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EXPERIMENTAL METHOD OF INVESTIGATION OF THE HEAT TRANSFER CRISIS IN A CAPILLARY-POROUS COOLING SYSTEM

Abstract. The crisis of heat exchange in grid porous structures at boiling water is studied. The study relates to heat and power installations of power plants. Experiments were carried out on an electric testing bench and on a rocket type burner, in which combustion chambers and supersonic nozzles were cooled with various capillary-porous structures. The model and mechanism of the heat exchange processes are described, the optimal dimensions of the cells of the porous structures are determined, and computational equations for determining the critical heat flow for a wide variation of pressure in the system and the parameters of the porous structures (pore sizes, structure thickness, permeability, geometric dimensions of the cooling surface and its orientation) are obtained. Experimental installations for determining integral (average) heat-exchange parameters in a capillary-porous cooling system are produced: operation scheme and a measurement technique, a cooling element with tubular arteries structure, a perforated clamping plate and micro arteries. Studies were carried out until the wall and the capillary-porous structures were overburnt.

Keywords: heat transfer crisis; capillary-porous structure; heat and power installations; steam bubble; capillary forces; mass forces; heat transfer control; permeability.

Introduction. The application of porous materials in boiler-and-turbine technology has attracted many researchers to create various devices. The intensity of the heat-eliminating systems and boosting of the processes occurring in them increased [1-3]. The application of porous materials in addition to cooling systems allowed to create units in which issues of explosion safety, work safety and durability were addressed [4-6]. This was facilitated by the ability to control the processes of steam formation due to asurplus of liquid in the porous and capillary structures created by the combined actions of capillary and mass forces [7-9].

In heat and power installations (HPI), capillary-porous materials are used to cool highly-boosted detonation burner devices [3], to create steam coolers in steam boilers [9], oil coolers preventing intrusion of oil to cooling water and of water to a bearing system [10], labyrinth seals [11] and in other devices [10].

We protected the main areas of application of capillary-porous systems by patents and inventor's certificates. Integration of equipment and technological processes in the energy sector should be carried out primarily from the ecological and economic terms. Proposed inventions will facilitate the implementation of processes, significantly improving and protecting the environment [3, 5, 8-11].

These systems allow to achieve fuel, raw materials, air, water and heat savings; they increase the reliability of cooling and fire and explosion safety of equipment operation; they facilitate highly effective destruction of rocks, concretes, metals, and reduce low-temperature corrosion of surfaces, as well as reduce bio contamination by toxic gases, dust, and heat. Furthermore, the systems facilitate the resolution of food program issues, whilst helping to achieve strong economic and social effects in the area of ecology and a work safety.

The main advantages of such systems are high intensity, high heat transfer ability, reliability, compactness, ease of manufacturing and operation; they improve the performance and technological parameters and have low capital and operating costs.