senonian	300 300	~1400 ~800	Sandy, dense gray clays, layered with interlayers of sandstones, siltstones
Turonian VIII horizon	800 900	~1200 ~1100	Fine-grained and highly argillaceous sandstones. The clays are sandy, grayish-green with interlayers of shell rock and siltstone.
Cenomanian IX horizon X horizon	1200 1200 1360	~1400 ~1300 ~1400	Sandstones, siltstones with interlayers of clays, gray, dark gray, in the lower part. Sandstones, layers of clay and siltstones. Alternation of sandstones and siltstones with interlayers of clays.
Lower Cretaceous:	1400	~2300	
Albian XI horizon	1400 1450	~1800 ~1600	In the lower part, the clays are light gray, gray, silty; in the upper part, there is an interbedding of dense, inequigranular gray sandstones, clays, and siltstones.
Neocomian – Aptian XII horizon XIII horizon XIV horizon	1700 1750 2050 2100	~2200 ~1950 ~2100 ~2250	In the lower part there are sandstones, clays, siltstones, brown red ones. In the middle part there are interlayers of sandstones and clays. In the upper part there are dark gray sandstones, fine-grained with interlayers of clays.
Jurassic:	2250	~2950	
Tithonian Upper anhydrites Upper salts Medium anhydrites Lower salts Lower anhydrites	2250 2250 2260 2640 2680 2745	~2760 ~2260 ~2640 ~2680 ~2745 ~2760	Salt-anhydrite stratum is represented by: Dense whitish-gray anhydrites. Gray halite with an admixture of red-colored clays. Dense anhydrites of gray color. Halite, light gray.
Oxfordian-Kimmeridgian	2760	~3000	Gray, dark gray limestone, polythomorphic, fine-grained.

However, not all production sites are located close enough to power lines, in which case a microgrid system can be used to power production processes. The electrical interconnection of the micro grid allows the integration of renewable energy sources at various network operating points, which in turn ensures distributed, reliable and environmentally friendly generation.

MATERIAL AND METHODS. The source of the micro grid is both power lines and its own generation sources, such as solar panels and wind generators, which can be installed on the roofs of residential cottages and dormitories for workers or administrative buildings. In addition, high-capacity batteries, as well as turbo expanders and other similar equipment of oil fields well pads and gas distribution lines can be used to convert mechanical energy into electricity with its further transmission to a micro grid with a controller that optimizes several sources, including environmentally friendly energy sources.

Let's consider an example of construction of 8 wells in the Alan field. Administratively, the Alan field belongs to the Mirishkor region and is located in the eastern part of the Kashkadarya region. The field involves Jurassic, Cretaceous, Paleogene and Neogene-Quaternary sediments in its geological structure (Table 1). The main gas-bearing horizon of the Alan field is the Jurassic sediments (Oxfordian-Kimmeridgian), consisting of fine-grained porous-fractured limestone with high productivity.

The gas-water contact is located at a depth of about 3000 m. The porosity of reservoir rocks varies over a wide range - from 8% to 25%. The average porosity according to the study of core material and field geophysics is 17%. The coefficient of permeability of reservoir rocks varies within 0.1 - 0.3, which indicates rather high filtration properties of reservoir rocks. Exact information on the depths of the formations is not provided due to an agreement on non-disclosure of data for official use in JSC "O'ZLITINEFTGAZ". Currently, intensive development of hydrocarbon deposits is underway in this region, which has a certain technogenic impact on the environment. The area is located in a desert, waterless, uninhabited area. Due to the lack of an extensive irrigation network in the area under consideration and the lack of fresh water, crops are not currently sown. The lands are managed by Karakul farms and are used as pastures for livestock.

Table 2

Duration of drilling and well casing by depth intervals

№	Casing string name	Duration, day	Drilling duration, day		
			Downhole motor	Rotary drilling	combined method
1	Surface casing	1,25	--	1,17	--
2	Conductor casing	3,29	2,28	--	--
3	Intermediate casing-I	6,51	26,54	--	--
4	Intermediate casing-II	3,22	--	13,74	--
5	Production casing	5,48	14,27	--	--
	Total for 1 well:	19,75	43,09	14,91	

A number of gas-oil and gas-condensate fields are located near the studied field: Kokdumalak, Zevardy, Kultak, Southern Pamuk, etc. The nearby territory is crossed by a network of gas pipelines going to the Mubarek Gas Processing Plant (GPP) from the Urtabulak-Dengizkul, Kokdumalak, Pamuk, Zevardy and Kultak fields. In the north, the Northern Urtabulak-Oil loading platform "Sulfur Plant" oil pipeline passes, as well as a water pipeline and a communication cable. The Alan field itself houses gas production wells, well production collection and transportation systems, and process equipment, which are the main sources of pollutant emissions into the atmosphere.

In accordance with the regulatory data of the industrial sites of Mubarekneftegaz LLC (Kashkadarya region), the total atmospheric emission from the Alan field is 61.783746 t/y. An analysis of the surface concentration fields at the Alan field showed that there is no excess of established standards for ingredients emitted by existing sources, however, with the expansion of the developed area, measures to reduce emissions will be required. Next, two options for managing energy resources when drilling wells are considered. In accordance with Table 2, the total duration of construction of 8 wells will be about 158 days.

Option 1 drilling 8 wells using a ZJ 30 DBS drilling rig. The well construction cycle consists of the following successive technological operations: construction and installation, preparatory work for drilling; drilling and well casing; well development (testing); dismantling of drilling equipment.

Type of drive of drilling rig ZJ 30 DBS – diesel. Power supply sources will be a 292 kW diesel generator and a 100 kW diesel generator for power supply of amenity premises. Combustive-lubricating materials (fuels and lubricants) will be used at the stages: rig installation works, preparatory work for drilling, drilling and well casing, well development. Calculation of the daily need for fuel and lubricants is calculated by the formula:

$$\frac{N \times K \times \rho \times t}{1000}, \tag{1}$$

where:

N – consumption rate of fuel and lubricants;

K – the coefficient of fuel and lubricants use over time;

ρ – the density of diesel fuel, g/cm3;

t – time, h.

The need for fuel and lubricants for various operations is shown in Table 3. In total, the construction of wells will require about 96.4 tons of fuel and lubricants. The calculations were carried out in accordance with NGH 39.0-140:2012 "Methodology for calculating emissions of pollutants into the atmosphere for oil and gas producing and oil refineries" JSC "O'ZLITINEFTGAZ" [9].

Table 3

Demand for fuel and lubricants

Demand for fuels and lubricants for drilling rig engines, tons			
Total	including		
	fuel	oil	lubricant
1. Derrick installation works			
2,7	2,66	0,04	-
2. Preparatory work for drilling			
1,503	1,44	0,063	-
3. Drilling and well casing			
87,52	83,62	3,9	-
4. Well development			
4,70	4,54	0,16	-

RESULTS AND DISCUSSION. Thus, the input of pollutants during the operation of the designed facility will be about 93.517 tons of pollutants of 13 types. The main contribution is made by carbon monoxide, nitrogen dioxide and hydrocarbons. The result of the calculation of pollutant emissions is shown in Table 4.

Table 4

List of pollutants

Ingredient name	MPC, mg/m^3	Emissions			
		From 1 well		From 8 wells	
		g/s	t/y	g/s	t/y
Carbon monoxide	5,00	1,121555	5,031177	8,972440	40,249420
Nitrogen dioxide	0,085	0,784000	3,516941	6,272000	28,135530
Hydrocarbons	1,000	0,488513	2,185098	3,908104	17,480780
Sulphur dioxide	0,500	0,119778	0,537310	0,958224	4,298480
Soot	0,150	0,076222	0,341925	0,609776	2,735400
Formaldehyde	0,035	0,016334	0,073272	0,130672	0,586176
Inorganic dust	0,500	0,002948	0,002123	0,023584	0,016984
Iron dioxide	0,200	0,000800	0,001244	0,006400	0,009952
Fluorides	0,200	0,000109	0,000170	0,000872	0,001360
Silicon dioxide	0,020	0,000109	0,000170	0,000872	0,001360
Hydrogen fluoride	0,012	0,000077	0,000120	0,000616	0,000960
Manganese dioxide	0,005	0,000039	0,000061	0,000312	0,000488
Benzopyrene	0,00001	0,000001	0,000005	0,000008	0,000040
Total:		2,610485	11,689616	20,883880	93,516930

Table 5

Demand for fuel and lubricants

Demand for fuels and lubricants for drilling rig engines, tons			
Total	including		
	fuel	oil	lubricant
14,52	14,29	0,23	-

Table 6

List of pollutants

Ingredient name	MPC, mg/m^3	Emissions			
		From 1 well		From 8 wells	
		g/s	t/y	g/s	t/y
Inorganic dust	0,500	0,002948	0,003205	0,023584	0,025640
Hydrocarbons	1,000	0,051613	0,423816	0,412904	3,390528
Iron dioxide	0,200	0,000825	0,001283	0,006600	0,010264
Manganese dioxide	0,005	0,000039	0,000061	0,000312	0,000488
Silicon dioxide	0,020	0,000108	0,000168	0,000864	0,001344
Fluorides	0,200	0,000108	0,000168	0,000864	0,001344
Hydrogen fluoride	0,012	0,000077	0,000120	0,000616	0,000960
Total:		0,055718	0,428821	0,445744	3,430568

Option 2 drilling 8 wells using an off-grid micro grid hybrid power plant, allowing a combination of renewable energy sources, in this case solar panels and diesel-powered units. The rig mainly provides power to the drilling rig during drilling, casing and completion of the well. The amount of energy consumed will be 548,700 kWh. In the second option, fuels and lubricants will be used mainly in technical units to reduce the effect of friction during rigging, drilling and well casing. The total consumption of fuels and lubricants will be 14.52 tons for 8 wells (table 5).

The result of the calculation of pollutant emissions is shown in Table 6. Thus, during the construction of wells according to the second option, emissions will amount to about 3.431 tons of pollutants of 7 types and the reduce will amount to 96.3% compared to the first option.

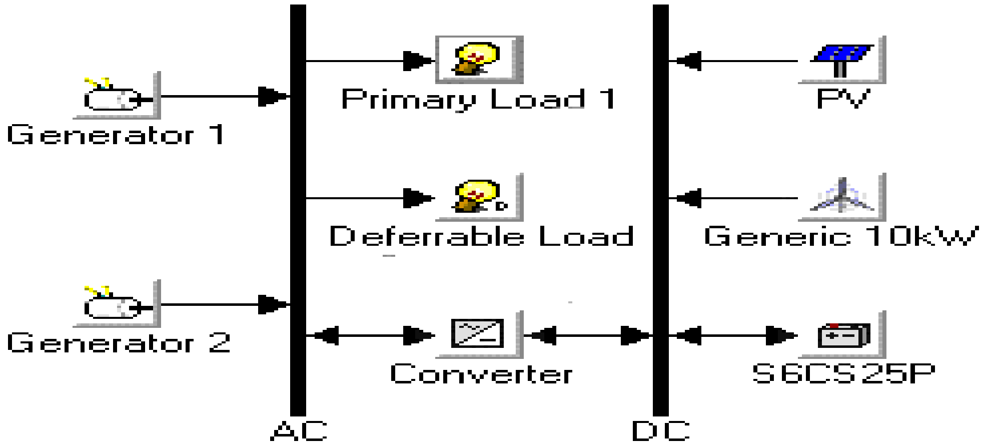

Fig. 3 Scheme of connecting power plants to the micro grid

CONCLUSION. The next fundamental step is modeling and optimizing the operation of an autonomous hybrid power plant. As an example, Figure 3 shows a microgrid diagram created in the HOMER program. The system uses two diesel generators (operating and standby) rated at 292 kW, a photovoltaic generator and a wind turbine. It's also necessary to consider AC/DC converters and inverters when connecting generators to the microgrid. The costs for the required power electronics were easier to model with this arrangement. Due to the relatively weak wind potential of the site, the wind power plant can be replaced by solar panels.

To date, the approach under consideration is successfully implemented at remote bases, in settlements and in isolated areas, as it makes it possible to adapt activities to the industrial process, taking into account known energy needs and available energy resources. An intelligent approach to power system management improves the environmental situation at field sites, ensures reliable power supply and optimizes operation at a lower cost.

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EVALUATION OF ENERGY EFFICIENCY OF PHOTOELECTRIC HEAT BATTERIES WITH MECHANISM OF SOLAR OBSERVATION

M.N. Tursunov[1,2], X. Sabirov[1,2], I.A. Yuldoshev[1], U.R. Xolov[2]

[1]*Tashkent State Technical University*
University st.,2 100095, Tashkent, Uzbekistan
[2]*Physical-Technical Institute of the Academy of Sciences of the Republic of Uzbekistan,*
Chingiz Aytmatov st., 2[B], 100084, Tashkent, Uzbekistan

Abstract: *Cooling of the rear surface of photoelectric batteries (PEB) was investigated by attaching a newly designed heat collector made of parallel channel cellular polycarbonate to the rear surface in order to improve the electrical and thermal efficiency in this research work. The experiment was conducted on June 7, 2022 at the Heliopolygon of the Physical-Technical Institute of Tashkent city (latitude: +41,34 (41°20'23"N), longitude: +69,3 (69°17'36"E). 2 340 W monocrystalline silicon PEBs(photoelectric batteries) were used as experimental devices. The rear surface of the first is equipped with a cooling system.*