

LUND UNIVERSITY

Mass-mobility Relationship of Soot Generator and Diesel Soot

Rissler, Jenny; Abdulhamid, Hussam; Pagels, Joakim; Nilsson, Patrik; Sanati, Mehri; Bohgard, Mats

Published in: European Aerosol Conference 2009

2009

Link to publication

Citation for published version (APA): Rissler, J., Abdulhamid, H., Pagels, J., Nilsson, P., Sanati, M., & Bohgard, M. (2009). Mass-mobiltiy Relationship of Soot Generator and Diesel Soot. *European Aerosol Conference 2009*, T083A09.

Total number of authors: 6

General rights

Unless other specific re-use rights are stated the following general rights apply: Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study

or research.
You may not further distribute the material or use it for any profit-making activity or commercial gain

· You may freely distribute the URL identifying the publication in the public portal

Read more about Creative commons licenses: https://creativecommons.org/licenses/

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

LUND UNIVERSITY

PO Box 117 221 00 Lund +46 46-222 00 00

Mass-mobility relationship of soot generator and diesel soot

J. Rissler, H. Abdulhamid, J. Pagels, P. Nilsson, M. Sanati, and M. Boghard

Department of Ergonomics and Aerosol Technology, Lund University, P.O. Box 118, SE-22100, Lund, Sweden

Keywords: Combustion particles, Particle density, Particle mass fractal dimension, Soot agglomerates, Diesel soot particles

When measuring aerosol particle size distributions many different techniques can be used. For the different techniques particle diameter can be defined differently depending on the principle of the technique. For example, the Differential Mobility Analyzer (DMA) classifies particles according to their mobility diameter (d_{me}), impactors according to the particle aerodynamic diameter, etc. To be able to compare the results, or convert between number and mass size distributions, information about the particle morphology and density is needed.

In this study the DMA–Aerosol Particle Mass Analyzer (DMA-APM) technique was used to study the effective density (ρ_{eff}) and mass fractal dimension of particles resulting from two combustion sources; a combustion soot generator (Abdulhamid et al., 2009) operated at 3 different air-to-fuel ratios, and an idling diesel engine (VF Passat -98, passenger car). Additionally, during all measurements a Scanning Mobility Particle Sizer (SMPS) measured the mobility number size distribution.

The DMA-APM system (Park et al., 2003) consists of a DMA coupled in series with an APM. The DMA selects particles one mobility diameter (50 to 400 nm were characterized). The APM consists of two rotating cylinders rotating at a rotational speed, ω . The mass size distribution of the selected particle size is measured by scanning the APM voltage (V_{APM}) and from the peak voltage, the particle mass (*m*) is calculated according to (Park et al., 2003):

$$m = \frac{\pi}{6} d_{ve}^{3} \rho_{true} = \frac{\pi}{6} d_{me}^{3} \rho_{eff} = \frac{q V_{APM}}{r^{2} \omega^{2} \ln\left(\frac{r_{2}}{r_{1}}\right)}$$

where *r* is the difference in radius of the APM inner and outer cylinder $(r_2 - r_1)$ and *q* the particle charge. Making the assumption that the radius of



Figure 1. Particle mass as a function of mobility diameter.

gyration is linearly proportional to the mobility diameter, which should hold for the conditions in this study (Park et al., 2003), the mass fractal dimension (Df_m) is given by $m = Cd_{me}^{Df_m}$

The results of the study are presented in Figure 1 and 2. For the soot generator the aerosol effective densities were found to vary between 0.85 and 0.16 g/cm³ over the size range studied, indicating that the particles become progressively more irregular as the mobility size increased. The fractal dimension of the burner particles was determined to 2.22, 2.35 and 2.38, increasing with increasing air to fuel ratio.

The particles from the diesel engine had a higher effective density than those resulting from the soot generator, and a fractal dimension of 2.41. This is very similar to the results found in Park et al., 2003 where the fractal dimension of a high-duty diesel engine working at low load was determined to 2.41 and at high load 2.33, see Figure 1 and 2. Assuming an inherent material density of 2 g/cm³, extrapolation of the densities gave a primary particle size was of 25 nm for the diesel particles and 10-19 nm for the soot generator.



Figure 2. Effective densities for the aerosols studied.

- The work was supported by the research councils FORMAS and VINNOVA
- Park K.,, Cao F., Kittelson D.B., and McMurry P.H. (2003). Relationship between Particle Mass and Mobility for Diesel Exhaust Particles, Environ. Sci. Technol., 37,577-583.
- H. Abdulhamid, J. Pagels, R. Bjorklund, A. Spetz, Peter Josza and M. Sanati. To be submitted. Detection of diesel-like generated soot particles by thermophoretic deposition on a resistivity soot sensor.