Effects of Fluid Composition on Mist Composition

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What is a mist?

- A liquid condensation particulate
- A suspension of a finely divided liquid in gas
- Liquid aerosols formed by mechanical means
- Can be complex

General Definition

Suspended liquid droplets generated by condensation from the gaseous to the liquid state, or by breaking up a liquid into a dispersed state, such as splashing, foaming or atomizing. Mist is formed when a finely divided liquid is suspended in air.

http://www.utexas.edu/safety/ehs/msds/msdsgloss2.html

Generation of 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

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 acids and triethanolamine (TEA), *particulate conc*.:
  - Laboratory conditions
  - Work place environment

Fatty Acids Utilized

- Saturated Fatty Acids:
  - **DODECANEDIOIC: $HOOC(CH_2)_{10}COOH$**
  - **ISONONANOIC: $CH_3C(CH_3)_2CH_2CH(CH_3)CH_2COOH$**
  - **NEO-DECANOIC:**
  - **NONANOIC: $CH_3(CH_2)_7COOH$**
  - **OCTANOIC: $CH_3(CH_2)_6COOH$**

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

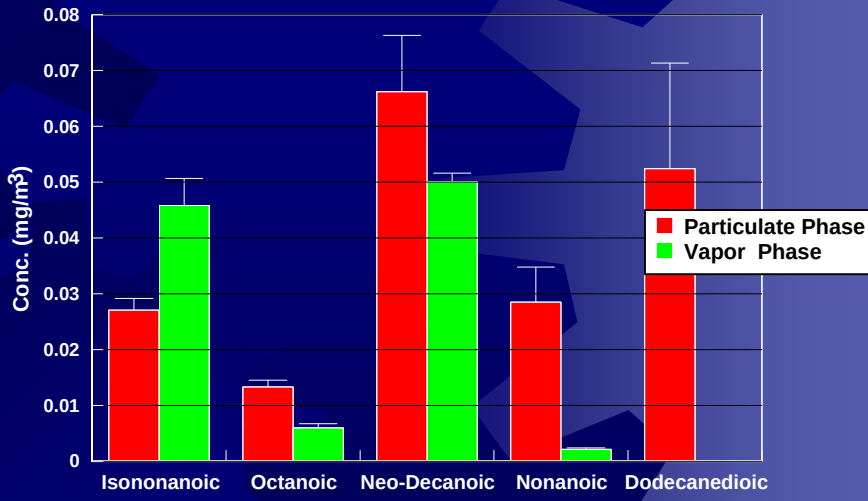
- Mechanisms of aerosol formation, investigate their effects on chemical distributions in generated particulates, vapors.
- Experiments performed in glove bag.
- Sparged synthetic *MWF, diluted*.
- Total particulate concentrations, 0.05 to 0.26 mg/m3.
- Lengthy experiments.

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).

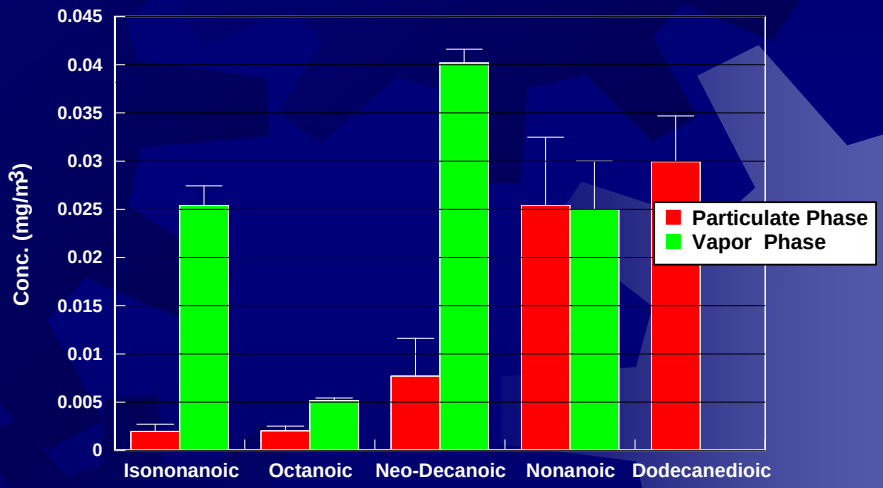
Nebulized MWF Mists

- For three acids, a significant portion is not captured by the filter
- Actual workplace exposures will be higher than estimated by simple gravimetric analysis

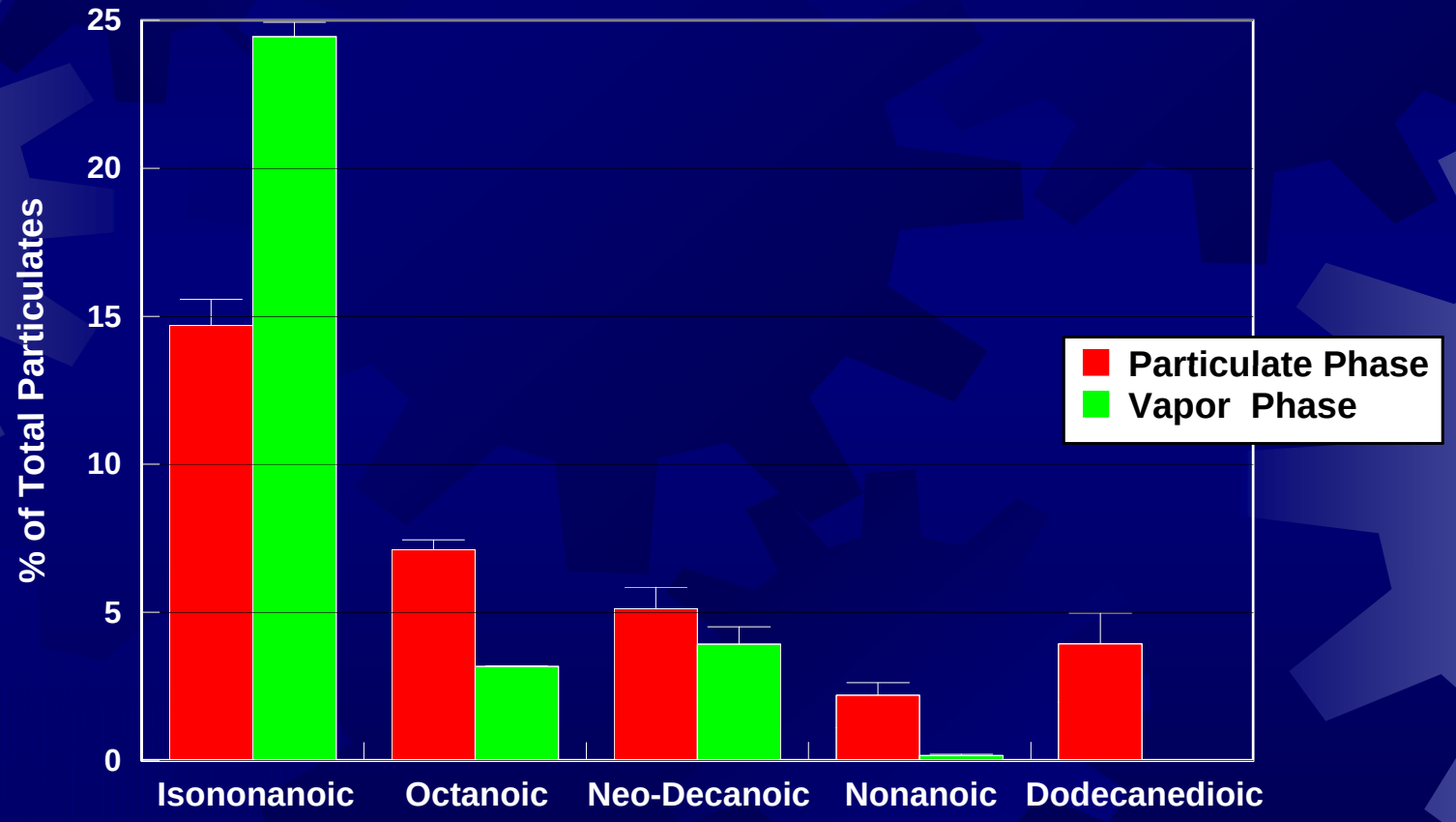


Bubbled MWF Mists

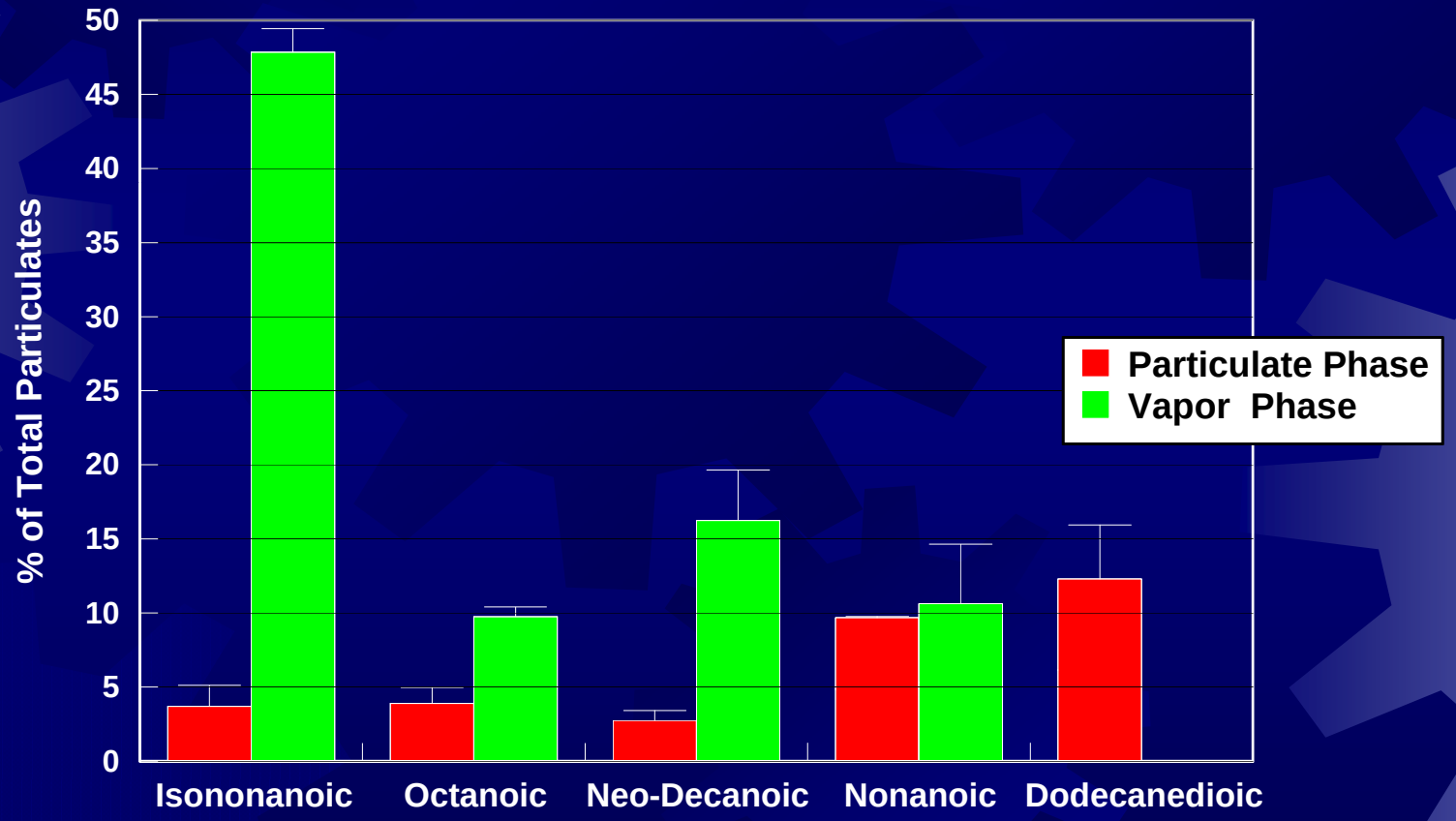
- Losses from the filter are even greater, reflecting longer sample collection times
- The distribution of acids in the air is significantly different than found for nebulized mist



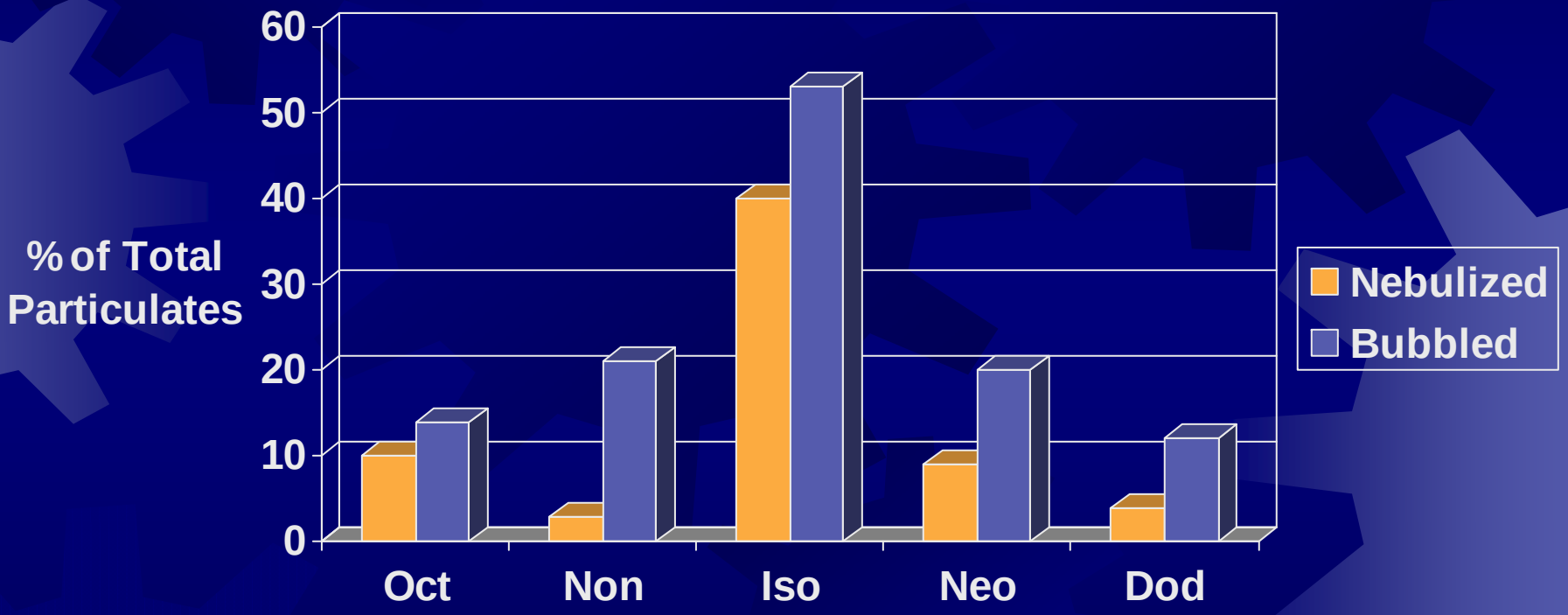
Nebulized MWF Mists



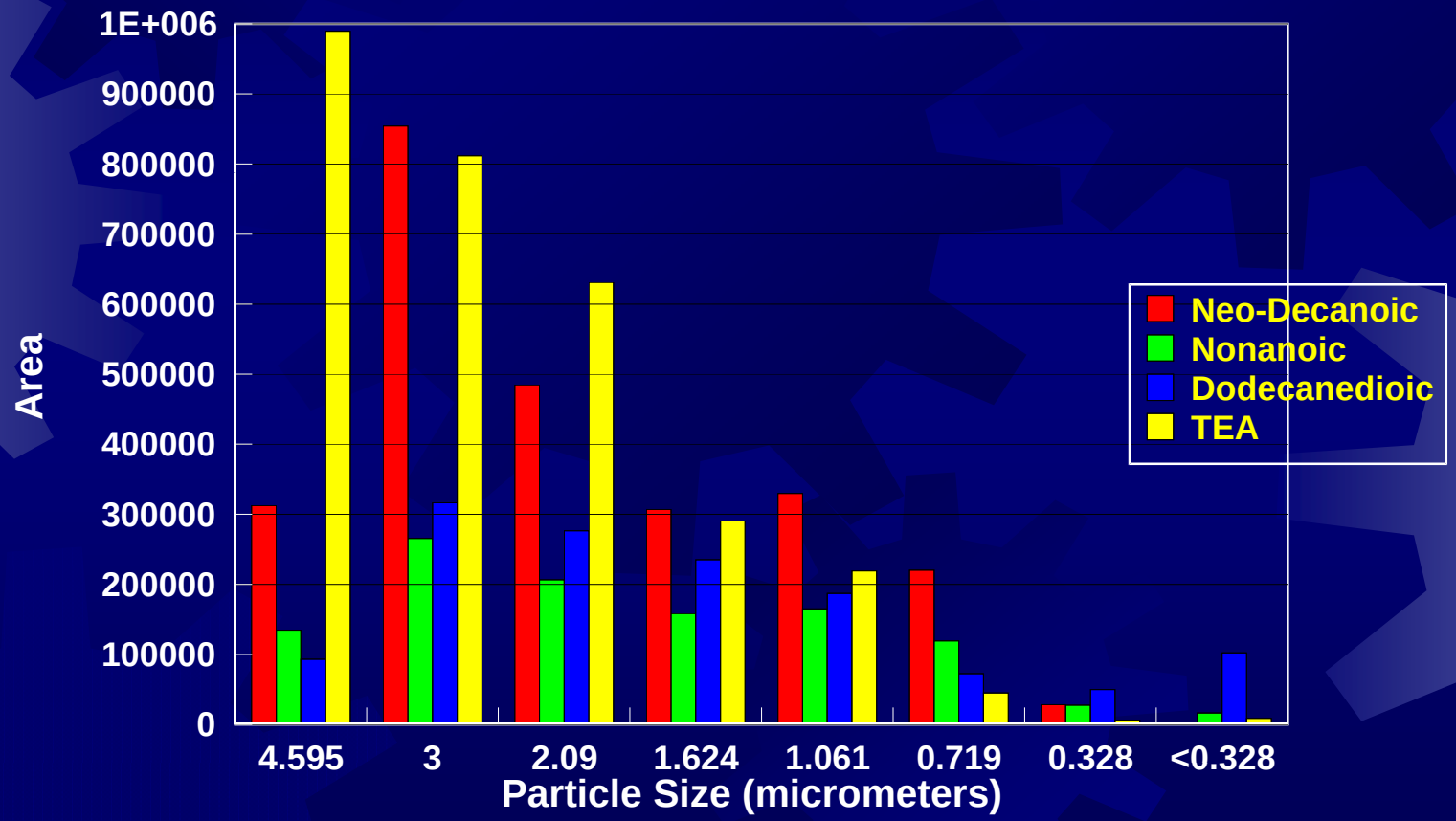
Bubbled MWF Mists



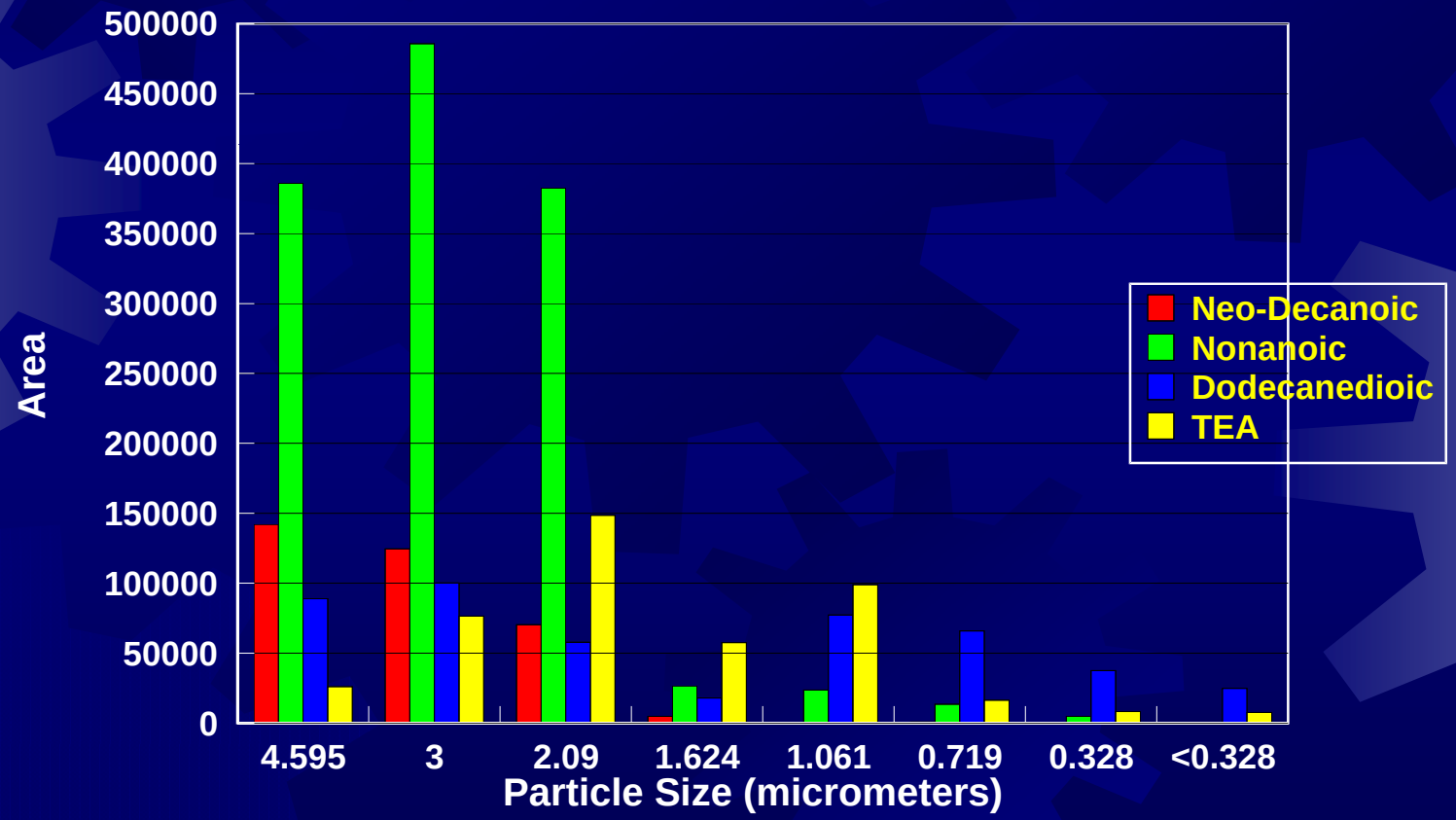
Effect of Mechanism on Aerosol Composition



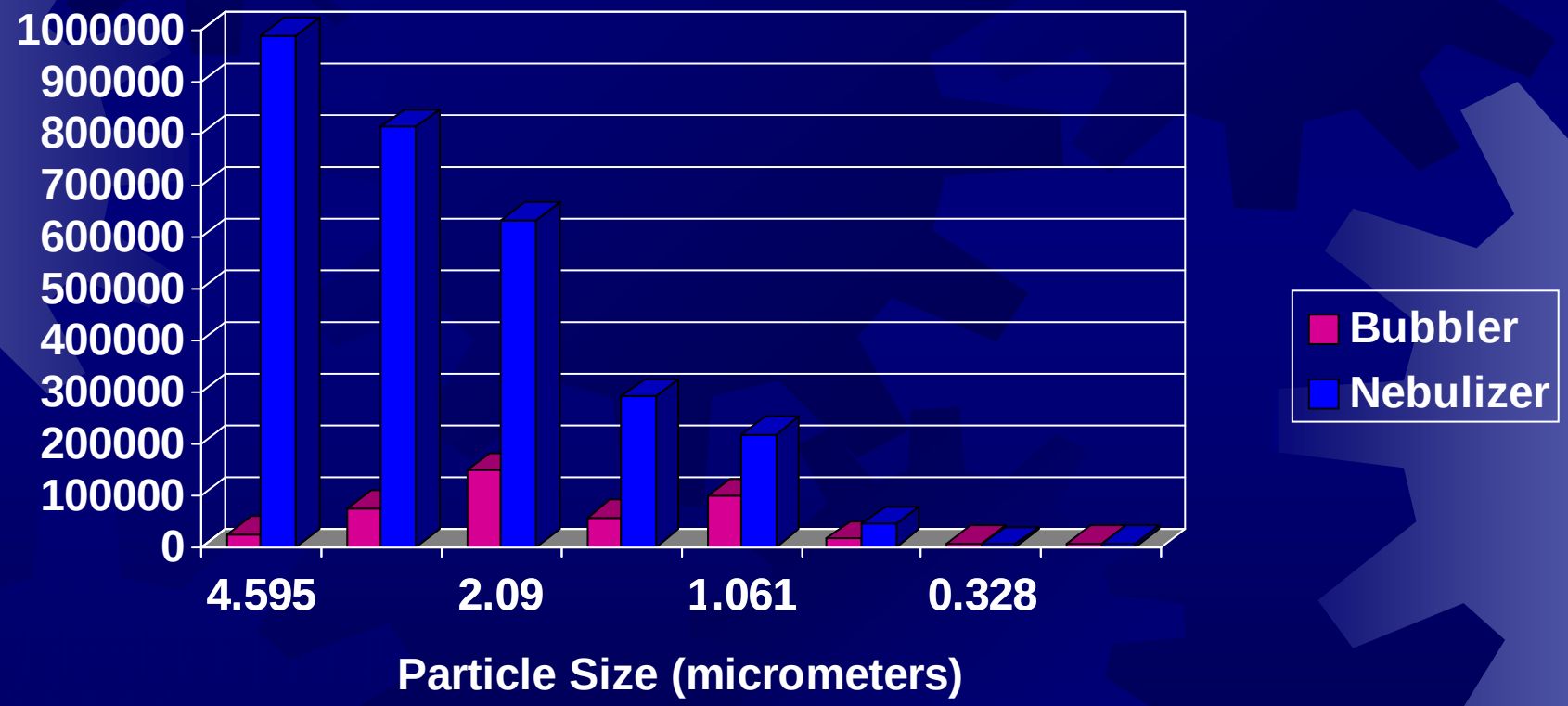
Particle Size Distribution: Nebulized Aerosol



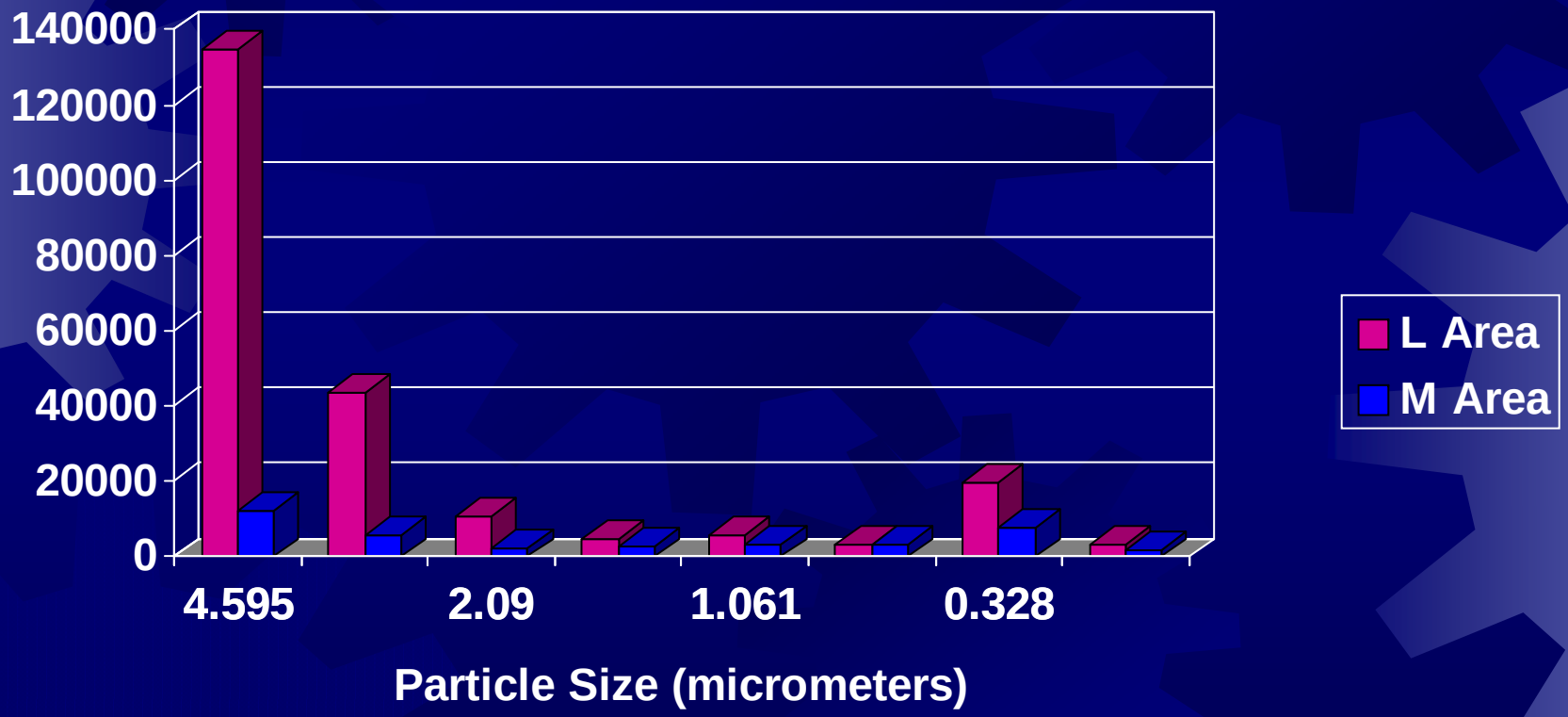
Particle Size Distribution: Bubbled Aerosol

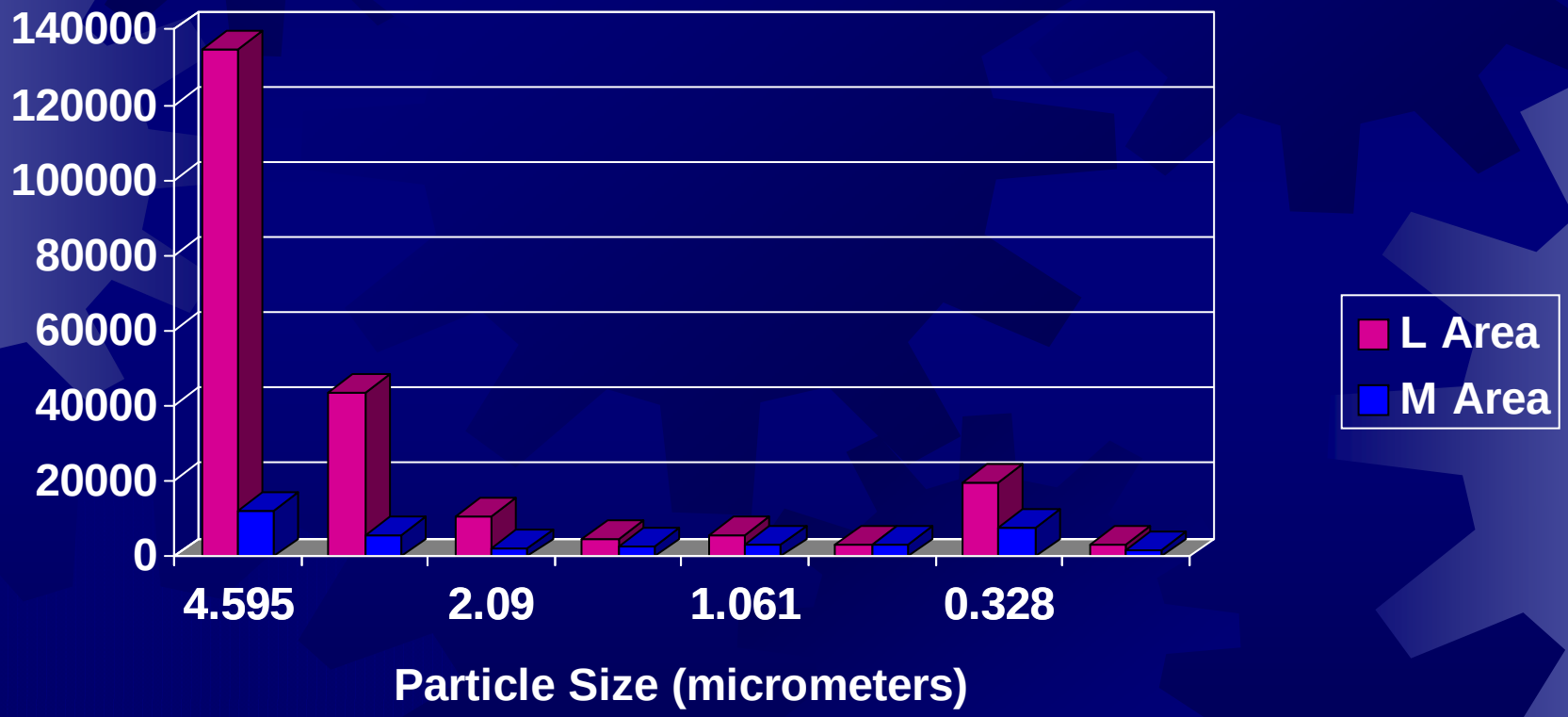


TEA Particle Size Distribution, Laboratory



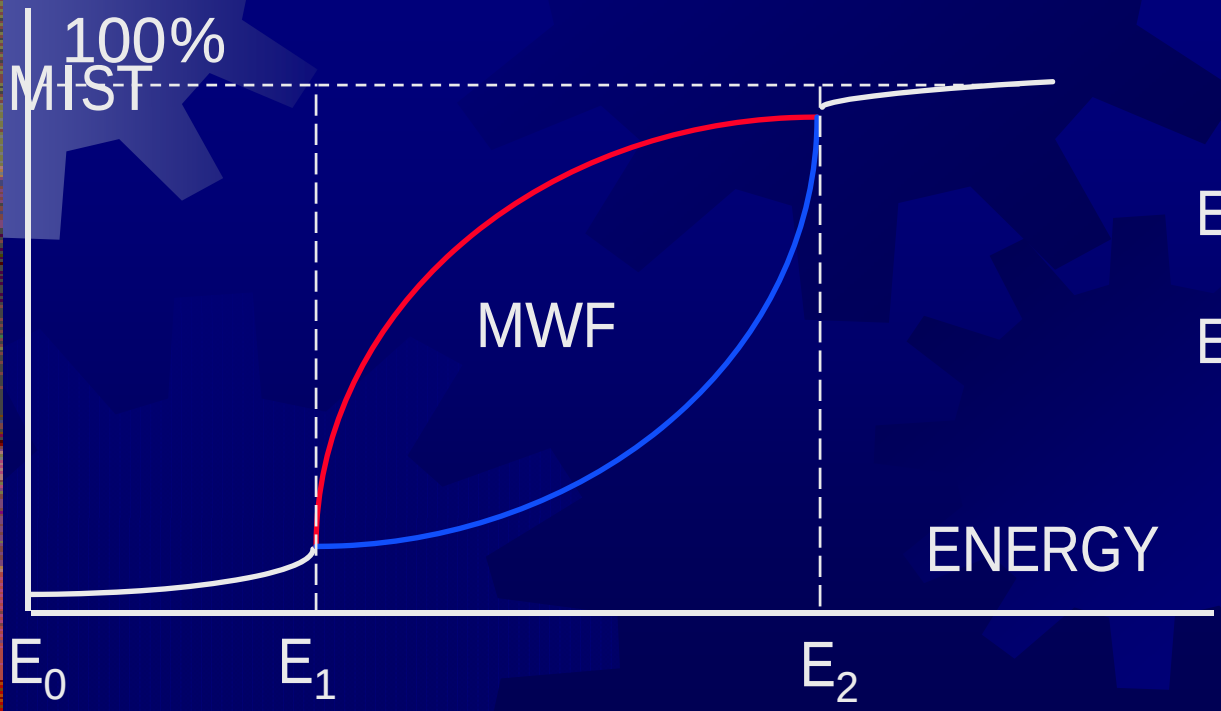
TEA Particle Size Distribution, Work Place




140000
120000
100000
80000
60000
40000
20000
0
4.595
2.09
1.061
0.328
Particle Size (micrometers)
L Area
M Area

MIST HYPOTHESIS:

MIST LEVEL DEPENDS ON THE BALANCE BETWEEN GENERATION FORCES SUPPLIED BY THE MACHINING PROCESS AND THE COHESIVE FORCES THAT RESULT FROM THE PROPERTIES OF THE METALWORKING FLUID



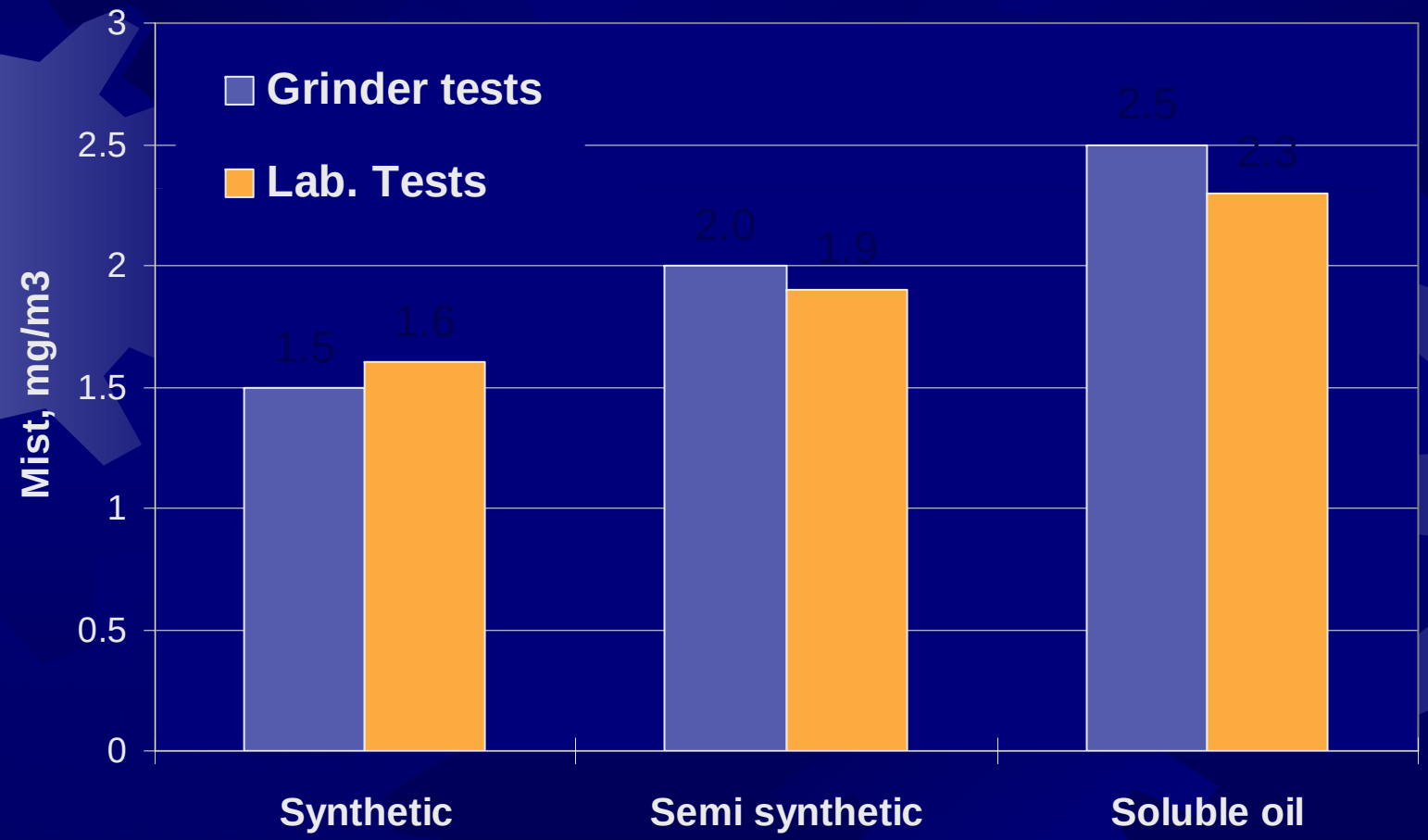
MIST REGIMES:

E_0 - E_1(no mist)

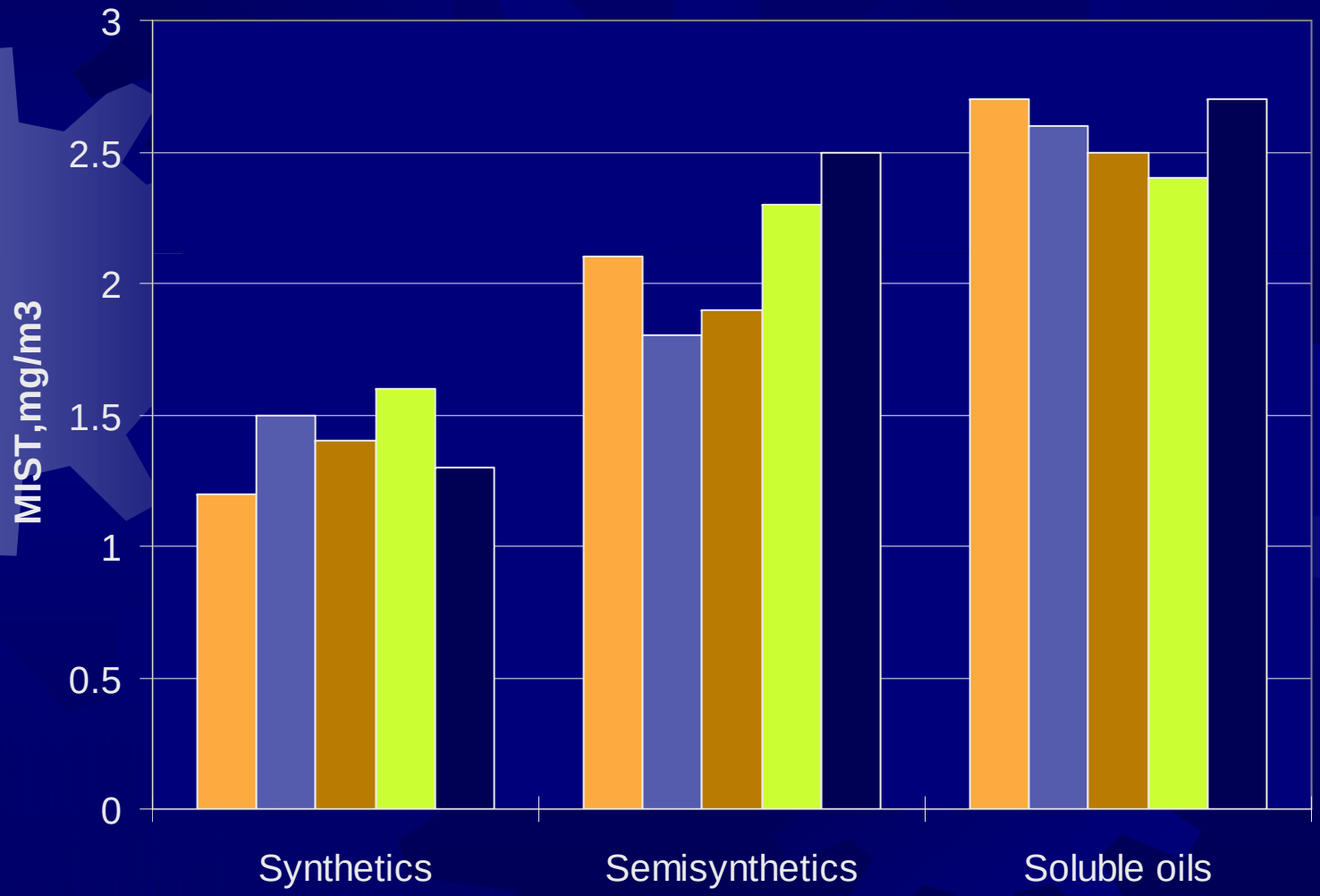
E_1 - E_2(fluid dependent)

> E_2 (just mist)

Comparison of Grinder and Mist Generator Results

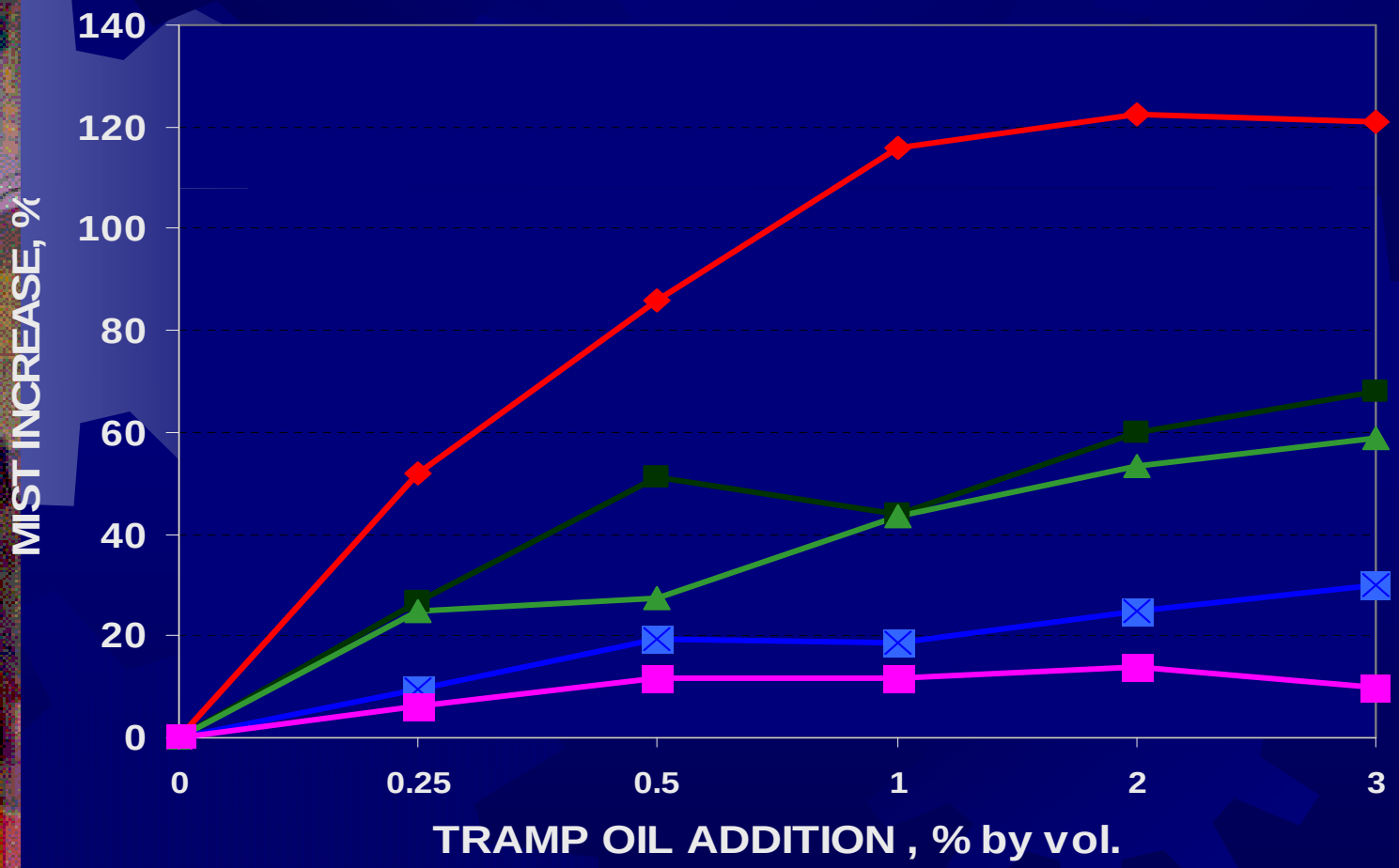


MIST PROPERTIES OF MWF

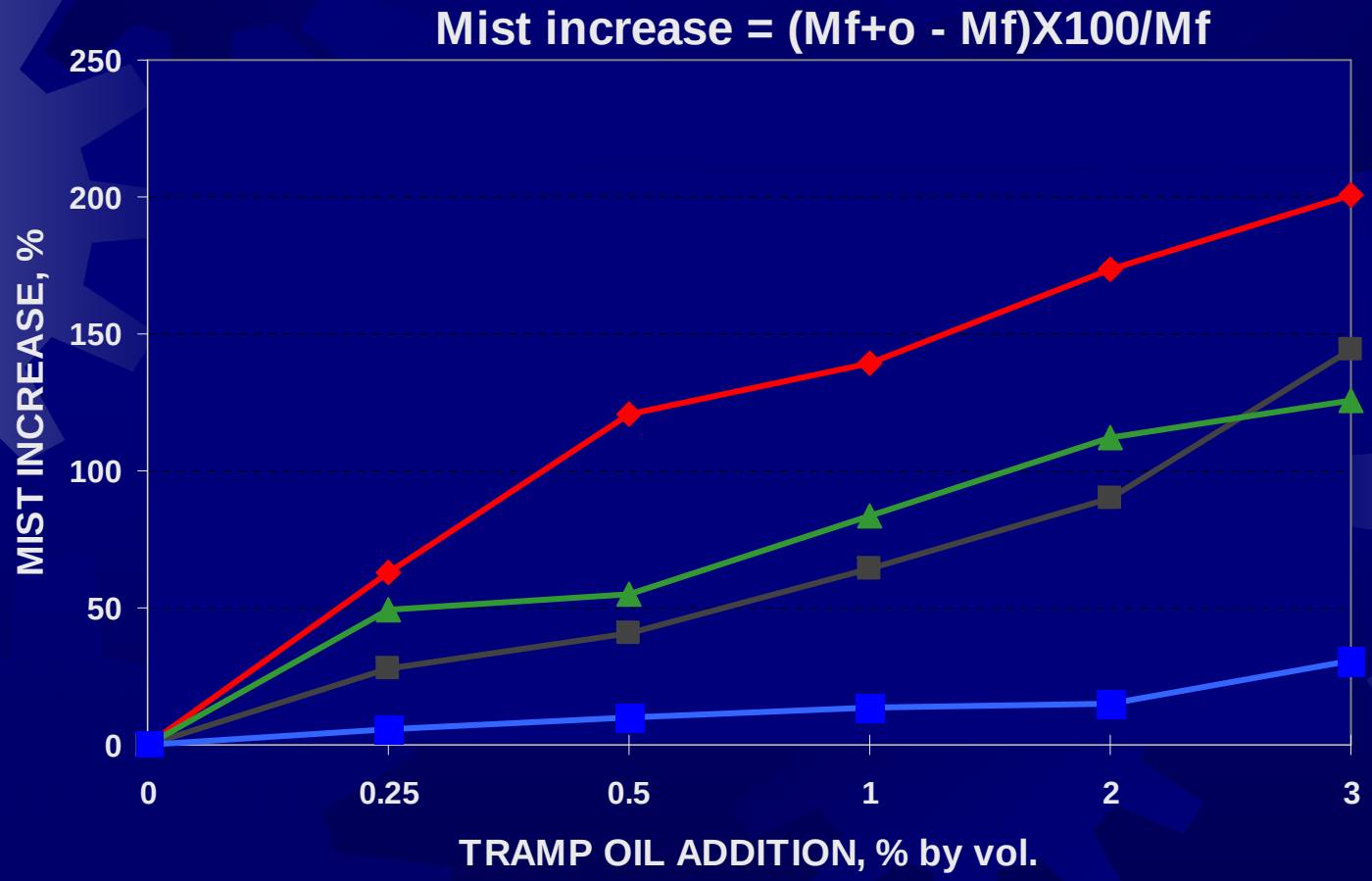


EFFECT OF TRAMP OIL ON MIST INCREASE IN SYNTHETIC PRODUCTS

Mist increase = (Mf+o - Mf)X100/Mf

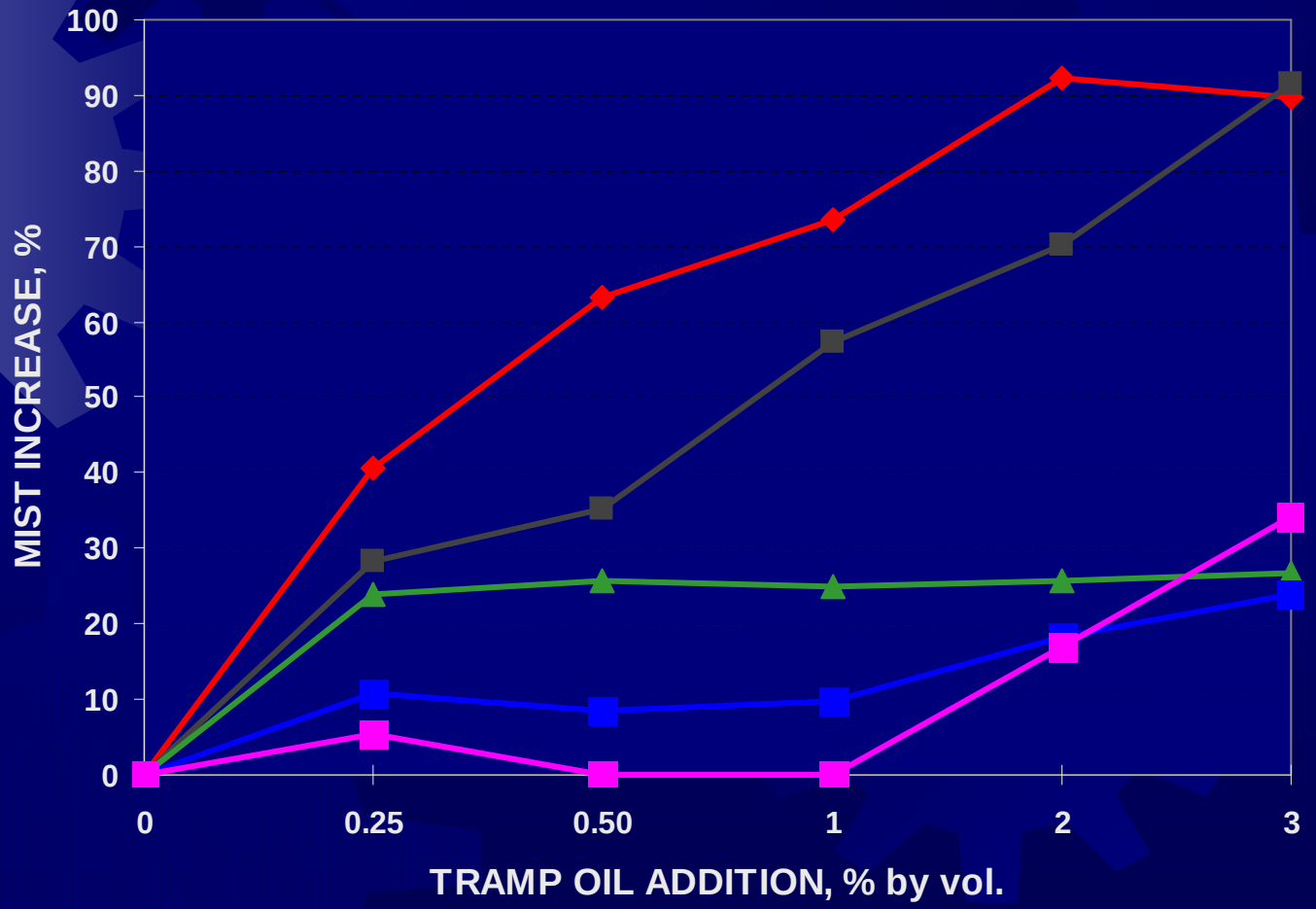


EFFECT OF TRAMP OIL ON MIST INCREASE IN SEMISYNTHETIC PRODUCTS



EFFECT OF TRAMP OIL ON MIST INCREASE IN SOLUBLE OILS

Mist increase = (Mf+o - Mf)X100/Mf



Summary

ACKNOWLEDGMENTS

- Aldrich Chemical Company
- Clariant Corporation
- Exxon Corporation
- General Motors Corporation
- Lubrizol Corporation
- Milacron Corporation
- National Oak Ridge Laboratories
- Rhein Chemie Corporation
- University of Cincinnati
- University of Pittsburgh
- Wayne State University

QUESTIONS