Further research is required for mixed aerosol composed of both spherical particles and aggregates. The new software provides the idealized aggregate limit that can be compared with current results based on spherical particles.

References

Implementation of IA Theory in TSI Aerosol Instrument Manager Software: Chain Aggregates

Motivation

Differential mobility analyzers (DMA) are routinely used to measure ultrafine aerosol number distributions. Current methods are based on spherical particle assumption. Aggregate morphology is the natural state of diesel emission solid particles. We present a novel method to determine the ultrafine aggregate number, surface area and volume distributions from DMA data.

Theory of Idealized Aggregates (IA)

Idealized Aggregates:

- Uniform primary particle size
- Primary particles much smaller than mean free path of the gas
- Transparent structure:  
  - Fractal dimension less than 2

Applications of IA Theory

- More accurate estimates of aggregate number, surface area and volume (or mass) distributions from DMA data.
- Estimates of total number concentration of solid spheroidal nanoparticles directly emitted from the diesel engine before aggregation: A conserved quantity.

Diesel Aggregate Emission Measurement

Measurement conditions:

- Heavy duty diesel engine
- Steady state operation at idle, 30, 40 and 50 mph.
- Sufficient dilution and residence time to eliminate volatile particles: Single mode corresponding to aggregates composed of solid particles is observed. The mode does not change upon further dilution.

Number Distributions

Primary particle diameter: 17 nm

- Total Number (#/cm³)
  - IA Theory: $2.73 \times 10^5$
  - Based on Spheres: $2.29 \times 10^5$
  - Direct CPC: $2.77 \times 10^5$

Volume Distributions

- Total Volume (nm³/cm³)
  - IA Theory: $2.17 \times 10^{10}$
  - Based on Spheres: $7.97 \times 10^{10}$

Summary

- The IA theory is verified experimentally by Lall et al. (2006) for laboratory silver aggregates and literature data on diesel aggregates.
- The total number concentration based on IA theory in good agreement with that measured directly by the CPC. Further verification of IA theory.
- The total ultrafine solid nanoparticle volume is determined from IA theory. The volume based on spheres with diameter equal to the mobility diameter was grossly overpredicted.

Implementation of IA Theory in TSI Aerosol Instrument Manager Software: Chain Aggregates

The new software provides the idealized aggregate limit that can be compared with current results based on spherical particles. Further research is required for mixed aerosol composed of both spherical particles and aggregates.

References
