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A theoretical study of aerosol sampling by an idealized spherical sampler in calm air

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Abstract

The performance of an idealized spherical sampler operating in calm air for an inlet arbitrarily oriented relative to the gravity force is studied theoretically. Under potential flow assumption the air velocity field is obtained by using a model of a finite-size sink on a sphere. The particle motion equations are solved to find the limiting trajectory surface and to calculate the aspiration efficiency. The singular points of the motion equations as a function of settling velocity of particles and the sampler orientation angle are investigated. The connection between the pattern of typical zones of particle trajectories around the sampler and the location of the singular points is illustrated. The effects of partial sampling from zones without particles and of particle screening are discussed. The results of parametrical investigations of the dependence of the aspiration efficiency on the Stokes number and their analysis are presented. In the case of vertically upwards orientation of the sampler the proposed mathematical model gives fair agreement with experimental data from the work by Su and Vincent (Abstracts of sixth international aerosol conference, Taipei, Taiwan, 2002a, pp. 639-640).

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Keywords

Aspiration efficiency, Calm air, Spherical sampler