Shifting the boiler units of mining enterprises and processing plants to a new scheme of heat supply

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Abstract. This article analyzes the current situation in the heating circuit of the boiler room. Nowadays the Taiginsky enterprise proposes to modernize the heat supply system. For the first time, the dual circuit scheme is applied instead of a three circuit scheme. The scheme was developed instead of the existing boiler room scheme. There is also a description of the main equipment of the boiler. A hydraulic calculation was performed and a piezometric graph of the existing and proposed schemes was built. In addition, there is the heat calculation of fire-tube boiler and calculated technological losses during the transfer of heat energy to consumers. The calculation of the main technical and economic indicators is given in the economic part. The protection system of boiler units from mechanical and chemical influences is considered.

1. Introduction

Taiginsky enterprise is a unique producer of natural flake graphite. Extraction of graphite is carried out during sixty years. Currently, the length of the pit is 2960 meters, the width of the pit is 400 meters, the reserves will last for 40 years. The graphite is exported to the foreign companies in Europe, Canada, Japan and other countries [1, 2]. The block-modular water boiler house is located near the mine. The heat is generated by the boiler house in the form of hot water and supplied to consumers for the needs of heating, ventilation and hot water supply. In the design process, the boiler unit was decided to connect with production and other premises according to a three-circuit scheme. The operation of the heating boiler is as follows. Water from the return line of thermal networks with small pressure comes to the network pump. Also, water is supplied from the feed pump to compensate for water leaks in the heating networks, as well as hot water, the heat of which is partially used in heat exchangers. These heat exchangers are used to heat, respectively, chemically purified and raw water. This is necessary to ensure the set water temperature in front of the boiler, in order to prevent corrosion. The required amount of hot water coming out of the hot water boiler is fed through a recirculating pump to the pipeline behind the network pump. The hot water line is called recirculation. In all modes of operation of the heating network, except the maximum winter one, a part of the water from the return line after the network pump, bypassing the boiler, is supplied via the bypass line to the supply line. At this point it is mixing with hot water from the boiler, it provides the specified design temperature in the heat supply line networks. Water intended to compensate for leaks in heat networks is pre-supplied with a raw water pump to a raw water heater, where it is heated to a temperature of 18-20°C and then sent to chemical water treatment [3, 4]. Chemically purified water is heated in heat exchangers and in the deaerator. The feed pump takes water for feeding the heat networks from the deaerated water tank and feeds it into the return line. The main purpose of the calculation of any thermal scheme of the boiler house is to select...
the main and auxiliary equipment with the definition of baseline data for subsequent technical and economic calculations [5, 6]. Reliability and efficiency of hot water boilers depend on the constancy of the flow of water through them [7, 8]. In order to avoid low-temperature and sulfuric acid corrosion of convective heating surfaces, the temperature of the water entering the boiler should be at least 60°C when burning non-sulfur fuels, not less than 70 °C – when burning low-sulfur fuels and not less than 110 °C – when burning high-sulfur fuels. A recirculation pump is installed at the boiler inlet to increase the temperature of the water when the water temperature is below a predetermined value [9, 10]. It is shown in figure 1.

Figure 1. The existed scheme of the heat supply system: 1 – boiler house, 2 – boiler unit, 3 – boiler pump, 4 – heat exchanger of the boiler house, 5 – heat network pump, 6 – heat network, 7 – consumer building heat exchanger, 8 - consumer building, 9 – circulation pump, 10 – heat system

2. Statement of the problem. Scientific novelty

The natural gas is used as fuel to produce the hot water. The heat carrier is heated to 115°C. At the same time, the heat carrier for heat supply should have temperature from 80°C to 105°C. It is ensured by the network pumps installed in the boiler room. In the case of the consumption heat carrier with the temperature from 70 to 95°C existed in the scheme does not work. However, authors found out the scientific problem in this case, because the selection of boiler equipment was done incorrectly. The temperature schedule of the project is 115/80°C. The water temperature is 115°C. This is the maximum possible temperature at the outlet of the boiler. With this mode of operation, the operational life of the equipment is reduced, and maintenance costs are increased.

3. Variants and analogues of developed scheme

As an alternative, a dual-circuit heating and hot-water supply system is considered using a plant with a main steam-ejector device. Such a scheme can be used for the combined production of steam and hot water [11, 12]. The closed two-circuit heating system is the network and boiler circuits. They are separated by a barrier heat exchanger. This allows protecting the boiler equipment from the negative impact of heating networks [13, 14]. The scheme provides an automatic system for controlling the heating temperature of the mains water, which monitors the fluctuations of the outdoor air temperature and optimally aligns the mode of fuel combustion and hydraulic flows through the circuits, providing the user with the nominal thermal load required [15, 16]. The frequency control system is the installation of variable frequency drives on make-up pumps. It provides significant energy savings.
4. Main results of application the new scheme. Discussion

In order to improve the quality of heat supply under existing conditions, it is proposed to replace the three-circuit heating system with a dual-circuit one by dismantling heat exchangers in the boiler room [2, 17]. The main result of this event is the cost reduction for maintenance and repair of heat exchangers. Furthermore, it is a reduction of electrical energy consumption in connection with the dismantling of the circulation pumps of the boiler circuit and clear economic effect compared with the replacement of boilers and the transition to the design schedule of the boiler circuit $t_1/t_2 = 115/80^\circ\mathrm{C}$. It is reduction the cost of heat production [3, 18], reduction of losses in the transfer of thermal energy from the boiler circuit to the network [19, 20] and an increase in the actual efficiency of the boiler as a result of the transfer from emergency to working mode, flue gas temperature reduction.

![Figure 2. The developed scheme of the heat supply system: 1 – boiler house, 2 – boiler unit, 3 – heat network pump, 4 – heat network, 5 – heat exchanger of consumption building, 6 - consumption building, 7 – circulation pump, 8 – heat system](image)

5. Practical significance

In case of dismantling the heat exchangers, the dry cleaning of the network and source water will be carried out according to the following scheme: the sump on the return main pipeline will protect the boilers from damage caused by mechanical impurities, rust. The automatic continuous installation is designed to remove stiffness cations from the water, carried out during the ion exchange process, namely the sodium cationization method by passing the source water through an ion exchange resin layer. The proposed scheme increases the boiler house efficiency according to preliminary estimates by 0.5-0.6%. The most common is its use in the mining and power energy industry. The developed scheme is especially important for mining enterprises. In this case, the boiler house, which is located close to consumers, should be shifted to the developed scheme.

6. Conclusion

Thus, the following scientific and practical results are identified and disclosed in the paper. The scheme has been developed that instead of existed scheme. The use of dual circuit schemes is possible under certain conditions. In particular, it is necessary to conduct a hydraulic calculation of heat networks and heat exchangers. In addition, calculate the heat load of hot water consumers. The paper shows that for the first time such a scheme is used instead of the existing three-loop scheme.
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