Sedimentation of soot particles in dark and under illumination in a rarified gas medium

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The study of the sedimentation of aerosol particles is important for understanding and predicting many industrial and natural processes. But simulating the motion of particles with complex shape and with surface temperature different from the temperature of the gas medium is significant problem. This is the case of photophoresis.

This report presents the results of a computational experiment to study the influence of the fractal dimension of soot aerosol clusters on their sedimentation in a rarefied gas medium under illumination and not. Illumination significantly changes the behavior of particles because of a gravito-photophoretic force arising. The latter has a gas-kinetic nature and is caused by absorption of the radiation energy fluxes of infrared and visible ranges by cluster.

The experiment is based on the application of the previously developed Monte Carlo method [1] to solve the problem of heat and mass transfer for particles of complex shape and aerosol clusters in the approximation of the free molecular regime. The algorithm solves the nonlinear problem of heat and mass transfer and estimates the force effect on the cluster from the rarefied gas medium - the photophoretic force, its moment and four tensors for the calculation of the viscous friction force and its moment. Then the equations of translational-rotational motion of the aerosol cluster are integrated.

The experiment was carried out on ensembles of clusters of different fractal dimensions. It is shown that there is a significant influence of illumination on the nature of sedimentation of soot aerosol clusters that absorb light well. In the case of clusters containing the same number of particles and having the same fractal dimension, the rate of their sedimentation in the absence of illumination is close to each other. The experiment demonstrates that there is a relationship between the cluster velocity and its fractal dimension. Under illumination, because of the influence of photophoretic force, a significant spread of velocities in the cluster ensemble is observed. Moreover, some of the clusters even begin to move upwards, against gravity.

[1] A.A.Cheremisin, Transfer matrices and solution of the heat-mass transfer problem for aerosol clusters in a rarefied gas medium by the Monte Carlo method // *Russian Journal of Numerical Analysis and Mathematical Modelling* **2010**, 25/3, pp. 209-233.