Use of the heat of exhaust fluge gases of gas turbine units in recovery boilers for heat and electric supply systems

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Abstract. In this article, the inextricable interconnection and interdependence of the conditions for ensuring the heat of energy consumption is considered. A highly efficient installation covers the heat and energy needs of the Mubarek gas processing plant. With simultaneous operation of gas turbine and steam boiler plant efficiency reaches 95%. The introduction of the proposed development will solve the problem of energy and resource-saving, enables the use of a steam boiler in heat supply and solves an environmental problem.

1 Introduction

Increasing the efficiency of capital investments, further industrialization of construction work, increasing labor productivity, improving quality and reducing costs in construction, and solving these problems should greatly contribute to the transition of enterprises and construction organizations to a new system of planning and economic incentives, a thrifty attitude towards building materials, which all types of fuel, heat, energy and electricity, as well as increasing the engineering level of the energy sector of construction. Achieving technical progress in construction is inextricably linked with the growth of energy consumption and the constant improvement of the energy management of construction sites and enterprises in the construction industry. Construction production has become a very energy-intensive sector of the national economy [1-10].

When studying the energy balances of industrial enterprises, the weight of waste heat energy is large, which requires its efficient use as much as possible. Among secondary energy resources in industrial enterprises, thermal energy resources take the main place and appear as a waste of almost all processes. In steam boilers, it comes out with flue gases with a temperature of 120-200℃ the waste of heat energy is very large, and the device in the heat balance is 16-20% [4-5].

In steam boilers one of the methods of effective use of fuel heat Condensation of exhaust gases in heat utilization deep cooling (below the dew point). In particular, the disposal of natural gas combustion products is high effective because of the smoke produced when natural gas burns gases contain more than 20% water vapor by volume.

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High-quality water vapor for deep cooling of flue gases condensate is formed and dissolved oxygen and carbonate from it quality supply water for the steam boiler by separating the anhydride can be obtained. Hence, the heat of condensation of flue gases First, flue gases through deep cooling in utilization its heat is utilized, that is, it leads to fuel savings. Second, steam boilers with condensate lost in the cycle will be possible to provide. Deep flue gases in steam boilers smoke from burning 1 m^3 of natural gas with the help of cooling At least 1.0-1.2 kg of condensate is obtained from gases [4,5]. As a result, it is possible to increase the efficiency of steam boilers by 8-10% through the use of condensing heat utilization. Therefore, utilization of secondary energy resources (SER), and flue gas heat in industrial enterprises is one of the urgent issues in energy saving [6-8].

Construction sites and construction industry enterprises in Uzbekistan annually spend over 760 thousand tons of standard fuel and 4000 thousand Gcal of heat, as well as about 345 million new m cubic natural gas. In addition, road transport consumes about 450 thousand tons of gasoline and more than 77 thousand tons of diesel fuel. It is quite obvious that saving energy resources in an amount of at least 1% means not only saving 8 thousand tons of standard fuel, 20 thousand Gcal heat, about 3.5 million kW/h of electricity, etc. but also the production of additional products at enterprises with the lowest energy costs, construction and installation work on the most important construction sites, which in itself is a significant reserve for reducing construction costs [9-12].

This issue becomes of great relevance because enterprises in the construction industry, in particular prefabricated reinforced concrete plants, gas processing plants, house-building organizations, etc., are very energy-intensive enterprises, the share of energy costs in the cost of production of which ranges from 14-22%.

2 Materials and methods

Thus, the reserves for saving fuel, heat, energy and electricity are great. Thus, only by streamlining the storage and accounting of fuel, maximum loading of machines and mechanisms, the widespread introduction of checking the serviceability of fuel equipment, eliminating idling mechanisms, and introducing preventive repairs of engines, it is possible to achieve savings of at least 17 thousand tons of standard fuel per year; the introduction of automatic combustion control in steam boilers, as well as improving the use of waste gas heat, can provide another 18 thousand tons of savings [13, 17-18].

In addition, partial changes in the design of cassettes of tables and large-sized forms, equipping them with thermal insulation, major repairs of steaming chambers and thermal insulation of steam pipelines, the introduction of an ejector heat treatment system for products in cassettes, reinforced concrete supports, hollow slabs, etc. and the introduction of automation of the heat treatment mode can save additionally at least 125 thousand Gcal of heat.

The same applies to energy savings. Activities such as repair and streamlining of compressed air routes, repair of shut-off valves, automation of the production and distribution of compressed air, partial replacement of pneumatic tools with electric ones, equipping all compressors with a capacity of more than 10 m^3 per minute with direct-flow valves can save 3.5 - 4 million kW/h [3].

Boiler house No. 1 was built in 1970. It has six boiler units of the GM-50/14 brand, which produce heat in the form of steam. Steam pressure up to the reactor plant (reducing unit) from 8 to 14 kg s/cm^2, temperature 160-200°C. Boiler house No. 1 mainly supplies steam to the technological installations of stages I and II of the plant. The boilers burn fuel gas supplied from workshop No. 1. In addition to providing steam for technological installations, the function of boiler house №1 includes providing feed water to waste heat boilers in workshop No. 3.

The burned gas in the boilers is discharged through a gas duct and a brick chimney, the height of which is 75 meters. At boiler room No. 1, all steam pipelines belong to category 4 “A”. The building of boiler house No. 1 belongs to category “G” in terms of explosion, explosion and fire hazards.

Boiler house No. 2 was built in 1980. It has five boiler units of the BBP -75/39 brand. The boilers operate on fuel gas supplied from the second stage of the plant. Boiler room No. 2 has 3 deaerators. and installation of PKKK for collecting and supplying steam condensate to the deaerator. The collection volume of steam condensate reserve is up to 1800 m^3. At PKKK installations, the separated steam from the separators is partially supplied to deaerator No. 4. At boiler house No. 2, eight RCUs (reducing cooling units) were built. Steam leaves the boiler at a pressure of up to 39 kgs/cm^2 and a temperature of 440°C, passing through the RCUs, the pressure drops to 6 kgs/cm^2 and the temperature drops to 180°C. The main consumer of heat from boiler house No. 2 is the II and III stages of the plant, which are partially transported to the IV stage [15-24].

In addition to generating steam, boiler room No. 2 is intended for the preparation of district heating water and provides heat to all industrial and non-industrial buildings of the plant. At boiler room No. 2, the steam lines of the boilers to the RCUs belong to category “A”, the remaining steam lines to category 4 “A”. The building of boiler house No. 2 in terms of explosion, explosion and fire hazards belongs to category “G”

The chemical water treatment plant (CWTP) was built in 1980. The main function of the water treatment plant is the softening of raw water supplied from Shakhrisabz sources and supplied to the Mubarek reservoir Kuyu-Mazar. The supplied raw water has a hardness of up to 120 mcg-eq/l. This water is softened on Na-cation exchange filters to 5 µg-eq/l and supplied as necessary to boiler rooms No. 1 and 2 to restore the loss of condensate steam. The chemical water treatment plant has five pairs of two-stage sodium cation exchange filters and six pairs of single-stage sodium cation exchange filters. Chemical water treatment capacity 320 t/h. Technical salt is used as a chemical reagent to saturate the cation exchanger with sodium ions.

3 Results and Discussions

The average values of the estimated useful pressures and water flow rates, and therefore the circulation rates in each circuit, obtained during circulation calculations are important characteristics. But these characteristics alone do not determine the reliability of the steam boiler. They only allow checking a number of provisions and criteria that determine the reliability of the operation of the steam boiler as a whole and its individual circuits. These criteria include:

- Absence of stagnation and overturning of the circulation (for circuits discharged into the water volume of the drum or into intermediate collectors) and the appearance of a free level.
- No disruption of the normal operation of the lowering links of each circuit.
- Ensuring reliable circulation during non-stationary boiler operation modes.
- Permissible temperature conditions of heated sections of the circuits.

Boilers BBP - 75/39 of the Mubarek gas processing plant must operate from 88% to 90% efficiency and have a maximum steam output of 45 to 50 t/h instead of the nominal - 75 t/h [14].

The use of the BBP - 75/39 boiler for the purpose of recycling flue gases, gas turbine units, to ensure the combustion process, will justify the heat and energy supply of the gas processing plant. The proposed project is intended to increase the efficiency of steam boilers of the Mubarek gas processing plant and for other similar industrial enterprises, using the heat of exhaust flue gases of gas turbine units in waste heat boilers for heat and power supply systems. This system consists of the following technological units: steam boiler, gas turbine unit, compressor, low and high pressure heaters, additional steam boiler furnace, additional fuel supply, smoke exhauster, main and auxiliary chimney. Use of flue gases $t_{flue\ gas.}$ = 550ºC, gas turbine units of the expired steam boiler BBP - 75/39, provides savings in energy resources supplied to the boiler, from each boiler $B_{cond.fuel}$ = 13x10^3 m^3 of standard fuel. At the same time, the environmental problem arising from flue gas emissions is also solved.

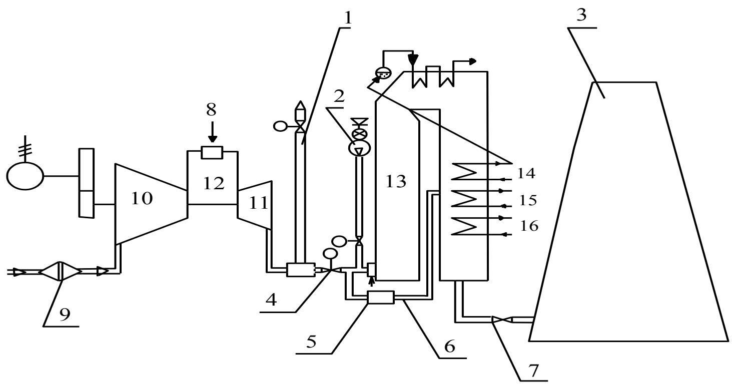

Fig. Using the BKZ - 75/39 boiler for the purpose of recycling flue gases from gas turbine units for heat and power supply to a gas processing plant.

Where, 1-spare chimney; 2 – smoke exhauster; 3 – chimney; 4.7 – repair gate; 5 – regulating gate; 6 – spare boiler furnace; 8 – combustion chamber; 9 – air exhaust pipe of the compressor; 10 – compressor; 11 – gas turbine unit; 12 – additional fuel supply; 13 – steam boiler; 14 – water economizer; 15,16 – gas-water heating installations high, low pressure.

We calculate secondary energy resources based on the following equation. The relative maximum amount of heat energy transferred from one unit to another is determined by the following equation:

$$\theta = \frac{t_{en} - t_{exit}}{t_{ent} - t_0} \tag{1}$$

Here, the temperatures of t_{en}, t_{ex}—SER's at the entrance and exit of the disposal device, °C; t_0-ambient temperature, °C.

The coefficient of use of hot SERs is expressed by the following expression:

$$\eta_{ut} = 1 - \frac{t_{ex} - t_0}{t_{en} - t_0} \tag{2}$$

Using the formula (1), the expression can be used to determine the heat used in the disposal coil:

$$Q = Q_{ex}\left[1 - \frac{t_{ex} - t_0}{t_{ex} - t_0}\right] \tag{3}$$

Where Q_{ex} is the amount of SER at the entrance to the disposal device kDj/h; Q is the amount of heat that can be used.

The amount of electricity in the amount of 46 MW for the plant's own needs is covered by a gas turbine unit. The highly efficient plant covers the heat and energy needs of the Muborek Gas Processing Plant. With simultaneous operation of a gas turbine and steam boiler plant, the efficiency will reach 90%. The implementation of the proposed development will solve the problem of energy and resource saving, make it possible to use a steam boiler in heat supply and solve the environmental problem. Due to flue gases $t_{smoke.gas.}$ = 550ºC of two gas turbine units GT-25-750 the plant supplies itself with electrical energy in the amount of 46 MW.

4 Conclusions

The implementation of the proposed development will solve the problem of energy and resource saving, make it possible to use a steam boiler in heat supply and solve the environmental problem.

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Of the secondary energy resources identified in Mubarek HPS 15-20% saving of primary energy using thermal power allows to do.

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