The possibilities of application of cogeneration plants at the boiler houses in Uzbekistan

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Abstract. At the moment, the fuel and energy complex of the republic is experiencing crisis state. The main manifestation of the crisis is that disruption and interruptions in the supply of fuel, electricity and heat to individual regions and consumers are becoming commonplace. One of the most promising solutions to this situation is the development of distributed power generation. The process of joint generation of electric and thermal energy 3/4 cogeneration, which, among other things, provides an opportunity for the development of the country's economy, has great potential here. The purpose of this work is to show the relevance and expediency of using cogeneration at heat sources of the republic. The usual (traditional) method of generating electricity and heat is to generate them separately (power plant and boiler house). At the same time, a significant part of the energy of the primary fuel is not used. It is possible to significantly reduce the total fuel consumption by using cogeneration. Cogeneration is the combined production of heat and electricity from a heat source. Cogeneration is a wide range of technologies that can be applied in various fields of economic activity. The cogeneration plant fits perfectly into the electrical circuit, both for individual consumers and for any number of consumers through state power grids. These units are compact, environmentally friendly and cover the deficit of generating capacity in large cities. Such installations make it possible to unload electrical networks and ensure stable power quality. Cogeneration plants (CHP) are essentially mini-heat power station, which have been successfully used all over the world for a long time.

1 Introduction

The relevance of this topic is justified by the fact that there is a serious problem in the energy sector of Uzbekistan - the problem of discrepancy between the volume, structure and technical condition of capacities and the rapidly growing demand for electricity and, as a result, a violation of the fuel and energy balance. Therefore, today the electric power industry can become a real inhibiting factor for the development of the entire economy of the country. The outstripping growth of electricity consumption requires: activation of energy saving and large-scale commissioning of new generating capacities.

Combined heat and power generation and cogeneration continue to play an important integrated role in global development. Combined heat and power generation and cogeneration can contribute to sustainable development because it is an energy-efficient technology. In addition, combined heat and power generation can have a beneficial effect on the local environment if cogeneration systems replace a number of energy facilities as sources of atmospheric pollution.
The object of study of this work is the process of joint generation of electricity and heat at boiler houses.

The subject of the study is the use of energy-saving equipment for the most complete use of the energy of the primary source (fossil fuel), as well as its economic and environmental assessment.

The purpose of studying the work is the need to assess the prospect of introducing the cogeneration process in the energy sector of Uzbekistan and to identify the need for the widespread use of energy-saving technologies in this industry.

2 Problem

For Uzbekistan, the problem of serious study of the use of energy-saving technologies, in particular, in heat supply for the efficient use of investments [1], is urgent. The search for large and small projects for the technical and technological renewal of production, to ensure the competitiveness of products, as well as the means and sources for this, should become, first of all, the most important business and responsibility of the manager and engineering and technical personnel of each heat supply enterprise. [2].

High-energy intensity still dominates in all sectors of the economy of the republic [3]. At present, manufacturing and technical enterprises are provided with some of the world's largest energy subsidies, estimated at approximately $4 billion per year [2,4]. The Government of Uzbekistan recognizes the need to increase domestic prices for electricity and gas to cover the real level of costs of energy supply companies

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necessary for direct satisfaction of demand, maintaining the level of reliability and maintenance of fixed assets. Enterprises will be able to remain competitive only by increasing labor productivity and energy efficiency. Projects for the modernization of equipment at industrial enterprises of the republic, implemented within the framework of the programs of the World Bank Group, led to a significant increase in energy efficiency of production and a decrease in specific energy consumption by 40-70%, as well as to an increase in operating profit by 5-7% even in non-energy-intensive industries. Despite these achievements, many industrial enterprises are ignoring possible investments that could contribute to improving energy efficiency. At least 20% of enterprises do not take into account operating costs and maintenance costs when purchasing new equipment and another 22% prefer less efficient, but cheaper models [5].

3 Solution to the problem

The essence of the cogeneration process:

The usual (traditional) method of generating electricity and heat is to generate them separately (power plant and boiler house). At the same time, a significant part of the energy of the primary fuel is not used. It is possible to significantly reduce the total fuel consumption by using cogeneration (co-production of electricity and heat) [6].

Cogeneration is the thermodynamic production of two or more forms of usable energy from a single primary source of energy.

The two most used forms of energy are mechanical and thermal. Mechanical energy are usually used to rotate an electric generator. The mechanical energy can also be used to keep auxiliary equipment such as compressors and pumps running. [7].

Currently, the market of power equipment offers turbine installations (energy-saving steam turbines, turbine generators, turbodrives) designed to generate cheap electricity and drive auxiliary mechanisms of the boiler house (compressors, pumps, fans, etc.).

Evaluation of the use of cogeneration plants in boiler houses:

At present, traditional large cogeneration, power plants and heat supply systems, as a rule, do not provide the estimated fuel savings at the heat power station and the overall efficiency of centralized supply of electricity and heat to consumers.

In the global energy sector, there is a steady trend towards an increase in energy production and consumption. Even taking into account significant structural changes in industry and the transition to energy-saving technologies, the demand for electricity will increase in the coming decades. As the analysis of the technology showed, mini-heat power stations are one of the key solutions to the problem. The construction, as well as the reconstruction of existing boiler houses in mini-heat power station, will not only ensure more efficient use of fuel due to the combined production of electric and thermal energy, but also increase the reliability of power supply to settlements and industrial enterprises [7].

The Decree of the President of the Republic of Uzbekistan "On measures for the construction, modernization and reconstruction of HP-8, 9, 10 of the State Unitary Enterprise "Toshkent Issiqlik Markazi" with the introduction of modern cogeneration technology of gas turbine units with a capacity of 480 MW in 2017-2021" was adopted.

The energy strategy of Uzbekistan for the period up to 2030 has formed new guidelines for the development of the energy sector, the most important of which is the transition to an innovative path. Among the requirements of the strategies is the achievement by the national economy of the level of energy intensity of GDP of developing countries with a similar climate and conditions, as well as increasing the efficiency of energy use and reducing the negative impact on the environment.

Unlike a traditional condensing power plant, which produces only electricity, in a steam extraction condensing system, some of the steam is taken from the turbine for use as a heat source. The use of cogeneration is associated with significant economic and environmental benefits. Combined cycle cogeneration plants ensure the most efficient use of fuel energy due to the simultaneous production of electrical and thermal energy with minimal losses [8].

The fundamental decision to use cogeneration and the choice of a specific method is determined by a number of factors; even businesses with similar energy needs cannot be considered the same in this regard.

In many cases, the fundamental decision to implement cogeneration is determined by the following factors:

- it is fundamental that there are sufficient heat needs that meet the possibilities of cogeneration in terms of quantity, temperature, etc.;
- the presence of a basic load at the enterprise, i.e. the level below which electricity consumption rarely falls;
- similar nature of the schedules of heat and electricity demands;
- the ratio of fuel prices to electricity tariffs, ensuring the economic efficiency of cogeneration;
- high expected level of workload (preferably more than 4-5 thousand hours of work at full load per year).

In general, the use of cogeneration is justified in those enterprises where there are significant heat requirements at temperatures corresponding to low or medium steam pressure.

When assessing production potential from a cogeneration perspective, it is important to ensure that there is no reason to expect a significant reduction in the heat demand. Otherwise, the operation of a system designed to produce excess heat will be ineffective.

Steam turbines may be an adequate option if the following conditions are met:

- the base electrical load exceeds 3-5 MW_{he};

- there is an application for low-potential steam, and the required ratio of electrical and thermal energy exceeds 1:4;
- availability of inexpensive fuel with low trading margins;
- availability of adequate area to accommodate the system;
- the presence of high- potential heat coming from technological processes (for example, from furnaces or incinerators);
- the need to replace the existing boiler room;
- it is necessary to minimize the ratio of electrical and thermal energy.

In cogeneration systems, maximizing the ratio of electrical and thermal energy requires minimizing the level of backpressure and maximizing the level of high pressure.

Cogeneration units are divided according to the principle of operation of the drive into: steam turbine, combined-cycle, gas piston units. According to the main criteria for evaluating efficiency: operational and repair, financial and economic, payback period. Gas reciprocating units in the range of unit power of 0.1÷10 MW have the best performance. World experience shows that the use of cogeneration is economically justified when there is a constant consumption of heat and electrical energy. With uneven consumption, the limiting energy carrier is heat.

Mini-heat power stations based on internal combustion engines with an electric power of 9 kW to 3.9 MW and a thermal power of 0.02 to 3.6 Gcal/h are presented on the world market.

A complete list of indicators by which GTU- heat power station and mini-heat power station based on internal combustion engines are compared is given in Table 1.

To generate thermal energy, fuel and electrical energy are required (drive pumps, fans, lighting, etc.).

If, when determining the costs of fuel and energy resources for the final product (thermal energy), we take into account all types of costs, i.e.: the cost of generating thermal energy, generating electrical energy and transporting it to the consumer, then we determine the consumption of primary fuel for the resulting final product.

This type of assessment of the efficiency of the use of fuel and energy resources is a system assessment that most fully and reliably reflects the energy efficiency of the use of fuel and energy resources. With this method of assessing the energy efficiency of production, the indicator is the fuel utilization factor (FUF).

It should be noted that in addition to saving money at the enterprise, in this case there is a saving of primary fuel, which should be taken into account as a reduction in costs directly in the fuel and energy complex of the Republic of Uzbekistan, in an amount equal to 0.5 million nm^3/ year. [10]

Table 1

Index	Gas piston	Gas turbine
Durability	full resource is 100...200 thousand hours	-full resource is 75÷140 thousand hours
Quantity and potential produced heat	-0.86÷1.29 Gcal/h per 1 kW of electric power; - network water with a temperature of 90–105 ºC.	-1.5−1.8 Gcal/h per 1 kW of electric power; - network water 115–150 ºC; - water vapor with a pressure of 9–40 kgf/cm^2 (at 250÷450 ºC).
Economy	-Electro efficiency 33÷40%; -Efficiency changes little at load from 100% to 50% (decreases by 5...8%).	- Electrical efficiency 25-35%; - Efficiency drops sharply at partial electrical loads (decreases by 13...18%).
Specific fuel consumption: 100÷50% electrical loads	0.25…0.33 m^3/kWh	0.35…0.503 m^3/kWh
Voltage drop and 50% load recovery time	22% 8 s	40% 38 s
Influence variable electrical load	- long work at loads <50% is not desirable; - with a lower unit capacity of the unit, more flexible operation of mini-heat power station and higher reliability of power supply	- operation at partial loads (less than 50%) does not affect the condition; - at a high unit power of the unit, shutdown causes a loss of 30 ... 50% of the mini- heat power station
Ecological	Harmful emissions: NO_X = 118÷185ppm; CO=50÷107ppm	Harmful emissions: NO_X=25–50 ppm; CO = 60–75ppm
Accommodation in the building	- more space is needed, because has more weight per unit of power - no compressor is required to compress gas (operating gas pressure at the inlet to the mini-heat power station is 0.1÷0.35 kgf/sm^2)	- with an electric power of a mini-heat power station of 5 MW and above; - minimum operating gas pressure at the inlet; - 12 kgf / sm^2 (requires a booster compressor, equipment for starting the turbine).
Service	- stop after 1000 hours o operation, (oil change); - overhaul after 72,000 hours on site.	- stop after every 2000 hours; - overhaul after 60,000 hours, carried out at a special factory.

4 Recommendations

Gas piston units are promising as the main source of electricity and heat generation at housing and communal services (with electrical and thermal loads of 0.3÷15 MW): in residential and public buildings, shopping and sports complexes, hotels, sanatoriums, boarding houses.

It is advisable to use gas piston units as a peak or backup source of power supply in industrial enterprises with sharply variable electrical load.

Environmental benefits of using the cogeneration process.

Energy production is a major source of pollution. Cogeneration, using primary fuel, is two to three times more efficient than traditional energy, reduces emissions of pollutants (nitrogen oxide, sulfur dioxide and volatile organic compounds) by 2-3 times, depending on the specific case [11].

Currently, power plants are responsible for 2/3 of total national emissions of sulfur dioxide (SO_2), 1/4 of nitrogen oxide (NOx), 1/3 of mercury (Hg) and 1/3 of carbon dioxide (CO2), the main greenhouse gas. Emissions contribute to serious environmental problems, including global climate change, acid rain, smog, pollution of waterways and eutrophication of critical water bodies, etc. These same emissions contribute to numerous health problems, such as chronic bronchitis and exacerbation of asthma, and other diseases, especially in children.

New large power plants deal the greatest blow to the environment. Cogeneration stations are small and usually located inside existing buildings and factories. In addition, their emissions are an order of magnitude lower than those of large power plants are.

Cogeneration systems can be especially useful in areas where development is limited due to environmental constraints.

Cogeneration plants are small and are usually located inside existing buildings and factories. In addition, the level of their emissions is an order of magnitude lower than the level of large power plants.

Stability

Cogeneration of electric and thermal energy is an energy-efficient technology that can play an important role in the XXI century in the implementation of Uzbekistan's transition to the path of sustainable development. With the help of cogeneration, it is possible to produce several types of energy services simultaneously:

- heating and cooling of buildings;
- generation of electricity for lighting and engine operation;
- production of process energy for industry, etc.

With combined heat and power generation, it is possible to utilize a large number of different fuels - not only natural gas, coal and oil, but also, for example, biomass and solid waste, using energy-efficient large-scale combustion plants equipped with modern systems, and also with the use of environmentally friendly technologies.

In addition, the combined production of thermal and electrical energy can have a beneficial effect on the local environment if cogeneration systems replace a number of energy facilities as sources of air pollution.

The implementation of cogeneration helps to increase the level of employment. This is because energy efficiency and the use of local energy resources associated with it mean that fuel imports can be reduced, thereby increasing the money supply available for investment in local cogeneration systems.

5 Conclusions

Combined heat and power generation can recycle a large number of different fuels, not only natural gas, coal and oil, but also, for example, biomass and solid waste, using energy-efficient large-scale combustion plants equipped with modern systems, as well as using environmentally friendly technologies.

In addition, the combined production of heat and electricity can have a beneficial effect on the local environment if cogeneration plants replace a number of energy facilities as sources of atmospheric pollution.

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