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EVAPORATION OF AMMONIUM NITRATE AEROSOL AND THE EFFECT OF ORGANIC COATINGS

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KEYWORDS

Ammonium nitrate, evaporation, Kelvin effect, equilibrium condition, inorganic aerosol.

Past experimental studies have yielded contradictory results regarding the evaporation rate of ammonium nitrate aerosol (Larson and Taylor G.S., 1983; Richardson and Hightower, 1987; Harrison *et al.*, 1990). As a result, current aerosol models that require input of a value for this accommodation coefficient, use values ranging from 0.001 to 1 (Meng and Seinfeld 1995).

The mass transfer rate of ammonium nitrate between the aerosol and gas phases was quantified experimentally by the use of the TDMA/SMPS (Tandem Differential Mobility Analyzer/Scanning Mobility Particle Sizer) technique. Experiments were run for both pure and covered with organic films particles. Fresh, ammonium nitrate particles with initial diameters in the submicrometer regime were produced and evaporated in purified air under temperatures of 20 to 40°C and relative humidities of 10 to 80%. Particles were coated with various film thicknesses by exposing the ammonium nitrate particles to an air stream supersaturated with an organic vapor. A differential mobility analyzer was used to extract a nearly monodisperse aerosol which was allowed to evaporate for approximately 30 seconds in an evaporator. A SMPS system was used to measure the size distribution of the evaporated particles with and without the organic coating.

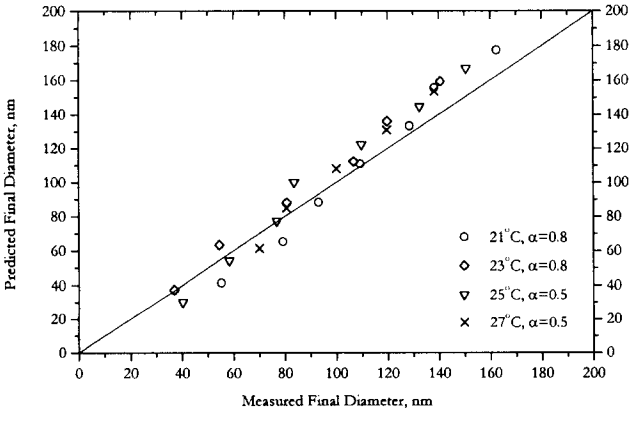

Fig. 1. Experimentally observed vs. theoretically predicted values of final diameter for the best-fit value of accommodation coefficient (pure ammonium nitrate).

A theoretical expression of the evaporation rate incorporating the Kelvin effect and the effect of relative humidity on the equilibrium constant is developed. For pure ammonium nitrate, the measurements were in general consistent with the theoretical predictions but there was evidence of a small kinetic resistance to the mass transfer rate (Figure 1). The discrepancy can be explained by a mass accommodation coefficient increasing from 0.8 to 0.5 as temperature increases from 20 to 27°C (Figure 1). The corresponding timescale of evaporation for pure NH_4NO_3 particles in the submicron regime is of the order of a few seconds to 20 minutes (Figure 2).

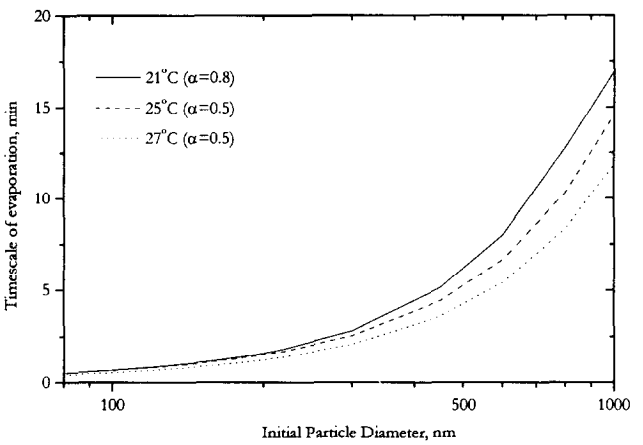

Fig. 2. Estimated characteristic times for mass transfer of ammonium nitrate between the particulate and gas phase for ambient temperatures of 21, 25 and 27°C.

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