“Preliminary results of the size comparison between APM and AMS - A brief report for the AMS users meeting 2004 at Atlanta”

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Objectives

• The Aerosol Particle Mass analyzer (APM) classifies the particle size by the balance of the centrifugal and electrostatic forces. Therefore, the particle mass can be measured directly.

• Objectives are to compare the mass equivalent diameter measured by APM to the vacuum aerodynamic diameter measured by AMS, which clarifies the uncertainty of the IE calibration. In addition, the dynamic shape factor, which is an important property of aerosol, is determined.
APM-AMS exp. But our DMA did not work due to the pump failure.

- Neutralizer Am241
- Drier
- Atomizer

**APM**
- Rotating of double cylinder with 750-1500 rpm
- Electric field (0-1000V) between inner and outer cylinders
- Classifies particle size by the balance of the centrifugal and electrostatic forces.

**Diagram:**
- Rotation
- Electric field
- Centrifugal force
- Electrostatic force
Calculation of mass \((m)\) by APM

\[
m_p = \frac{q V_{APM}}{r^2 \omega^2 \ln \left( \frac{r_1}{r_2} \right)} = \rho_m \frac{\pi}{6} d_{me}^3
\]

- \(m_p\): the particle mass, \(r\): the radial distance to the annular gap from the axis of rotation \(r=(r_1+r_2)/2\), \(\omega\): the APM rotational speed, \(r_1\): the inner radius, \(r_2\): the outer radius, \(q\): the particle charge, \(V_{APM}\): the APM voltage applies to the inner electrode.

AMS Calibration by PSL. **Peak time** was taken for the calibration.
AMS Calibration by PSL

\[
vel = p_1 + \left( \frac{p_0 - p_1}{1 + \left( \frac{d_{in}}{p_2} \right)^{p_3}} \right)
\]

Coefficient values ± one standard deviation:

\[
p_0 = 5.1179 \pm 1.33 \times 10^3
\]

\[
p_1 = 29.067 \pm 6.64
\]

\[
p_2 = 5.4125 \pm 6.02
\]

\[
p_3 = 0.4131 \pm 0.517
\]

Typical flight record for ammonium nitrate classified by APM (DMA did not work for this experiments.)

Neutral small particle

Mass = m, single charge

Mass = 2m, double charge

70nm
Flight time record for ammonium nitrate at 1500 rpm of APM rotational speed

![Graph 1](image1)

Flight time record for ammonium nitrate at 1000 rpm of APM rotational speed

![Graph 2](image2)
Flight time record for ammonium nitrate at 750 rpm of APM rotational speed

\[ d_{va} = p_2 \left( \frac{P_0 - P_1}{V_{el} - P_1} - 1 \right) \left( \frac{1}{p_3} \right) \]

The ratio of \(d_{me}/d_{va}\) against \(d_{va}\)

for NH4NO3 (NH4)2SO4, PSL

\[ \chi_{v}^{me} = \frac{\rho_m d_{me}}{\rho_0 d_{va}} \]

Slight Increase

Averaged this part
Ratio of $d_{me}$ to $d_{va}$

- The average value of $d_{me}/d_{va}$ is **0.714** when taking out the first 3 points and the last point which is not a good datum.

- With 0.714, NH4NO3 particle with $d_{me}=350$ nm corresponds to $d_{va}=490$ nm by AMS.

Dynamic Shape factor ($\chi$)

$$\chi_{v}^{me} = \frac{\rho_{m}}{\rho_{0}} \frac{d_{me}}{d_{va}}$$

- The average ratio of $d_{me}$ to $d_{va}$ is 0.714. The dynamic shape factor, $\chi_{v}^{me}$, for NH4NO3; **1.23** (density = 1.72 g/cc).
- For PSL, $\chi_{v}^{me} =$1.03 (del 1st point).
- For (NH4)2SO4, **1.0** (all)

- $1/(0.8*1.72)=0.73$
- Pete’s expectation $\chi_{v}^{ve} =$ **1.12**
Typical signal of 1:1 Mixture (mol / liter) of ammonium nitrate and ammonium sulfate

Similar shape → Internal mixture
Mass against dva
Mixture comes between nitrate and sulfate

Future plans

- Re-calibration of AMS with PSL.
- A direct DMA-APM-AMS comparison
- Variation of RH (though acids may harm APM due to the Al construction.)
- Species like NaNO₃, Pb(NO₃)₂ (heavier and more irregular shape)
- Organics (soot), coated and mixtures.