Using refrigeration machines and heat pumps in the cycle of oil preheating using electricity

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Abstract. Tank electric heating systems are designed to compensate for heat losses to the environment. The main way of heating technological machines in the negative ambient temperatures is electric heating. Also, electric heating serves to prevent phase changes in the energy carrier. Furthermore, it is needed to control the required viscosity and maintain the set temperatures. The problem of limited resources has always faced humanity. In the field of energy this problem is now more urgent than ever before, because every year, the planet's hydrocarbon reserves are becoming less and less. Hydrocarbon cost is increasing, which leads to an increase in the cost of the final product. Therefore, it is necessary to use resources more efficiently, increase the efficiency of equipment, and introduce new technologies. In addition to limited resources, the problem of environmental pollution is no less acute.

1. Introduction

The use of electrical heating systems varies across the energy industry. If a liquid heat carrier is stored in the tank in winter, then its temperature can be maintained by heating and thermal insulation. An optimal system should have these two components. Heating by one of the components in the absence of the other is ineffective due to large heat losses [1, 2]. Thermal insulation provides a reduction in heat loss. Problems that can arise in cold weather are crystallization of the medium, coagulation of particles with precipitation, condensation, changes in the physical and chemical properties of the product. Heating is not used to heat the medium to a higher temperature [3]. It is needed to provide the desired temperature, compensating for heat loss.

2. Scientific novelty

The regenerating system of the low-power steam generator is less effective without low temperature utilization machines. However, when applying methods of additional energy generation in the form of heat, it is possible to increase the thermal efficiency of a thermal power plant. The authors propose the use of refrigeration machines and heat pumps in the regenerating system of the steam generator [4, 5]. The most effective at the moment are absorption chillers, as well as heat pumps in the ORC cycle. One of the first methods of heating and the most common is heating with steam supplied directly to the environment. Steam heating has a large number of disadvantages, namely the presence of technology for generating steam, the need for large human and technological resources. In addition, the disadvantage should be attributed to the complexity of control of the temperature of the environment,
the formation of water condensate when using steam, low efficiency, increased costs to obtain more steam [6, 7].

The supply of steam to the inter-wall space in double-walled tanks, along with conventional steam heating, has disadvantages. First of all these are the following disadvantages - the elimination of condensate from the inter-wall space, uneven heating of the heated medium. In addition, these disadvantages are an increase in the heating time. The heating of the medium is slower or does not occur entirely, the possibility of effective use in small tanks.

Heating of tanks with a heating cable occurs by heating the wall of the tank itself. This system is the most effective and widespread due to its simplicity and reliability. When using electric heating, the design of the system is greatly simplified, its service life is increased, the service and the repair period of this system are reduced due to its independence from the technological cycles of the boiler room.

Typically, a cable heating system includes such elements as a cable and the necessary fasteners, a control system (thermostats, temperature sensors, controller), a power supply system (power cables, junction boxes, control cables).

This heating method is used in the absence of steam, or in case of insufficient production. The heating cable is laid out on the surface of the tank in a spiral or serpentine manner [8]. Fastening is carried out using special fastening materials: aluminum tape, professional mounting tape, mesh. On top of the cable, the container is covered with a layer of thermal insulation and a protective casing. A casing is required to prevent the insulation from getting wet [9, 10].

The preheating scheme using ORC and an absorption refrigeration machine is working by pump 1 in figure 1. We use water line 2 and water output 3, absorption machine 4. The main machine is oil-water electric heat exchanger 5. The cold-water input 6 is going to water tank 7. The pump has an electric drive 8 and electric cable input 9, electric cable output 10. Furthermore, CHP or boiler unit has a low temperature source 11, compressor 12 and high temperature source 13, ORC turbine 14. It is realized in an ORC with low temperature source, electric drive 15 and electric cable 16.

3. Results

Research and development have shown that it is possible to significantly increase the efficiency of utilizing heat and mass of blow down water by using the high energy potential of this water in individual technological processes of boiler plants. At the same time, one should strive to use blow down water as a working medium directly in the apparatus where these technological processes take place, in order to partially or completely exclude special utilization equipment from the boiler room scheme. Naturally, when using new methods of utilizing blow down water, the rules for the design and
safe operation of boilers and pipelines provided for by the guidelines for boiler supervision must be strictly observed.

One of the possible ways to implement the above idea is the use of blow down water as a heating agent for the jet-bubbling vacuum degasser. This method makes it possible to fully use the energy potential of the purge water in the process of desorption of dissolved gases from the boiler feed water or the make-up water of the heating system. This solution reduces or eliminates the need for steam or direct mains water commonly used as a heating agent in the vacuum degasser. In low-pressure boilers with closed heating systems, the blow down water can be supplied directly to the evaporator compartment of the vacuum degasser [11, 12].

In high-pressure boilers, it is advisable to use unevaporated water as a heating agent in a vacuum degasser after the first stage continuous blow down separator, excluding the second stage separator from the boiler room scheme. The use of blow down water as a heating agent for vacuum degassing of the make-up water of the heating network also contributes to the stabilization of the temperature regime of operation of the vacuum degasser. To ensure normal degassing, the temperature of the heating agent should not be less than 90 - 100 °C in installations with horizontal vacuum degassers and 120 - 150 °C - with vertical vacuum degassers [13, 14].

Typically, in vacuum degassers for replenishing the heating network, the heating agent is direct network water, the temperature of which has significant seasonal fluctuations and does not reach the above minimum values in the warm season. Since the temperature of the blow down water is constant, the use of this water instead of the mains water makes it possible to stabilize the temperature regime and improve the quality of vacuum degassing of the make-up water. It should be noted that when using blow down water for the technological needs of the boiler room instead of other, more valuable heat carriers and with a high degree of utilization of heat and mass of blow down water, it is not necessary to strive for the minimum course of continuous blow down of boilers [15, 16].

The purge flow rate may slightly exceed the norm and is determined by the energy requirement of the process carried out with the help of purge water. This consideration is also valid when implementing another technical solution, according to which the blow down water is used to regulate the supply of fuel oil to the boiler furnace. This method is implemented in steam-mechanical nozzles, where, instead of steam, blow down water is used, taken from the boiler drum.

Heaters made in the form of perforated rings can be installed in fuel oil tanks in the area where the suction pipes of fuel pumps are connected to them. Calculations and accumulated operational experience show that with the correct application of the technology under consideration, the possibility of excessive watering of fuel oil or accumulation of water in fuel oil tanks is excluded. This solution is much easier to implement in boiler plants, however, the economic and environmental effect of its use is practically the same as when using the previous method.

The most effective technology provides for the use of blow down water simultaneously for heating and transporting fuel oil from the fuel oil facility to the boiler using jet pumps. When supplying steam to some industrial plants. That do not require a high purity of the process steam. It is recommended to use blow down water, which ensures complete utilization of its heat and mass. This invention provides for the complete mixing of blow down water with steam used in production processes, which include steaming of reinforced concrete products, contact heating of raw materials, fuel, that is, processes for which the presence of a certain amount of mineral salts in the steam is not essential. In low pressure boilers with steam superheating, blow down water can be supplied to the live steam pipeline supplied to the consumer. In boilers of medium and high pressure, it is advisable to introduce the blow down water into the bleed-off steam pipeline of the turbines or use it as a cooling medium in reduction-cooling plants.

4. Conclusion
The process in the heat exchanger is very beneficial, since with a decrease in the temperature of a weak solution, the absorption proceeds more vigorously, and with an increase in the temperature of a strong solution, savings are achieved in the heat consumption for evaporating ammonia in the boiler generator.
Since the pressure in the boiler-generator is high, and in the absorber is low, a weak solution enters the throttle valve on the way from the first to the second. Reserve fuel heating currently has a lot of solutions. Considering the methods and technology of systems for ensuring the required temperature value of the fuel in a gas boiler house, based on the availability of media used for these purposes, two possible and effective methods are considered. Summarizing the above, each of the methods has both advantages and disadvantages. Based on the available technological cycles of the boiler room, the use of electric heating is the most effective due to its simplicity, reliability and maintainability.

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