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**REPORTS OF THE NATIONAL ACADEMY OF SCIENCES
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A.A. Genbach¹, D.Yu. Bondartsev²¹Genbach A.A., Doctor of Engineering Science, Professor of AUPET;²Bondartsev D.Yu., Postdoctoral student at AUPET, leading engineer, JS «Trest Sredazenergomontazh»
d.bondartsev@saem.kz**SCIENTIFIC METHOD OF CREATION CAPILLARY-POROUS
COOLING SYSTEMS FOR ELEMENTS
OF ENERGY BUILDING OF POWER STATIONS**

Abstract. To create a scientific methodology, studies of the ultimate heat fluxes in metallic and poorly heat-conducting porous structures operating under the combined action of gravitational and capillary forces and cooling various devices of thermal power plants have been carried out. On the basis of the problem of thermoelasticity and experimental data, the mechanism of destruction of metal vaporising surfaces and poorly heat-conducting coatings of low porosity made of natural mineral media (granite) is described. On the basis of the analogy of the phenomena, the dependences of the heat fluxes on the time of their action and the depth of penetration of temperature perturbations are revealed. Capillary - porous systems have high intensity, high heat transfer ability, reliability, compactness.

Keywords: heat transfer crisis; capillary-porous structure; heat and power installations.

INTRODUCTION. Successful use of capillary-porous materials in engineering attracted many researchers and inventors to create different devices on their basis. The intensity of heat-eliminating systems and the forcing of processes taking place therein increased [1-3]. In addition to cooling systems, the use of porous materials allowed the creation of units which addressed the problems of explosion safety, labor protection and durability [4,6]. This was facilitated by the ability to control evaporation processes due to excess fluid in pores and capillary structures, formed by the combined action of capillary and mass forces [7-9].

In thermal power plants (TPPs), capillary-porous materials are used to cool highly-forced detonation burner units [3], to create steam coolers in steam boilers [9], oil coolers that prevent oil from entering cooling water and water from entering the bearing system [10] and labyrinth seals [11], and are used in other devices [10]. The main areas of practical application of capillary-porous systems are presented in [3,5,8-11]. Equipment and technological processes in the energy sector should be introduced from the ecological and economic positions primarily. The proposed development of capillary-porous systems will facilitate the implementation of processes, significantly improving and preserving the natural environment.

The main advantages of capillary-porous systems include high intensity, high heat transportability, reliability, compactness, simplicity in manufacture and operation. These systems improve operational and technological performance and have low capital and operating costs. Based on the study of capillary-porous systems, new technical solutions have been developed to improve the performance characteristics of the thermal power plant in relation to the powerful power units of combined heat and power plants.

The authors of [12] carry out a comparative analysis of methods for calculating the heat transfer, based on the water boiling with underheating in vertical channels, and they consider that the hot spot corrosion of fuel element claddings of nuclear reactor fuel elements is similar to the capillary-porous structure [13,14]. However, no studies of heat transfer through a regular structured surface have been carried out.

According to the authors' opinion [15,16], surface boiling on porous surfaces can influence the development of corrosion due to the erosive action on the heat exchange surface, when the bubbles of steam fall in an underheated liquid. Therefore, it is required to investigate the evaporation of liquid in capillary-porous structures in the field of capillary and mass forces, taking into account the velocity and underheating, which are formed by excess fluid.

An estimated intensity of heat transfer for liquid boiling in a large volume and thin films on a smooth surface showed equal possibilities [12-14] at high thermal flow and higher heat transfer parameters than that in systems with a capillary-porous coating [15-16]. It is required to carry out investigations of the heat transfer capabilities of capillary-porous coatings operating in the field of capillary and mass forces, and to establish ultimate (critical) load values leading to the destruction of the heating surfaces. Figure 1 presents a method for studying capillary-porous systems for various elements of power plants. The systems differ in the fact that they have predominantly a gravitational fluid supply and occupy an intermediate position between thin-film evaporators and porous evaporators with a predominantly capillary fluid supply (heat pipes) in terms of the intensity of heat transfer. Therefore, such systems should be identified in a separate class of heat-eliminating systems.

The performed researches make it possible to give recommendations on the selection of the heating-and-cooling medium, take into account the type of its circulation, determine the geometry and material of apparatuses and heat exchange intensifiers, taking into account the conditions and orientations of the system operation under pressure or underpressure, the energy supply and type and the system orientation. Generalization of the experimental results and calculation procedure for heat and mass transfer in capillary-porous systems in accordance with Figure 1 are presented in [17-21].

The investigation of various factors affecting the heat transfer in the structures shows that the critical states of the heating surface are of particular interest, when the system is capable of carrying the maximum flows of energy and substance. In this case, however, the values of thermal flows and thermal stresses are required to be known in order to ensure a reliable long-term operation of the unit. Consequently, the maximum energy and substance transfer can be obtained for the following conditions: a pure liquid circulating in a forced scheme in closed elliptical heat exchangers under pressure in perforated and profiled heating surfaces made of stainless steel is used.

The system operates with an excessed fluid, and the presence of mass forces ensures the forced flow of the heating-and-cooling medium with underheating. Energy is supplied to the vertical surface along the perimeter, with a supersonic high-temperature pulsating rotating torch [1,3,11,19].

AN EXPERIMENTAL METHOD

Experimental units allowing to investigate the following integral characteristics of heat transfer have been developed: ultimate thermal flows (q), up to critical ones; liquid (m_l) and vapor (m_v) flow rates; distribution of the temperature field along the height and the length of the heat exchange surface. Studies are carried out in a capillary-porous cooling system which can operate on the principle of a closed evaporative-condensation design, or to be open. Various heat exchange conditions are studied, including: method of the coolant supply; the extent of tightness of the capillary-porous structure; ability to feed up the micro-arterial structure along the height of the heat exchange surface; orientation of the surface relative to gravitational forces; geometry: flat, tubular and curved cooling surfaces; influence of pressure up to manifestations of crisis with wall burning (see Fig. 1). To study the mechanism of heat transfer, holography methods and the generalization of similar and analogous phenomena are used [1,3,11,20,21]. The heat exchange is controlled using the elliptical systems, by the combined action of capillary and mass forces [1,3]. The study of heat transfer is of a practical nature. It is intended for the creation of various thermal power plants: steam attemperators of steam boilers, porous coatings of poorly heat-conducting material, seals in steam turbines and a number of other power plants [1,3,7,10,19].

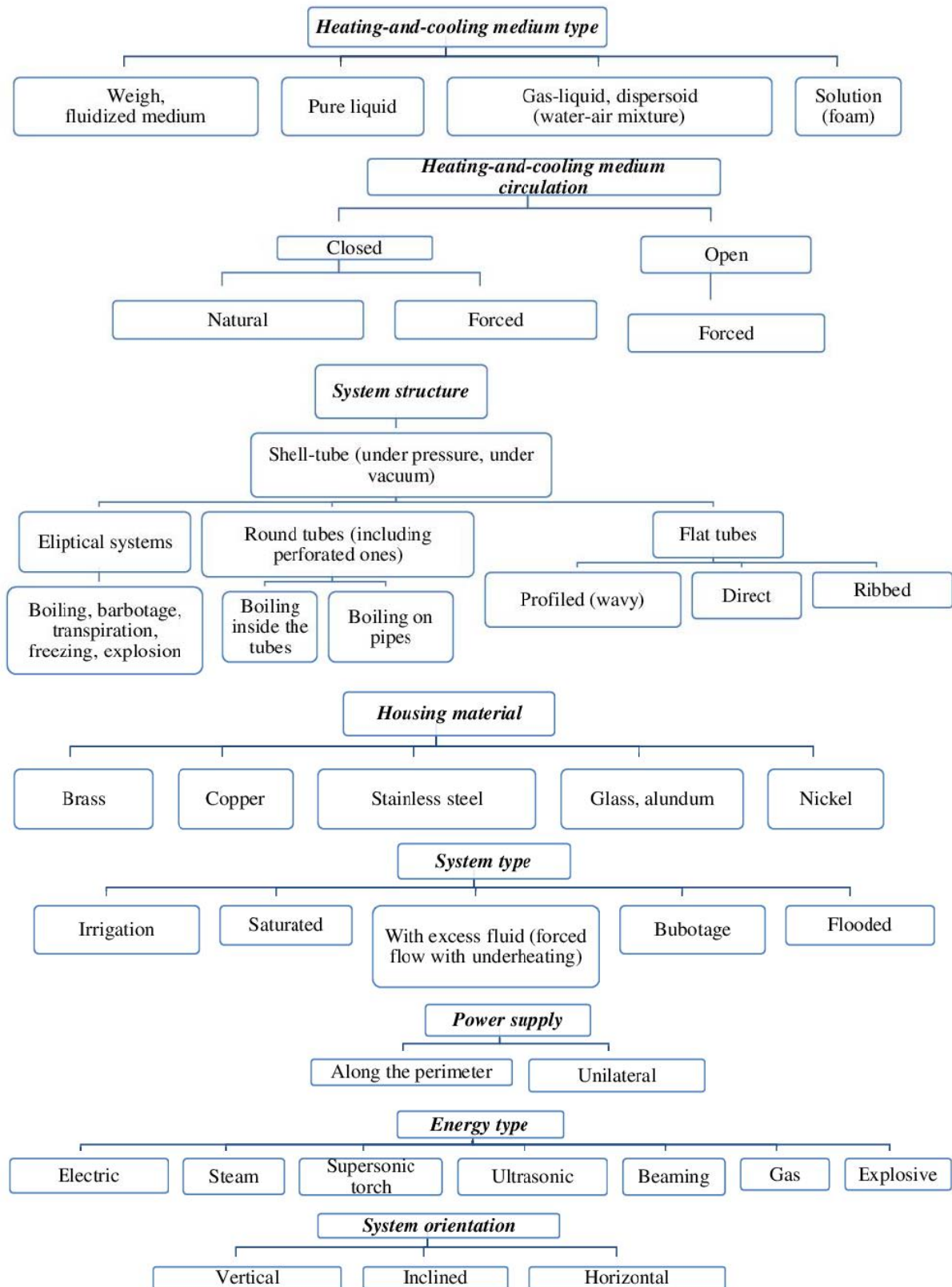


Figure 1 - A method for investigating various factors affecting the heat and mass transfer in capillary-porous systems of TPPs

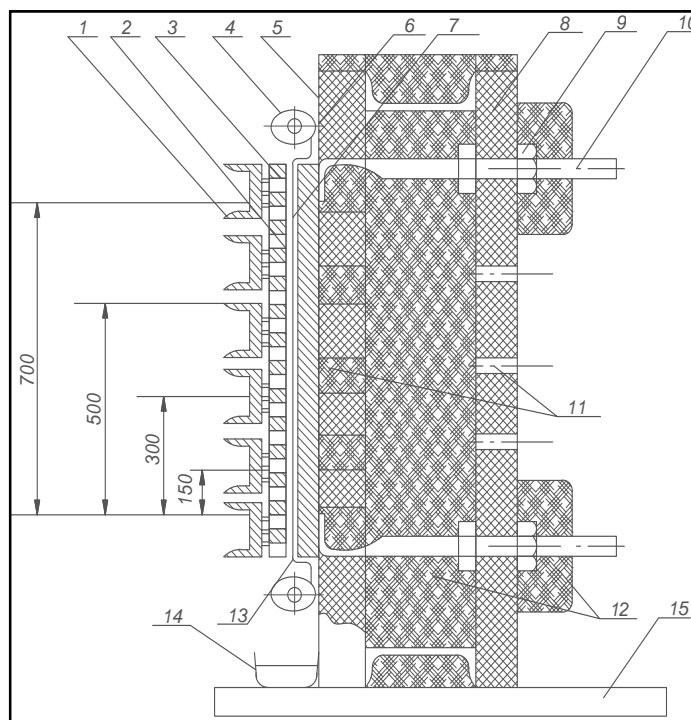


Figure 2 - Cross section of a flat experimental unit: 1 – pressing bar, 2 – capillary-porous structure, 3 – perforated pressure plate, 4 – tubular artery, 5 – asbestos cement plate, 6 – heater, 7 – insulation, 8 – plate, 9 – clamping nut, 10 – electrode, 11 – windows, 12 – heat insulation, 13 – coolable wall, 14 – collector, 15 – stand.

Figure 2 shows a cross section of a flat experimental unit with a perforated pressure plate 3 (Fig. 3), tubular arteries 4 and a capillary-porous structure 2.

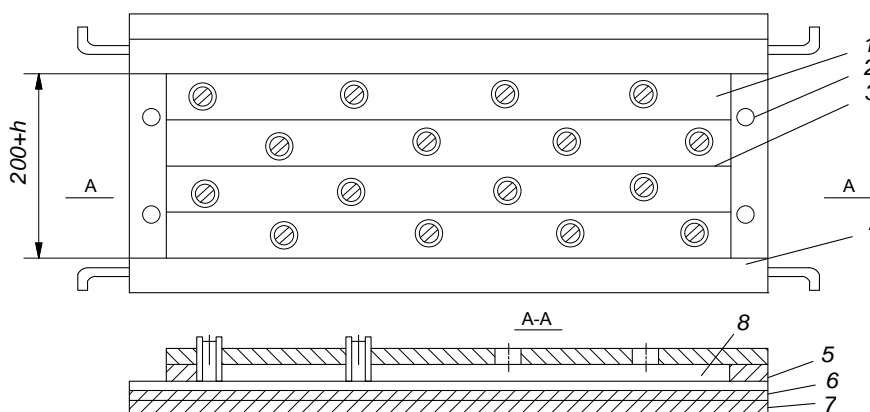


Figure 3 - Pressure scheme for the capillary-porous structure: 1 – plates, 2 – pressure screws, 3 – steam slots, 4 – fluid supply, 5 – pressure perforated plate, 6 – capillary-porous structure, 7 – heated wall, 8 – microartery

The maximum possible error:

A) $\pm 0.6\%$, when measuring current; $\pm 1\%$, when voltage is dropped; power is $\pm 1,6\%$,

B) $\pm 3\%$, when determining the liquid flow rate, using a rate-of-flow meter.

The imbalance of the current-supplied heat and the heat led to circulation and excess water, taking into account heat losses through the insulation, did not exceed $\pm 12\%$, and $\pm 11\%$ through circulating water. The discrepancy between the material balance between the flow rate of the cooling liquid and drainage and condensate flow is no more than $\pm 10\%$. The measurement procedure and the processing of experimental data were published in [2,4].

To study the boiling crisis, we also assembled the units made in the form of a rocket-type flame-jet burner. The scheme of the experimental unit and the experimental conditions are presented in [3]. Ignition chambers and supersonic nozzles were cooled using a capillary-porous and water system (Fig. 4). The thermoreactive burner was also used to study the critical state of capillary-porous coatings made of natural mineral media (granite, quartz and teschenite coatings). The thermal effect was realized by a supersonic (up to 2000 m/s) high-temperature (up to 2500°C) pulsating torch (see Fig. 1, form of energy). Fig. 4 shows the results of the destroyed ignition chambers.

RESULTS OF THE HEAT TRANSFER CRISIS IN THE CAPILLARY-POROUS COOLING SYSTEM AND THE DISCUSSION THEREOF.

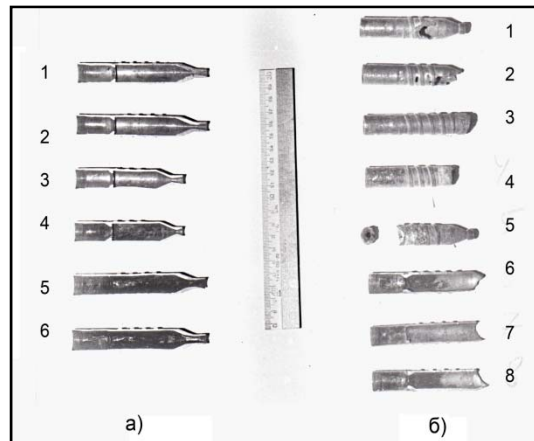


Figure 4 - Destroyed ignition chambers and supersonic burner nozzles:

- a) nozzles are made without a wall thickening: 1, 2, 3, 4 – before operation; 5, 6 – after 40 hours of operation (the deflector rings are destroyed and nozzle cross-sections are enlarged); 1, 2, 5, 6 – $\alpha = 0,8$; 3, 4 – $\alpha = 0,6$; 4 – ignition chambers with a shortened nozzle (this ensured the detonation combustion condition). Cooling system is water - operated ($q_{\text{ccs}} = 1 \times 10^6 \text{ W/m}^2$;))
 b) nozzles are made with a wall thickening: 1-8 – $\alpha = 0,6 \dots 0,65$, the destruction occurred as a result of the breakdown of gases into the water cooling system when the seals became depressurized; 5 – ignition chamber with a fused swirler. Cooling system is capillary - porous ($q_{\text{ccs}} = 1 \times 10^6 \text{ W/m}^2$;))

MODEL OF A CAPILLARY-POROUS

To determine the critical thermal flows and stresses, the thermoelasticity problem [3,9,10] is solved under the secondary limiting conditions for the one-dimensional equation of nonstationary heat conductivity.

Let's consider a plate with the thickness of $2h$. The constant ultimate thermal flow q is supplied to the surface $z = +h$, starting from the timepoint $t = 0$. The bottom surface $z = -h$ and the plate side edges are thermally insulated.

Thermal conductivity equation with limiting and initial conditions can be written in the form:

$$\alpha_w \frac{\partial^2 T}{\partial z^2} = \frac{\partial T}{\partial \tau}, \quad T = 0, \quad \tau < 0; \quad (1)$$

$$\lambda_w \frac{\partial T}{\partial z} = q, \quad z = +h;$$

$$\lambda_w \frac{\partial T}{\partial z} = 0, \quad z = -h.$$

The temperature distribution along the thickness depends on the thermophysical properties of the material, the thermal flow value and the feeding time:

$$T\left(\frac{z}{h}; \tau\right) = q \left\{ \frac{M}{2(c\lambda\rho)_w} \tau + \frac{3z^2 + 6z}{h^2 + h} - \frac{4}{\pi^2 M} \sum_{n=1}^{\infty} \frac{(-1)^n}{n^2} \exp\left[-n^2 \frac{\pi^2 M^2}{4(c\lambda\rho)_w} \tau\right] \cos\left[\frac{n\pi}{2}\left(\frac{z}{h} + 1\right)\right] \right\}, \quad (2)$$

where $M = \frac{\lambda_w}{h}$; n – positive numbers.

Using the known temperature distribution in the plate, we can find the thermal tension and compression stresses arising at a certain time t at various depths from the surface $\delta_i = (h = z_i)$ for a given value of the thermal flow q , since the plate with a variable temperature is in the plain stress condition.

$$\sigma_{xx} = \sigma_{yy} = -\frac{\alpha E}{(1-\nu)} T\left(\frac{z}{h}; \tau\right) + \frac{1}{(1-\nu)2h} \int_{-h}^{+h} \alpha 2' E T\left(\frac{z}{h}; \tau\right) dz, \quad (3)$$

where the first term is the component of the compression stress, and the second term is the tension stress.

SOLUTION TO THE EQUATION (1).

If we are given the limiting values of tension and compression stresses for the rock (porous coatings from the natural mineral medium) and the metal, we obtain the dependence of the thermal flow required for destruction on the time of delivery and the depth of penetration. In addition, equating the temperatures on the plate surface to the rock and metal melting temperature, we find the values of the ultimate thermal flows necessary for melting the surface layer for a different period of their action:

surface melting:

$$q_1 = \frac{T_f}{\left\{ \frac{M}{2(c\rho\lambda)_w} \tau + \frac{2}{3M} - \frac{4}{\pi^2 M} \sum_{n=1}^{\infty} \frac{(-1)^n}{n^2} \exp\left[-n^2 \frac{\pi^2 M^2}{4(c\rho\lambda)_w} \tau\right] \cos n\pi \right\}}; \quad (4)$$

development of limiting compression stresses:

$$q_2 = \frac{\frac{(1-\nu)\sigma_{ut}}{\alpha E}}{\frac{M}{2(c\lambda\rho)_w} \tau + \frac{3z^2 + 6z}{h^2 + h} - \frac{4}{\pi^2 M} \sum_{n=1}^{\infty} \frac{(-1)^n}{n^2} \exp\left[-n^2 \frac{\pi^2 M^2}{4(c\lambda\rho)_w} \tau\right] \left[\cos \frac{n\pi}{2}\left(\frac{z}{h} + 1\right)\right]}; \quad (5)$$

creating ultimate tension stresses:

$$q_3 = \frac{\frac{(1-\nu)\sigma_{ut}}{\alpha E}}{\frac{M}{2(c\lambda\rho)_w} \tau}. \quad (6)$$

The dependences of q_1 , q_2 , q_3 on time for fixed particle size δ values for the coating, or the penetration depth of temperature perturbations for the metal, were calculated on a PC with respect to a plate made of quartz, granite and metal (copper and stainless steel).

Conclusion

Based on the conducted studies in the case of irradiation with a torch of a kerosene-oxygen burner of the porous coating in the working area, we have up to 4×10^7 W / m², which corresponds to q coatings of $0,4 \times 10^7$ W/m². The mechanism of the destruction of metals is fundamentally different from the mechanism of destruction of coatings from rocks.

A scientific method for studying and creating capillary-porous cooling systems and coatings for various heat and mass transfer conditions in power equipment elements has been developed.

Symbols

m – flow rate, kg/s;	τ – time, s;
q – thermal load, W/m ² ;	a – thermal conductivity factor, m ² /s;
h – film height, thickness, m;	λ – thermal conductivity factors, W/mK;
– average velocity, m/s;	C – thermal capacity, J/kgK;
α – excess air factor;	ρ – density, kg/m ³ ;
T – temperature, K;	δ – thickness of the structure (depth of wave propagation, particles size), m;
w – grid cell width, inside-light inspection (hydraulic pore size), m;	σ – stress;
G – specific flow rate, kg/m ² s;	α – linear expansion factor, K ⁻¹ ;
d – grain size (diameter) of the structure, m;	ν – Poisson ratio (lateral contraction);
x – coordinate (direction of fluid motion), m;	E – Young's modulus (elasticity modulus), Pa;
y – coordinate (direction of fluid motion), m;	Q – specific crushing energy, J/m ³
z – coordinate, m;	

Indexes

f, v – fluid, vapor; ccs- critical cross-section; h - hot; w - wall; h - hydraulic; s - saturation; f - fusion (film); us - ultimate shortening; ut - ultimate tension.

REFERENCES

- [1] Polyayev, V.M. et al., *Methods of Monitoring Energy Processes, Experimental Thermal and Fluid Science, International of Thermodynamics. Experimental Heat Transfer, and Fluid Mechanics. Avenue of the Americas, New York, USA, 1995*, Vol. 10, pp. 273-286.
- [2] Polyayev, V.M., Genbach A.A., *Heat Transfer in a Porous System in the Presence of Both Capillary and Gravity Forces*, Thermal Engineering, 40 (1993), 7, pp. 551-554.
- [3] Polyayev, V.M. et al., *A Limit Condition of a Surface at Thermal Influence* (in Russian), Teplofizika Vysokikh Temperatur, 29 (1991), 5, pp. 923-934.
- [4] Polyayev, V.M., Genbach A.A., *Control of Heat Transfer in a Porous Cooling System*. Proceedings, 2nd World Conference on Experimental Heat Transfer, Fluid Mechanics and Thermodynamics, Dubrovnik, Yugoslavia, 1991, pp. 639-644.
- [5] Polyayev, V.M. et al., *Processec in the Porous Elliptic Heat Exchanger* (in Russian), Izvestiya Vuzov, Mashinostroyeniye, (1991), 4-6, pp. 73-77.
- [6] Genbach A.A., Bakhytzhyanov I.B., *Protection Against Earthquakes TPP Bases with the Help of Porous Geo Screens* (in Russian), Poisk, MES of RK, (2012), 1, pp. 289-298.
- [7] Genbach A.A., Danilchenko I., *Porous Desuperheater Steam Boilers* (in Russian), Promyshlennost Kazakhstana, 70 (2012), 1, pp. 72-75.
- [8] Genbach A.A., Olzhabayeva K.S., *Visualization of Thermal Impact on Porous Material in Thermal Energy Installations of Power Plants*, Bulletin of the National RK Engineering Academy, 45 (2012), 3, pp. 63-67.
- [9] Genbach A.A., Islamov F.A., *Research of the Nozzle Fillets in Electrical Installations* (in Russian), Vestnik KazNTU, 97 (2013), 3, pp. 245-248.
- [10] Genbach A.A., Baibekova V.O. MODELING OF HEAT TRANSFER IN A POROUS TURBINE BEARING COOLING SYSTEM. *ENERGETIKA. Proceedings of CIS higher education institutions and power engineering associations*. 2017; 60(6): 558-570. (In Russ.).
- [11] Polyayev, V.M., Genbach A.A., *Control of Heat Transfer in Porous Structures* (in Russian), Proceedings, Russian Academy of Sciences, Power Engineering and Transport, 38 (1992), 6, pp. 105-110.
- [12] Jamialahmadi M., et al., *Experimental and Theoretical Studies on Subcooled Flow Boiling of Pure Liquids and Multicomponent Mixtures*, Intern. J Heat Mass Transfer. 51 (2008), 9-10, pp. 2482-2493.
- [13] Ose Y., Kunugi T., *Numerical Study on Subcooled Pool Boiling*, Progr. In Nucl. Sci. and Technology 2, (2011), pp. 125-129.
- [14] Krepper E., et al., *CFD Modeling Subcooled Boiling-Concept, Validation and Application to Fuel Assembly Design*, Nucl. Eng. and Design, 237 (2007), 7, pp. 716-731.
- [15] Ovsyanik A.V., *Modelling of Processes of Heat Exchange at Boiling Liquids* (in Russian), Gomel State Technical University named after P.O., Sukhoy, Gomel, Belarus, 2012.
- [16] Alekseik, O.S., Kravets V.Yu., *Physical Model of Boiling on Porous Structure in the Limited Space*, Eastern-European Journal of Enterprise Technologies, 64 (2013), 4/8, pp. 26-31.
- [17] Polyayev, V.M., Genbach A.A., *Analysis of Laws for Friction and Heat Exchange in the Porous Structure* (in Russian), Bulletin of MGTU, Mechanical Engineering Series, (1991), 4, pp. 86-96.
- [18] Polyayev, V.M., et al., *The Influence of Pressure on the Intensity of Heat Transfer in a Porous System* (in Russian), Izvestiya Vuzov, Mashinostroyeniye, (1992), 4-6, pp. 68-72.

[19]Polyaev, V.M., Genbach A.A., *Field of Application of Porous System* (in Russian), *Izvestiya Vuzov, Energetika*, (1991), 12, pp. 97-101

[20]Genbach A.A., Jamankylova N.O., Bakic Vukman V. *The processes of Vaporization in the Porous Structures Working With The Excess of Liquid*, *Thermal Science: Year 2017*, Vol. 21, №1A, pp. 363-373. DOI:10.2298/TSCI160326313G.

[21]Genbach A.A., Olzhabayeva K.S., Iliev I.K., *Boiling Process in oil Coolers on Porous Elements*, *Thermal Science: Year 2016*, Vol.20. № 5, pp. 1777-1789. DOI:10.2298/TSCI150602166G.

А.А. Генбач¹, Д.Ю. Бондарцев²

¹Генбач А.А., техникалық ғылым докторы, профессор АЭЖБУ;

²Бондарцев Д.Ю., докторант АЭЖБУ, бас инженер, АО «Трест Средазэнергомонтаж»

ЗЕРТТЕУ НӘТИЖЕСІ ҚУАТТЫЛЫҚ-БІРЖАБДЫҚ ЖҮЙЕСІ ЭНЕРГИЯ ҚҰРЫЛЫСЫНЫҢ ЭНЕРГЕТИКАЛЫҚ ҚҰРЫЛЫСЫНЫҢ ЭЛЕМЕНТІ

Аннотация. Ғылыми-зерттеу әдістерін жасау үшін гравитациялық және капиллярлық силдермен жұмыс істейтін металл және платформациялық поршенді құрылымдардағы жылу құятын жылу көздерін зерттеу және жылу қондырғыларының түрлі салқындатқыш құрылғыларын зерттеу жұмыстары жүргізілді. Негізінен минералдық ортадан (гранит) шығарылған металды парогенерирующих сырықтардан шығарылатын механизмдер мен оптикалық деректерді табу механизмі қажет. Осындай ұқсастықтар негізінде жылу алмастырулардың өздігінен өтетін температуралық және жылжымалы жылу алмастырулардың шығу тәсілдерін анықтайды. Бұл жүйе жоғары қарқындылықпен, үлкен жылумен, сенімділікпен ерекшеленеді.

Түйін сөздер: жылу тасымалдау дағдарысы; капиллярлық-кеуекті құрылым.

УДК 536.248.2

А.А. Генбач¹, Д.Ю. Бондарцев²

¹Генбач А.А., доктор технических наук, профессор АУЭС;

²Бондарцев Д.Ю., докторант АУЭС, ведущий инженер, АО «Трест Средазэнергомонтаж»

НАУЧНАЯ МЕТОДИКА СОЗДАНИЯ КАПИЛЛЯРНО-ПОРИСТЫХ СИСТЕМ ОХЛАЖДЕНИЯ ДЛЯ ЭЛЕМЕНТОВ ЭНЕРГООБОРУДОВАНИЯ ЭЛЕКТРОСТАНЦИЙ

Аннотация. Для создания научной методики проведены исследования предельных тепловых потоков в металлических и плохотеплопроводных пористых структурах, работающих при совместном действии гравитационных и капиллярных сил, и охлаждающих различные устройства теплоэнергоустановок. На основе задачи термоупругости и опытных данных описан механизм разрушения металлических парогенирующих поверхностей и плохотеплопроводных покрытий малой пористости, выполненных из естественных минеральных сред (гранита). На основе аналогии явлений выявлены зависимости тепловых потоков от времени их действия и глубины проникновения температурных возмущений. Капиллярно – пористые системы обладают высокой интенсивностью, большой теплопередающей способностью, надежностью, компактностью.

Ключевые слова: кризис теплопередачи; капиллярно-пористая структура; тепловые энергоустановки;

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