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## HEAT EXCHANGE PROCESSES IN THERMAL INSTALLATIONS (QUALITY OF HEAT CARRIER)

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*Abstract.* The operation of boiler equipment is adversely affected by the need to decentralize heat supply systems, unauthorized withdrawal of coolant, switching to low-temperature operation without updating equipment, reducing boiler capacity due to low gas pressure, violation of operating modes and repair schedules, scale deposition on heat exchange surfaces, increased electricity consumption, physical and moral wear and tear of auxiliary equipment and heating networks. These factors lead to chemical incomplete combustion of fuel and its irrational use, corrosion and premature failure of equipment, reduced quality of heat supply and justified consumer complaints. This situation requires immediate modernization of the heat generation and distribution system, as well as the use of low-cost measures to increase the service life of existing equipment.

*Keywords:* process, heat exchange, boiler, methodology, heat carrier.

*Introduction.* At present, autonomous (decentralized) heat supply is becoming more and more widely used. It is especially developed in those regions of Ukraine, where there is no shortage of network (natural) gas and there is a sufficiently developed gas supply system. Boilers are used as heat sources for these heat supply systems. In general, these systems provide a higher level of thermal comfort and create additional opportunities for energy saving. To date, the issues of heat exchange in boilers from the side of both combustion products and coolant are poorly studied. Also remain poorly studied processes of formation of deposits in boilers, which significantly affect the reliability of operation and energy efficiency of the boiler. In accordance with the above mentioned, there is a need to improve the boiler design to improve the reliability and efficiency of operation.

The *object* of the study is boilers with developed heat exchange surfaces.

The *subject* of research is the process of heat transfer from combustion products to the water coolant through a developed heat exchange surface, taking into account the possible process of sediment formation.

The *purpose* of the work is to study the processes of heat exchange in a hot-tube boiler, taking into account the quality of the water coolant to increase the energy efficiency of the boiler.

*Objectives* of the study:

1. To develop a method of thermal calculation of the boiler, taking into account the physical and chemical mechanism of fuel combustion, heat exchange processes from the side of combustion products and from the side of the coolant, as well as geometric characteristics of the heating surfaces of the flame tube and gas-tube bundle.
2. To determine the dependence of the rate of formation of deposits on the heating surface of the boiler and to develop a methodology for determining the inter-flushing interval.
3. To develop methods of experimental investigation of the processes of complex heat exchange in gas channels washed by the coolant and the process of scale formation on the heating surfaces. To carry out a comparative analysis of the results of the numerical solution with the experimental data.
4. To offer recommendations for the choice of rational geometrical characteristics of heating surfaces of the flame tube and gas tube bundle according to the results of feasibility study.

The *novelty* covers the methods of thermal calculation of the boiler, which takes into account the rate of formation of deposits on the heating surfaces from the side of the coolant and the geometry of the heating surface of the pipe.

*Presentation of the main research material.*

The main element of any heat-generating apparatus is the furnace, where chemical transformations take place and generate heat. It is possible to burn fuel efficiently, obtaining maximum heat, but to use this heat inefficiently. On the contrary, it is possible not to fully extract the heat of combustion, but to use it efficiently. Therefore, the furnace efficiency includes the combustion efficiency and the efficiency of utilization of the released heat. The combustion efficiency shows how much of the calorific value of the fuel can be converted into heat. It largely depends on the method of combustion and the design of the boiler. In order to burn fuel more efficiently, it is necessary to increase the temperature in the furnace and reduce the impact of ballast gases. Inventive activity was aimed at optimizing the supply of primary and secondary air, combining different fires into complexes, and improving various parts of the thermal plant.

Intensification of heat exchange in the boiler elements is an effective way to increase the reliability and efficiency of the boiler. Intensification of

heat transfer in boiler elements can be carried out by installing heat transfer intensifiers in the furnace or in the heat-tube element [1-2].

The factors influencing the rate of deposit formation are considered: concentration of impurities, heat flux density, speed of coolant movement. To the main types of deposits formed on the heating surfaces on the side of water coolant can be attributed the following: iron oxide, alkaline earth, copper, aluminum compounds and easily soluble compounds. Reasons of boilers operation with the coolant that does not meet the normative parameters: boiler make-up due to unauthorized water intake exceeds the normative values, and water treatment plants cannot cope with the volume of make-up. In remote areas it is difficult to ensure the necessary quality of water treatment and therefore there is a need to tighten the requirements to the quality of heat transfer medium for boilers, as they are designed for hot water tube boilers; when Na-cationization is used, the amount of hardness salts is reduced, but Na salts are added, which form loose deposits.

To study the heat transfer processes in boilers, a joint, conjugate solution of the problems of external (water volume) and internal (gas volume) heat transfer according to the scheme was used. To reduce the rate of fouling growth it is proposed to use developed heat exchange surfaces in the zone of maximum heat flux densities. These measures make it possible to reduce the temperature of combustion products at the outlet of the flame tube and, accordingly, the heat load in the chamber.

*Conclusions.* The current trend of decreasing production of natural fuel and energy resources has a very significant impact on the development of boiler construction. Given the current state of the boiler industry in Ukraine, there is a significant potential for modernization and reconstruction of boiler equipment. This is due to a significant number of boiler units with outdated designs and a significant degree of physical and moral wear and tear. A complete replacement of boiler units requires significant investments, so an effective modernization is needed to give a significant effect. One of the most important processes in a boiler unit is heat exchange, and the efficiency of this process has a significant impact on the boiler's operation. Therefore, to ensure highly efficient operation of the boiler, it is necessary to ensure maximum heat transfer in the boiler by utilizing the maximum possible amount of heat released during the combustion process. To do this, it is necessary to install additional elements in the boiler, namely a heat exchanger that will lower the temperature of the outgoing gases from the boiler and transfer the resulting heat to water. There are different types of such heat exchangers and all of them give the effect of their work. The main goal is to determine the best possible heat exchanger option to ensure optimal boiler performance parameters.

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## **DEVELOPMENT OF CONTROL ALGORITHMS FOR MODERN INVERTERS OR CONVERTERS OF ENERGY STORAGE SYSTEMS WITH FUNCTIONS OF VIRTUAL SYNCHRONOUS MACHINES**

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*Abstract.* The ESCRI-SA project represents Australia's first large-scale Battery Energy Storage System (BESS), with the Dalrymple BESS featuring an innovative energy storage system capacity of 30 MW and 8 MWh (BESS). This system operates as a virtual synchronous generator with grid-forming capability. The introduction of such equipment into operation confirms that energy storage plays a crucial role in the energy system, both currently and in the future, where the growth of various types of renewable energy sources will continue.

*Keywords:* Renewable Energy Sources (RES); inertia; inverters; power system stability; primary frequency response (PFR); mathematical modeling; computer model; simulation.

*Introduction:* The significant growth in electricity generation in recent years, particularly from renewable energy sources (hereafter RES, such as solar, wind, biofuels, etc.), does not ensure reliable synchronous operation of energy facilities within the power system. Consequently, a threshold is established for non-synchronous generation associated with RES and the operation of their energy inverters and other converters. For instance, overseas, the threshold for non-synchronous generation relative to peak load in 2017 was set at 65% in Ireland and 54% in Texas.