MAXIMUM TEMPERATURE DROPS AND STRESSES DUE TO ASYMMETRICAL HEATING OF A PLATE AND A PRISM OF RECTANGULAR CROSS SECTION

N. Yu. Taits and A. G. Sabel'nikov

UDC 539.31:536.24

When heating equipment is used in practice the metal is often heated asymmetrically; this is associated with imperfect design of the furnaces, or with the nature of the technological process. This factor can lead to the formation of considerable temperature drops (Δt) and dangerous magnitudes of thermal stresses (σ). The present work solves the problem of determining the maximum temperature drops and the thermoelastic stresses in the case of asymmetrical heating of the plate and the prism of rectangular cross section in a medium with a constant gas temperature (t_g = const).

The value of the Fourier criterion has the form

$$(\mathrm{Fo})_{\Delta tm,\,2B} = \frac{1}{\mu_2^2 - \mu_1^2} \ln \frac{A_2\mu_2^2\left[\cos(\mu_2 - \delta_2) - 1\right]}{A_1\mu_1^2\left[1 - \cos(\mu_1 - \delta_1)\right]}, \tag{1}$$

when maximum values are reached.

The thermoelastic stresses in this case are determined from the equation

$$\frac{\sigma(1-\nu)}{\beta E\,(t_g - t_{av}^0)} = \sum_{n=1}^{\infty} A_n \left[\cos\left(\mu_n \frac{y}{2B} - \delta_n\right) - \frac{\sin(\mu_n - \delta_n) + \sin\delta_n}{\mu_n}\right] \exp\left[-\mu_n^2 \frac{a\tau}{(2B)^2}\right], \tag{2}$$

where a is the coefficient of thermal diffusivity, m^2/h; ν is the Poisson ratio; β is the coefficient of linear expansion, deg^{-1}; E is the modulus of elasticity, kg/cm^2; t_{av} is the average temperature of the metal, °C; 2B is the thickness of the plate; μ_n and δ_n are the roots of the characteristic equations; τ is the duration of heating, h.

By using (1) it is possible to calculate the maximum values of σ.

Similar solutions are obtained for the case of asymmetrical heating of a prism of rectangular cross section.

The criterion relationships are represented in the form of graphs which are convenient for carrying out calculations.

Metallurgical Institute, Dnepropetrovsk. Translated from Inzhenerno Fizicheskii Zhurnal, Vol. 19, No. 5, p. 944, November, 1970. Original article submitted January 22, 1970; abstract submitted March 23, 1970.

PIECEWISE-CONSTANT PERIODIC THERMAL INFLUENCE OF A MEDIUM ON A SOLID

Ya. A. Levin and M. S. Shun

UDC 536.24

The solution of the third boundary problem of thermal conductivity is presented for the case of piecewise-constant periodic laws of variation of the coefficient of heat transfer and the temperature of the medium with respect to time in a quasisteady state.

The present work is an attempt to establish a region in which the principle of independence of the average temperature for the period $t_{av}(\overline{x}, \infty)$ is correct with a given accuracy in a quasisteady state from the dimensions and thermophysical characteristics of the body.

We will introduce the following designations: $\overline{\tau} = \tau/T$ is dimensionless time; $T = \tau_1 + \tau_2$ is the period of variation of the coefficient of heat transfer α_s and the temperature of the medium t_s, $\overline{x} = x/R$ and $\theta = \theta/R$ are dimensionless coordinates; R is half the thickness of the infinite plate; $b = 2\pi/\mathrm{Pd}$, $\mathrm{Pd} = 2\pi R^2/aT$ is the Predvoditel' criterion; $\mathrm{Bi}_s = \alpha_s R/\lambda$ is the Biot criterion, a is the coefficient of thermal diffusion; $s = 1, 2$ is the number of the part of the period.

If

$$f_n(\overline{x}) = f_n(-\overline{x}) = t(\overline{x}, \overline{\tau}_n), \text{ while } y_n(\overline{x}) = \frac{f_{2n+1}(\overline{x}) - t_2}{t_1 - t_2} \text{ and } z_n(\overline{x}) = \frac{f_{2n+2}(\overline{x}) - t_1}{t_2 - t_1},$$

then in the quasisteady-state system $y(\overline{x}) = \lim_{n\to\infty} y_n(\overline{x})$, $z(\overline{x}) = \lim_{n\to\infty} z_n(\overline{x})$ and the functions $y(\overline{x})$, $z(\overline{x})$ are solutions of the system

$$y(\overline{x}) = 1 - \frac{1}{b}\int_0^1 \Phi_1(\overline{x}, \overline{\theta}, \overline{\tau}_1)\, z(\overline{\theta})\, d\overline{\theta};$$

$$z(\overline{x}) = 1 - \frac{1}{b}\int_0^1 \Phi_2(\overline{x}, \overline{\theta}, \overline{\tau}_2)\, y(\overline{\theta})\, d\overline{\theta},$$

where

$$\Phi_s(\overline{x}, \overline{\theta}, \overline{\tau}) = 2b \sum_{k=1}^{\infty} \frac{z_k^2 + \mathrm{Bi}_s^2}{z_k^2 + \mathrm{Bi}_s^2 + \mathrm{Bi}_s} \exp(-b z_k^2 \overline{\tau}) \cos z_k \overline{\theta} \cos {}_k \overline{x}$$

and

$$\mathrm{th}\, iz_k + \frac{\mathrm{Bi}_s}{iz_k} = 0.$$

The solution is obtained in the form

$$t_{av}(\overline{x}, \infty) = \frac{\mathrm{Bi}_1 \overline{\tau}_1 t_1 + \mathrm{Bi}_2 \overline{\tau}_2 t_2}{\mathrm{Bi}_1 \overline{\tau}_1 + \mathrm{Bi}_2 \overline{\tau}_2}\left[1 + \Delta(\overline{x})\right],$$

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where

$$\Delta(\bar{x}) \approx \frac{b^2 (t_2 - t_1)}{(\mathrm{Bi}_1 \bar{\tau}_1 + \mathrm{Bi}_2 \bar{\tau}_2)(\mathrm{Bi}_1 \bar{\tau}_1 t_1 + \mathrm{Bi}_2 \bar{\tau}_2 t_2)} \left[(\mathrm{Bi}_2^2 \bar{\tau}_2 - \mathrm{Bi}_1^2 \bar{\tau}_2) + \frac{\mathrm{Bi}_1 \mathrm{Bi}_2 \bar{\tau}_1 \bar{\tau}_2}{\sqrt{2}} (\mathrm{Bi}_2 \bar{\tau}_2 - \mathrm{Bi}_1 \bar{\tau}_1) \right].$$

Example. If $t_1 = 1000°$, $t_2 = 100°$, $\mathrm{Bi}_1 = 0.1$, $\mathrm{Bi}_2 = 1$, $\bar{\tau}_1 = \bar{\tau}_2 = 0.5$, $b = 0.01$ (Pd = 628), then, on the basis of (4) the relative error $\Delta(\bar{x}) = -0.05\%$.

Obviously the relationship (4) in this case expresses the principle of independence almost exactly.

SOLUTION OF NONLINEAR HEAT-CONDUCTION PROBLEMS BY THE COMBINED APPLICATION OF PERTURBATION METHODS AND FINITE INTEGRAL TRANSFORMS

A. M. Aizen

UDC 536.21

The three-dimensional nonlinear heat-conduction equation is considered. It is assumed that the thermal conductivity is linearly dependent on temperature and that the Sturm condition is satisfied. It is shown that the solution can be reduced to a set of ordinary differential equations by expanding the required solution in a series and then making successive finite integral transforms.

It is shown that the kernel of the transformation for obtaining the unknown functions appearing in the expansion in powers of a small parameter does not depend on the order of the approximation. Thus explicit formulas for the temperatures can be obtained

$$t \approx \sum_{\mu} P_1 \Big| \sum_{\nu} P_2 \Big\{ \sum_{\sigma} P_3 \exp\left[-a_0(\mu^2+\nu^2+\sigma^2)\right](K_0+\alpha K_1+\alpha^2 K_2+\ldots)\Big\}\Big|.$$

Here P_1, P_2, and P_3 are solutions of the corresponding Sturm–Liouville problems used to eliminate the spatial coordinates by the method of finite integral transforms; μ, ν, and σ are eigenvalues of these problems; $a_0 = \lambda_0/c_0\rho_0$ is the diffusivity, determined by the temperature-independent parts of the thermal conductivity and the volumetric heat capacity;

$$K_0 = \int_0^{\tau} f_0^* \exp\left[a_0(\mu^2+\nu^2+\sigma^2)\tau\right] d\tau + \varphi^*,$$

$$K_1 = a_0 \int_0^{\tau} F_0^* \exp\left[a_0(\mu^2+\nu^2+\sigma^2)\tau\right] d\tau$$

etc.

In the latter relations f_0^* is the volumetric heat source strength transformed by the successive applications of finite integral transforms; φ^* is the transformed initial condition, and F_0^* is the transformed right-hand side of the first-approximation equation.

The proposed method is illustrated by solving a nonlinear problem of the heating of a plate of finite thickness having boundary conditions of the first kind specified on its lateral forces.

All-Union Scientific-Research Planning and Design Institute of the Petroleum Refining and Petroleum Chemistry Industry, Kiev. Translated from Inzhenerno-Fizicheskii Zhurnal, Vol. 19, No. 5, p. 947, November, 1970. Original article submitted November 18, 1969; abstract submitted April 3, 1970.

THERMAL STRESSES IN AN UNBOUNDED VISEOELASTIC PLATE

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UDC 539.377

The paper deals with an unbounded viscoelastic plate of Kelvin or Maxwell material, which is heated by an immobile instantaneous line source or by a source whose output alters by a set amount at the initial instant. The solution is derived for the case $\varkappa^2 a < \varkappa_1$, where $\varkappa^2 = \alpha/\lambda a$, with α heat-transfer factor for the side surfaces $z = \pm\delta$, λ is the thermal conductivity, and a is the thermal diffusivity, $\varkappa_1 = 3/(1-2\nu_k)\vartheta^*$, $\varkappa_2 = E_M/3G_M\vartheta$, $\vartheta = \eta/G_M$ is the relaxation time, η/G_k is the delay, η is viscosity, ν_k is Poisson's ratio for the Kelvin material, G_k is the shear modulus for that material, and E_M and G_M are Young's modulus and the shear modulus for the Maxwell material.

The solution is expressed via the functions

$$M_\nu(\xi,\ \mathrm{Fo},\ \rho) = \int_0^{\mathrm{Fo}} \zeta^{\nu-1} \exp\left[\zeta(\mathrm{Fo}-\zeta) - \frac{\rho^2}{4\zeta}\right] d\zeta,\ \nu = 0,\ \pm 1,\ \pm 2,\ \pm 3\ldots,$$

for which recurrence relations are established, while computed tables of values are given for the zero and first-order functions.

The numerical results are presented as graphs for an insulated plate of Maxwell material.

The solution for $\varkappa^2 a > \varkappa_j$ has been given in a published paper (Inzh. Fiz. Zh., 17, No. 5, 1969).

Physical Mechanics Institute Academy of Sciences of the Ukrainian SSR L'vov. Translated from Inzhenerno-Fizicheskii Zhurnal, Vol. 19, No. 5, p. 948, November, 1970. Original article submitted December 11, 1969; revision submitted May 5, 1970.

THE NUMERICAL SOLUTION OF MULTIPHASE AND MULTIDIMENSIONAL MODIFIED STEFAN PROBLEMS

V. F. Demchenko and D. A. Kozlitin

UDC 536.248.2

The simplest one-dimensional model of mass transport in a monophase binary system forming a sequence of continuous solid solutions has the form

$$\frac{\partial C_i}{\partial t} = \frac{\partial}{\partial x}\left(D_i \frac{\partial C_i}{\partial x}\right), \ \xi_{i-1}(t) < x < \xi_i(t), \tag{1}$$

where $\xi_i = \xi_i(t)$ is the position of the boundary between phases i and i + 1 (the equation of motion is assumed known), C_i and D_i are weighted concentrations and diffusion coefficients for one of the elements of the binary system in phase i. At the boundary between the phases we have the following compatibility conditions:

$$C_i(\xi_i, t) = \varkappa_i C_{i+1}(\xi_i, t), \tag{2}$$

$$D_i \frac{\partial C_i}{\partial x}\Big|_{x=\xi_i(t)} - D_{i+1}\frac{\partial C_{i+1}}{\partial x}\Big|_{x=\xi_i(t)} = \frac{d\xi_i}{dt}[C_{i+1} - C_i]_{x=\xi_i(t)}. \tag{3}$$

The discontinuity in the unknown function at the interphase boundary may be eliminated by introducing a new function – the mass-transport potential, which is linked with the concentrations by means of the equation

$$C_i(x, t) = \rho_i(x, t)\, u_i(x, t),$$

where $\rho_i = [\prod_{j=1}^{i} \varkappa_j]$ is the solubility coefficient, $u_i = u_i(x, t)$ the mass-transport potential of the i-th phase. If we make the change of variable (4) in (1)-(3) and interpret the discontinuities in the mass transport potential fluxes at the interphase boundaries as the presence of a system of δ-shaped sources, we can write the generalized equation describing the mass-transport process throughout the whole of a monophase system as

$$\frac{\partial}{\partial t}[\rho u] = \frac{\partial}{\partial x}\left(D \frac{\partial u}{\partial x}\right), \tag{4}$$

where $\rho(x, t) = \rho_i(x, t)$, $D(x, t) = D_i \rho_i$, if $x \in [\xi_i, \xi_{i+1}]$.

Similarly we can write the generalized equation in the multidimensional case. Equation (5) makes it possible to construct difference schemes for direct calculation. The method of constructing direct calculation schemes for Eq. (5) was described in [1]. In solving multidimensional problems the discontinuous functions ρ and D have to be subjected to smoothing in the neighborhood of the interphase boundaries and a locally one-dimensional method has to be applied to the smoothed equation.

The above method was used to solve the problem of the redistribution of an impurity in a three-phase system consisting of a solid body, a liquid, and a solid body, similar to the system which occurs in the zone refinement of a metal; it was also used to calculate the chemical inhomogeneity in the dendritic (cellular) character of crystallization [2].

Institute of Electric Welding, Academy of Sciences of the Ukrainian SSR. Translated from Inzhenerno-Fizicheskii Zhurnal, Vol. 19, No. 5, pp. 949-950, November, 1970. Original article submitted December 11, 1969; abstract submitted April 7, 1970.

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ANALOG-COMPUTER SIMULATION OF THE RELATIONS BETWEEN THE PARAMETERS OF MOIST AIR

A. E. Pass and N. P. Agafonov

UDC 533.1

It is fairly troublesome to calculate the temperature and humidity of air by tables, nomograms, and analytical relationships, which are difficult to use, in order to choose the optimal characteristics for a system of air processing.

The paper here abstracted presents a method we have developed for calculating the parameters of moist air via electronic analog computers.

The initial parameters are the barometric pressure, the air temperature, and some one of the parameters characterizing the humidity: the water vapor pressure, the water content, the relative humidity, or the wet-bulb thermometer temperature. The electronic apparatus enables one to determine not only all the missing parameters characterizing the state of air, but also the parameters at the saturation point in this system.

The model is based on general analytical relationships between the basic parameters of moist air, and the parameter characterizing the humidity is the water vapor pressure (the partial pressure of water vapor in the air). The general electronic system is built up from particular models and is very simple to operate to determine the changes in all the interesting parameters on heating, cooling, drying, or humidification in air-conditioning equipment and in mixing various quantities of air in different states.

One can therefore use existing schemes for air conditioning to choose the optimum conditions of operation and to determine the parameter via which the operation should be controlled; in designing an air conditioning system from scratch, one can determine the optimal design and energy characteristics of the parts in order to obtain the best economic performance.

Higher Marine Engineering College, Odessa. Translated from Inzhenerno-Fizicheskii Zhurnal, Vol. 19, No. 5, p. 951, November 1970. Original article submitted November 19, 1969; abstract submitted April 8, 1970.

DESIGN OF HEAT EXCHANGERS WITH COMPOUND FLOW

K. F. Nechitailo, V. A. Safonov,
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UDC 536.27

Using the equations of heat balance and heat transfer in an elementary segment of a two-pass heat exchanger and the solution of a system of differential equations we determine the current value of the temperature in the direct and counter flow passes of a heat exchanger with compound flow:

$$t_{2\mathrm{I}} = C_1 S_1 e^{m_1 x} + C_2 S_2 e^{m_2 x} + t''_{\mathrm{I}},$$

$$t_{2\mathrm{II}} = C_1 e^{m_1 x} + C_2 e^{m_2 x} + t''_{\mathrm{I}},$$

where

$$m_{1,2} = \left(\frac{k_{\mathrm{II}}}{W_{\mathrm{I}}} + \frac{k_{\mathrm{I}}}{W_{\mathrm{I}}} + \frac{k_{\mathrm{I}}}{W_2} - \frac{k_{\mathrm{II}}}{W_2}\right) \pm \sqrt{\left(\frac{k_{\mathrm{II}}}{W_1} + \frac{k_{\mathrm{I}}}{W_1} + \frac{k_{\mathrm{I}}}{W_2} - \frac{k_{\mathrm{II}}}{W_2}\right)^2 + \frac{k_{\mathrm{I}} k_{\mathrm{II}}}{W_2^2}};$$

$$S_{1,2} = 1 - \frac{W_1}{W_2} m_{1,2}; \quad C_{1,2} = \frac{t'_2 - t''_1 - S_{2,1}(t''_2 - t''_1)}{(S_{1,2} - S_{2,1})\, e^{m_{1,2} l}}.$$

A new nondimensional form of the equation between the parameters has been derived for a heat exchanger with compound flow

$$\bar{l} = \frac{l k_{\mathrm{II}}}{W_1} = \left[A^2 + \frac{4}{R^2} \cdot \frac{k_{\mathrm{I}}}{k_{\mathrm{II}}}\right]^{-0.5} \ln\left\{\left[\frac{1-RP}{1-P-RP} + \frac{1-R}{R} + 0.5A - 0.5\left(A + \frac{4}{R^2} \cdot \frac{k_{\mathrm{I}}}{k_{\mathrm{II}}}\right)^{0.5}\right]\right.$$

$$\times \left[\frac{1}{R} + 0.5A + 0.5\left(A^2 + \frac{4}{R}\frac{k_{\mathrm{I}}}{k_{\mathrm{II}}}\right)^{0.5}\right]\left[\frac{1-RP}{1-P-RP} + \frac{1-R}{R} + 0.5A + \left(A^2 + \frac{4}{R^2}\frac{k_{\mathrm{I}}}{k_{\mathrm{II}}}\right)^{0.5}\right]^{-1}$$

$$\left.\times \left[\frac{1}{R} + 0.5A - 0.5\left(A^2 + \frac{4}{R^2}\frac{k_{\mathrm{I}}}{k_{\mathrm{II}}}\right)^{0.5}\right]^{-1}\right\},$$

where l is the length of the heat exchanger, W_1 is the water equivalent of the coolant in the interpipe space, k_{I}, k_{II} are the products of the heat transfer coefficients with the perimeters of the first and second passes, $A = 1 + \frac{k_{\mathrm{I}}}{k_{\mathrm{II}}} + \frac{1}{R}\frac{k_{\mathrm{I}}}{k_{\mathrm{II}}} - \frac{1}{R}$; $R = \frac{t'_1 - t''_1}{t''_2 - t'_2}$; $P = \frac{t''_2 - t'_2}{t'_1 - t'_2}$; t'_1, t''_2, t'_2, t''_1 are the temperatures at the inlet and outlet in the interpipe space and the main passage.

The dependences $\bar{l} = \bar{l}(R, P, k_{\mathrm{I}}/k_{\mathrm{II}})$ were derived on a computer and reduced to the form of nomograms $\bar{l} = \bar{l}(R, P)$ for $k_{\mathrm{I}}/k_{\mathrm{II}} = 0.5, 1, 2, 3$. Using these nomograms we can calculate, without involving successive approximations, both design and check (operational) calculations. Analysis of the above equations shows that for particular combinations of R and P an increase in the intensity of heat transfer in the direct flow leads not to a reduction, but to an increase, in the total length of the heat exchanger.

It is particularly important to take into account the above equations when the heat-transfercoefficients or the heat-exchanger surfaces in the counter flows are significantly dissimilar (for example, when some of the tubes in a tubular heat exchanger are clogged or when the heat exchange conditions are different in the direct and counter flows of a heat exchanger with coaxial coolant flow).

Aviation Institute, Khar'kov. Translated from Inzhenerno-Fizicheskii Zhurnal, Vol. 19, No. 5, pp. 952-953, November, 1970. Original article submitted October, 1969; abstract submitted April 1, 1970.

INVESTIGATION OF A VERTICAL STABILIZED FLOW OF A GAS SUSPENSION

M. E. Dogin

UDC 532.529.5:628.567.8

A dimensionless equation for calculating the resistance of a material-conducting pipeline for a vertical stabilized flow of a gas suspension was established on the basis of experimental and theoretical investigations [1].

The experimental investigations were carried out on a pneumatic transporting device the principal characteristic features of which were: great length of the vertical material-conducting pipeline, wide range of variation of the parameters of the two-phase flow, and their automatic recording. The device consisted of two vertical steel material-conducting pipelines, 27 m high, with an inside diameter of the pipes of 125 and 70 mm. The initial section of the pipelines, of length 150-260 diameters, provided in all modes an acceleration of the solid component being transported to the maximum steady speed. The air velocity at the entrance of the device was varied from 5 to 50 m/sec. The maximum capacity of the device reached 30 tons/h.

The analysis of the experimental results was based on the principle of additivity of the resistances of the conveying medium and solid component being transported.

On the basis of the investigations the dimensionless equation for calculating the resistance coefficient of the vertical pipeline with a stabilized two-phase flow has the form

$$\lambda = \lambda_0 + C\mu \left(\frac{D}{d}\right)^{0.97} \mathrm{Fr}_t^{-0.77},$$

where λ and λ_0 are the resistance coefficients of the two-phase mixture and conveying medium; μ is the mass flow concentration; D and d are the diameters of the pipeline and particles; Fr_t is the Froude number for the transported particles.

The second addend includes, in addition to losses due to friction and impact of particles, the losses due to lifting the solid component.

The generalizing character of the equation obtained and the numerical value of its coefficient C were established in experimental investigations of the pneumatic transport of dustlike, powdery, and granular materials of nine items differing substantially in fractional composition, hydraulic and geometric size of the particles, and their density. The transport regimes covered a wide range of variations of the mass concentration ($2 < \mu < 90$), speed of transport, and density of the conveying medium.

For materials the pneumatic transport of which is not accompanied by the formation of a film from the transported particles on the wall of the pipeline, the coefficient C is equal to $22.5 \cdot 10^{-2}$. The standard deviation in treating the experimental data was $\pm$ 8.7%.

A special series of experiments on pneumatic transport in rough pipes made possible an evaluation of the effect of relative roughness of a pipeline on the value of the resistance coefficient of a two-phase mixture.

Institute of Railroad-Transportation Engineers, Gomel'. Translated from Inzhenerno-Fizicheskii Zhurnal, Vol. 19, No. 5, pp. 954-955, November, 1970. Original article submitted November 11, 1969; abstract submitted March 23, 1970.

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INVESTIGATION OF THE REGION OF STABILITY OF THE CONTOUR OF NATURAL CIRCULATION DURING BOILING

A. P. Proshutinskii and R. A. Shugam

UDC 532.501.34

This work is devoted to experimental and analytical research on the boundaries of the stability region of a contour of natural circulation during boiling. The phenomenon of dynamic instability, expressed in the form of nondamped vibrations of the working parameters, is characteristic for a whole series of systems such such as uniflow boilers, nuclear water-cooled water-moderated boiling reactors etc.

Experimental research on the boundaries of the stability region was carried out on a special test rig designed for studying the hydrodynamics of two-phase flows. The circulation contour of this test-rig was formed by a lifting section, heated by an electric current, a comparatively long nonheated lifting tube, a separation column, and, finally, a lowering branch.

The outlet of the system on the stability boundary was achieved either by increasing the heating of the water at the inlet to the heated section to the saturation temperature in the case of constant pressure and heat emission, or by reducing the pressure in the case of constant remaining parameters. As shown by the experiments carried out (Fig. 1), the region of unstable flow of the circulation contour in the coordinates pressure (P)–heating ($\Delta\vartheta_u$) is situated within a triangle formed on the one hand by the axis of heating of the heat carrier to the saturation temperature at the inlet to the heated part (ordinate), and on the other hand, by the straight lines which respect the boundary of the region obtained from the experiments.

Pressure increase leads to approach to the upper and lower houndaries of the instability region; when it reaches a certain value these interlock. Increase of the density of the thermal flux leads to displacement of this point into the high pressure region.

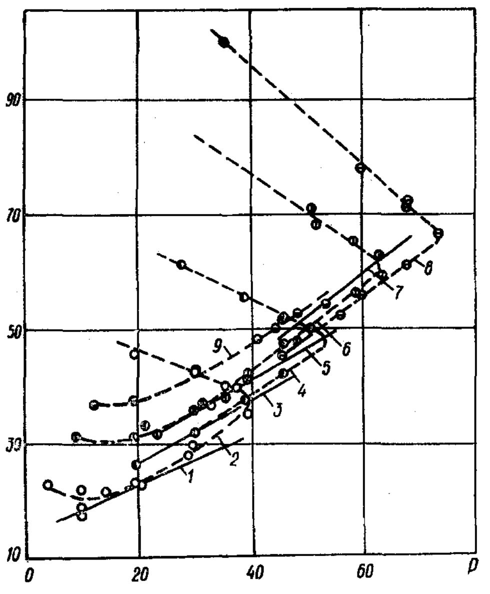

Fig. 1. Boundaries of the stability region in the plane of the parameters $\Delta\vartheta_u$–P where n = 1 ($\Delta\vartheta_u$, °K; P, bar): 1-8) theoretical and experimental curves respectively, for q = 1.27 mV/m^2, 1.72, 2.20, 2.60; 9) experimental curve for q = 2.90 mV/m^2.

All-Union Central Scientific-Research Institute of Complex Automation, Moscow. Translated from Inzhenerno-Fizicheskii Zhurnal, Vol. 19, No. 5, pp. 956-957. Original article submitted December 16, 1969; abstract submitted May 16, 1970.

Researchwas carried out on the influence of the resistance of the contour on its stability. As the experiments have shown, the increase of this parameter is a stabilizing factor.

In addition to experimental research on the stability of the contour, analytical research was also carried out on the stability boundaries using a frequency criterion. The amplitude–phase characteristic of an open system was obtained from equations of conservation of mass, energy, and momentum, written in integral form and complemented by the expression for leakage of vapor, which is assumed to be constant with respect to time.

The main allowances made on converting the initial equations are assumptions about the absence of surface boiling, constancy with respect to time and the level of the region of the physical parameters of water and vapor, and the constancy of the temperature of the wall of the tube with respect to time. Moreover, the relationship between the actual speeds of the vapor and water and the coordinate were approximated by linear functions.

Research on the stability of the investigated model was carried out by linear approximation. Comparison of theoretical and experimental data was included in the comparison of the boundaries of the stability region obtained by means of calculation according to the amplitude–phase characteristic of the open system, by using the frequency criterion of stability, and experimentally (Fig. 1).

In addition, the values of the frequency on the stability boundary obtained from calculation and experimentally were compared; these also agreed quite satisfactorily.