# Evaluation of the DiSCmini Personal Aerosol Monitor for Submicrometer Sodium Chloride and Metal Aerosols


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## Background

Nanoparticles (particles < 100 nm) are an increasing exposure hazard in occupational settings. Robust, lightweight and reliable direct reading instruments have been unavailable for nanoparticles. The DiSCmini (DM) operates by diffusion charging and an electrometer to enable nanoparticle detection which provides a direct reading of particle number concentration and mean particle diameter. However, the DM has not been evaluated for occupationally-relevant aerosols, such as welding fume.

## Objective

Compare the performance of DM with two reference instruments, the condensation particle counter (CPC) and the scanning mobility particle sizer (SMPS).

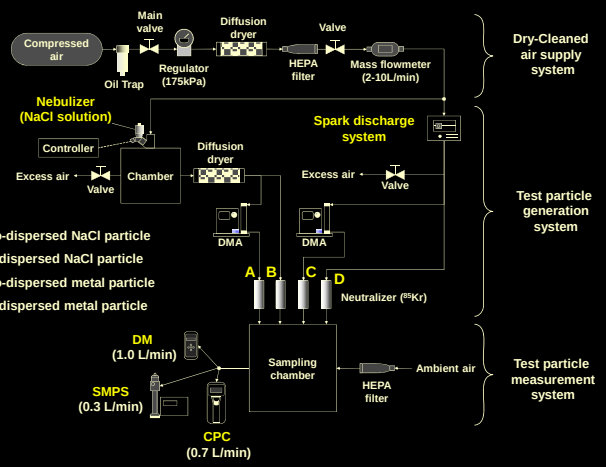
## Methods

- Poly-dispersed particles were generated using sodium chloride (NaCl) particles nebulized from solution, and metal particles generated with a spark discharge system using welding rods
- For mono-dispersed particles, aerosols were classified into three sizes (30, 100, and 300 nm)
- Both mono- and poly-dispersed particles were controlled in three different steady-state concentration ranges (<$10^3$, $10^3$-$10^4$, and >$10^4$ particles/cm$^3$) and particle number concentration and size were measured by the DM, CPC, and SMPS for a total of 24 test conditions

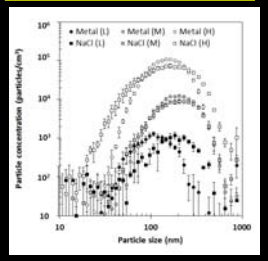
***1. Test instruments***

| | Grimm SMPS 5.402 | TSI CPC 3007 | Matter Aerosol DiSCmini 1.1 |
|---|---|---|---|
| Measurement principle | Electrical & Optical | Optical | Electrical |
| Size range (nm) | 11-1083 | 10-1000 | 10-300 |
| Concentration range (particles/cm$^3$) | 0-$10^7$ | 0-$10^5$ | 20nm: $10^3$-$10^6$<br>100nm: $5\times10^2$-$5\times10^5$ |
| Sampling flow rate (L/min) | 0.3 | 0.7 | 1.0 |
| Weight (kg) | DMA: 7.8<br>CPC: 11.5 | 1.7 | 0.7 |
| Limitations | Large, bulky size & low resolution time | Too large for personal monitoring | Less accurate than reference instruments (±30%) |
| Cost (USD) | $40,000 | $8,000 | $ 15,000 |


***2. Experimental setup***




**Poly-dispersed test particles**

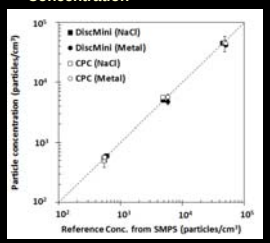



## Results

***1. Poly-dispersed particles***

**NaCl and metal particles**

- **Concentration**




- **Size**

| Test particles | Conc. | DiscMini Size (nm) | DiscMini Std | SMPS Size (nm) | SMPS Std | Ratio |
|---|---|---|---|---|---|---|
| NaCl | L | 180.9 | 10.3 | 157.2 | 1.9 | 1.15 |
| | M | 239.5 | 2.2 | 191.5 | 1.6 | 1.25 |
| | H | 277.3 | 9.1 | 152.9 | 1.8 | 1.81 |
| Metal | L | 106.6 | 2.7 | 106.6 | 1.6 | 1.00 |
| | M | 239.5 | 7.2 | 193.9 | 1.5 | 1.24 |
| | H | 175.9 | 3.9 | 150.3 | 2.3 | 1.17 |

*L:<$10^3$, M: $10^3$-$10^4$, and H: >$10^4$ particles/cm$^3$

$$\text{Ratio} = \frac{d_{p,DM}}{d_{p,SMPS}}$$

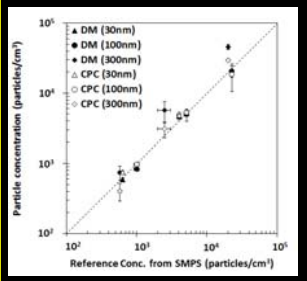
$d_{p,DM}$: average diameter from DM
$d_{p,SMPS}$: geometric mean diameter

- For NaCl and metal 100 nm particles, a ratio close to "1" was observed when the DM was compared to the SMPS for size
- Tests for size comparisons were similar for DM and SMPS, except for NaCl particles in high concentration, which measured 81% higher than SMPS

***2. Mono-dispersed particles***

**NaCl particles**

- **Concentration**

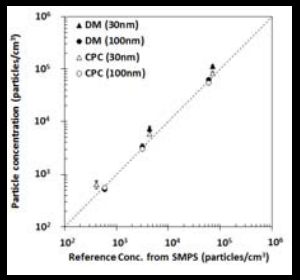



*x-axis: L:<$10^3$, M: $10^3$-$10^4$, and H: >$10^4$ particles/cm$^3$

- Particle concentrations measured by DM 300-nm for mono-dispersed NaCl particles were 30-130% higher than SMPS measurements
- Both DM and SMPS underestimated size for 300 nm particles

**Metal particles**

- **Concentration**




- Within the medium and high ranges of 30 nm particles, DM underestimated the particle size
- Both DM and SMPS underestimated size for 100 nm particles

## Conclusions

- The DiSCmini and CPC provided similar measurements to the SMPS
- DiSCmini is useful for monitoring various nanoparticles including welding fume, diesel soot, engineered nanoparticles, and outdoor ultrafine particles

## Future Research

Deploy DiSCmini in ongoing welding fume study to monitor overall performance and long term usage.

## Acknowledgements


This research was funded by CDC/NIOSH Education and Research Training Grant T42OH008491 and Center for Construction Research and Training Grant 2301200.



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