Estimation of the mean particle size by sampling in parallel with two Pegasor Particle Sensors

Stavros Amanatidis1, Leonidas Ntziachristos1, Matti Maricq2, Antti Rostedt3, Kauko Janka4, Juha Tikkanen4, Zissis Samaras1

(1) Aristotle University of Thessaloniki, Mechanical Engineering Dept., Lab of Applied Thermodynamics, Thessaloniki, Greece
(2) Ford Motor Company, Chemical Engineering Department, Research & Advanced Engineering, Dearborn, Michigan, USA
(3) Tampere University of Technology, Department of Physics, Aerosol Physics Laboratory, Tampere, Finland
(4) Pegasor Oy, Tampere, Finland

Introduction

- The Pegasor Particle Sensor (PPS) signal has a size-dependent response to particle size ($\propto d^{1.25}$).
- Errors in the reported particle mass & number are expected when the size distribution differs from the calibration’s reference ($D_0=50$nm, $\sigma_g=1.7$).

Scope of this study:

- Estimation of the mean particle size by sampling in parallel with 2 PPSs at different ion trap voltage and correction of the original mass & number calibration formulas.
- Validation of the method with diesel exhaust particles during transient testing.

Theoretical Background

Pegasor Particle Sensor

- Measurement of “escaping current”
- Particles are not collected
- Hot & undiluted sampling directly from the tailpipe
- High resolution and sensitivity (10 Hz, 0.3s response time)

PPS Linearity

Correlation of the 2 PPS signals during the FTP

With equal ion trap voltage

With different ion trap voltage

Results

- Mean particle size during FTP estimated @ 80nm

PPS Configuration:
Hot sampling with heated lines

Experimental

Basic Calculation Steps
i. Simultaneous sampling with 2 PPSs with ion trap @ 400V & 800V
ii. CMD estimation based on monodisperse calibration & PPS current ratio
iii. $D_0$ is assumed to be 1.7
iv. Correction of the original mass and number calibration coefficients

Outlook & Conclusions

- The mean particle size can be estimated by sampling in parallel with 2 PPSs
- The method is based on the different PPS response for different ion trap voltage according to monodisperse calibration
- Size estimation offers correction of the original mass & number calibration formulas
- The method was applied on diesel vehicle exhaust particle measurements over the FTP driving cycle:
  - Linearity between the 2 sensors was 99.9%
  - PPS : MSS (soot particle mass) ratio increased from 50% to 80%
  - PPS : APC (solid particle number) ratio decreased from 220% to 140%

Contact: Leonidas Ntziachristos, leon@auth.gr, +30 2310 99 60 03