Aerosol Science and Technology 2006 vol.40 N7, pages 477-489

A numerical study of calm air sampling with a blunt sampler

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Abstract

The performance of an idealized spherical sampler facing both vertically upwards and downwards in calm air is studied numerically. To describe the air flow around the sampler, both potential and viscous flow models have been adopted. The equations of particle motion are then solved to calculate the aspiration efficiency. The dependence of the aspiration efficiency upon the various parameters of importance in calm air sampling are investigated and compared where possible with the experimental work of Su and Vincent (2003, 2004a, b). It is found that in the case of upwards sampling the bluntness of the sampler only has a significant effect upon aspiration for large sampling velocities, values that would not generally be physically realistic. In the case of downwards sampling an important non-dimensional quantity, B 2RC, is identified, where B represents the sampler bluntness and RC represents the gravitational effects. This quantity determines the physical conditions for which aspiration will not occur and also the limiting values of the aspiration efficiency when aspiration does occur. In the case of low sampling velocities a difference is noted between experimental and numerical results for aspiration efficiency raising the need for more experimental data in this area. For both upwards and downwards sampling the semi-empirical models of Su and Vincent (2004b) have been modified to account for the information gained from the study. This is particularly important in the downwards sampling case where the modified model is found to agree particularly well with the results obtained.

http://dx.doi.org/10.1080/02786820600672726