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THE MAXWELL EFFECT FOR POLYMER SOLUTIONS AT LARGER VELOCITY GRADIENTS*

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The orientation angle and birefringence were found to run asymptotically in the case of rigid, anisotropic particle solutions (macromolecules) at larger flow gradients (the model examined is that of a two-dimensional flow of particles). The applicability of the produced formulae and the possibilities of using them to determine the particle dimensions have been established. The formulae indicate a monotony of the theoretical curves between the angle of orientation and the birefringence at larger flow gradients. The found analytical expressions are compared with the results of computing the orientation angle.

THE Maxwell effect is the birefringence of flow due to an orientation of the anisotropic particles (macromolecules) by laminar flow; it is one of the means of studying the structure of polymers and of colloidal particles. By assuming the main axis of a rigid particle to have the shape of a rotation ellipsoid and to be within the laminar flow (two-dimensional) in the direction of axis x ($u_y=u_z=0$) at a constant flow gradient $g=\partial u_x/\partial y$ in direction of axis y (the zero point of the system of coordinates is the particle centre), one gets the following equation for the angle distribution function $\rho(\varphi, t)$ of macromolecules in solution [1]:

$$\frac{\partial\rho}{\partial\tau}=\frac{\partial^2\rho}{\partial\varphi^2}+\sigma\frac{\partial}{\partial\varphi}((1+b\cos 2\varphi)\rho), \tag{1}$$

in which $\tau=D_rt$ (D_r—rotational diffusion coefficient), $\sigma=g/2D_r$, $b=(1-p^2)/(1+p^2)$ (p—ratio of geometrical axia of ellipsoid), φ—angle between the particle axis and the flow direction.

The stationary distribution function $\rho(\varphi)$ is met by the equation

$$\partial\rho/\partial\varphi+\sigma(1+b\cos 2\varphi)\rho=c(\sigma), \tag{2}$$

in which $c(\sigma)$—some constant. The birefringence within $\rho(\varphi)$ is calculated from the formula [1]:

$$\Delta n=\frac{2\pi N(\gamma_1-\gamma_2)}{n}f(\sigma, b), \tag{3}$$

in which N—number of macromolecules per unit volume of the solution, $\gamma_1-\gamma_2$—

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