NOTATION

α, absorption coefficient of the medium, m^{-1}; w, specific heat of the mass flow rate of the gas, W/deg; σ_0, Stefan–Boltzmann constant; T_t, theoretical combustion temperature, °K; T_1, temperature of the beginning of the process, °K; a_r, a_w, a_f, absorptivities of the heating surface, the wall, and the volume of the chamber; H_r, area of the heating surface; l, h, chamber length and height, m; ε_v, visible emissivity; ψ, degree of shielding; φ, angular coefficient between the ray-perceiving surface and itself; θ_y, θ_w, dimensionless temperatures of the waste gases and the wall; Bo, Bu, Boltzmann and Bouger criteria.

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RADIANT HEAT CONDUCTION IN A LAYER WITH A HIGH PARTICLE CONCENTRATION

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The optical thickness of a layer with a high particle concentration is computed by the Monte Carlo method. The radiant component of the heat conduction is found.

The following expression is obtained in [1] for the optical thickness of a medium with a high particle concentration:

$$\tau_0 = \frac{n_0 \sigma'}{P'} L. \tag{1}$$

This formula has been obtained in the geometric optics approximation for the case of opaque chaotically arranged particles. To clarify the limits of applicability of (1), a computation has been carried out by the method of statistical tests for the transmissivity of a medium D containing opaque, optically large-scale particles of identical radius. An arrangement of 100 particles of radius 0.075 has been modeled in a volume in the shape of a parallelepiped of dimension 1 × 1 × L. The length dimensionality plays no part in the geometric optics approximation. The coordinates of the particle centers were determined by using a standard program to obtain pseudorandom numbers. The mutual penetration of the particles was excluded. The volume was filled sequentially. The greater the number of particles and the smaller the porosity, the more difficult it is to seek free space for the particles. The porosity was varied between P' = 0.911 and 0.646 by changing the length L of the parallelepiped. A

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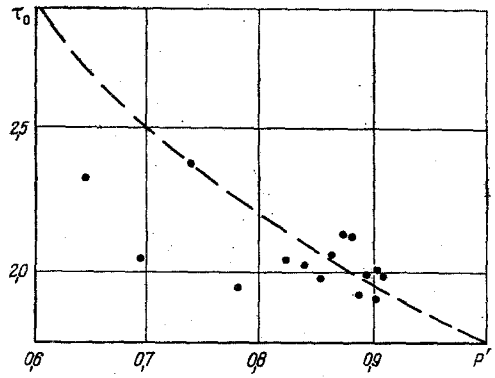

Fig. 1. Dependence of the optical thickness of the layer on porosity: dashed line, calculation by formula (1); points, calculation by the Monte Carlo method at the same values of the limiting optical thickness.

parallel beam of photons incident perpendicularly to the facet 1×1 was modeled by generating pseudorandom coordinates distributed uniformly in [0, 1]. The contiguity of the photon trajectory to the particles was verified. If a photon is contiguous to particles, then it is considered to have left the beam because of absorption or scattering. The transmissivity

$$D = e^{-\tau_0} \tag{2}$$

was determined as the ratio between the number of photons which have passed and the number of incident photons. The peripheral region near the side surface of the parallelepiped with the thickness of the particle radius was not considered since the density of the substance near the boundary is less than the mean density. This has been shown experimentally in [2]. For each particle arrangement, 3000 photons have been tested. The computations were performed on a "Minsk-22" electronic digital computer. The pseudorandom number transmitter was taken from the library of autocode programs "Inzhener." R. L. Shvartsblat compiled the computation program. The results of the computations are represented in the figure, from which it follows that a computation by means of (1) is satisfied up to the values $P' \geq 0.8$. A comparison of the computation by means of (1) with the results of the modeling has been made for identical values of the quantity $\tau_0^! = n_0\sigma' L$. For $P' < 0.8$ formula (1) can be used only for approximate computations.

The optical thickness of a medium is related to the photon mean free path in the medium [3]

$$l = L/\tau_0. \tag{3}$$

If the particles are spherical, of identical diameter d, then we obtain from (1)

$$l = \frac{2}{3}\,\frac{P'd}{1-P'}. \tag{4}$$

Starting from the diffusion approximation and considering the scattering index spherical and the particles gray, the following formula is obtained in [4] for the coefficient of radiant heat conductivity of the medium:

$$\lambda_r = \frac{16}{3}\, l\sigma T^3. \tag{5}$$

Taking account of (4) and (5) we find

$$\lambda_r = \frac{32}{9}\,\frac{P'}{1-P'}\,\sigma T^3 d. \tag{6}$$

This formula can be used to estimate the radiant component of the heat conductivity of a medium with an elevated particle concentration.

NOTATION

τ_0, optical thickness of the layer; L, layer thickness; P', porosity; σ', mean particle midsection; d, particle diameter; n_0, mean number of particles per unit volume; D, transmissivity; l, photon mean free path in the medium; λ_r, radiant component of the effective heat conductivity of the medium; σ, Stefan — Boltzmann constant; T, temperature, °K; τ_0^0, optical thickness for unit porosity.

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THERMAL INSTABILITY OF A VISCOELASTIC FLUID LAYER WITH LIFT AND THERMOCAPILLARY FORCES TAKEN INTO ACCOUNT

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The stability problem of a viscoelastic fluid layer of integral type is investigated by the Fourier method during heating from below. The simultaneous effect of the lift and thermocapillary forces is taken into account. The critical values of the Rayleigh and Marangoni criteria are determined.

The stability of a horizontal viscoelastic fluid layer heated from below has been considered up to now only under the effect of Archimedes forces [1, 2]. However, another instability mechanism is possible — the change in the thermocapillary forces on the free fluid surface [3]. In the general case, instability can originate as a result of the simultaneous action of these two forces.

Let us consider an infinite horizontal viscoelastic fluid layer bounded from above by an undeformable free surface and from below by a solid mass of finite thickness and heat conductivity (Fig. 1). The surface $z = -d_1$ is maintained at the constant temperature T_1^0, and heat is transmitted from the free surface $z = d$ to the surrounding medium with temperature T_2^0 by convection.

The thermal boundary conditions of this problem can be formulated in the form

$$T = T_1^0 \quad \text{for} \quad z = -d_1, \tag{1}$$

$$T = T_1, \ \varkappa_1 \frac{\partial T_1}{\partial z} = \varkappa \frac{\partial T}{\partial z} \quad \text{for} \quad z = 0, \tag{2}$$

$$\alpha (T - T_2^0) = -\varkappa \frac{\partial T}{\partial z} \quad \text{for} \quad z = d. \tag{3}$$

The amplitude equations of the perturbed state are written in the Boussinesq approximation in the form

$$[\sigma \Pr^{-1} - \psi(\sigma)(D^2 - \gamma^2)](D^2 - \gamma^2) W = -R\gamma^2\Theta, \tag{4}$$

$$(\sigma - D^2 + \gamma^2)\Theta = W, \tag{5}$$

$$(D^2 - \gamma^2 - \sigma/\bar{\varkappa})\Theta_1 = 0. \tag{6}$$

The previous dimensionless variables [2] were hence used.

The boundary conditions for the perturbations are expressed by the following dependences:

$$\Theta(0) = \Theta_1(0), \ D\Theta(0) = \bar{\varkappa} D\Theta_1(0), \tag{7}$$

$$\Theta_1(-L) = 0, \quad L = d_1/d, \tag{8}$$

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