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OF HEAT UTILIZATION EFFICIENCY OF EXHAUST GASES OF GAS PUMPING UNITS OF COMPRESSOR STATIONS OF SHURTAN OIL AND GAS PRODUCTION MANAGEMENT

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Annotation

This article discusses the possibility and feasibility of utilizing the heat of high-temperature exhaust gases of one gas-pumping unit of a compressor station on a waste heat boiler to generate heating water for heating and hot water supply of compressor station facilities in order to save energy. These specific conditions, mainly of a regime nature, require mini-CHPs to meet fairly stringent requirements for the reliable supply of thermal energy to consumers. These requirements are provided by a set of measures, including improving the reliability of individual elements and units of heat supply systems, using various methods of redundancy, in particular functional and temporary. An example of the implementation of these methods for improving reliability is the use of hot water storage tanks (AHV) at a mini-CHP with a gas turbine. The specific choice of the design scheme for a gas turbine plant (GTU)-CHP depends on a number of factors: the magnitude of the connected heat load and its structure, heat consumption modes, climatic conditions, required reliability, etc. The results of the theory of technical and economic calculations in the implementation of the waste heat boiler are presented, the potential opportunities and benefits from the implementation are shown.

Keywords: gas turbine plant, storage tanks, centrifugal, main gas pipeline, compressed, collector, transportation, compressor station

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Introduction

With the largest reserves of natural gas, Uzbekistan has a developed network of gas pipelines for its transportation through the territory of the Republic and abroad. Compressor station is an integral part of the main gas pipeline, designed to ensure its design throughput by increasing the gas pressure at the CS outlet using various types of gas compressor units. Several hundred GPUs with centrifugal superchargers with a capacity of 6 to 25 megawatts have been installed during the years of the creation of the gas transportation system of the republic and continue to be installed on gas pipelines under construction [L.1].

From the suction manifold, process gas through a valve enters the suction line of the GPU, where compressed gas is produced to the design pressure. Compressed - this is an increase in gas pressure with the help of a compressor, one of the main operations in the transportation of hydrocarbon gases through main pipelines, their injection into oil and gas structures to maintain reservoir pressure, in the process of filling underground gas storage facilities and during gas liquefaction. Compressed is carried out in one or more stages. The type and power of the compressor are determined depending on the amount of compressed gas and the required pressure ratio (compression ratio). Compressed gas is accompanied by an increase in gas temperature and, as a rule, requires its subsequent cooling. Therefore, the gas through the valve enters the discharge manifold of the GPU and then enters the suction manifold of the air coolers [L.1;, 2].

The gas industry is itself one of the largest consumers of natural gas and energy. An increase in gas production is accompanied by an increase in fuel gas consumption and an increase in the yield of secondary energy resources (SER) during its transportation. Of the total volume of gas consumed by main gas pipelines, 85–90% is fuel and start-up gas during the operation of gas compressor units (GPU) of a compressor station (CS), the remaining 15–10% is spent during maintenance of process units of compressor and gas distribution stations and during operation of a linear parts of main gas pipelines [L.3].

The Relevance of the Work

Gas-fired hot water boilers are installed at the main gas pumping compressor stations for heating and hot water supply of the objects of the station itself and the nearby residential village, which burn part of the commercial gas (fuel gas) taken from the main gas pipeline to generate hot water. Meanwhile, gas turbines of gas compressor units emit combustion products with a temperature of 550 - 650 ° C into the atmosphere, the heat of which can be completely used by installing a waste heat boiler behind the turbine that produces hot water for heating and thereby save fuel gas.

Goals and objectives. To study the possibility of introducing a heat recovery device at a compressor station, calculate the thermal potential of combustion products behind a gas turbine plant and perform a thermal calculation of a waste heat boiler, which will replace the boiler house.

Scientific novelty. Thermal calculations of the waste heat boiler designed to fully cover the thermal needs of the compressor station by utilizing high-temperature flue gases downstream of the gas turbine have been performed.

The practical significance of the work. It consists in unlocking the energy saving potential of compressor stations through the use of a secondary energy resource - the heat of combustion products of gas turbine plants to produce hot water for heating an industrial enterprise.

Object of study. Gas turbine, air recuperator, volume and temperature of combustion products, waste heat boiler. Heat recovery of exhaust gases of gas pumping units of compressor stations for oil and gas production control Shurtan.

The most efficient use of secondary energy resources (SER) at CS is possible with an integrated approach that gives the highest degree of SER utilization, since there are a large number of directions and methods for utilizing these resources at CS.

One of the directions of energy saving is the combination of the gas turbine process with the process of generating steam or heating water in a waste heat boiler. The waste heat boiler located after the exhaust pipe of the turbine makes it possible to significantly reduce heat losses with flue gases and, at a gas temperature at the outlet of the boiler of 220–250 °C, to bring the total fuel utilization rate to 70%.

With the current situation at gas pumping stations of main gas pipelines, a huge amount of heat from high-temperature (450-500 °C) waste gases (at fuel gas flow rates of about 25 m3 per 1 MW of GCU power) behind the unit is usually lost in the atmosphere. At present, when the cost of energy resources in the world market is constantly growing, it is necessary to take measures to reduce the consumption of primary energy resources (for example, by utilizing the heat of high-temperature exhaust gases), including at gas compressor stations. Installing a waste heat boiler of the appropriate capacity in the flue gas path between the GPA outlet and the chimney will allow using the recovered heat to heat the network water of the heating system of the main production and auxiliary premises of the compressor station and the heat of consumers of nearby workers' settlements.

In this work, a variant of utilization of the heat of the exhaust gases of the gas compressor unit was developed. The results of calculations have been obtained, showing the possibility and profitability of such a reconstruction, as well as significant savings in fuel and energy resources during the transition from a primary energy resource to a secondary one [L.4;, 5].

Taking into account the state and trends in the formation of the country's fuel balance, natural gas should be considered the main fuel supply for the energy sector in the near future. The task is to increase the efficiency of its use through the use of new highly efficient technologies and technical solutions, for example, combined-cycle plants and cogeneration gas turbines.

The volumes of gas production and, accordingly, its use will depend primarily on the volume of investment, the scale and pace of increasing industrial gas reserves, the conditions for its production and transportation.

The following types of highly automated, environmentally acceptable modular plants for the production of electricity and heat of small and medium capacity are being developed and implemented:

- Cogeneration gas turbines based on gas turbine engines of aircraft and ships with a unit electric power of 50 to 6000 kW and a thermal power of 0.6 to 90 MW (t) for installation at the locations of heating and industrial boilers running on natural gas;
- Cogeneration diesel plants for decentralized power supply based on engines of ships, wheeled and caterpillar vehicles with a unit electric power of up to 600 kW and a thermal power of up to 4 Gcal/h;
- Steam power and gas turbine drive with heat recovery capacity from 5 to 20,000 kW for power supply of oil and gas production complexes.

The expansion of the construction of mini-CHPs based on gas turbines of small and medium power makes it possible to solve the problem of electricity and heat supply to enterprises of the fuel industries of the country's fuel and energy complex and social infrastructure in a new way.

Thus, the use of power plants of the GTU-CHP type can bring gas production, processing and transportation enterprises to full self-sufficiency, which will free up significant volumes of gas for sale.

The use of highly efficient conversion gas turbines in heat and power supply systems will reduce the consumption of fossil fuels by consumers by up to 20%, reduce the need for capital investments by up to 20%, reduce the number of personnel involved in electricity production by 10% and reduce emissions of harmful substances by 1.9

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times. For example: Shurtan oil and gas production department has 10 gas booster stations installed. Thermal exhaust emissions from 550 -650 0C atmosphere from these installations [L.2; 3; 4; five].

Economic efficiency and indicators of the reconstruction of the tail section of the GPU by installing a waste heat boiler:

1. Capital costs for reconstruction (cost of equipment, project and installation works).

$$К_{exp} = 48000 \$ \quad (1)$$

2. Tariff for thermal energy:

$$T_{t/e} = 10 \$/Gcal \quad (2)$$

3. Labor costs for workers (average wage fund of workers for the year).

$$S_{sf} = 44400 \$/year \quad (3)$$

4. The amount of heat energy generated by the waste heat boiler:

$$Q = 3{,}14 \ Gcal/h \quad (4)$$

5. Duration of the heating season (taken 6 months):

$$T_{he} = 4320 \ h \quad (5)$$

6. Depreciation rate:

$$a = 0{,}037 \quad (6)$$

7. Repair ratio:

$$a_{rep} = 0{,}06 \quad (7)$$

8. Calculation of costs for the operation of equipment:

$$S = S_L + S_w + S_{sf} + S_{de} + S_{rep} + S_{ot} \quad (8)$$

where S_L is the cost of fuel (absent, because exhaust gases of a gas turbine are used); S_w - water costs (none, because water from own well); S_{sf} - wage costs; S_{ot}, - other costs that may arise during operation.

9. Depreciation costs:

$$S_{de} = a \cdot К_{exp} = 1776$$

(9)

10. Repair costs:

$$S_{rep} = a_{rep} \cdot К_{exp} = 2880 \quad (10)$$

11. Other unforeseen costs of equipment operation:

$$S_{ot} = 0.25 \cdot (S_L + S_w + S_{sf} + S_{de} + S_{rep}) = 12264 \quad (11)$$

12. Calculation of costs for the operation of equipment:

$$S = S_L + S_w + S_{sf} + S_{de} + S_{rep} + S_{ot} = 0 + 0 + 44400 + 1406 + \\ +2280 + 9522 = 61320 \quad (12)$$

13. The cost of heat energy received from the waste heat boiler during the heating season:

$$W = Q \cdot T_{t/e} \cdot T_{he} = 3{,}14 \cdot 10 \cdot 4320 = 135648 \quad (13)$$

14. Possible profit P (with an annual operating time of the waste heat boiler of 6 months):

$$P = W - S = 3135648 - 61320 = 74328 \,\$/year$$

(14)

15. Payback period for the purchase and installation of a waste heat boiler:

$$t_{pa} = К_{exp}/P = 48000/74328 = 0{,}65\, year = 7{,}9\, month \quad (15)$$

Since the payback period of the waste-heat boiler is less than 1 year, the introduction of a CHP at one of the gas compressor stations of the compressor station is cost-effective, without taking into account the fact that the replacement of primary fuel (natural gas) with secondary fuel (exhaust gas heat from GTU) when generating thermal energy for heating CS releases about 2 million m3 of commercial gas. The calculation results are shown below.

Calculation of savings of primary fuel (fuel natural gas)

1. Efficiency of the existing boiler compressor station:

$$Q_{boi} = 0{,}8$$

2. Hourly generation of thermal energy by the waste heat boiler:

$$Q_{he} = 3{,}14\, Gcal / h$$

3. The duration of the CU:

$$S_{he} = 4320h$$

4. Calorific value of fuel gas:

$$Q^{hc}_{h} = 8500\, kcal / m^3$$

5. Tariff for natural gas:

$$T_{nt} = 370\, sum / m^3$$

6. Annual production of thermal energy by the waste heat boiler:

$$C_{py} = C_{py} \cdot T_{py} = 2{,}07 \cdot 10m^6 \cdot 170 = 13565\, mln \cdot \frac{sum}{year}\, l/\text{year}$$

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7. Fuel gas consumption for the boiler room:

$$B_{py} = Q_{year} Q_h^{hc} \cdot \eta_{boi} = 13565 \frac{\cdot 10^6}{8200} \cdot 0{,}8 = 2422 \text{ t.n.f}$$

8. Cost of saved natural gas:

$$C_{py} = B_{py} \cdot T_{py} = 2{,}07 \cdot 10^6 \cdot 170 = 351{,}5 \frac{\text{mln. sum}}{\text{year}}$$

Conclusions

Ensuring the indicated scale of mini-CHP application is impossible without solving the following problems:

- Development and serial production of environmentally acceptable modular power plants with a unit electrical capacity of 1 to 30 MW at defense industry enterprises as part of the conversion program;
- Creation of routine maintenance systems for power plants of small and medium capacity on the basis of defense industry enterprises;
- Development and production of power generating plants with heat recovery with a capacity of up to 1000 kW to drive units for auxiliary needs of boiler houses, as well as automatic power supply for small consumers.

Utilization of the heat of combustion products of the GPA for the heating needs of the compressor station leads to savings in fuel burned in the boiler house in the amount of 2422 tons of reference fuel per year, which is equivalent to 2070 thousand m3 of natural (natural) gas, and in monetary terms 351.5 million soums / year. The payback period of the project is about 8 months, the possible annual profit from the implementation is 170 million soums. In addition, the amount of harmful emissions of the boiler house into the atmosphere is reduced in proportion to the saved fuel.

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