Distribution of Fatty Acids and Triethanolamine in Synthetic Metalworking Fluid Aerosols Generated in the Laboratory and Field

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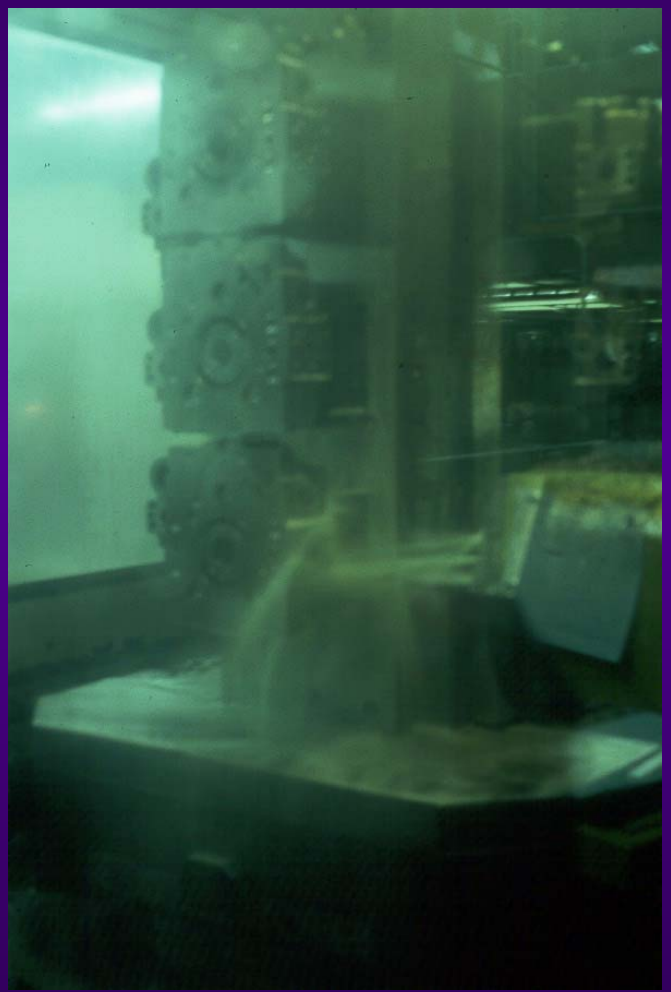
Exposure to MWF Mists

- During machining, several mechanisms of aerosol formation operate simultaneously:
  - elevated temperatures
  - mechanical motion
  - bubbling of the machining fluid.
- Component distribution in air is dependent on mist formation mechanisms.



Exposure to MWF Mists, Continued

- Once chemicals become distributed in the air, *removal* by filtration, adsorption or other means often *difficult or inefficient.*
- Controlled, low total particulates, *significant vapor phase concentrations* of certain species.
- High vapor phase levels *even with reduced mist levels*, obtained with efficient air cleaning devices.
- Chemical *vapor conc. may build up* in work place air.

Collectable Particulates are Present in Real Workplace Air

High volume particulate sample collection in a clean machining operation facility

Fatty Acids in MWF

- Short chain *carboxylic acids*, normally benign compounds.
- Certain components are potential human *respiratory irritants*.
- Anecdotal evidence of *potential irritation from short chain fatty acids* prompted lab and field studies.
- Comparisons of fatty acid and triethanolamine (TEA), *particulate and vapor conc.*, measured in the laboratory and work place environment.

Aerosol Generation Experiments, Nebulization

- Laboratory simulations, field MWF mist generation mechanisms.
- Utilized standard *ASTM method*, animal exposure.
- Small glass exposure chamber, Pitt 1 nebulizer.
- Synthetic *MWF concentrates*.
- Total particulate concentration, 0.19 to 1.3 mg/m^3.

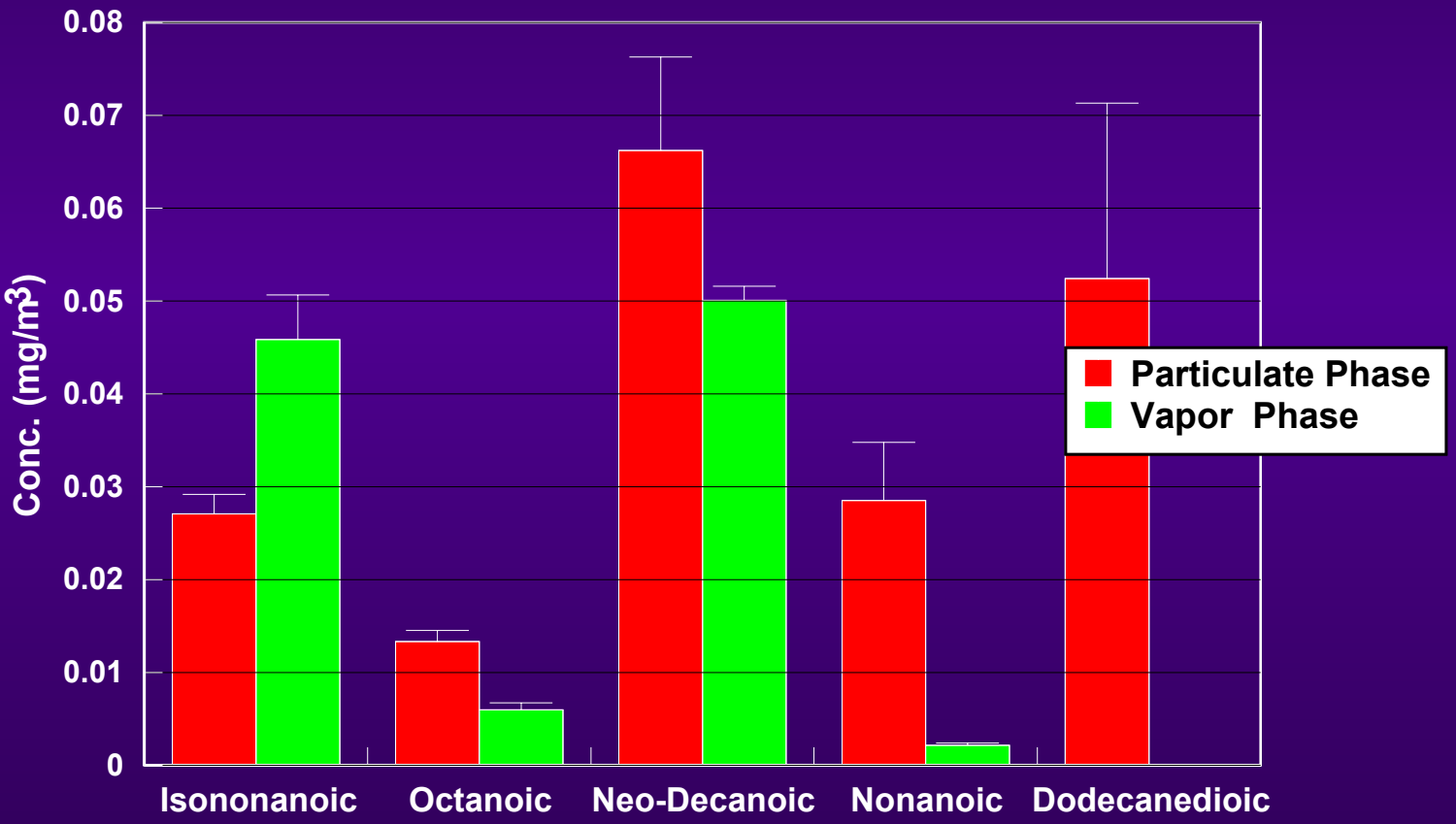
Aerosol Generation Experiments, Bubbler

- Mechanisms of aerosol formation, investigate their effects on chemical distributions in generated particulates, vapors.
- Experiments performed in glove bag.
- Sparged synthetic *MWF, diluted*.
- Total particulate concentrations, 0.05 to 0.26 mg/m3.
- Lengthy experiments.

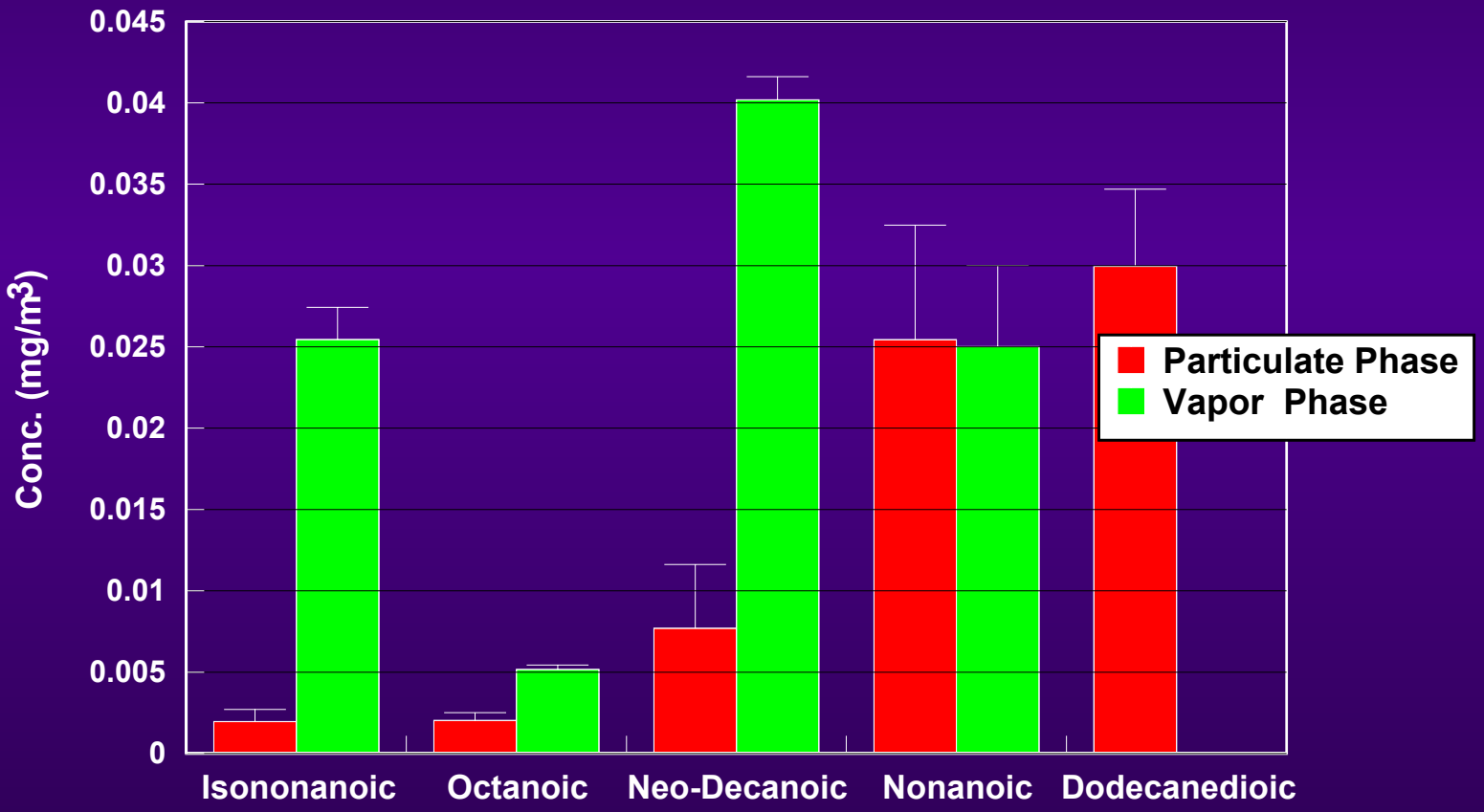
Mist Sampling and Analysis

- Particulate phase, coated glass fiber absolute filters.
- Vapor phase, *XAD-2* resin cartridges.
- In series, in air sampling stream, 0.9 to 3.5 liters/minute.
- Particle size distribution, cascade impactor, *0.33 to 4.6 μ meters*.
- Methanol and ethyl acetate sample extraction.
- Fatty acid derivatization, On line GC, N,O bis(trimethylsilyl)trifluoroacetamide (BSTFA).

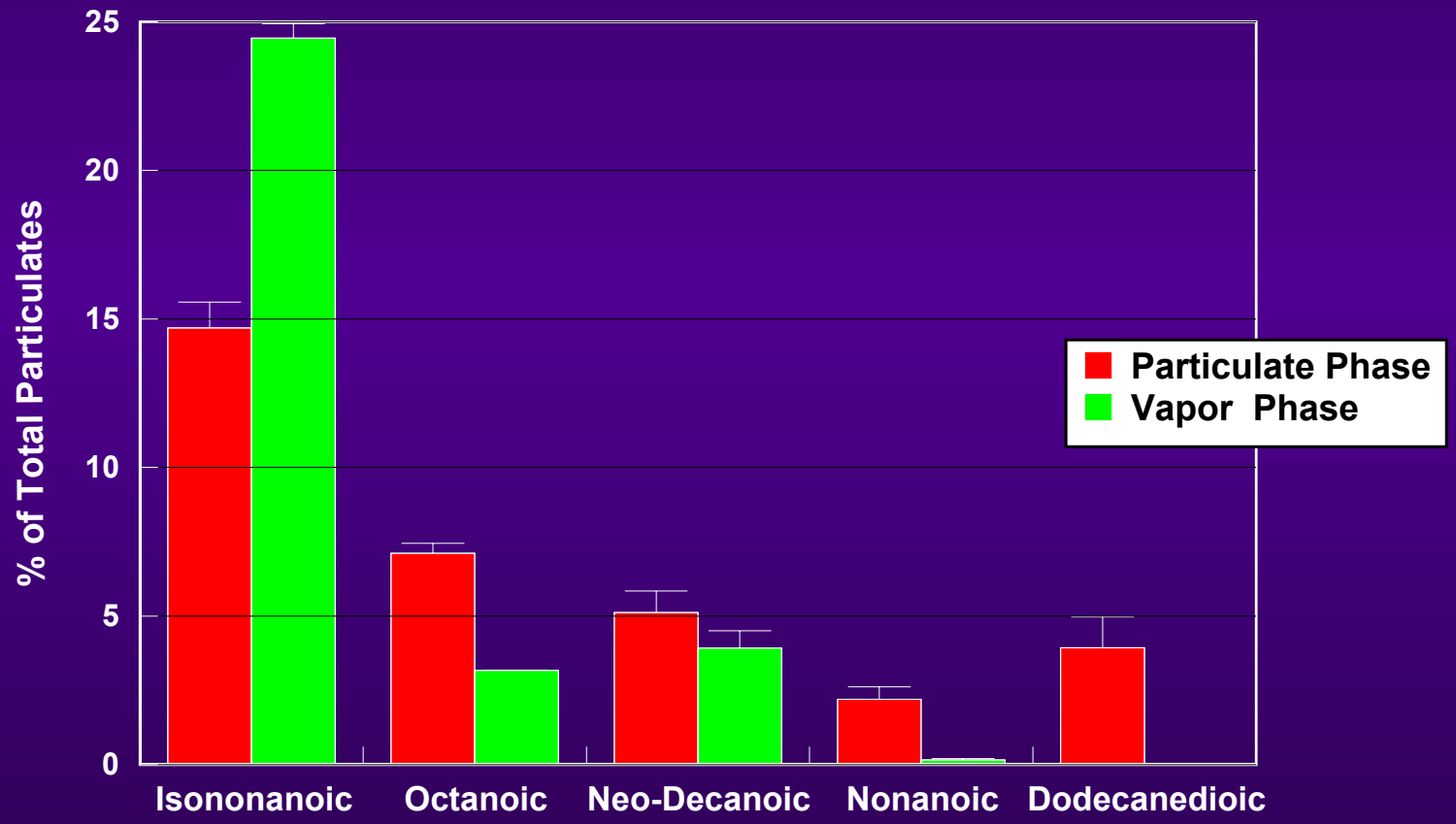
Nebulized MWF Mists



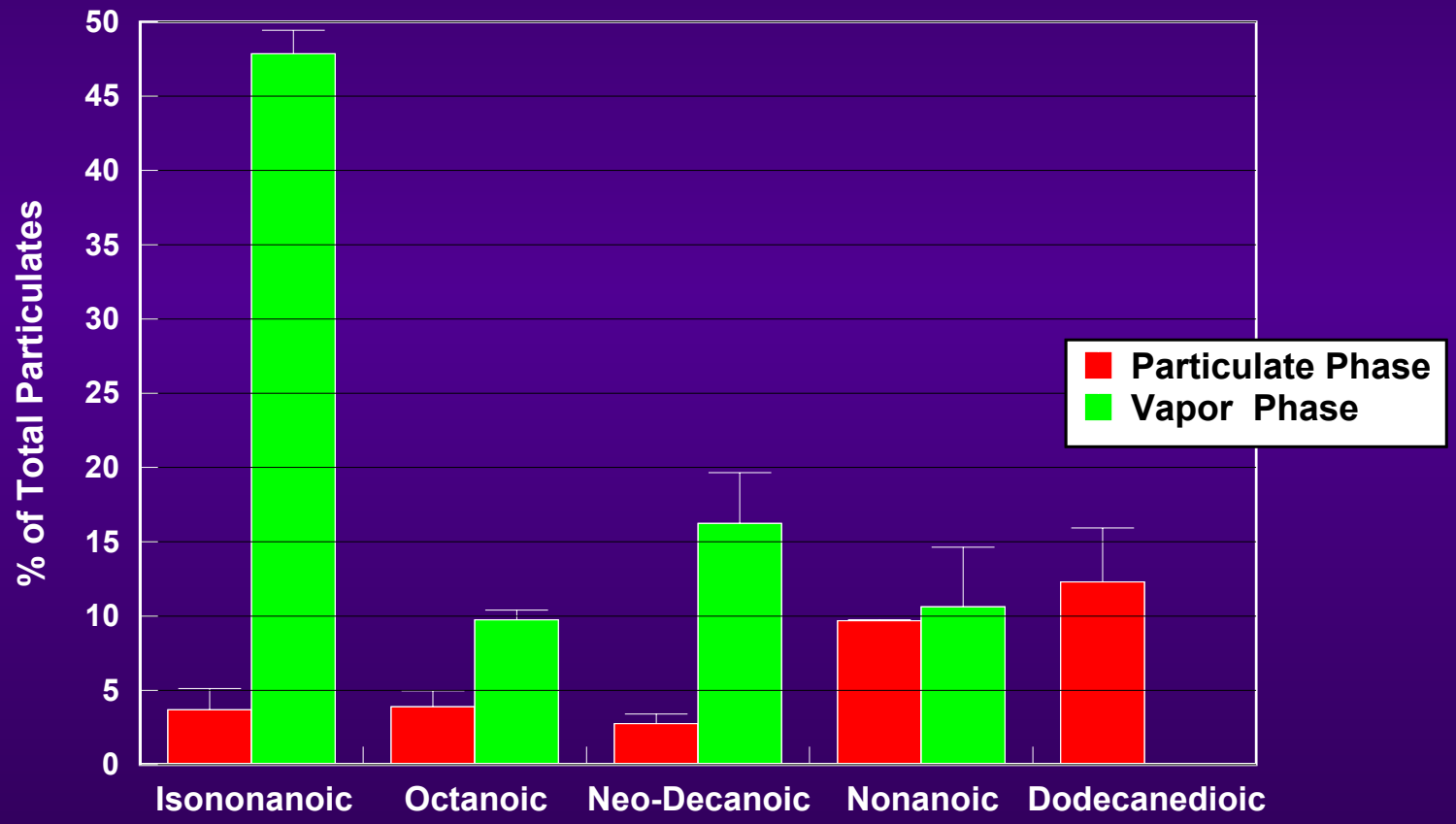
Bubbled MWF Mists



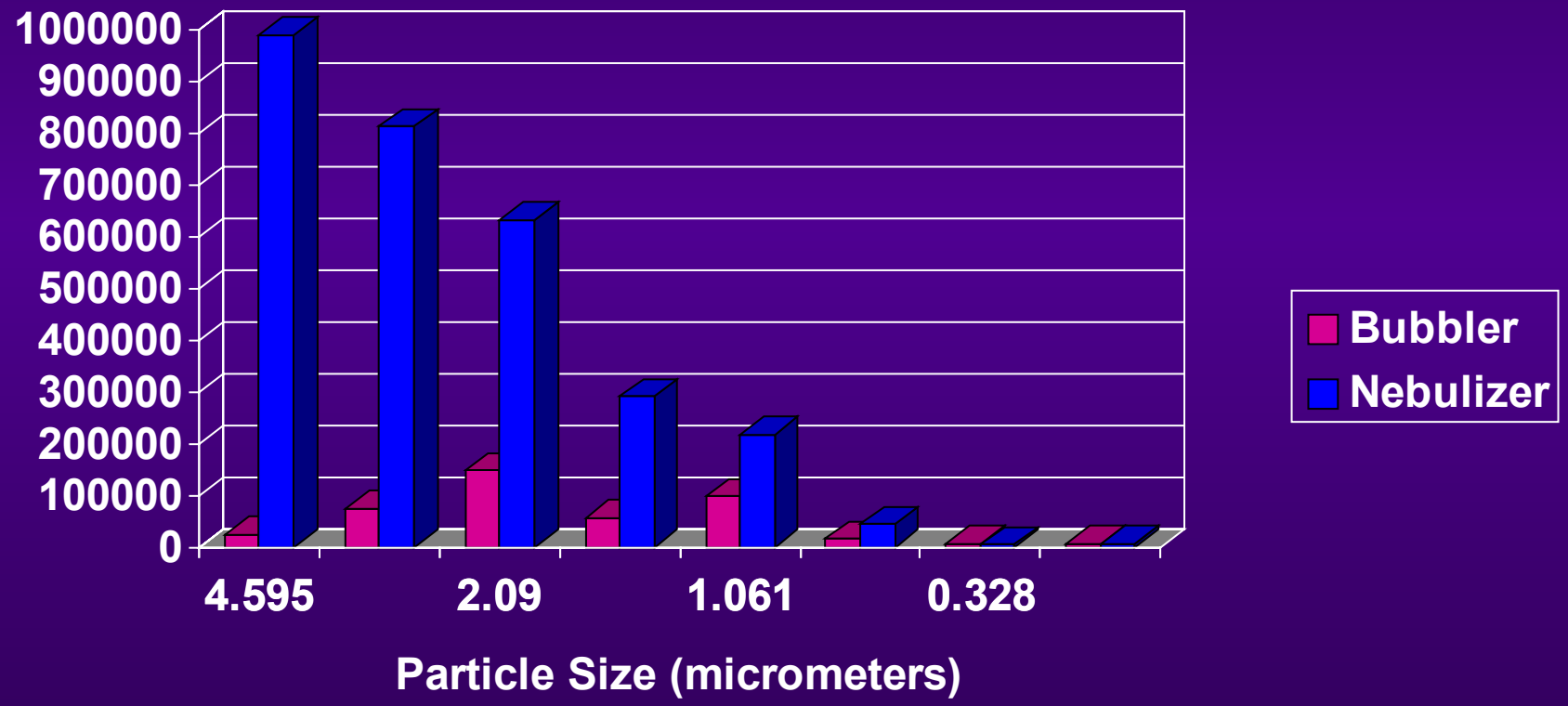
Nebulized MWF Mists



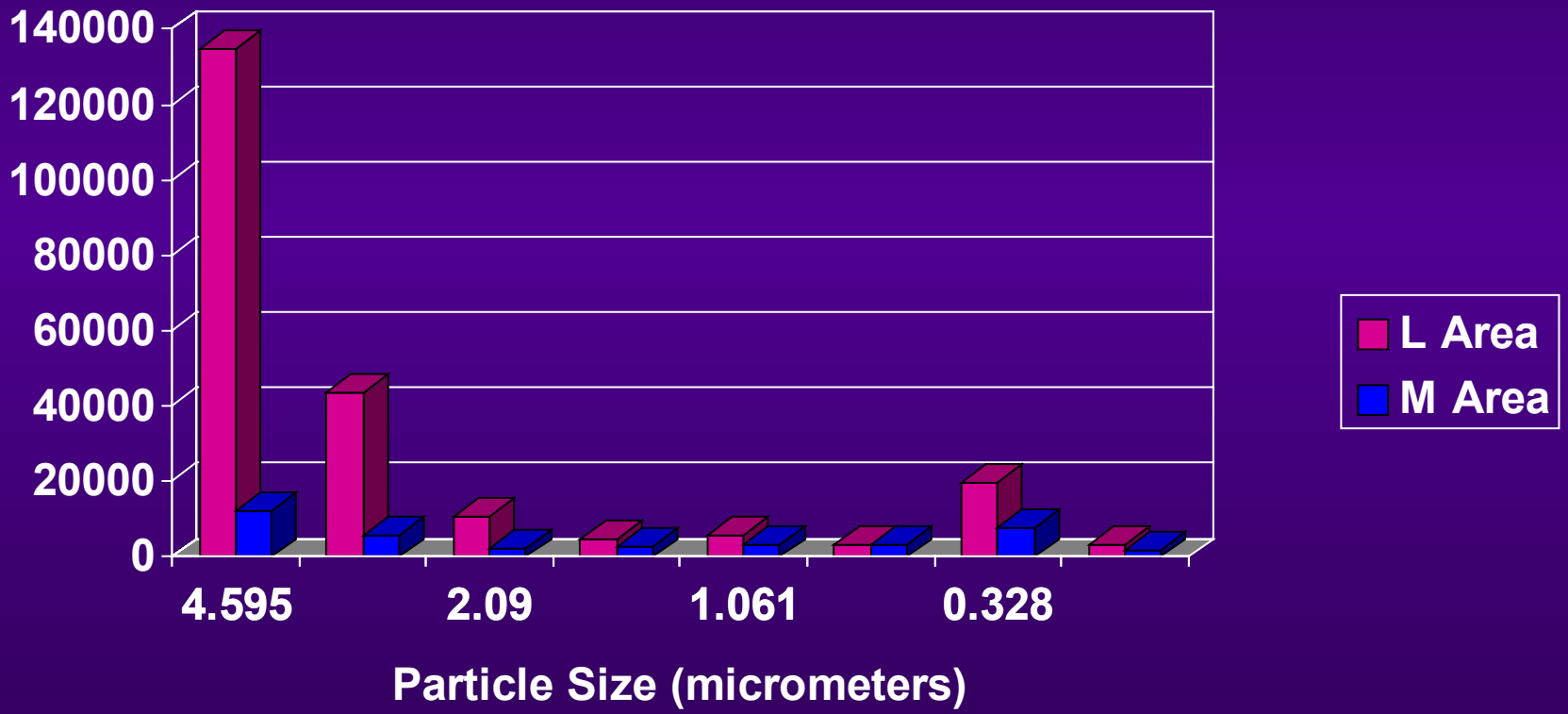
Bubbled MWF Mists



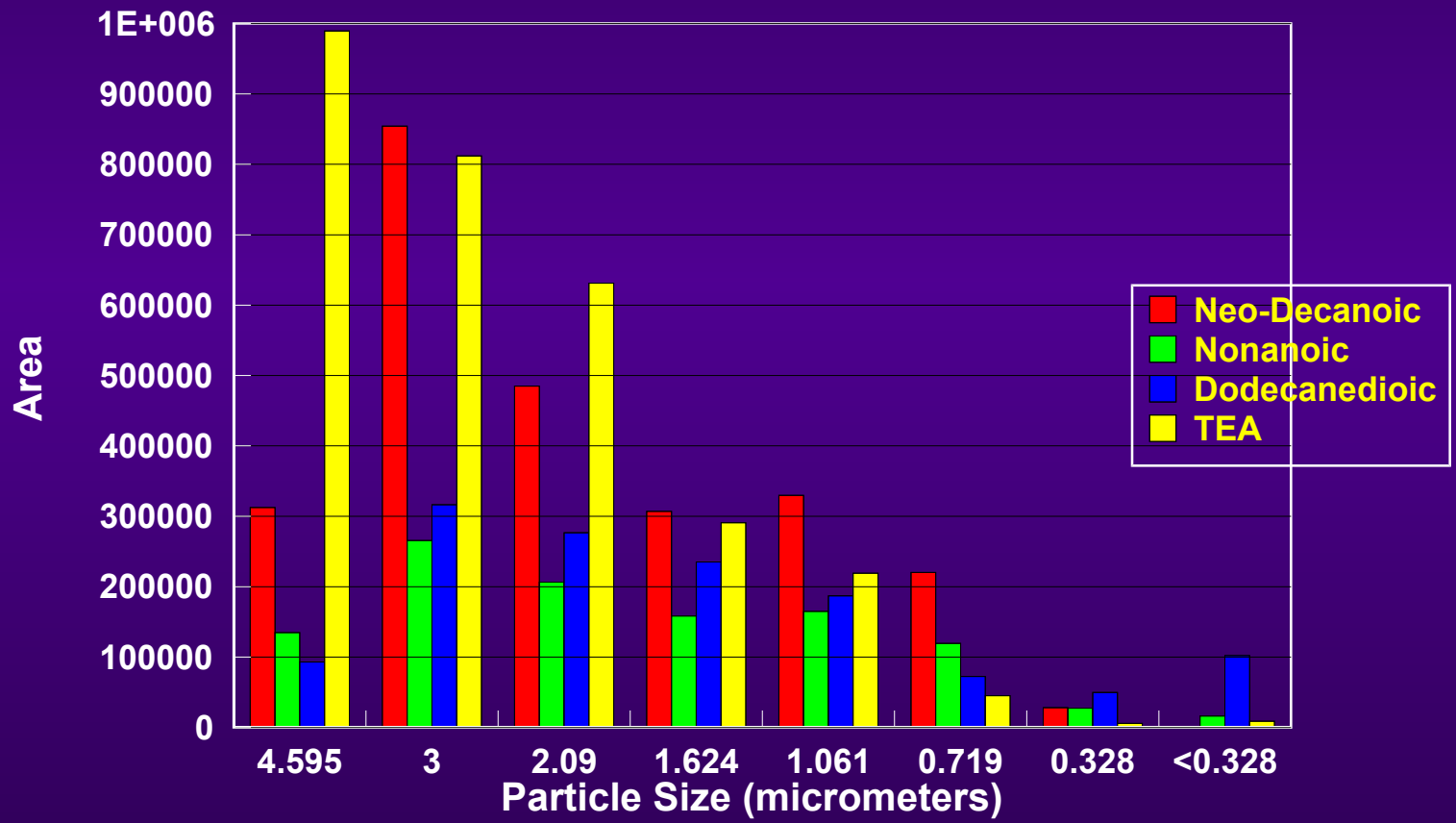
TEA Particle Size Distribution, Laboratory



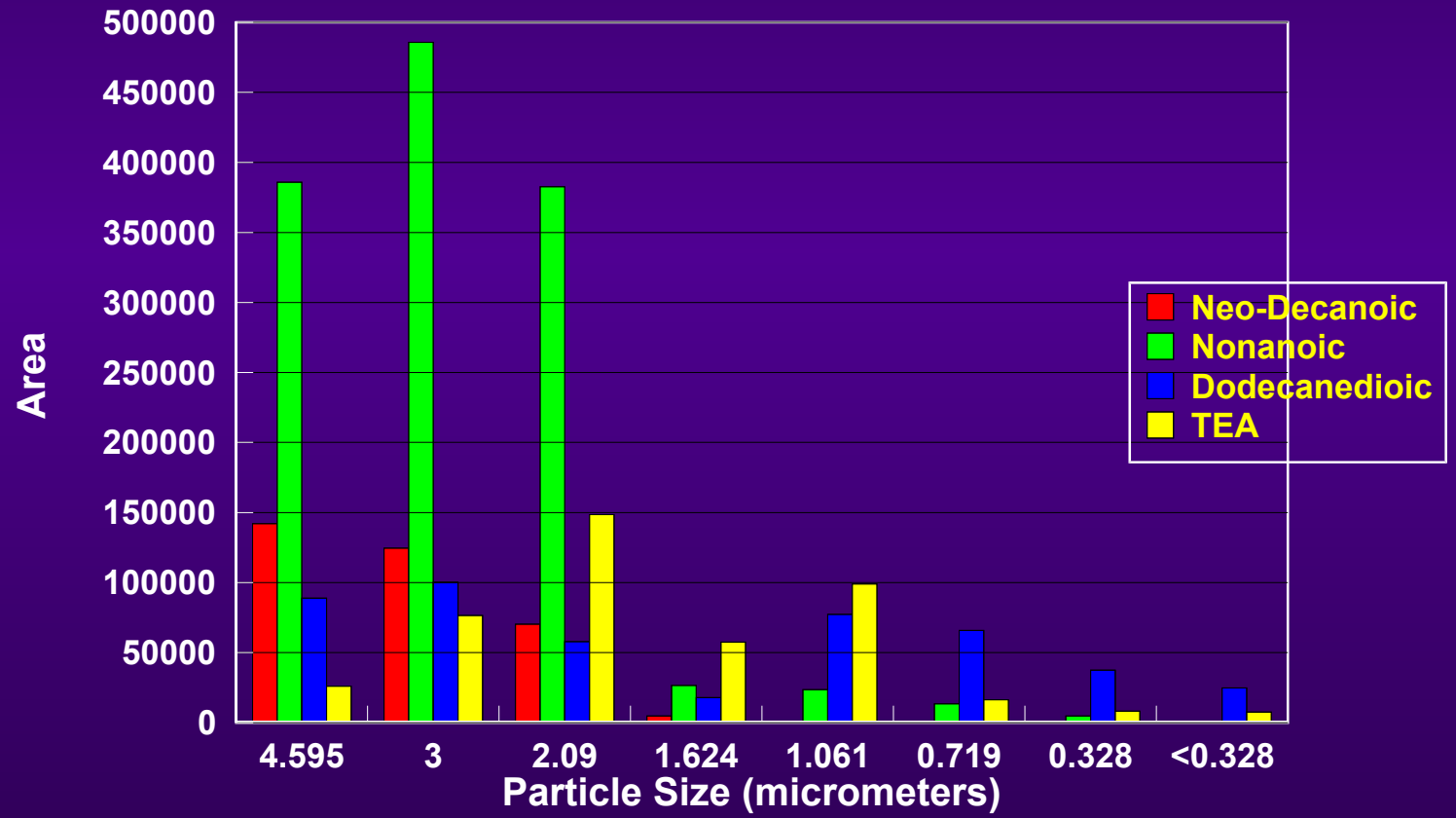
TEA Particle Size Distribution, Work Place



Particle Size Distribution: Nebulized Aerosol



Particle Size Distribution: Bubbled Aerosol



Results: Workplace

- Neo-decanoic acid in *particulates, 10 to 100 fold* < vapor phase conc., 0.1 mg/m3.
- Nonanoic acid found in the *vapor phase*, 0.01 to 0.020 mg/m3.
- TEA *vapor /particulate* phase conc. ratios: *Area L*, 0.15; and *Area M*, 0.75. TEA particulate conc. were 0.05 and 0.03 mg/m3 respectively.
- Dodecanedioic acid not found, insufficient analytical sensitivity.
- Total particulate levels, from 0.05 to 0.4 mg/m3.

Results: Laboratory

- Neo-decanoic acid *vapor phase conc*. were 12 to 19 % and 4 to 5 % of respective bubbler and nebulizer total particulates.
- Nonanoic acid *vapor phase conc.: 10 times* > in bubbled aerosols, 0.025 mg/m^3, than in nebulized.
- Nonanoic acid in *bubbler and nebulizer generated total particulates were*, 9.7 % and 1.6 % respectively.
- TEA *vapor/particulate phase conc. ratios*: bubbled, 0.34 and nebulized, 0.05.

Results Continued: Laboratory

- Dodecanedioic acid not found in nebulizer or bubbler vapor phase.
- Isononanoic acid *vapor/particulate phase ratios*: 10 for bubbler and 0.8 for nebulized mists.
- Octanoic acid *vapor/particulate phase ratios*: 3 for bubbler and 0.5 for nebulized mists.
- Total particulate conc.: bubbled, 0.05 to 0.26 mg/m3 and nebulized, 0.19 to 1.3 mg/m3.

Conclusions:

- Work place *vapor conc. data* > laboratory results.
  - Neo-decanoic acid, 0.1 and 0.05mg/m^3
  - Nonanoic acid, 0.02 and 0.025 mg/m^3
  - TEA, comparable V/P ratios, 0.75 and 0.34
- Mist generation *mechanism*, important.
  - Particle size, a factor?
  - MWF concentration.