The modeling of heat and mass transfer processes in colloidal suspension

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Abstract: In the current paper, we consider a liquid-phase medium with nanoparticles irradiated by a light beam with a Gaussian intensity profile. As a result of the action of the light field in the medium, gradients of temperature and concentration arise, which cause heat and mass transfer. These phenomena are described by a system of balance equations for temperature and particles both with concentration convection. Let us take into account the fact that the temperature establishment processes go faster than the diffusion processes. Therefore, we study the diffusion processes at a stationary temperature. As a result of introducing dimensionless variables and parametrization, we obtained an initial boundary value problem for a one-dimensional nonlinear parabolic equation.

In this case, the intensity with a Gaussian profile was considered as the initial condition. The boundary conditions are obtained by equating to zero the sum of the thermodiffusion and electrostriction flows of nanoparticles. In deriving the parabolic equation, we used a linear dependence of the thermal conductivity of the medium on temperature. Such dependence is confirmed by a number of experiments. We use the predictor-corrector method for the numerical solving of the nonlinear initial boundary value problem. The constructed difference scheme is unconditionally stable and has second-order accuracy in time and space variables. In this paper, we presented the conclusions about the dynamics of concentration using the numerical experiment results.

Throughout this note we mainly use techniques from the paper [1].

Keywords: heat and mass transfer, dynamics of nanoparticles, Sore effect, non-linear equation, predictor-corrector method

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References

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