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

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F100 Particulate Emissions

Emission Index (1E15/kg)

Fuel Type: JP8+100, JP8, Low_Sul, Med_Sul, High_Sul

- **Airborne**
  - > 4 nm
  - > 16 nm

- **Test Cell**
  - > 10 nm
Processes Influencing Particle Size and Concentration

- Inertial Effects
- Thermophoretic Effects
- Loss in Bends
- Coagulation
- Turbulent Deposition
- Gravitational Settling

ENGINE

INSTRUMENTS
Effects of Non-isokinetic Sampling

Velocity Ratios (m/s)
Exhaust/Inlet

Fractional Penetration

Diameter (nm)

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Thermophoretic and Gravitational Losses

Deposition Velocity (cm/sec) vs. Diameter (nm)

- Thermophoretic Velocity
- Settling Velocity

300 K/mm
J85-GE Aerosol Emissions at 1 m

Aerosol Emission Index (1e14/kg)

Engine Power (%)

No Water Cooling

With Water Cooling

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Particle Losses in 0.25" Elbow

Penetration vs. Diameter (nm)

- 50 LPM
- 20 LPM
- 10 LPM
Coagulation for EI=5e15/kg

15 m pipe @ 10 LPM

$N_f/N_0=0.28$

Initial

2 Seconds Later

$dN/d\log(D_p)$ vs. Diameter (nm)
Coagulation for EI=5e15/kg w/10 Fold Dilution

15 m pipe @ 10 LPM

Initial

2 Seconds Later

Nf/No=0.87
Impact of Dilution on EI

Sample CO
- 3200 ppm
- 1600 ppm
- 800 ppm

Engine Power

(X 1.E15)
Coagulative Growth for EI=5e15/kg

15 m pipe @ 10 LPM

No Dilution

10-Fold Dilution

Count Mean Diameter (nm)

Time (seconds)
Coagulative Losses for EI = 5e15/kg

10X Dilution

No Dilution

Remaining Fraction

Time (seconds)
Turbulent Diffusion Losses

15 m Tube, 10 LPM

Fractional Penetration

Diameter (nm)

0.5" ID

0.25" ID

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Coagulation+Diffusion Losses for EI=5e15/kg

- 10X Dilution
- No Dilution

0.5" Tube
EI = 2.4e15

0.25" Tube
EI = 8.5e14
Relative Humidity of Sample
100 % Power Setting

Sample Temperature (K)

Relative Humidity (%)

No Dilution
2:1
4:1
8:1
Condensation of Volatile Species

FSC 1820 ppm, 1.3 epr, 1m

University of Minnesota

20°C

300°C