Factors to Consider in Designing Aerosol Inlet Systems for Engine Exhaust Plume Sampling

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Processes Influencing Particle Size and Concentration

- Inertial Effects
- Loss in Bends
- Thermophoretic Effects
- Coagulation
- Turbulent Deposition
- Gravitational Settling
Effects of Non-isokinetic Sampling

Velocity Ratios (m/s)
Exhaust/Inlet

Fractional Penetration

Diameter (nm)
Thermophoretic Velocity
Settling Velocity

300 K/mm

Diameter (nm)

Deposition Velocity (cm/sec)

Thermophoretic and Gravitational Losses
Aerosol Emission Index (1e14/kg)

With Water Cooling

No Water Cooling
Particle Losses in 0.25" Elbow

Penetration

Diameter (nm)

10 LPM

20 LPM

50 LPM
Coagulation for EI=5e15/kg

15 m pipe @ 10 LPM

2 Seconds Later

Initial

Nf/No=0.28
Coagulation for EI=5e15/kg w/10 Fold Dilution

15 m pipe @ 10 LPM

Nf/No=0.87

Initial

2 Seconds Later

dN/dLog(Dp)

Diameter (nm)
Impact of Dilution on EI

Sample CO
- 3200 ppm
- 1600 ppm
- 800 ppm

Engine Power

(X \times 1.E15)
Coagulative Growth for $EI=5\times10^{15}/kg$

- **15 m pipe @ 10 LPM**
- **No Dilution**
- **10-Fold Dilution**
Coagulative Losses for EI = 5e15/kg

10X Dilution

No Dilution

Remaining Fraction

Time (seconds)

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Turbulent Diffusion Losses

15 m Tube, 10 LPM

Fractional Penetration vs. Diameter (nm)

- 0.5" ID
- 0.25" ID
Coagulation + Diffusion Losses for EI = 5e15/kg

- **10X Dilution**
  - 0.5" Tube
  - EI = 2.4e15

- **No Dilution**
  - 0.25" Tube
  - EI = 8.5e14
Condensation of Volatile Species

FSC 1820 ppm, 1.3 epr, 1m

20 C

300 C

University of Minnesota

unheated

heated