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Condensation Growth of Aerosols**

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Presented at  
European Aerosol Conference  
September 4 to 9, 2011  
Manchester, United Kingdom

<http://www.eac2011.com/scientific-programme>

# Development and Characterization of a Novel Approach for Water-Based Condensation Growth of Aerosols

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Keywords: Instrumentation, CPC, CFD

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Condensational growth is commonly used in Condensation Particle Counters (CPC) to provide the necessary particle enlargement to detect particles smaller than 1  $\mu\text{m}$  using conventional light scattering techniques. Traditionally, laminar thermally diffusive methods of condensation particle growth have relied on butyl alcohol and other fluids with similar thermodynamic properties.

In traditional laminar diffusive methods a hot, vapor-laden aerosol is introduced into a cold wall condenser where, due to a Lewis number greater than unity, a central core of high-supersaturation ratios provides the necessary activation for condensational growth of nanometer-sized particles (Stolzenburg et al. 1991).

Because water vapor in air has a Lewis number less than unity, the regions of high supersaturation form near the walls in a traditional laminar diffusive approach. This results in reduced particle growth and activation when water is used as the working fluid (Hering et al 2005).

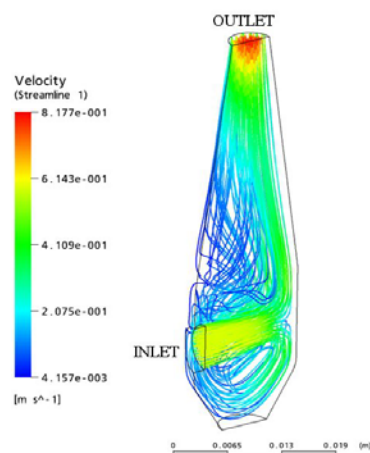
We have developed a new growth method to generate sufficient supersaturation conditions with a traditional hot to cold thermal approach. The Single Flow Mixing (SFM) method (patent pending) results in the turbulent mixing of a hot, water-vapor-saturated aerosol stream in a cool mixing chamber to produce supersaturation values sufficient for nanoparticle growth. The geometry consists of an inlet placed perpendicular to a tapered cylinder. The inlet flow impinges on the cylinder wall resulting in turbulent mixing within the device as shown in Figure 1.

Using a commercially available Computational Fluid Dynamics (CFD) software package, a 3D fluid model was developed for the flow geometry. Parameters investigated were the flow, temperature and vapor profiles generated by the SFM method. Further computations were performed to determine Kelvin diameter and expected particle growth rates.

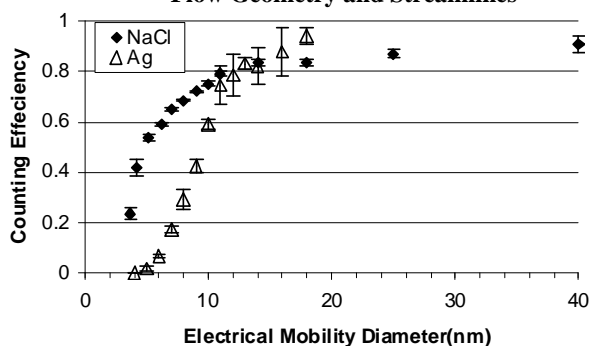
Measurements of particle activation were performed using DMA-classified aerosol in the 5 to 40nm size range. A Faraday Cup Electrometer (FCE) was used as the reference concentration measurement, whereby combined with the CPC count data, provide a measurement of counting efficiency. Material effects were also investigated using both hydrophobic and hydrophilic particle materials to ascertain the influence of hydrophobicity in the SFM method of condensation growth.

Figure 2 shows the counting efficiency for both Ag (hydrophobic) and NaCl (hydrophilic) particles as

function of electrical mobility diameter. As expected, the counting efficiency decreases with decreasing particle diameter with a measured cutpoint ( $dp_{50}$ ) of 4.6nm for the NaCl test data. The measured cutpoint for the Ag test data is 9.8nm. The observed effect of particle hydrophobicity on the measured counting efficiency is consistent with the work of Hering et al.(2005), Stratmann et al.(2009) and Mordas et al.(2008).



**Figure 1**  
Flow Geometry and Streamlines



**Figure 2**  
Counting Efficiency for NaCl and Ag Particles

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