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TRANSFER OF HETEROGENEOUS DROPLETS IN THE FIELD OF A TEMPERATURE GRADIENT

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The thermophoresis of a double-layer moderately large volatile droplet with a solid core, placed in a binary viscous gas mixture, is considered. The thermodiffusion within the volume of a two-component gas mixture is allowed for, and all corrections for the Knudsen number are taken into account completely. An equation for the thermophoresis rate is derived, and a full analysis of the velocity of a large particle as a function of its radius and the core radius is given.

The theory of motion of double-layer aerosol particles in heterogeneous gases was treated in [1-8]. This article is a further development of this issue in the sense of allowing for the thermodiffusion in the volume of a two-component gas mixture and completely taking into account all corrections for the Knudsen number λ/R. For the first time a numerical analysis of the velocity of a large particle as a function of its radius and the size of the inner core when $\lambda/R \to 0$ is carried out.

We consider a spherical droplet of radius R with a solid core of radius a, placed in a binary viscous gas mixture, in which a temperature gradient, constant at infinity $(\nabla T_e)_\infty$, is maintained. On the droplet surface, evaporation (or condensation) occurs. We will assume that one of the components of the external binary gas mixture coincides, in chemical composition, with the liquid of the particle shell. This particle will be set in thermophoretic motion at a certain velocity U_T. The particle radius R will be assumed to be much larger than the mean free path of the molecules of either external mixture component. In this case, a hydrodynamic method of describing the behavior of the medium surrounding the particle can be employed to a sufficient accuracy [1-5].

In order to solve the problem we resort to a spherical coordinate system (r, θ, φ) with origin fixed at the droplet center. We regard the particle as being at rest, and the medium as moving relative to the droplet at the mean mass velocity $U = -U_T$ at $r \to \infty$. The external medium is characterized by the mean viscosity η_e, the density ρ_e, the temperature T_e, and the thermal conductivity κ_e. The relative concentration of the first component of the external binary gas mixture is C_{1e}.

The distribution of velocities, pressures, temperatures, and concentrations outside and within the liquid phase of the particle is prescribed by a system of linearized equations [1-5, 8]:

$$\eta_e \nabla^2 \mathbf{v}^{(e)} = \nabla p^{(e)}; \tag{1}$$

$$\operatorname{div} \mathbf{v}^{(e)} = 0; \tag{2}$$

$$\nabla^2 T_e = 0; \tag{3}$$

$$\eta_i \nabla^2 \mathbf{v}^{(i)} = \nabla p^{(i)}; \tag{4}$$

$$\operatorname{div} \mathbf{v}^{(i)} = 0; \tag{5}$$

$$\nabla^2 T_i = 0; \tag{6}$$

$$\nabla^2 C_{1e} = 0; \tag{7}$$

$$\nabla^2 T_a = 0. \tag{8}$$

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The subscripts e and i belong to quantities characterizing the external medium and the liquid phase of the particle, respectively, and the subscript a belongs to quantities characterizing the solid core. At $r \to \infty$ we have the following boundary conditions:

$$v_r^{(e)} = |\mathbf{U}| \cos \theta; \tag{9}$$

$$v_\theta^{(e)} = -|\mathbf{U}| \sin \theta; \tag{10}$$

$$p^{(e)} = p_0^{(e)}; \tag{11}$$

$$T_e = T_{0e} + |(\nabla T_e)_\infty| \, r \cos \theta; \tag{12}$$

$$C_1^{(e)} = C_{10}^{(e)}. \tag{13}$$

We now examine the boundary conditions on the droplet surface. The droplet surface is impermeable to the second component of the binary gas mixture, which may be expressed by the relation

$$n_{2e} v_r^{(e)}|_{r=R} + D_{12}^{(e)} \frac{n_e^2 m_1}{\rho_e} \frac{\partial C_{1e}}{\partial r}\bigg|_{r=R} = n_{2e} \frac{C_{2v}^{(T)} \lambda}{R} \frac{\eta_e}{\rho_e T_{0e}} \times \frac{1}{R}\left(\operatorname{ctg}\theta \frac{\partial T_e}{\partial \theta} + \frac{\partial^2 T_e}{\partial \theta^2}\right)\bigg|_{r=R} - D_{12}^{(e)} \frac{n_e^2 m_1}{\rho_e} \frac{K_{TD}^{(e)}}{T_{0e}} \frac{\partial T_e}{\partial r}\bigg|_{r=R}. \tag{14}$$

With a phase transition on the droplet surface, there is continuity of the flow of the first mixture component:

$$n_{1e} v_r^{(e)}|_{r=R} - D_{12}^{(e)} \frac{n_e^2 m_2}{\rho_e} \frac{\partial C_{1e}}{\partial r}\bigg|_{r=R} = n_{1e} \frac{C_{1v}^{(T)} \lambda}{R} \frac{\eta_e}{\rho_e T_{0e}} \times \frac{1}{R}\left(\operatorname{ctg}\theta \frac{\partial T_e}{\partial \theta} + \frac{\partial^2 T_e}{\partial \theta^2}\right)\bigg|_{r=R} + D_{12}^{(e)} \frac{n_e^2 m_2}{\rho_e} \frac{K_{TD}^{(e)}}{T_{0e}} \frac{\partial T_e}{\partial r}\bigg|_{r=R} + n_{1i} v_r^{(i)}|_{r=R}. \tag{15}$$

In Eqs. (14) and (15), n_{1e} and n_{2e} are the mean concentrations of the components of the external gas mixture; n_{1i} is the molecular concentration in the liquid shell of the particle; m_1 and m_2 are the molecular masses of the components of the external mixture; $n_e = n_{1e} + n_{2e}$; $n_{1e}v_r^{(e)}$ and $n_{2e}v_r^{(e)}$ are the radial convective flows of the components of the gas mixture; $n_{1i}v_r^{(i)}$ is the radial flow of the particle substance at the particle-external medium interface.

The second terms in Eqs. (14) and (15) are the radial diffusional flows of the components of the external mixture, and D_{12} is the interdiffusion coefficient.

The first terms on the right side of Eqs. (14) and (15) account for the moderately large particles of the part of the radial flow going to the Knudsen layer. The second terms on the right side are the radial thermodiffusional flows of the components of the external mixture, which are proportional to the thermodiffusion coefficient $K_{TD}^{(e)}$.

The tangential velocity components outside and within the particle satisfy the slip condition on the droplet surface

$$(v_\theta^{(e)} - v_\theta^{(i)})|_{r=R} = C_m \lambda \left(r \frac{\partial}{\partial r}\left(\frac{v_\theta^{(e)}}{r}\right) + \frac{1}{r}\left(\frac{\partial v_r^{(e)}}{\partial \theta}\right)\right)\bigg|_{r=R} + K_{TSl}^{(e)} \frac{\eta_e}{\rho_e T_{0e}} \frac{1}{R}\left(1 + \frac{\sigma_T \beta_R^{(T)} \lambda}{R} + \frac{\beta_R^{\prime(T)} \lambda}{R}\right) \frac{\partial T_e}{\partial \theta}\bigg|_{r=R} + K_{TSl}^{(e)} \frac{\eta_e}{\rho_e T_{0e}} \frac{\beta_B^{(T)} \lambda}{R}\left(\frac{\partial^2 T_e}{\partial r \partial \theta} - \frac{1}{r} \frac{\partial T_e}{\partial \theta}\right)\bigg|_{r=R} + K_{DSl}^{(e)} D_{12}^{(e)} \frac{1}{R}\left(1 + \frac{\sigma_C \beta_R^{(D)} \lambda}{R} + \frac{\beta_R^{\prime(D)} \lambda}{R}\right) \frac{\partial C_{1e}}{\partial \theta}\bigg|_{r=R} + \tag{16}$$

$$+ K_{DSl}^{(e)} D_{12}^{(e)} \frac{\beta_Б^{(D)}\lambda}{R} \left(\frac{\partial^2 C_{1e}}{\partial r \partial \theta} - \frac{1}{r} \frac{\partial C_{1e}}{\partial \theta} \right) \Bigg|_{r=R}.$$

Here account is taken of isothermal, thermal, and diffusional slips, which are proportional to the coefficients C_m, $K_{TSl}^{(e)}$, and $K_{DSl}^{(e)}$, respectively. Expressions for the rate of the thermal slip with consideration of the curvature effect and the Barnett effects for binary gas mixtures as well as all coefficients appearing in boundary condition (16) (C_m, $K_{TSl}^{(e)}$, $K_{DSl}^{(e)}$, σ_T, σ_C, $\beta_R^{(T)}$, $\beta_R'^{(T)}$, $\beta_R^{(D)}$, and $\beta_R'^{(D)}$) were obtained in [8-12].

The continuity condition for the tangential components of the tensor of viscous stresses on the particle surface has the form (see [8])

$$\eta_e \left(\frac{1}{r} \frac{\partial v_r^{(e)}}{\partial \theta} + \frac{\partial v_\theta^{(e)}}{\partial r} - \frac{v_\theta^{(e)}}{r} \right) \Bigg|_{r=R} + \frac{1}{R} \frac{\partial \sigma_i}{\partial T_i} \frac{\partial T_i}{\partial \theta} \Bigg|_{r=R} = \eta_i \left(\frac{1}{r} \frac{\partial v_r^{(i)}}{\partial \theta} + \frac{\partial v_\theta^{(i)}}{\partial r} - \frac{v_\theta^{(i)}}{r} \right) \Bigg|_{r=R}. \tag{17}$$

Here, σ_i is the surface tension of the liquid on the particle-external medium interface.

For the temperature on the particle surface we have

$$(T_e - T_i)|_{r=R} = K_T^{(T)} \frac{\partial T_e}{\partial r} \Bigg|_{r=R} + K_T^{(n)} T_{0e} \frac{\partial C_{1e}}{\partial r} \Bigg|_{r=R}. \tag{18}$$

Here, $K_T^{(T)}$ and $K_T^{(n)}$ are the coefficients of the temperature jumps.

For heat fluxes with a phase transition at the droplet-external medium interface the following condition holds:

$$\left(-\varkappa_e \frac{\partial T_e}{\partial r} + \varkappa_i \frac{\partial T_i}{\partial r} \right) \Bigg|_{r=R} = L m_1 \frac{m_2 n_e^2}{\rho_e} D_{12}^{(e)} \left(\frac{\partial C_{1e}}{\partial r} + \frac{K_{TD}}{T_{0e}} \frac{\partial T_e}{\partial r} \right) \Bigg|_{r=R} - C_q^{(Cm)} \frac{\varkappa_e}{R} \left(\operatorname{ctg} \theta \frac{\partial T_e}{\partial \theta} + \frac{\partial^2 T_e}{\partial \theta^2} \right) \Bigg|_{r=R}. \tag{19}$$

In Eq. (19), L is the specific heat of the phase transition, κ_e and κ_i are the specific heats of the external medium and the droplet, respectively, and $C_q^{(Cm)}$ is a coefficient whose expression was obtained in [9].

The phase transition of the droplet substance to the first component of the external gas mixture leads to the boundary condition

$$(C_{1e} - C_{1e}^{(H)})|_{r=R} = K_n^n \frac{\partial C_{1e}}{\partial r} \Bigg|_{r=R} + K_n^{(T)} \frac{\partial T_e}{\partial r} \Bigg|_{r=R}. \tag{20}$$

Here, $C_{1e}^{(H)}$ is the relative concentration of saturating vapors of the first component of the mixture at the temperature T_e.

Expanding $C_{1e}^{(H)}$ in a temperature series, we arrive at

$$C_{1e}^{(H)}|_{r=R} = C_{01e}^{(H)}|_{r=R} + \frac{\partial C_{1e}}{\partial T_e} (T_e - T_{0e})|_{r=R}. \tag{21}$$

On the core surface (r = a), the boundary conditions

$$v_r^{(i)} = 0; \tag{22}$$

$$v_\theta^{(i)} = K_{TSl}^{(i)} \frac{\eta_i}{\rho_{0i} T_{0i}} \frac{1}{r} \frac{\partial T_i}{\partial \theta} \Bigg|_{r=a} \tag{23}$$

are fulfilled (see [1]). Condition (23) accounts for the thermal slip of the liquid shell along the core, which is proportional to $K_{TSl}^{(i)}$. The coefficient $K_{TSl}^{(i)}$ was determined experimentally for a variety of liquids in [13].

On the core surface, the conditions of continuity of the heat and temperature fluxes hold:

$$\varkappa_i \frac{\partial T_i}{\partial r}\bigg|_{r=a} = \varkappa_a \frac{\partial T_a}{\partial r}\bigg|_{r=a}; \tag{24}$$

$$T_i|_{r=a} = T_a|_{r=a}. \tag{25}$$

The value of the resultant of all forces applied to the elements of the spherical surface is zero. This condition has the form

$$F = \iint_S (p_{rr}^{(e)} \cos\theta - p_{r\theta}^{(e)} \sin\theta)|_{r=R} dS = 0. \tag{26}$$

By solving the system of equations (14)-(26) (see [1, 8]), for the thermophoresis rate U_T for a moderately large double-layer volatile particle we obtain

$$\mathbf{U}_T = -6D_{12}^{(e)} \frac{n_e^2}{n_{2e}\rho_e}\left(m_1\nu + \frac{2}{3}\frac{\beta}{\alpha}\frac{n_{1e}m_1 + n_{2e}m_2}{n_{1i}}\right) \times$$

$$\times \frac{\dfrac{K_n^T}{R} + \dfrac{K_T^T}{R}\delta' + \xi(1+\varphi)}{\left(1 + 2\dfrac{K_n^n}{R}\right)\gamma} (\nabla T_e)_\infty +$$

$$+ 6\frac{C_{2v}^{(T)}\lambda}{R}\frac{\eta_e}{\rho_e T_{0e}}\left(\nu + \frac{2}{3}\frac{\beta}{\alpha}\frac{n_{1e}}{n_{1i}}\right) \times$$

$$\times \frac{\dfrac{K_T^T}{R} - 2\dfrac{K_T^n}{R}\dfrac{\dfrac{K_n^T}{R}}{1 + 2K_n^n/R} + \xi(1+\varphi)}{\gamma} (\nabla T_e)_\infty +$$

$$+ 3D_{12}^{(e)} \frac{n_e^2}{n_{2e}\rho_e}\frac{K_{TD}^{(e)}}{T_{0e}}\left(m_1\nu + \frac{2}{3}\frac{\beta}{\alpha}\frac{n_{1e}m_1 + n_{2e}m_2}{n_{1i}}\right) \times$$

$$\times \frac{1 + 2\dfrac{K_T^n}{R}\dfrac{\delta'}{1 + 2K_n^n/R} - 2\xi(1+\varphi)}{\gamma} (\nabla T_e)_\infty -$$

$$-\frac{2}{3}\frac{R}{\eta_i}\frac{\partial\sigma_i}{\partial T_i}\delta\xi(1+\varphi)\frac{1}{1 + 2\dfrac{C_m\lambda}{R} + \dfrac{2}{3}\dfrac{\eta_e}{\eta_i}\delta}(\nabla T_e)_\infty -$$

$$-2K_{TSl}^{(i)}\frac{\eta_i}{\rho_i T_{0i}}\mu\xi\left(1 + \varphi\frac{R^3}{a^3}\right)\frac{1}{1 + 2\dfrac{C_m\lambda}{R} + \dfrac{2}{3}\dfrac{\eta_e}{\eta_i}\delta}(\nabla T_e)_\infty - \tag{27}$$

$$-4\frac{C_{1v}^{(T)}\lambda}{R}\frac{\eta_e}{\rho_e T_{0e}}\frac{\beta}{\alpha}\frac{n_{1e}}{n_{1i}}\frac{\dfrac{K_T^T}{R} - 2\dfrac{K_T^n}{R}\dfrac{\dfrac{K_n^T}{R}}{1 + 2K_n^n/R} + \xi(1+\varphi)}{\gamma}(\nabla T_e)_\infty -$$

$$-2K_{TSl}^{(e)}\frac{\eta_e}{\rho_e T_{0e}}\left[1 + \frac{\sigma_T \beta_R^{(T)}\lambda}{R} + \frac{\beta_R'^{(T)}\lambda}{R}\right] \times$$

$$\times \frac{\frac{K_T^T}{R} - 2\frac{K_T^n}{R}\frac{\frac{K_n^T}{R}}{1+2K_n^n/R} + \xi(1+\varphi)}{\gamma}(\nabla T_e)_\infty +$$

$$+2K_{TSl}^{(e)}\frac{\eta_e}{\rho_e T_{0e}}\frac{\beta_Б^{(T)}\lambda}{R}\frac{3\xi(1+\varphi) - 1 + \frac{K_T^T}{R} - 2\frac{K_T^n}{R}\frac{\frac{K_n^T}{R}+\delta'}{1+2K_n^n/R}}{\gamma}(\nabla T_e)_\infty -$$

$$-2K_{DSl}^{(e)}D_{12}^{(e)}\left(1+\frac{\sigma_C\beta_R^{(D)}\lambda}{R}+\frac{\beta_R^{'(D)}\lambda}{R}\right)\frac{\frac{K_n^T}{R}+\frac{K_T^T}{R}\delta'+\xi(1+\varphi)}{\left(1+2\frac{K_n^n}{R}\right)\gamma}(\nabla T_e)_\infty +$$

$$+6K_{DSl}^{(e)}D_{12}^{(e)}\frac{\beta_Б^{(D)}\lambda}{R}\frac{\frac{K_n^T}{R}+\frac{K_T^T}{R}\delta'+\xi(1+\varphi)}{\left(1+2\frac{K_n^n}{R}\right)\gamma}(\nabla T_e)_\infty ,$$

where

$$\alpha = 3\frac{R^4}{a^2} + 2\frac{a^3}{R} - 2\frac{R^5}{a^3} - 3a^2;$$

$$\beta = \frac{5}{2}R^2 + \frac{3}{2}\frac{R^4}{a^2} + \frac{a^3}{R} - 2\frac{R^5}{a^3} - 3a^2;$$

$$\gamma = \left(1 + 2\frac{K_T^T}{R} + 2\frac{K_T^n}{R}\frac{\delta' - 2\frac{K_n^T}{R}}{1+2\frac{K_n^n}{R}}\right)\left(1 + 2\frac{C_m\lambda}{R} + 2\frac{\eta_e}{\eta_i}\delta\right);$$

$$\delta = \frac{2\frac{R^5}{a^3} + 2\frac{a^3}{R} - \frac{9}{2}\frac{R^4}{a^2} - \frac{9}{2}a^2 + 5R^2}{2\frac{R^5}{a^3} - 3\frac{R^4}{a^2} - 2\frac{a^3}{R} + 3a^2};$$

$$\mu = \frac{\frac{a^3}{R} - \frac{R^4}{a^2} - 5aR + 5R^2}{2\frac{R^5}{a^3} - 3\frac{R^4}{a^2} - 2\frac{a^3}{R} + 3a^2};$$

$$\varphi = \frac{\frac{\varkappa_i}{\varkappa_a} - 1}{1 + 2\frac{\varkappa_i}{\varkappa_a}}\frac{a^3}{R^3};$$

$$\nu = \frac{2C_m\lambda}{R} + \frac{1}{3} + \frac{2}{3}\frac{\eta_e}{\eta_i}\delta;$$

$$\delta' = \frac{\partial C_{1e}}{\partial T_e};\quad \psi' = \frac{2Lm_1m_2n_e^2}{\rho_e}D_{12}^{(e)}\left(\frac{K_{TD}^e}{T_e} + \frac{\delta' - 2\frac{K_n^T}{R}}{1+2\frac{K_n^n}{R}}\right)(1+\varphi);$$

$$\xi = \left\{ \varkappa_e \left(1 + 2 \frac{K_T^n}{R} \frac{\delta'}{1 + 2K_n^n/R} \right) + \right.$$

$$+ \frac{Lm_1 m_2 n_e^2}{\rho_e} D_{12}^{(e)} \frac{K_{TD}^{(e)}}{T_e} \left(1 + 2 \frac{K_T^T}{R} \frac{\delta'}{1 + 2K_n^n/R} \right) + \left. \psi \right\} \times$$

$$\times \left\{ \varkappa_i (1 - 2\varphi) \left(1 + 2K_T^T + 2K_T^n \frac{\delta' - 2 \frac{K_n^T}{R}}{1 + 2 \frac{K_n^n}{R}} \right) + \right.$$

$$\left. + 2\varkappa_e (1 + \varphi)(1 - C_q^{(Cm)}) + \psi' \right\}^{-1};$$

$$\psi = 2C_q^{(Cm)} \varkappa_e \left(\frac{K_T^T}{R} - 2 \frac{K_T^n}{R} \frac{\frac{K_n^T}{R}}{1 + 2 \frac{K_n^n}{R}} \right) -$$

$$- \frac{2Lm_1 m_2 n_e^2}{\rho_e} D_{12}^{(e)} \frac{\frac{K_n^T}{R} + \delta' \frac{K_T^T}{R}}{1 + 2 \frac{K_n^n}{R}}.$$

For a large spherical double-layer volatile particle, $\lambda/R = 0$. In this case, the thermophoresis rate is determined from the following equation:

$$\mathbf{U}_T = - 2K_{TSl}^{(e)} \frac{\eta_e}{\rho_e T_{0e}} \frac{\xi_1 (1 + \varphi)}{\gamma_1} (\nabla T_e)_\infty -$$

$$- \frac{2}{3} \frac{R}{\eta_i} \frac{\partial \sigma_i}{\partial T_i} \delta \xi_1 (1 + \varphi) \frac{1}{1 + \frac{2}{3} \frac{\eta_e}{\eta_i} \delta} (\nabla T_e)_\infty -$$

$$- 2K_{TSl}^{(i)} \frac{\eta_i}{\rho_i T_{0i}} \mu \xi_1 \left(1 + \varphi \frac{R^3}{a^3} \right) \frac{1}{1 + \frac{2}{3} \frac{\eta_e}{\eta_i} \delta} (\nabla T_e)_\infty + \tag{28}$$

$$+ 3D_{12}^{(e)} \frac{n_e^2}{n_{2e} \rho_e} \frac{K_{TD}^{(e)}}{T_{0e}} \left(m_1 \nu_1 + \frac{2}{3} \frac{\beta}{\alpha} \frac{n_{1e} m_1 + n_{2e} m_2}{n_{1i}} \right) \times$$

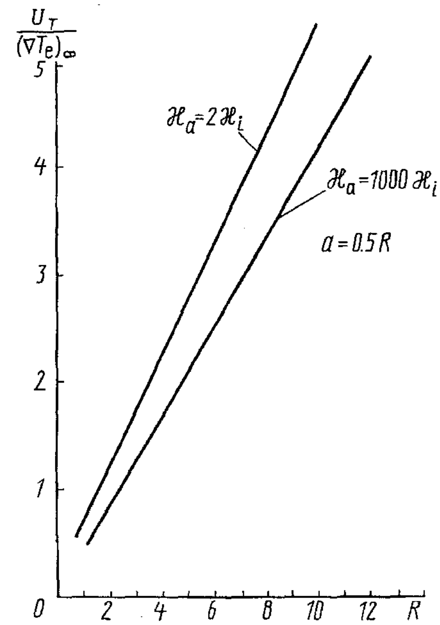
$$\times \frac{1 - 2\xi_1 (1 + \varphi)}{\gamma_1} (\nabla T_e)_\infty - 6D_{12}^{(e)} \frac{n_e^2}{n_{2e} \rho_e} \left(m_1 \nu_1 + \frac{2}{3} \frac{\beta}{\alpha} \frac{n_{1e} m_1 + n_{2e} m_2}{n_{1i}} \right) \times$$

$$\times \frac{\xi_1 (1 + \varphi)}{\gamma_1} (\nabla T_e)_\infty - 2K_{DSl}^{(e)} D_{12}^{(e)} \frac{\xi_1 (1 + \varphi)}{\gamma_1} (\nabla T_e)_\infty.$$

Here

$$\gamma_1 = 1 + 2 \frac{\eta_e}{\eta_i} \delta; \quad \nu_1 = \frac{1}{3} + \frac{2}{3} \frac{\eta_e}{\eta_i} \delta;$$

$$\xi_1 = \frac{\varkappa_e + \frac{Lm_1 m_2 n_e^2 D_{12}^{(e)}}{\rho_e} \frac{K_{TD}^{(e)}}{T_{0e}}}{\varkappa_i (1 - 2\varphi) + 2\varkappa_e (1 + \varphi) + \frac{2Lm_1 m_2 n_e^2}{\rho_e} D_{12}^{(e)} \frac{(K_{TD}^{(e)} + \delta')}{T_{0e}} (1 + \varphi)}.$$



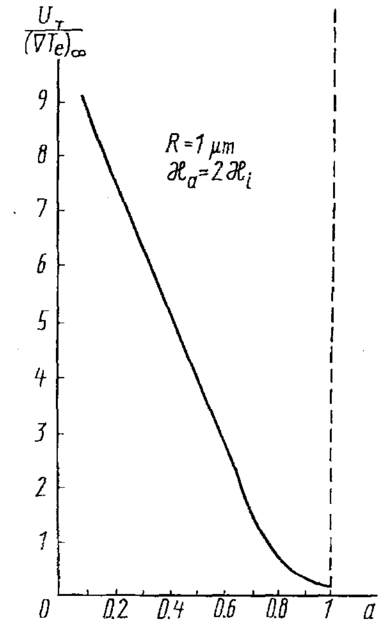


Fig. 1. Droplet velocity vs radius. $U_T/(\nabla T_e)_\infty$, 10^{-5} $m^2/(sec \cdot K)$; R, μm.

Fig. 2. Droplet velocity vs core size. $U_T/(\nabla T_e)_\infty$, 10^{-6} $m^2/(sec \cdot K)$; a, μm.

Using Eq. (28), calculations were performed for $U_T/(\nabla T_e)_\infty$ of a spherical double-layer volatile aerosol particle suspended in steam-nitrogen mixture, whose outer shell was water (Fig. 1). Analysis of the terms in Eq. (28) showed that the droplet tends to move toward the temperature fall in the external medium due to the first, fourth, fifth, and sixth terms. However, the contribution of these terms to the net result is not decisive because their magnitude is much smaller than that of the second term, which is proportional to $\partial\sigma_i/\partial T_i$. By virtue of the fact that $\partial\sigma_i/\partial T_i < 0$, the particle moves toward the temperature rise in the external medium. The effect of the term proportional to $K_{TD}^{(e)}$ is insignificant.

The effect of the core on the droplet velocity was evaluated. As the core grows with a constant droplet radius, a decrease in velocity to a certain value is observed. A further increase in the core radius (R = a) makes it necessary to consider the motion of a solid aerosol particle (Fig. 2).

An increase in the thermal conductivity of the core leads to a decrease in the particle velocity.

REFERENCES

1. A. M. Tatevosyan and Yu. I. Yalamov, Kolloidn. Zh., **40**, No. 1, 88-91 (1978).
2. Yu. I. Yalamov, A. M. Tatevosyan, and M. N. Gaidukov, Physics of Aerodispersed Systems and Physical Kinetics, Dep. in VINITI, No. 3014-79, July 13, 1979, Issue 3, p. 70.
3. Yu. I. Yalamov, A. M. Afanasiev, and M. A. Melkumyan, Physics of Dispersed Systems and Physical Kinetics, Dep. in VINITI, No. 5320-81, October 26, 1981, Issue 6, Pt. 2, p. 108.
4. A. V. Myagkov, Yu. K. Ostrovskii, E. R. Shchukin, and Yu. I. Yalamov, Zh. Fiz. Khim., **52**, No. 6, 1545 (1978).
5. Yu. I. Yalamov, A. A. Gukasyan, and M. A. Melkumyan, Physics of Dispersed Systems and Physical Kinetics, Dep. in VINITI, No. 3865-81, June 29, 1981, Issue 5, p. 79.
6. Yu. I. Yalamov, A. A. Gukasyan, and M. N. Gaidukov, Dokl. Akad. Nauk SSSR, **260**, No. 4, 871 (1981).
7. Yu. I. Yalamov, M. N. Gaidukov, A. A. Gukasyan, and Yu. P. Podryvayev, Physics of Dispersed Systems and Physical Kinetics, Dep. in VINITI, No. 1647-81, October 26, 1981, Issue 6, Pt. 1, p. 137.
8. Yu. I. Yalamov amd V. S. Galoyan, Dynamics of Droplets in Heterogeneous Viscous Media [in Russian], Erevan (1985).
9. S. A. Savkov, A. A. Yushkanov, and Yu. I. Yalamov, Abstracts of Reports of the XIV All-Union Conf. "Topical Questions of the Physics of Aerodispersed Systems," Vol. 2, Odessa (1986), p. 201.

10. S. A. Savkov, A. A. Yushkanov, and Yu. I. Yalamov, Physical Kinetics and Hydromechanics of Dispersed Systems, Dep. in VINITI, No. 5321-V86, July 2, 1986, pp. 57-80.
11. N. Ya. Ushakova and Yu. I. Yalamov, Thermo- and Diffusiophoretic Transfer of Droplets of Binary Solutions, Dep, in VINITI, No. 5958-V89, February 16, 1989.
12. Yu. I. Yalamov and E. I. Alekhin, Kinetic Effects at a Liquid-Multicomponent Gas Mixture Interface, Dep. in VINITI, No. 41190-V90, July 11, 1990.
13. G. S. McNab and A. Meisen, J. Colloid Interface Sci., **44**, No. 2, 339-346 (1973).