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ELECTROHYDRODYNAMIC DISPERSION OF DEFORMABLE AEROSOLS IN THE PRESENCE OF AN ELECTRIC FIELD AND CHEMICAL REACTION USING TAYLOR DISPERSION MODEL*

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Abstract: Under the effects of electric field and chemical reaction, the problem of dispersion of aerosols in a poorly conducting fluid in a channel is solved analytically using the mixture theory together with a regular perturbation technique. It is shown that the aerosols are dispersed relative to a plane moving with the mean speed of atmospheric fluid as well as the mean speed of agglomeration of aerosol with a relative diffusion coefficient, called the Taylor dispersion coefficient. This coefficient is numerically computed and the results reveal that it increases with an increase in the electric number, but decreases with increasing porous parameter. The physical explanations for the phenomena are given in this article.

Key words: dispersion, aerosols, electrohydrodynamics, mixture theory

Introduction

This article deals with the effects of electric field and chemical reaction on the dispersion of deformable aerosols in a poorly conducting atmospheric fluid flowing in a channel bounded by porous layers using Taylor's model[1].

Electric fields are used extensively in different industrial problems, particularly in those concerned with chemical, electrical, electronic and drug industries for various separation processes. Waterman[2] reviewed the process of using electric fields to improve coalescence and found these techniques to be quite effective in the removal of water from oil. Williams and Bailey[3] examined coalescence of poorly conducting drops in the presence of an electrical field both theoretically and experimentally. Schmidt[4] performed experiments with different aerosols and observed that the application of an electric field had the effect of reducing sedimentation time. A detailed calculation of the aerosol particles and size distribution suggested that this phenomenon of reduction of sedimentation time is due to the electric field enhancing aerosol particle coalescence.

Studies of predicting the collision frequencies of settling mechanisms have been carried out in the past. Also, the deposition of nano-particles under different conditions was investigated in the recent numerical studies by Sun et al.[5], Gan et al.[6], Yin and Lin[7], and Liu and Lin[8]. Wang et al.[9] used a trajectory analysis for estimating the aggregation rates and found that the electric fields can enhance the gravitational settling of charged particles.

Usually, when the Earth's local weather is fine, the electric field is about 180 Vm^{-1} – 280 Vm^{-1} depending on the concentration of aerosols (see Jayaratne and Verma[10]). When the aerosols are in continuous deformation with relative motion resulting in particles colliding and coalescing to form larger

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