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ELECTROCOAGULATION OF AEROSOLS IN NONCOLLINEAR ELECTRIC AND GRAVITATIONAL FIELDS

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METHODS

Electrocoagulation may play a key role for fairly small aerosol particles when inertial effects are insignificant. Its important kinetic characteristic is the collision cross section s. We consider the problem of determining s as a function of the intensities of generally noncollinear electric and gravitational fields **E** and **g**, and as a function of the radii R and r, and charges q and e of the two particles when $R >> r$. To find the quantity s, the behavior of streamlines of the small particle velocity **v** has been investigated qualitatively and numerically in a coordinate system in which the large particle is at rest. The inertial effects have been neglected, and the expression

$$\mathbf{v} = \mathbf{u} + b\,\mathbf{E}, \quad b = \frac{e}{6\pi\mu r}, \qquad \mathbf{u}(\infty) = -\frac{M\,\mathbf{g}}{6\pi\mu R}, \qquad \mathbf{E}(\infty) = E \qquad (1)$$

was applied to determine **v**. Here, **u** is the velocity distribution of air in Stokes flow over a sphere of radius R, **E** is the distribution of electric field strength around a perfectly conducting sphere of radius R with a charge q that is in external electric field, M is the mass of the large particle, μ is the air viscosity.

RESULTS

The dementionless quantity $S = s/(4\pi R^2)$ is completely determined by dementionless parameters

$$G = \frac{rgM}{RE\,|e|}, \quad Q = \frac{eq}{3R^2E\,|e|}, \quad \psi \qquad (2)$$

where ψ is the angle between the vectors - $\mathbf{g}$ and $e\,\mathbf{E}$. The result of the investigation of the dependence S on parameters (2) can be represented in the form

$$S = \frac{J\,(G,Q,\Psi)}{\sqrt{(1+2G\cos\Psi + G^2)}}$$

where function J is approximated by following formulas when $G > 1$, $|Q| < 1$.

$$J = -\frac{3}{2}Q + \frac{3}{2}|Q| \qquad -1 \le \cos\Psi \le A$$

$$J = -\frac{3}{2}Q + F(Q,\Psi) \qquad A \le \cos\Psi \le B$$

$$J = -\frac{3}{2}Q + \frac{3}{4}(1+Q^2) \qquad B \le \cos\Psi \le 1$$

$$F = \frac{3}{2}|Q| + \frac{3}{4}(1-|Q|)^2\,\frac{\cos\Psi - A}{B-A}$$

$$A = 2|Q|^{\alpha} - 1, \quad \alpha = \frac{G}{G-1}, \qquad B = |Q| - \frac{1+|Q|}{G}$$

If at least one of the inequalities $G < 1$ or $|Q| > 1$ is satisfied, then for all Ψ

$$J = \frac{3}{4}(1+|Q|)^2 \qquad \text{for } |Q| < 1,\ G < 1$$

$$J = \frac{3}{2}(|Q| - Q)^2 \qquad \text{for } |Q| > 1,\ 0 < G < \infty$$

If electric and gravitational fields are collinear, these formulas coincide with the known results (Levin, 1961).

REFERENCES

Levin, L.M.,(1961), Research on the Physics of Coarsely Disperse Aerosols (in Russian), Izd. Akad. Nauk SSSR, Moscow.