3. B. Ya. Lyubov, Theory of Crystallization in Large Volumes [in Russian], Nauka (1975).
4. B. I. Vaiman and E. L. Tarunin, "The effect of crystallization on the process of free convection in melted metals," in: Hydrodynamics [in Russian], Perm, No. 4, 107-118 (1972).
5. É. A. Iodko et al., "Investigation of convective flows in hardening ingots," Izv. Akad. Nauk SSSR, Metally, No. 2, 102-108 (1971).
6. P. F. Zavgorodnii, I. L. Povkh, and G. M. Sevast'yanov, "Intensity of thermal convection as a function of the Grashof members and the hardening kinetics of a melt," Teplofiz. Vys. Temp., 14, No. 4, 823-828 (1976).
7. A. A. Samarskii, Introduction to the Theory of Difference Schemes [in Russian], Nauka, Moscow (1973).
8. N. N. Yanenko, The Method of Fractional Steps in Multivariate Problems of Mathematical Physics [in Russian], Nauka, Novosibirsk (1957).
9. P. F. Zavgorodnii, "Numerical investigation of thermally concentrated convection in the liquid nucleus of a crystallizing binary melt," Inzh.-Fiz. Zh., 35, No. 1, 155-162 (1978).
10. P. F. Zavgorodnii et al., "Calculation of the impurity distribution in a crystallizing ingot," Izv. Vyssh. Uchebn. Zaved., Metall., No. 3, 47-50 (1977).

THERMAL DIFFUSIVITY OF INHOMOGENEOUS SYSTEMS
1. TEMPERATURE-FIELD CALCULATION

G. N. Dul'nev and A. V. Sigalov UDC 536.24.02

The possibility of analyzing the nonsteady temperature fields of inhomogeneous systems using the quasi-homogeneous-body model is investigated.

Definition of Quasi-Homogeneous Body

A system consisting of homogeneous regions (components) divided by boundary surfaces is usually referred to as inhomogeneous or heterogeneous. Often, in order to calculate the temperature field, this body is replaced by a quasi-homogeneous body with effective thermal conductivity and diffusivity (λ, a) and volume specific heat ($c\rho$). It is then postulated that the temperature field of this body is described at all points by the equation

$$\frac{1}{a}\frac{\partial t}{\partial \tau} = \nabla^2 t, \tag{1}$$

and in specifying the conditions at the external boundaries the effective thermal conductivity is used. This is determined either experimentally, or by the methods of generalized conduction theory [1], and is equal to the ratio of the mean flow $\langle \mathbf{q} \rangle$ through the body and the mean temperature gradient $\langle \nabla t \rangle$ in the body

$$\lambda = -\langle \mathbf{q} \rangle / \langle \nabla t \rangle . \tag{2}$$

The effective volume specific heat is determined from the additive formula

$$c\rho = \sum_{i=1}^{k} c_i \rho_i m_i , \tag{3}$$

and the effective thermal diffusivity is found from a formula valid for a homogeneous body

$$a = \lambda / c\rho. \tag{4}$$

This approaches to the analysis of inhomogeneous-system temperature fields is widely known, but it is not possible to find a sufficiently general justification of this method in the literature. In the present work, the error involved in passing to a quasi-homogeneous body for the calculation of nonsteady temperature fields is investigated, and the limits of applicability of the model in Eqs. (1)-(4) are established.

Leningrad Institute of Precision Mechanics and Optics. Translated from Inzhenerno-Fizicheskii Zhurnal, Vol. 39, No. 1, pp. 126-133, July, 1980. Original article submitted September 12, 1979.

0022-0841/80/3901-0803$07.50

Consider, first of all, the accurate formulation of the problem of the temperature field of a system of k components with the properties λ_i, a_i, $(c\rho)_i$ (i = 1, ..., k). The temperature field of the system is described using k differential equations

$$\frac{1}{a_i}\frac{\partial t_i}{\partial \tau} = \nabla^2 t_i \tag{5}$$

with the following conditions on all the boundary surfaces S_i of the components

$$\lambda_i \left.\frac{\partial t_i}{\partial n}\right|_{S_i} = \lambda_{i+1} \left.\frac{\partial t_{i+1}}{\partial n}\right|_{S_i}, \quad t_i|_{S_i} = t_{i+1}|_{S_i} \tag{6}$$

and corresponding conditions on the external boundaries of the system and initial conditions.

The basic method of investigation is to compare the accurate and approximate solutions and formulate, on this basis, the definition of a quasi-homogeneous body. In the past, a quasi-homogeneous body has been taken to be a model satisfying Eqs. (1)-(4), but it is necessary to formulate an additional condition on the temperature field of the quasi-homogeneous body. Various requirements may be assumed, for example, equality between the volume-averaged temperature t_V of the quasi-homogeneous body and t_{VI} of an inhomogeneous system

$$t_V(\tau) = t_{VI}(\tau), \tag{7}$$

or equality between the nonsteady heat fluxes absorbed by a quasi-homogeneous body and a heterogeneous system

$$\int_S \lambda \frac{\partial t}{\partial n}\, dS = \sum_{i=1}^{k} \int_{S_i} \lambda_i \frac{\partial t_i}{\partial n}\, dS_i, \tag{8}$$

or minimizing the mean-square error in determining the temperature field σ

$$\sigma^2 = \frac{1}{V(\tau_1 - \tau_0)} \int_{\tau_0}^{\tau_1} \int_V (t - t_I)^2\, dV d\tau. \tag{9}$$

In the given definitions, conditions have been imposed on certain integral characteristics of the system; other conditions may also be proposed.

Analysis of the Simplest System

The general definition of a quasi-homogeneous body will be applied to the simplest inhomogeneous system consisting of two plates perpendicular to a heat flow. The temperature field of the plates (i = 1, 2) is described by Eq. (5) for the region $x \in (0, l_1)$, $x \in (l_1, l)$, and in the plane $x = l_1$ the condition in Eq. (6) is specified

$$t_1(l_1, \tau) = t_2(l_1, \tau), \quad \lambda_1 \left.\frac{\partial t_1}{\partial x}\right|_{l_1} = \lambda_2 \left.\frac{\partial t_2}{\partial x}\right|_{l_1}. \tag{10}$$

The temperature field of a quasi-homogeneous body is described by Eq. (1). Suppose that the thermal conductivity and volume specific heat are defined by Eqs. (2) and (3). Adopting the requirement that Eq. (7) be satisfied for the quasi-homogeneous body, it will be investigated whether Eq. (4) holds for the model described by Eqs. (1)-(3) and (7).

The averaging operation

$$I[f] = \frac{1}{d-b} \int_b^d f dx = f_V \tag{11}$$

is applied to Eqs. (1) and (5) on the segments $[0, l_1]$, $[l_1, l]$, and $[0, l]$. Manipulation leads to the relations

$$\frac{dt_{1V}}{d\tau} = \frac{a_1}{l_1}\left[\left.\frac{\partial t_1}{\partial x}\right|_{l_1} - \left.\frac{\partial t_1}{\partial x}\right|_0\right], \tag{12}$$

$$\frac{dt_{2V}}{d\tau} = \frac{a_2}{l - l_1}\left[\left.\frac{\partial t_2}{\partial x}\right|_{l} - \left.\frac{\partial t_2}{\partial x}\right|_{l_1}\right], \tag{13}$$

$$\frac{dt_V}{d\tau} = \frac{a}{l}\left[\left.\frac{\partial t}{\partial x}\right|_l - \left.\frac{\partial t}{\partial x}\right|_0\right]. \tag{14}$$

Multiplying Eq. (12) by λ_1 and Eq. (13) by λ_2, and adding them, it is found, when the equality of the fluxes at the boundary surface in Eq. (10) is taken into account, that

$$\frac{\lambda_1 l_1}{a_1}\frac{dt_{1V}}{d\tau} + \frac{\lambda_2(l-l_1)}{a_2}\frac{dt_{2V}}{d\tau} = \lambda_2 \left.\frac{\partial t_2}{\partial x}\right|_l - \lambda_1 \left.\frac{\partial t_1}{\partial x}\right|_0. \tag{15}$$

Consider the difference Δq in the heat fluxes entering and leaving the inhomogeneous system and the quasi-homogeneous body

$$\Delta q = \lambda\left(\left.\frac{\partial t}{\partial x}\right|_l - \left.\frac{\partial t}{\partial x}\right|_0\right), \tag{16}$$

$$\Delta q_{\mathrm{I}} = \lambda_2 \left.\frac{\partial t_2}{\partial x}\right|_l - \lambda_1 \left.\frac{\partial t_1}{\partial x}\right|_0.$$

The effective thermal conductivity of the given plate system is [1]

$$\lambda = \left(\frac{m_1}{\lambda_1} + \frac{1-m_1}{\lambda_2}\right)^{-1}, \quad m_1 = l_1/l. \tag{17}$$

It may be shown that, with this definition of λ, equality of the unsteady fluxed absorbed by the heterogeneous system and the quasi-homogeneous body is not ensured, and a flux-difference parameter can be introduced

$$\gamma(\tau) = \frac{\Delta q_{\mathrm{I}} - \Delta q}{\Delta q_{\mathrm{I}}}.$$

It follows from Eq. (7) that

$$\frac{dt_V}{d\tau} = m_1 \frac{dt_{1V}}{d\tau} + (1-m_1)\frac{dt_{2V}}{d\tau}. \tag{18}$$

Substituting Eq. (18) into Eq. (14), and taking Eqs. (15) and (16) into account, the following expression is obtained for the parameter a

$$a = \frac{\lambda(m_1 + Km_2)}{(1+\gamma)[m_1(c\rho)_1 + m_2 K(c\rho)_2]}, \quad K = \frac{dt_{2V}}{d\tau} \Big/ \frac{dt_{1V}}{d\tau}, \tag{19}$$

which differs from Eq. (4) in including the regime parameters K and γ. Processing in the opposite direction, and requiring that the flux equality $\Delta q = \Delta q_{\mathrm{I}}$ be satisfied at any moment of time, would lead to the following expression for λ

$$\lambda = \frac{\lambda_2 \left.\frac{\partial t_2}{\partial x}\right|_l - \lambda_1 \left.\frac{\partial t_1}{\partial x}\right|_0}{\left.\frac{\partial t}{\partial x}\right|_l - \left.\frac{\partial t}{\partial x}\right|_0}, \tag{20}$$

i.e., the effective conductivity of the system would become a regime parameter, but the parameter γ would disappear from Eq. (19).

If the parameters $a(\tau)$ and $\lambda(\tau)$ are determined from Eqs. (19) and (20), it is possible to satisfy the two conditions of a quasi-homogeneous body: $t_V = t_{V\mathrm{I}}$ and $\Delta q = \Delta q_{\mathrm{I}}$. However, when even one of the coefficients λ, a, and $c\rho$ becomes a function of the time, it is no longer of any practical interest, since the analysis of the temperature field becomes problematic. Therefore, the usual quasi-homogeneous-body definition in Eqs. (1)-(4) will be adopted, and the conditions under which its temperature field satisfies Eqs. (7)-(9) with a satisfactory degree of approximation will be investigated.

Error of Approximate Calculations. Plates Perpendicular to Flow

The temperature field of a two-component inhomogeneoss system consisting of N plates normal to the direction of heat flow (Fig. 1) will now be compared with that of a quasi-homogeneous body with various heat-

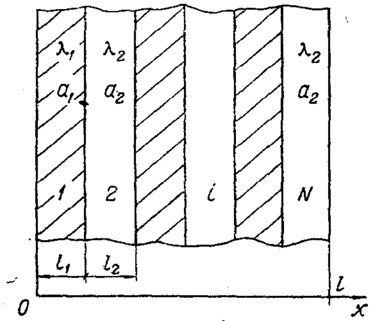

Fig. 1

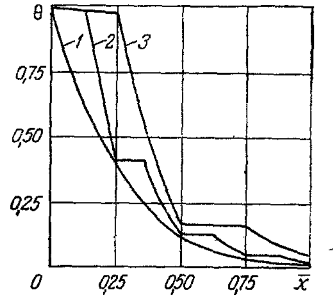

Fig. 2

Fig. 1. System of plates perpendicular to heat flow.

Fig. 2. Temperature field of quasihomogeneous body and system of plates perpendicular to heat flow for $\nu = 10^{-2}$, $\beta = 10^{-2}$, Fo = 0.05; 1) quasi-homogeneous body; 2) N = 8; 3) N = 4.

transfer conditions at its external boundaries. For convenience, Eqs. (1), (5), and (6) are written in dimensionless form, introducing the dimensionless numbers

$$\Theta(\bar{x},\ \mathrm{Fo}) = \frac{t(\bar{x},\ \mathrm{Fo}) - t_0}{t_c - t_0},\quad \mathrm{Fo} = \frac{a\tau}{l^2},\quad \bar{x} = \frac{x}{l}, \tag{21}$$

where t_0 is the initial temperature and t_c the characteristic temperature chosen in the light of the conditions being considered.

The thermal conductivity of the quasi-homogeneous body is determined from Eq. (17), and the thermal diffusivity from Eqs. (3) and (4)

$$\frac{a}{a_1} = \left[\left(m_1 + \frac{m_2}{\nu}\right)\left(m_1 + m_2\frac{\nu}{\beta}\right)\right]^{-1},\quad \nu = \frac{\lambda_2}{\lambda_1},\quad \beta = \frac{a_2}{a_1}. \tag{22}$$

The quantities

$$\Delta\Theta_V = \frac{t_{V\text{н}} - t_V}{t_c - t_0} = f(\nu,\ \beta,\ m_1,\ N,\ \mathrm{Fo}) \tag{23}$$

and

$$\sigma_{\perp}^2 = \int_0^1 (\Theta_\text{н} - \Theta)^2\, d\bar{x} = \varphi(\nu,\ \beta,\ m_1,\ N,\ \mathrm{Fo}) \tag{24}$$

are introduced for quantitative description of the error in determining the inhomogeneous-system temperature field from the quasi-homogeneous-body model.

The temperature field of the inhomogeneous system was determined by numerical solution of Eqs. (5) and (6) by the finite-difference method, using an implicit scheme realized on an ES-1022 computer; the error of the numerical calculations $\Delta\Theta \approx 0.01$-$0.02$ [2].

The results calculated for the error in passing to a quasi-homogeneous body with different heat-transfer conditions at the boundaries are given below.

In the case of thermal impact at one of the faces, the boundary conditions take the form

$$\Theta(0,\ \mathrm{Fo}) = 1,\ \Theta(1,\ \mathrm{Fo}) = 0,\ \Theta(\bar{x},\ 0) = 0. \tag{25}$$

The change in the arguments in studying Eqs. (23) and (24) was within the following limits

$$\nu = 10^{-3} - 1,\ \beta = 10^{-3} - 10^3,\ N = 2 - 24,\ \mathrm{Fo} = 0.02 - \infty. \tag{26}$$

The concentrations of the components were taken to be $m_1 = m_2 = 0.5$, since in this case the error in passing a quasi-homogeneous body is a maximum.

In steady conditions, with the boundary conditions in Eq. (25), the temperature distribution in the component plates takes the form of a discontinuous curve, and the errors $\Delta\Theta_V$ and $\sigma_\perp$ are given by the expressions

$$(\Delta\Theta_V)_{st} = \frac{(1-\nu)}{2N(1+\nu)}, \quad (\sigma_\perp)_{st} = \frac{|1-\nu|}{\sqrt{3}N(1+\nu)}. \tag{27}$$

The calculations showed that, in nonsteady conditions, $\Delta\Theta_V$ varies weakly over time and, when $N \geq 8$, $\Delta\Theta_V \approx (\Delta\Theta_V)_{st}$. The mean-square error $\sigma_\perp$ may be evaluated from the machine-empirical relations

$$\sigma_\perp = \frac{|1-\nu|}{\sqrt{3}N(1+\nu)}\left(1 + \frac{0.055}{\mathrm{Fo}\sqrt{N}}\right). \tag{28}$$

Thermal impact at the heat-insulated end of the face is described by the boundary conditions

$$\Theta(0, \mathrm{Fo}) = 1, \quad \frac{\partial\Theta(1, \mathrm{Fo})}{\partial\bar{x}} = 0, \quad \Theta(\bar{x}, 0) = 0. \tag{29}$$

When Fo = 0.02-0.5, the error $\Delta\Theta_V$ and $\sigma_\perp$ may be evaluated from Eqs. (27) and (28); when Fo > 0.5, they are less than the steady values in Eq. (27).

In conditions of thermal impact at both faces, described by the boundary conditions

$$\Theta(0, \mathrm{Fo}) = 1, \quad \Theta(1, \mathrm{Fo}) = 1, \quad \Theta(\bar{x}, 0) = 0, \tag{30}$$

the error $\Delta\Theta(1/2, \mathrm{Fo})$ in determining the temperature at the center of the plate and $\Delta\Theta_V$ is practically zero, while $\sigma_\perp$ may be determined as for the conditions in Eq. (29) if half the system is considered.

The effect of the ratio β when ν_i = const on the error in determining the temperature field of the given plate system does not exceed the error of the numerical solution. The recommendations given for evaluating the error are valid for $N \geq 4$; for N = 2, the quasi-homogeneous-body model is inapplicable.

The error in determining the temperature field with boundary conditions of the third kind for the case of identical heat-transfer coefficient α at the two faces take the following values for $\mathrm{Bi} = \alpha l/\lambda$ = 0.1-10:

$\Delta\Theta_V$ and $\Delta\Theta(1/2, \mathrm{Fo})$ do not exceed the error of numerical calculation over the whole range of Fo;

the error of calculating the surface temperatures $\Delta\Theta(1, \mathrm{Fo})$, $\Delta\Theta(0, \mathrm{Fo})$ rises with increase in Bi, reaching $\Delta\Theta \approx 1/N$ when $\mathrm{Fo} \leq 0.01$; when $\mathrm{Fo} \geq 0.1$, this error does not exceed the error of the numerical calculation;

$\sigma_\perp$ rises with increase in Bi, but does not exceed the value determined for the boundary conditions in Eq. (30).

Steady conditions in heterogeneous systems with an internal heat source were studied in [2], where the error of passing to a quasi-homogeneous body was estimated by the formula

$$\delta\vartheta = \frac{1}{p}\sum_{i=1}^{p}\frac{\vartheta_{iI} - \vartheta_i}{\vartheta_M} = \frac{|1-\nu|}{1 + l_2/l_1}\left[\frac{\lambda_2}{\alpha l_2} + \frac{p}{2}\left(1 + \nu\frac{l_1}{l_2}\right)\right]^{-1}, \tag{31}$$

where ϑ_i is the overheating with respect to the temperature of the medium at the center of the i-th pair of plates; ϑ_M, maximum overheating in the system; p, number of pairs of plates.

Calculations of the nonsteady heating of an inhomogeneous system with uniformly distributed local heat sources have shown that the error with reference to the current value of the maximum overheating $\vartheta_M(\tau)$ is close to $\delta\vartheta$ as determined from Eq. (31).

As an example, the temperature field of the inhomogeneous system and the quasi-homogeneous body with the boundary conditions in Eq. (29) is shown in Fig. 2, for $\nu = 10^{-2}$, $\beta = 10^{-2}$, N = 4, and N = 8.

Plates Parallel to Heat Flow

Consider a system of plates of dimensions l (macrodimension) and h (microdimension), consisting of two components with properties λ_i, $(c\rho)_i$, and a_i (Fig. 3). It is sufficient to perform the temperature-field analysis in a system of two half-plates bounded by the adiabatic planes y = 0 and y = h.

The thermal conductivity λ of the system is [1]

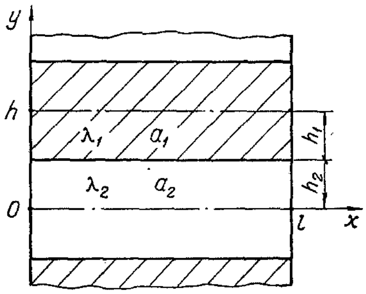

Fig. 3

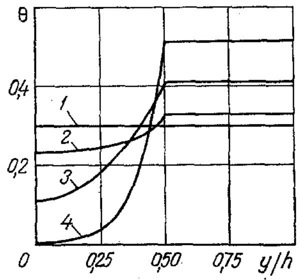

Fig. 4

Fig. 3. System of plates parallel to heat flow.

Fig. 4. Temperature fields of quasi-homogeneous body and system of plates parallel to heat flow in cross section $\bar{x} = 1$ when $\nu = 10^{-2}$, $\beta = 10^{-2}$, Fo = 0.25; 1) quasi-homogeneous body; 2) $\varepsilon = 0.1$; 3) $\varepsilon = 0.2$; 4) $\varepsilon = 0.5$.

$$\lambda = m_1\lambda_1 + m_2\lambda_2\,,\ m_i = h_i/h, \tag{32}$$

while the volume specific heat and thermal diffusivity are determined from Eqs. (3) and (4), which leads to the expression

$$\frac{a}{a_1} = \frac{m_1 + \nu m_2}{m_1 + \dfrac{\nu}{\beta}\, m_2}\,.$$

In the accurate temperature-field analysis, the problem was solved numerically by the finite-difference method, using a locally one-dimensional scheme [3]. The error of the numerical calculations was $\Delta\Theta = 0.02$–0.03.

As a quantitative characteristic of the difference between the temperature fields of the inhomogeneous system and the quasi-homogeneous body the mean-square error $\sigma_{\parallel}$ was chosen

$$\sigma_{\parallel}^2 = \frac{1}{\varepsilon}\int\limits_0^{\varepsilon}\int\limits_0^{1} (\Theta_{\mathrm{I}} - \Theta)^2\, d\bar{x} d\bar{y} = \psi(\varepsilon,\ \nu,\ \beta,\ m_1,\ \mathrm{Fo}),\ \varepsilon = h/l. \tag{33}$$

The calculations showed that the error in Eq. (33) reaches a maximum in conditions of thermal impact with the following boundary conditions

$$\Theta_i(0,\ \bar{y},\ \mathrm{Fo}) = 1,\ \left.\frac{\partial\Theta_i}{\partial\bar{x}}\right|_{\bar{x}=1} = 0\ (i = 1,\ 2). \tag{34}$$

The case of equal concentrations of the components was considered.

The error $\sigma_{\parallel}$ depends significantly on all the factors– ε, ν, β, and Fo. The dependence on Fo was not studied, in view of its complexity, and the maximum value of $\sigma_{\parallel}$ in the range Fo = 0.05–0.5 was considered. To estimate $\sigma_{\parallel}$, a machine-empirical dependence was constructed using the complete three-factorial plan of the experiment [4]: when $\nu = 10^{-3}$–10^{-1}, $\beta = 10^{-3}$–10^{-1}, and $\varepsilon = 0.05$–0.2

$$\sigma_{\parallel} = 0.014\,(1 + \lg\beta)\lg\nu + \varepsilon\,(0.28 + 0.12\lg\nu + 0.18\lg\beta + 0.22\lg\nu\lg\beta), \tag{35}$$

and when $\nu = 10^{-2} - 10,\ \beta = 10^{-1} - 1,\ \varepsilon = 0.1 - 0.5$

$$\sigma_{\parallel} = (0.075\lg\nu - 0.13)\,\varepsilon\lg\beta. \tag{36}$$

Investigation of the nonsteady conditions for heat transfer with boundary conditions of the third kind

$$\left.\left(\frac{\partial\Theta_i}{\partial\bar{x}} + \frac{\lambda}{\lambda_i}\,\mathrm{Bi}\,\Theta_i\right)\right|_{\bar{x}=0} = 0,\ \left.\frac{\partial\Theta_i}{\partial\bar{x}}\right|_{\bar{x}=1} = 0,\ i = 1,\ 2 \tag{37}$$

showed that the error $\sigma_{\parallel}$ may be given an upper bound using Eqs. (35) and (36), except in the case $\beta \approx 1$, $\nu \ll 1$, since under the conditions in Eq. (34) $\sigma_{\parallel} \to 0$ when $\beta \to 1$, and for Eq. (37) $\sigma_{\parallel} \neq 0$ when $\beta = 1$ if $\lambda_1 \neq \lambda_2$.

In Fig. 4, the temperature fields of the inhomogeneous system and the quasihomogeneous body are compared in the case of the boundary conditions in Eq. (34) when $\nu = 10^{-2}$, $\beta = 10^{-2}$, $\varepsilon = 0.5, 0.2, 0.1$ (the temperature distribution in the cross section $\overline{x} = 1$ is shown).

Thus, the temperature field of the inhomogeneous system may be approximately calculated from the quasi-homogeneous-body model in Eqs. (1)-(4); in this case, Eqs. (7)-(9) are satisfied with a certain degree of approximation. For the simplest inhomogeneous systems, estimates of the error in passing to a quasi-homogeneous body have been obtained. For more complex systems (e.g., a structure with mutually interpenetrating components [1]), the following estimate may be proposed

$$\sigma \leqslant \max\{\sigma_\perp,\ \sigma_\parallel\}. \tag{38}$$

NOTATION

t, t_I, t_i, temperature of quasi-homogeneous body inhomogeneous system, and i-th component of system; a, λ, $c\rho$, thermal diffusivity and conductivity and volume specific heat of quasi-homogeneous body; a_i, λ_i, $c\rho_i$, the same quantities for the i-th component; q, heat flux; S, V, system surface and volume; x, y, coordinates; l, macrodimension of system; Θ, dimensionless temperature; $\mathrm{Fo} = a\tau/l^2$, $\mathrm{Bi} = \alpha l/\lambda$, Fourier and Biot numbers; $\nu = \lambda_2/\lambda_1$; $\beta = a_2/a_1$; N, number of plates; $\varepsilon = h/l$, ratio of micro- and macrodimensions; $\Delta\Theta_V$, σ, volume-averaged and mean-square error of dimensionless-temperature determination; τ, time; m_i, i-th component concentration.

LITERATURE CITED

1. G. N. Dul'nev and Yu. P. Zarichnyak, Heat Conduction of Mixtures and Composite Materials [in Russian], Énergiya, Leningrad (1974).
2. B. V. Pol'shchikov, Investigation of Thermal Conditions of Electronic Equipment in Integral Use with Conductive Heat Transfer, Author's Abstract of Candidate's Dissertation, LITMO, Leningrad (1974).
3. A. A. Samarskii, Difference-Scheme Theory [in Russian], Nauka, Moscow (1977).
4. Yu. P. Adler, E. V. Markova, and Yu. V. Granovskii, Planning Experiments with Search for Optimum Conditions [in Russian], Nauka, Moscow (1976).

DETERMINATION OF PARAMETERS OF ARTIFICIAL CONSTRUCTIONAL CONGLOMERATES USING CRITERIAL EQUATIONS

V. N. Evstifeev and L. S. Evstifeeva

UDC 539.21

Generalized similarity criteria and criterial equations are proposed for determining the physicomechanical and thermotechnical parameters of artificial constructional conglomerates and their mixtures.

The definition of artificial constructional conglomerates (ACC), nomenclature, and theoretical and experimental investigations of their properties are given in [1].

At present, considerable experience has been accumulated in determining the change in ACC parameters on the basis of experimental investigations. These parameters, as a rule, are expressed by empirical dependences. The result of this empirical approach, however, is that sometimes there is a large number of formulas for determining the same ACC parameters.

In the present work, an approach to the determination of ACC parameters is outlined involving the use of criterial equations which include both individual criteria and generalized similarity criteria obtained as a result of similarity theory and dimensional analysis of physical quantities characterizing the ACC properties.

Central Scientific-Research Institute of Experimental Design and Planning for Agricultural Construction, Computer Station, Academy of Sciences of the USSR.

Translated from Inzhenerno-Fizicheskii Zhurnal, Vol. 39, No. 1, pp. 134-137, July, 1980. Original article submitted May 3, 1979.