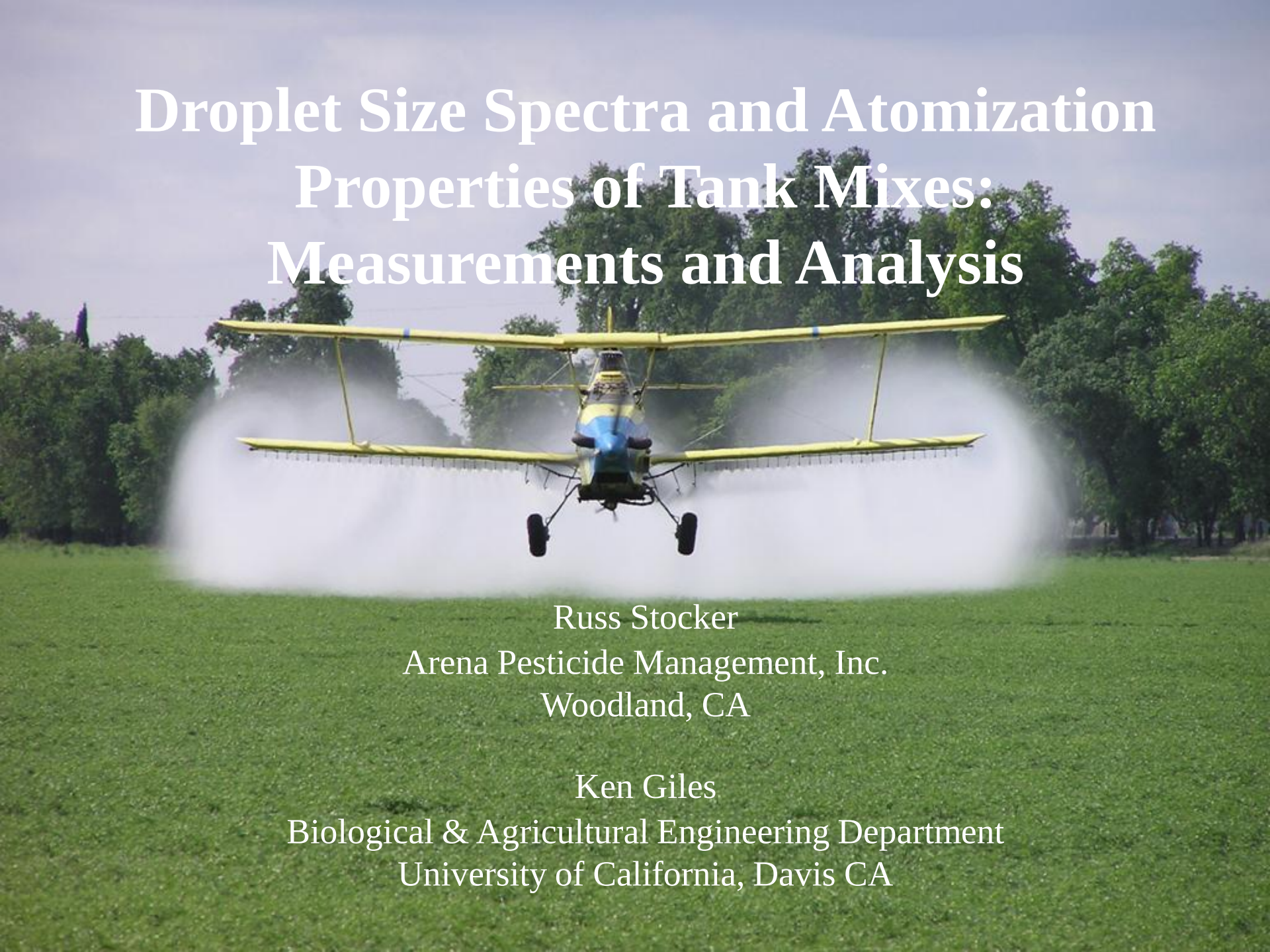
Droplet Size Spectra and Atomization Properties of Tank Mixes: Measurements and Analysis



Russ Stocker
Arena Pesticide Management, Inc.
Woodland, CA

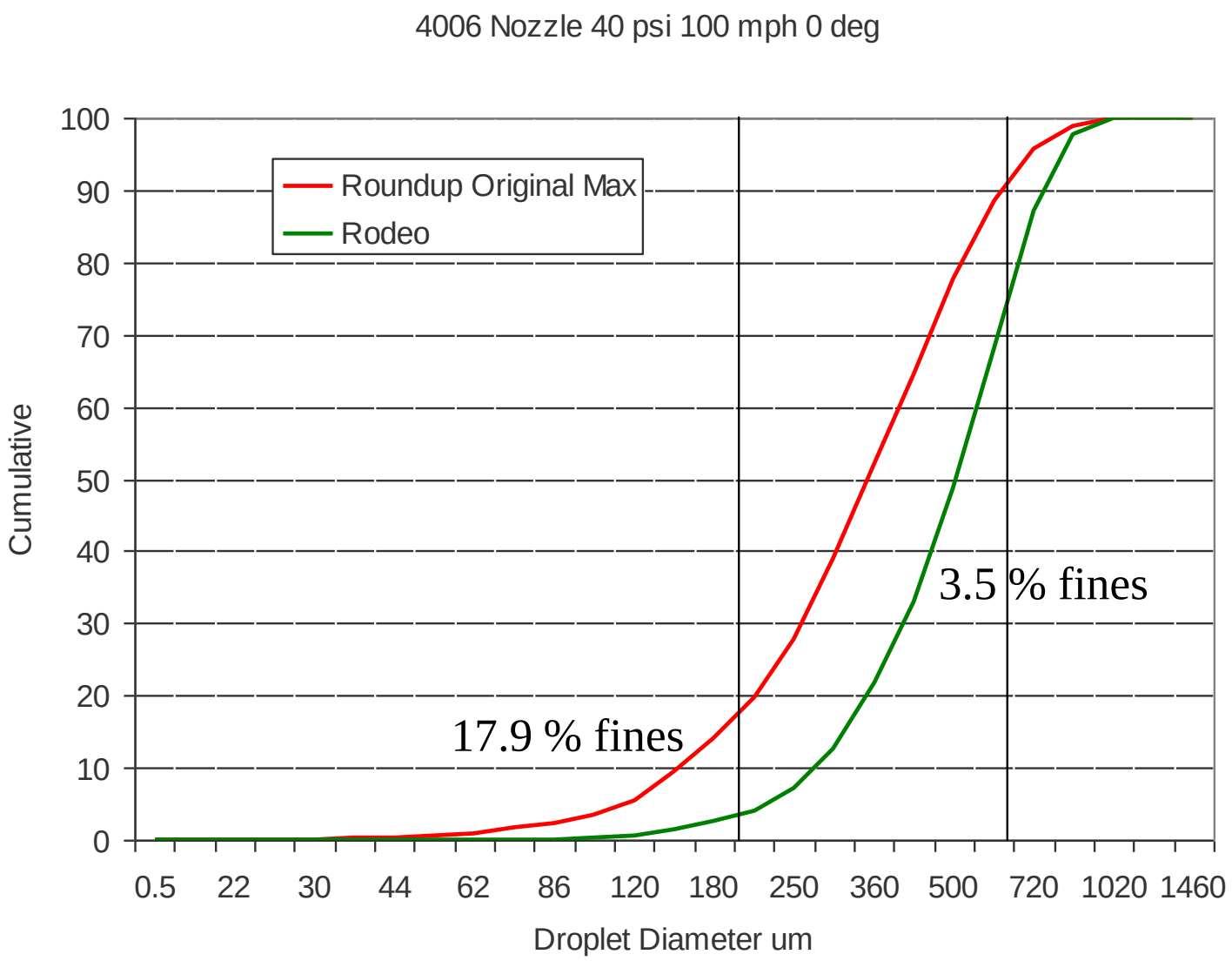
Ken Giles
Biological & Agricultural Engineering Department
University of California, Davis CA

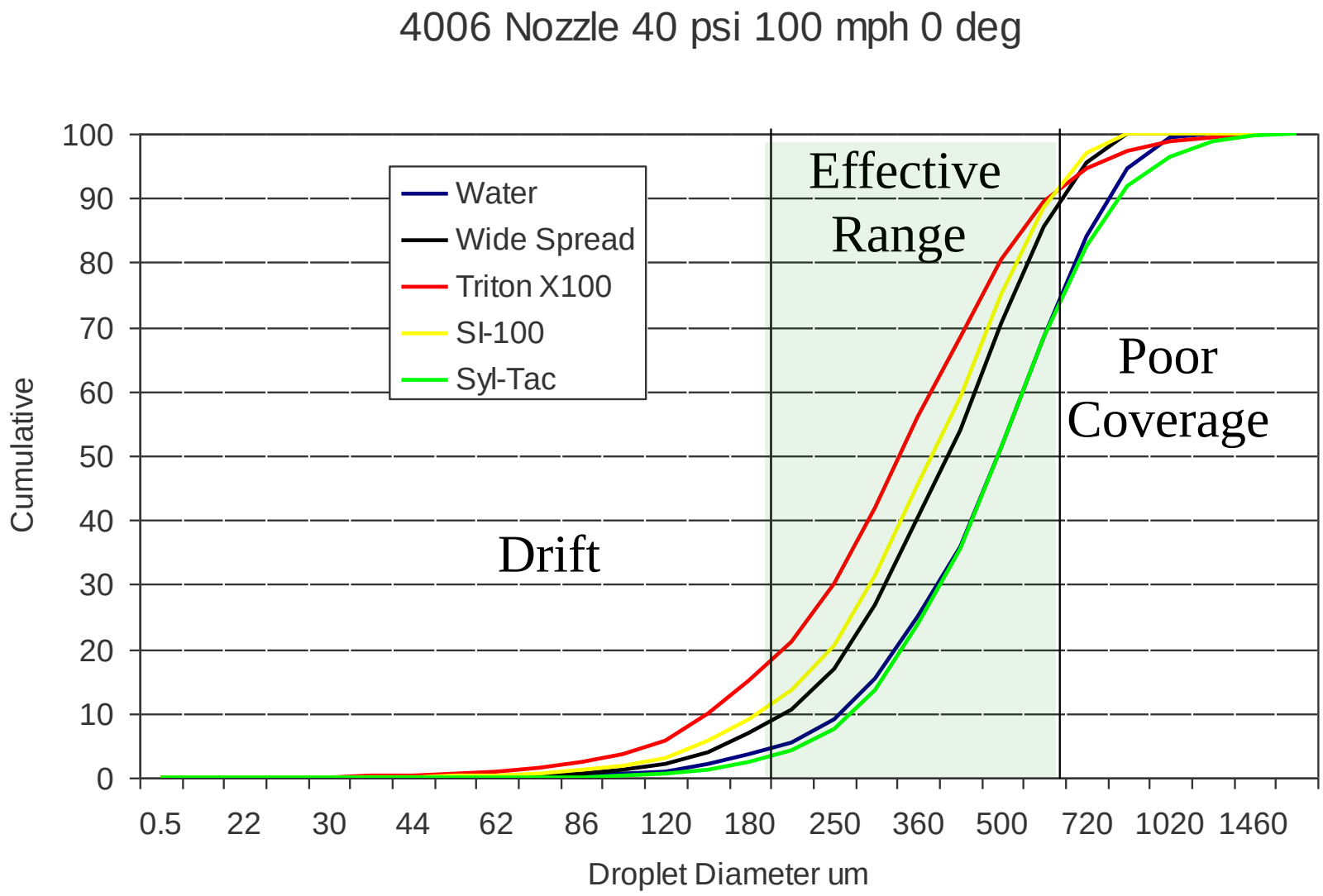
N8347K

Problem:

1. Tank mixes have multiple chemical and adjuvants mixed together and these mixtures may atomize differently from water or researcher-tested mixtures.
2. Applicators don’t know how these mixtures affect drift and efficacy.
3. A simple way of testing a mix before or during a spray job would help in management of the best equipment combination and field conditions to spray in.
4. Spray mix properties can change during a spray job; a method of monitoring is needed.

Effects of formulation with similar active ingredient

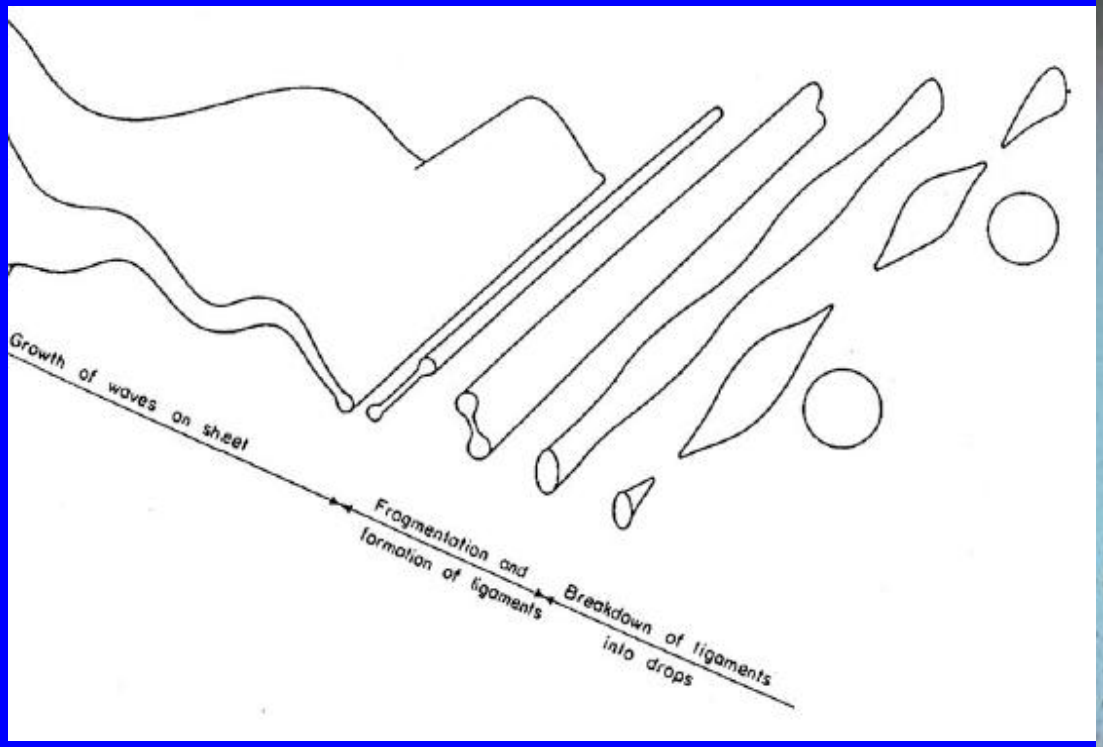


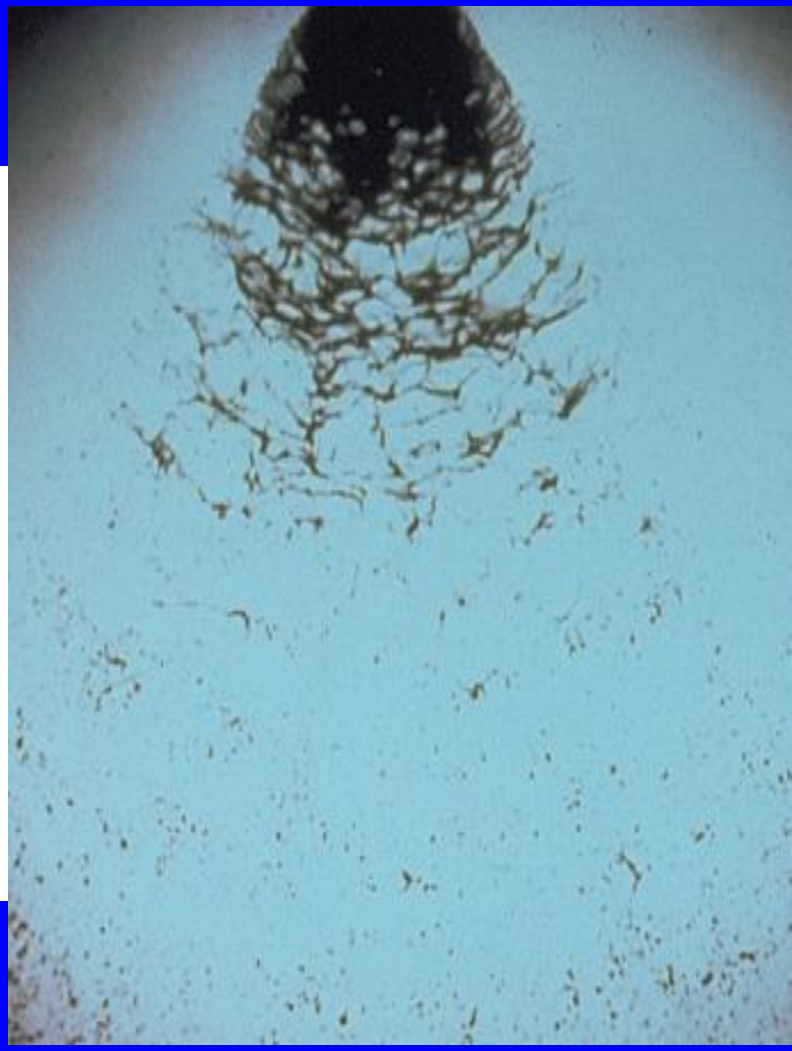

4006 Nozzle 40 psi 100 mph 0 deg
Water
Wide Spread
Triton X100
SI-100
Syl-Tac
Effective Range
Poor Coverage
Drift
Cumulative
100
90
80
70
60
50
40
30
20
10
0
0.5
22
30
44
62
86
120
180
250
360
500
720
1020
1460
Droplet Diameter um

Objectives for this project:

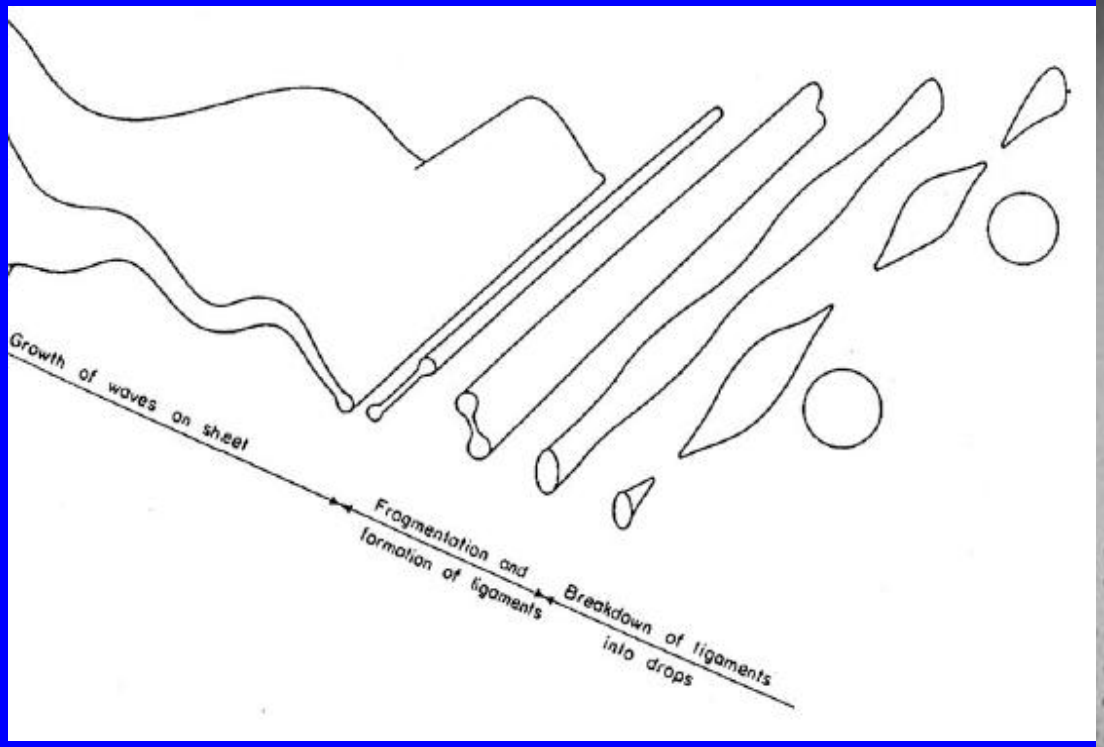
1. Determine feasibility for using a simple vibration measurement, based on commercial components, to predict spray quality.
2. Implement a commercial system suitable for on-board and in-field use.

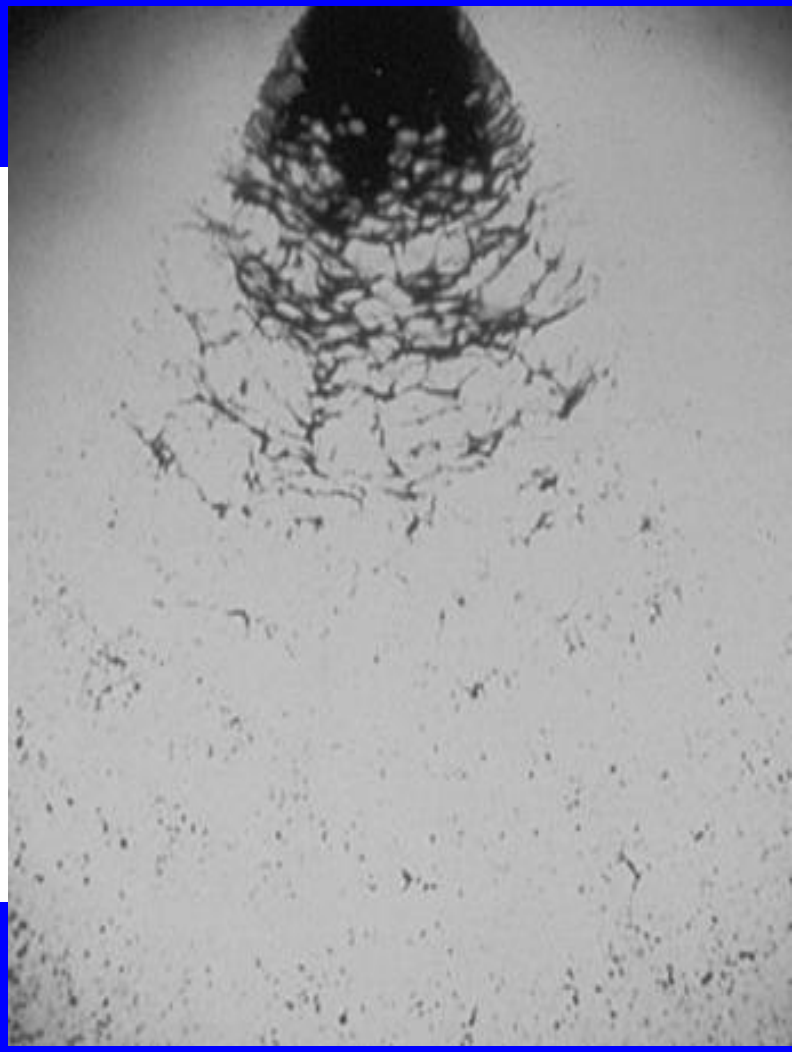
Why *vibration*?



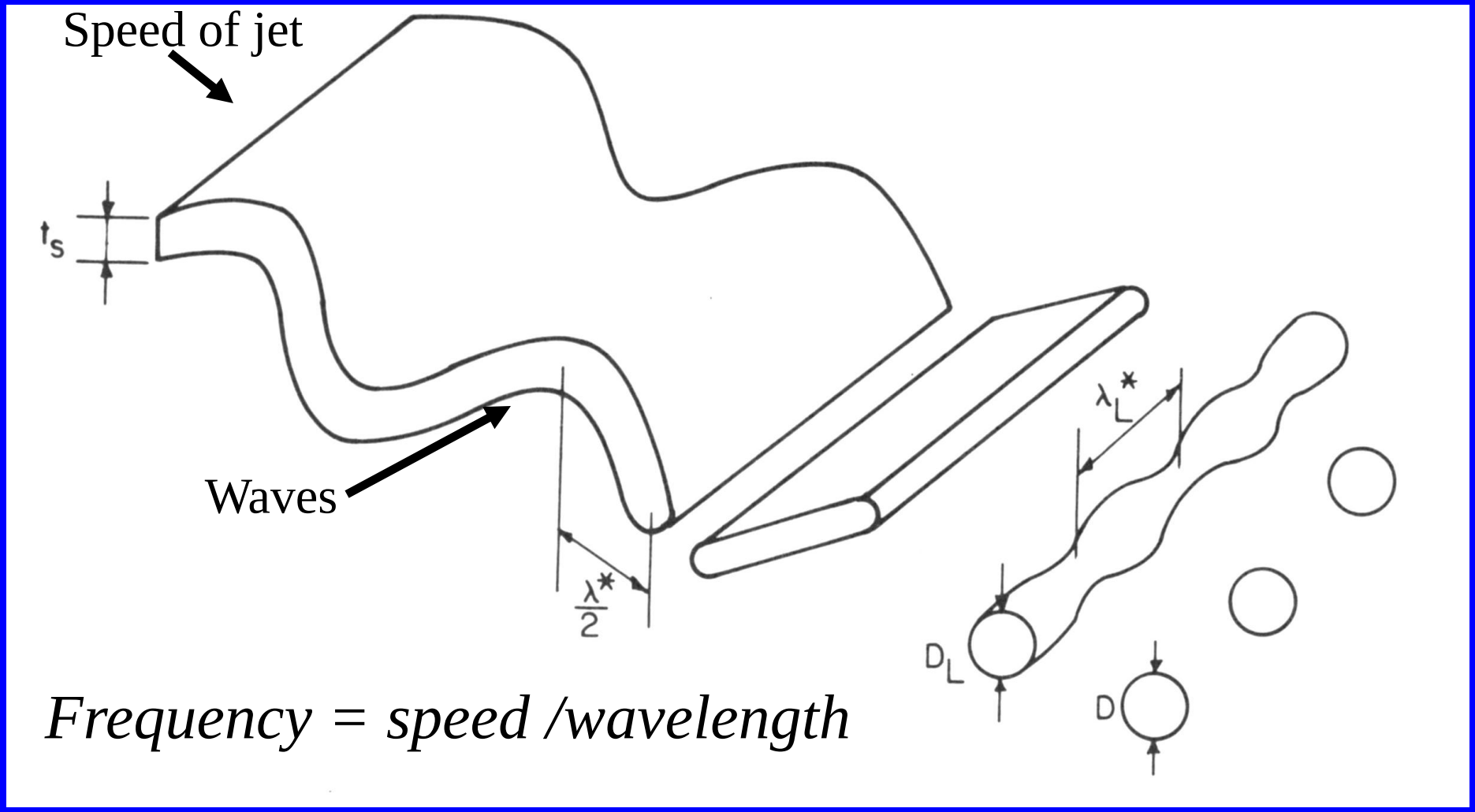


Atomization is *vibration.*





Idealized sheet breakup (Lefebvre, 1989)



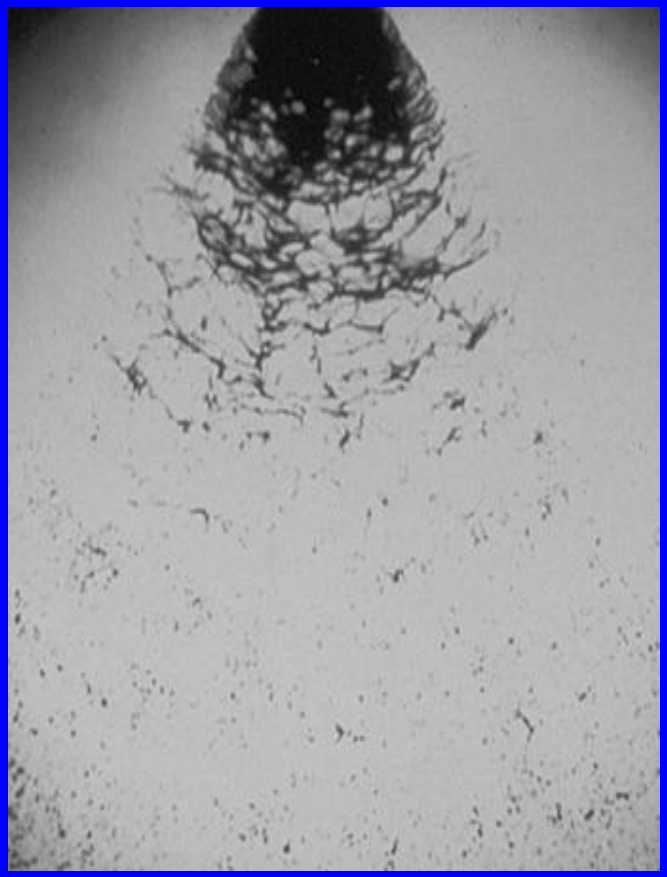
Frequency = speed /wavelength

Theory says

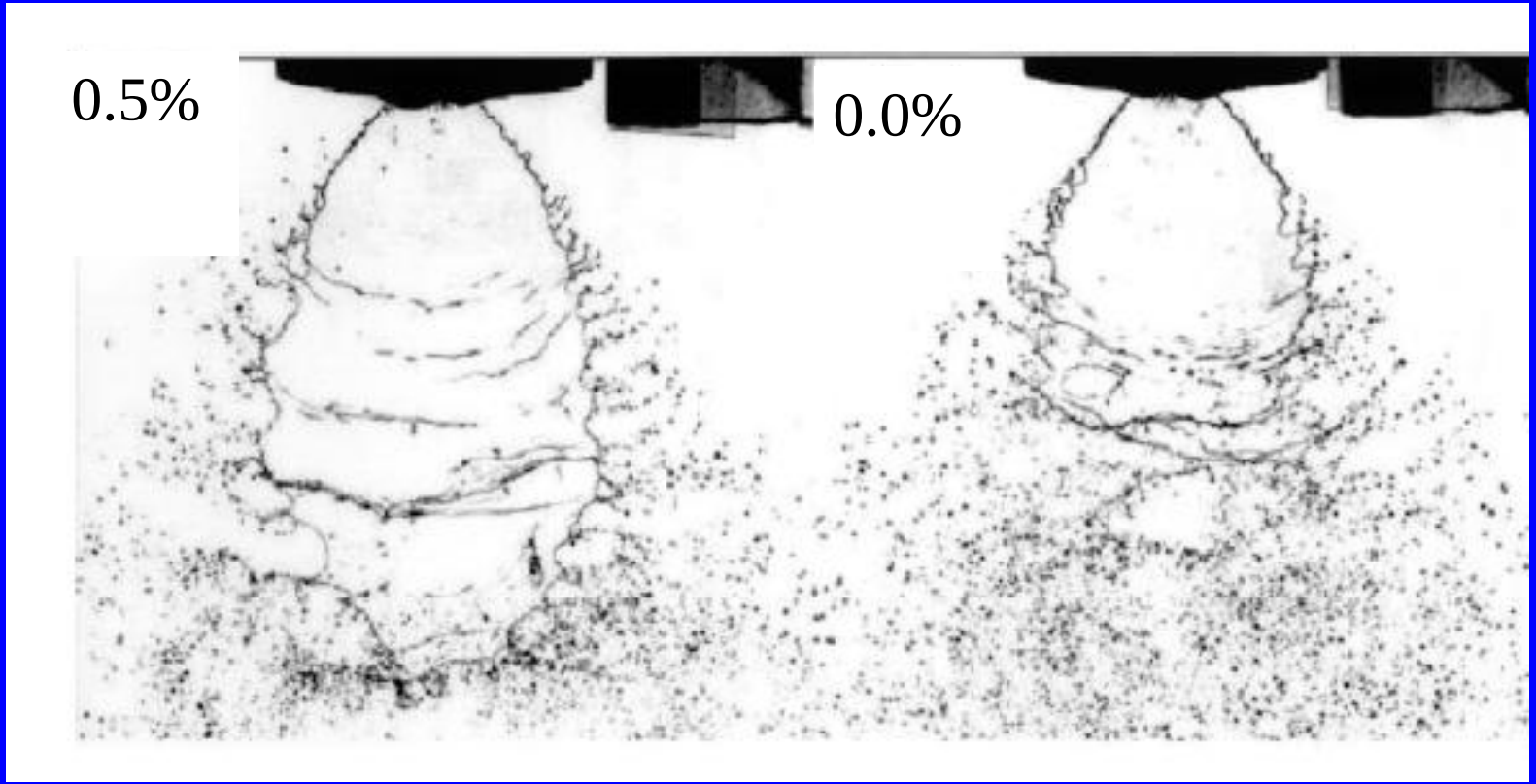
f **= 3.5 to 9.5 kHz**

is the frequency of most ag nozzles.

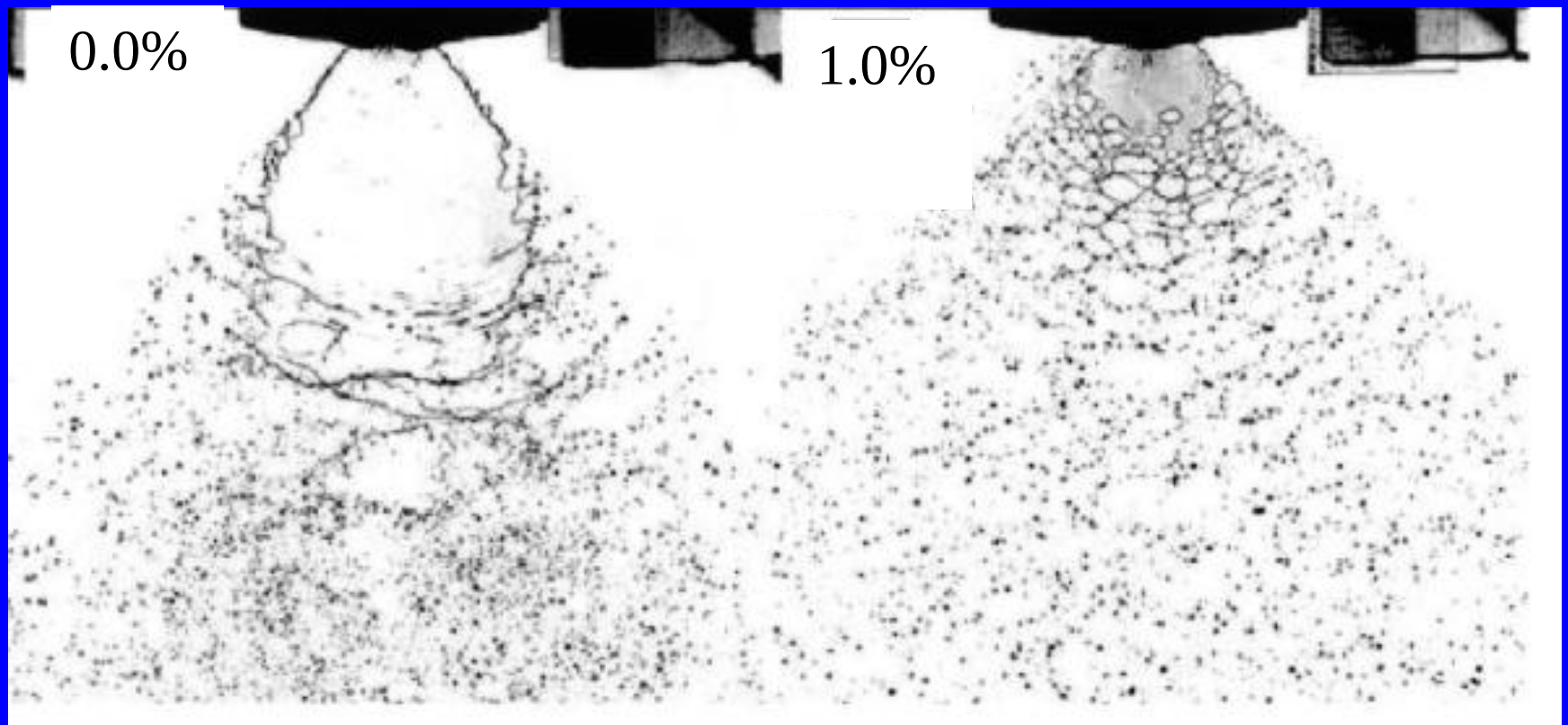
Fluid properties affect these frequencies.



Atomization
- surfactant addition



Atomization
- oil addition



Instruments, apparatus and procedures

- Sympatec laser droplet size analyzer
- Static test stand
- Wind tunnel
  - 150 mph
  - 2 ft X 2ft X 8 ft working section
- Vibration measured with ICP tri-axial accelerometer (20 kH sampling, 10 kHz cut off, FFT analysis)
- Commercial, handheld Palm-based vibration system.

Instruments, apparatus and procedures

- Static test
  - nozzles
    - TX-6
    - 80015
    - 8004
    - 8008
    - AI11004
    - ULD8002
    - XR11005
    - TT11004
  - 4 pressure settings 20, 40, 60 and 80 psi
  - 20 tank mixes

Instruments, apparatus and procedures

- Wind tunnel testing
  - Tested Nozzles
    - 4006
    - CP
    - D5-45
    - D5
  - Pressures
    - 20 psi
    - 40 psi
    - 60 psi
    - 80 psi

-Angles to airstream

0

45

90

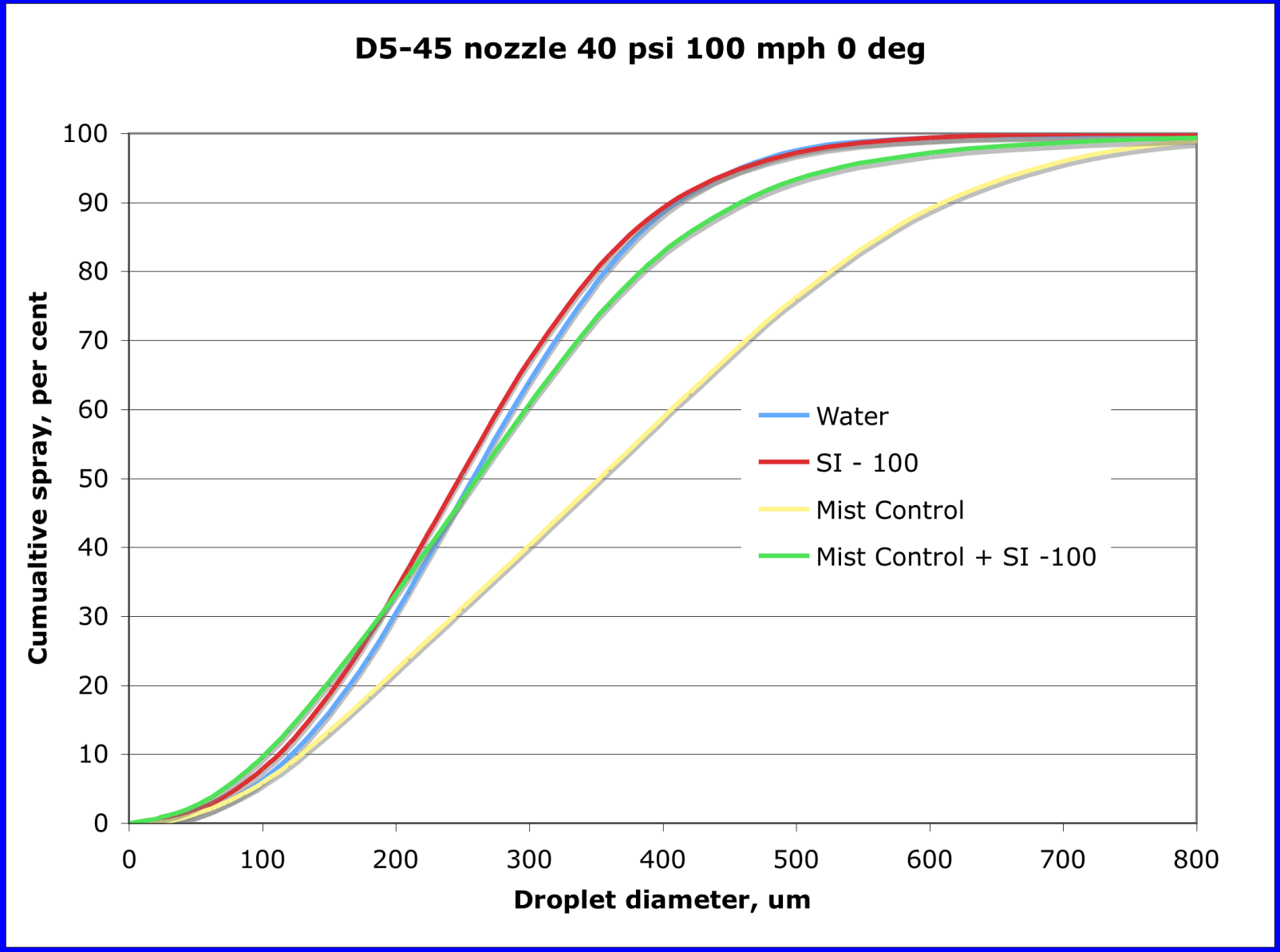
Fluid properties of the test fluids

Fluid	Concentration	Surface Tension	Viscosity
-	per cent	mN/m	mPa S
Ethanol	10	50.3	1.21
Ethanol	20	40.9	1.52
Ethanol	50	29.5	2.29
Glycerin	10	71.6	1.29
Glycerin	25	70.7	1.83
Glycerin	40	70.1	4.43
Wide Spread	0.5	36.0	0.93
Acti-Spread	0.5	40.4	0.92
Ethanol +	25/25	37.3	4.23
Glycerin			
Si-100	0.25	25.7	1.09
Mist Control	1	72.3	1.01
Si-100 +	0.25/1	26.1	1.15
Mist Control			

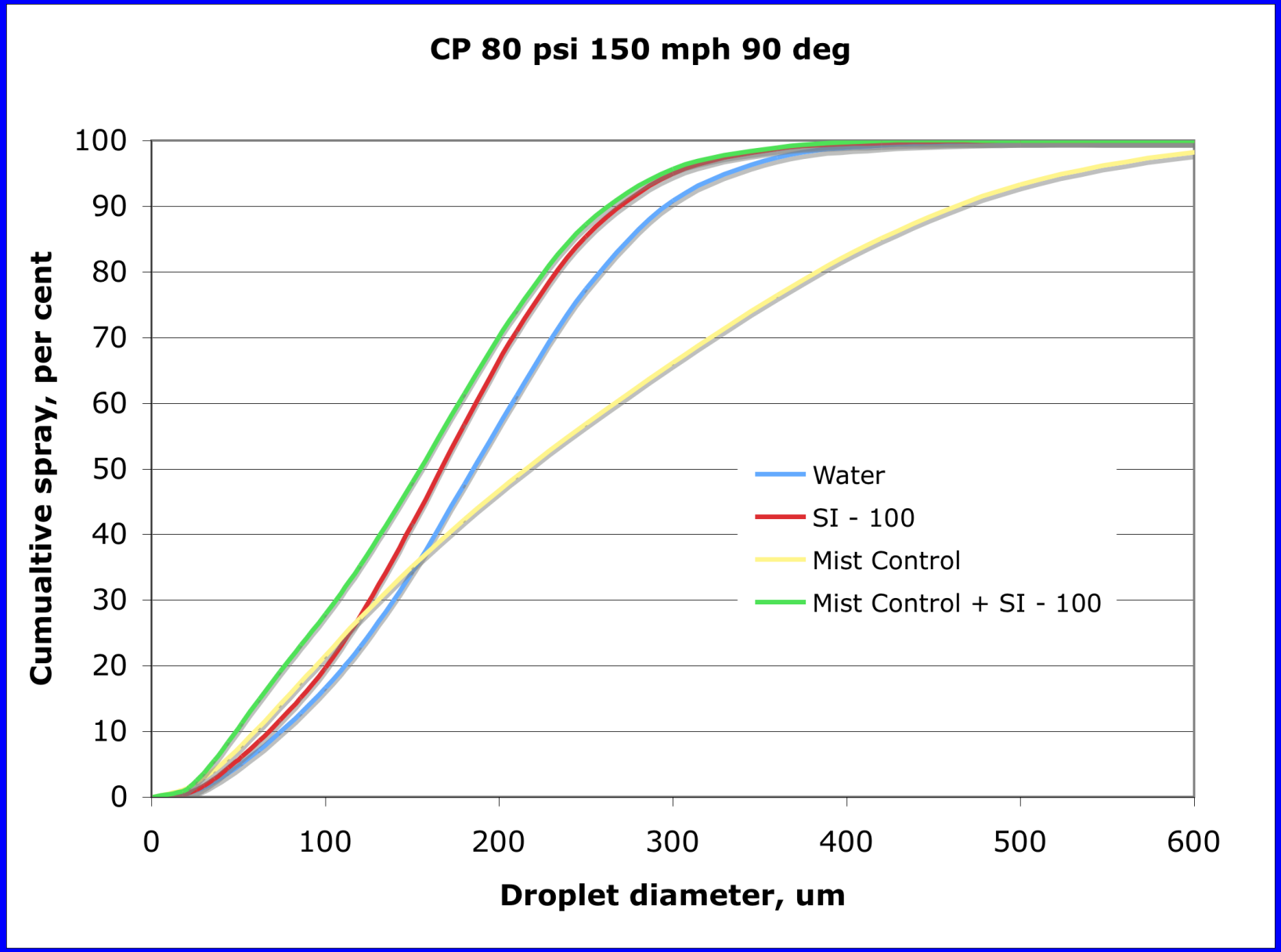
HELOS/KF
DANGER
CRAFTSMAN

HELO/KF

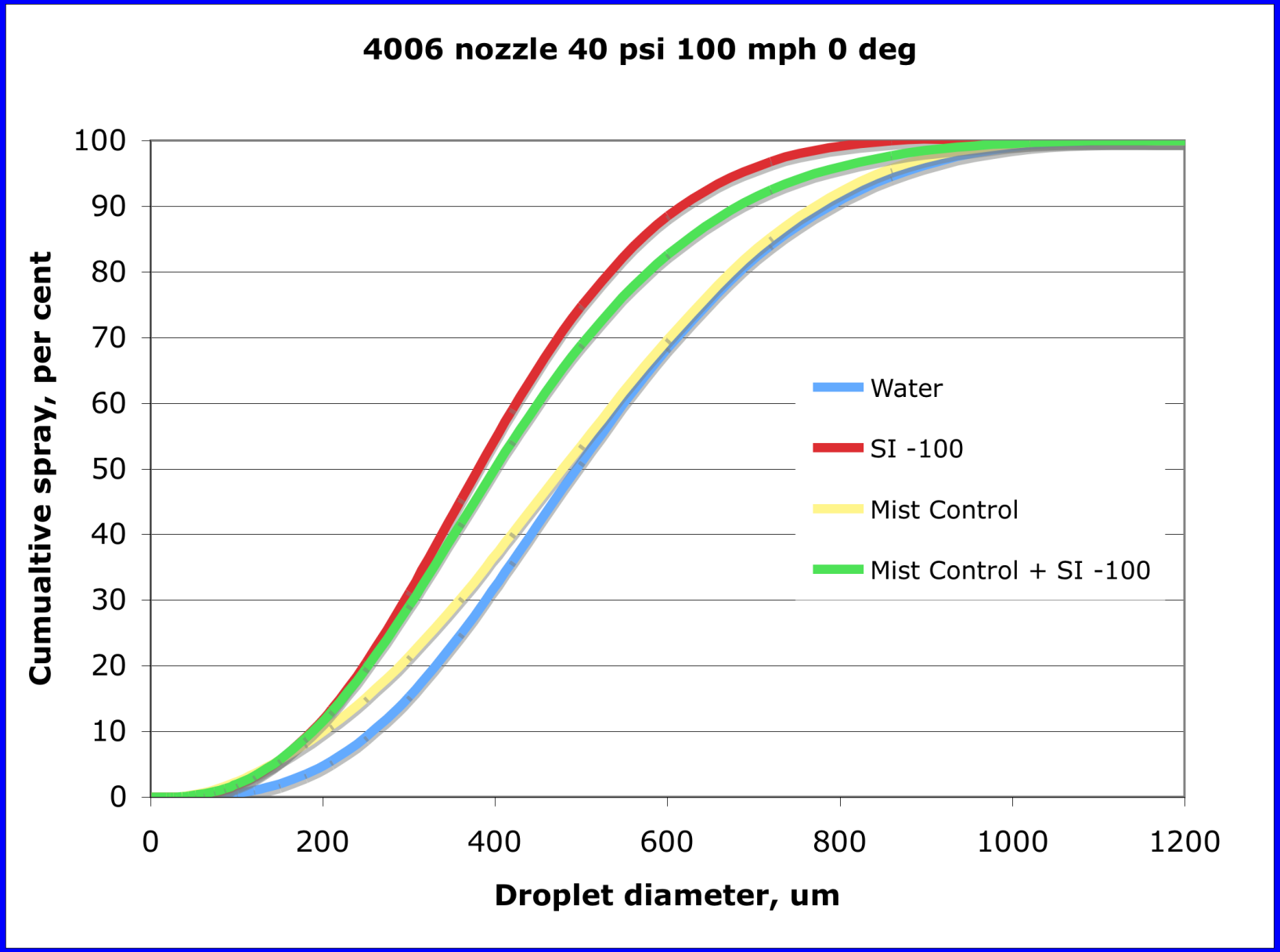
Droplet size results - effect of mixture



Droplet size results - effect of mixture



Droplet size results - effect of mixture

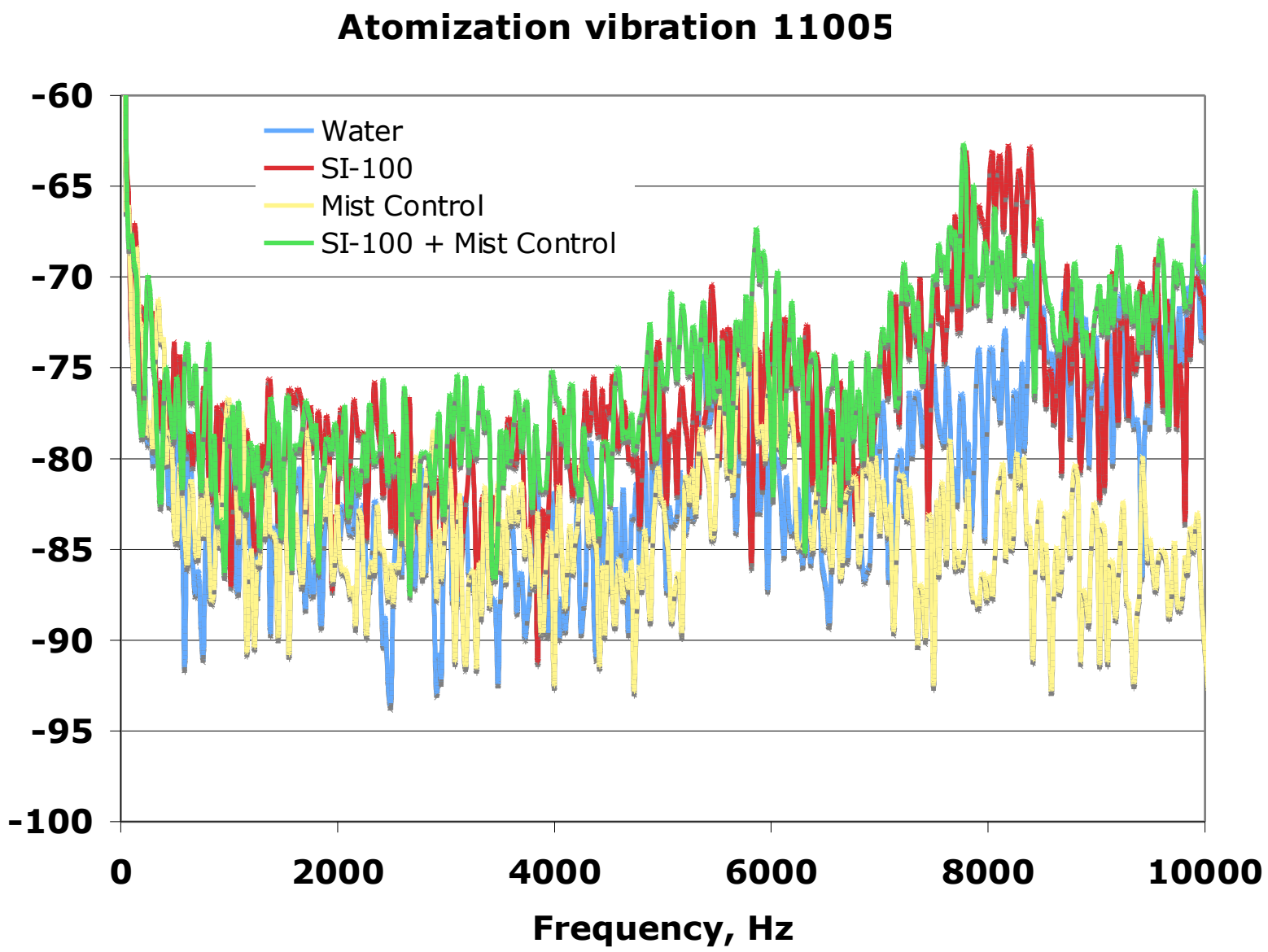


Z 356A22
SN 22589

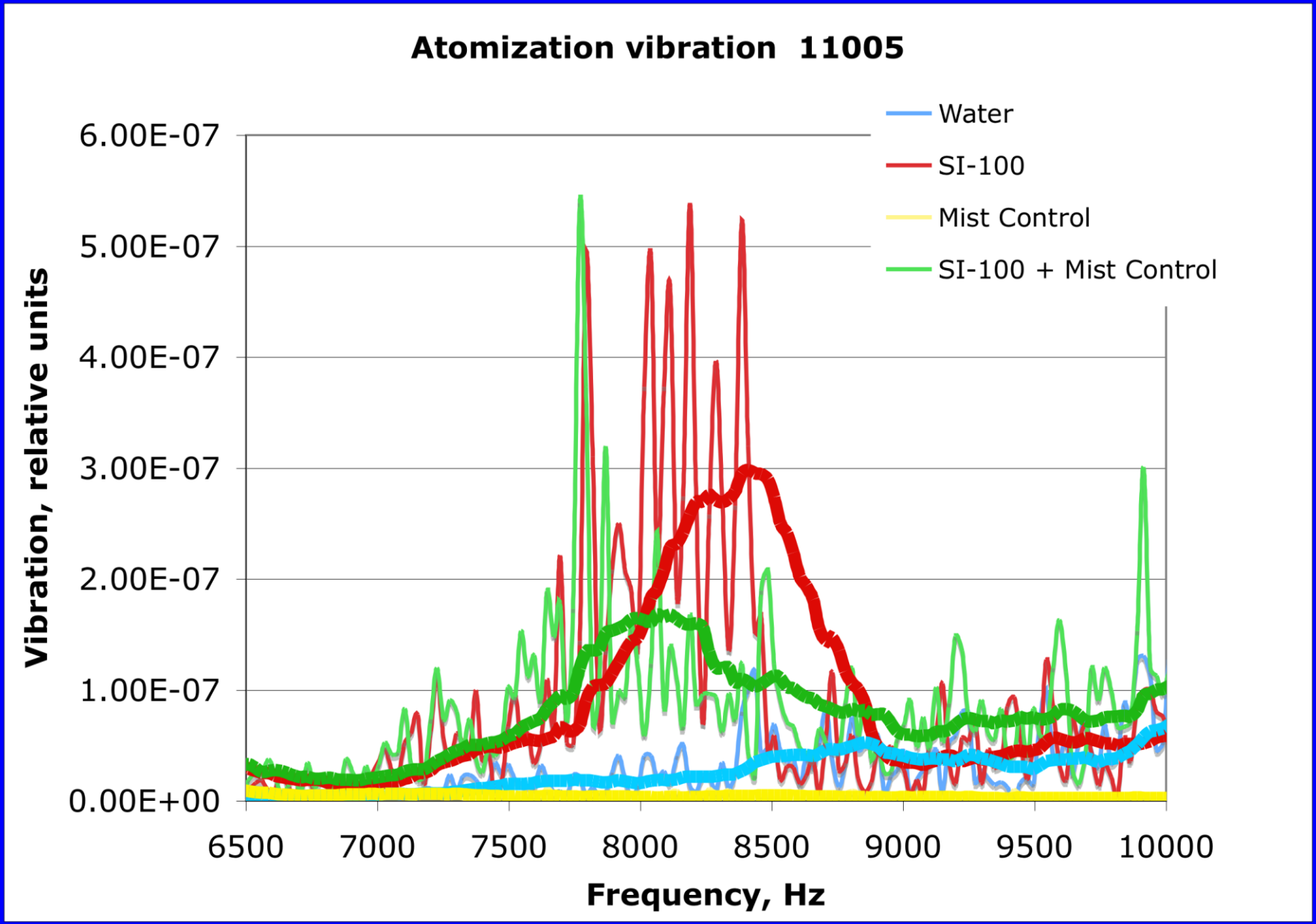
Tektronix
TPS 2012
PCB
Lab-Volt

Datastick Spectrum
VSA-1214
StartCfg
Overall: 0.033 g rms
Pwr
Read
Setup
palm

Nozzle vibration



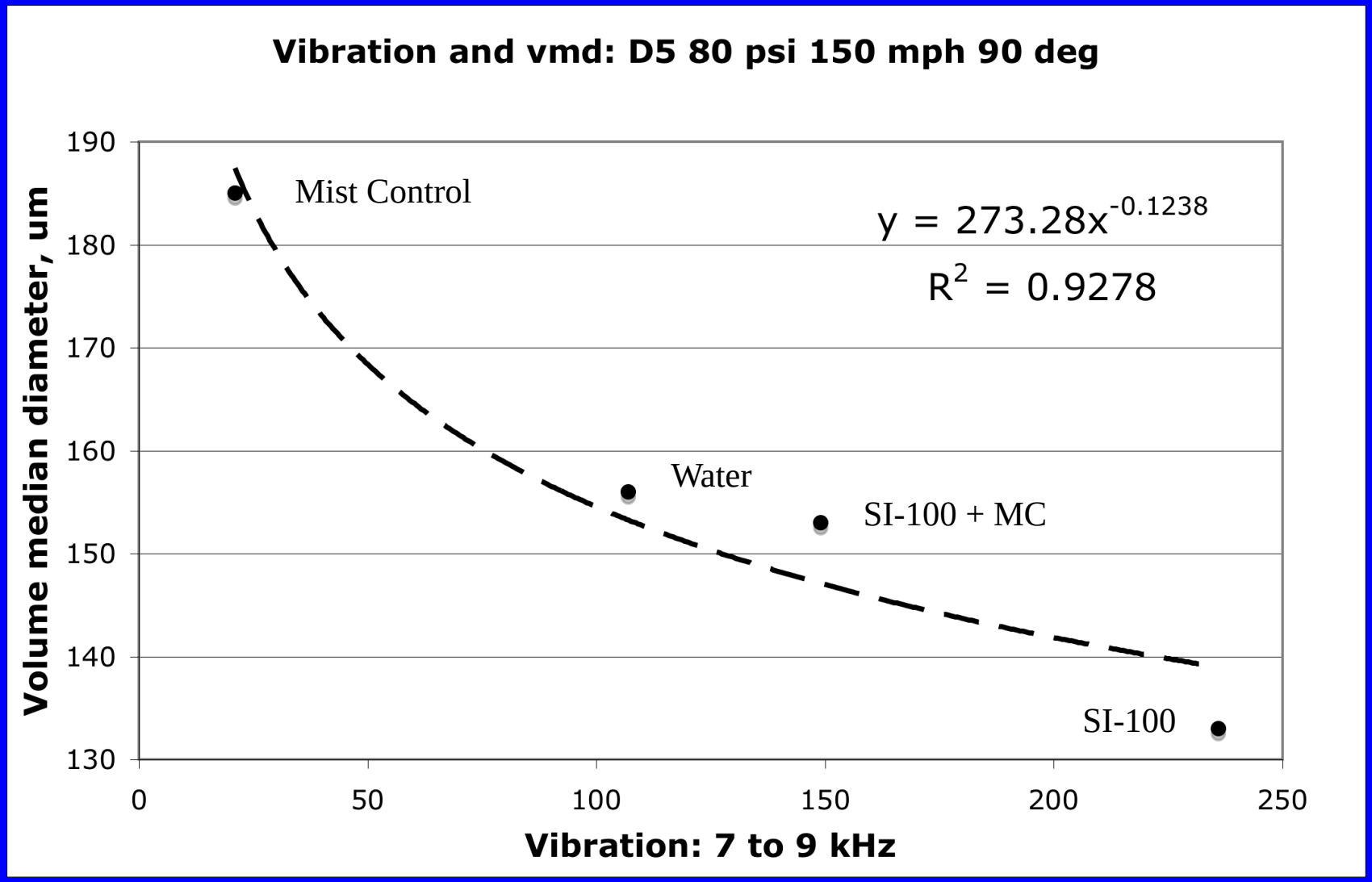
Nozzle vibration



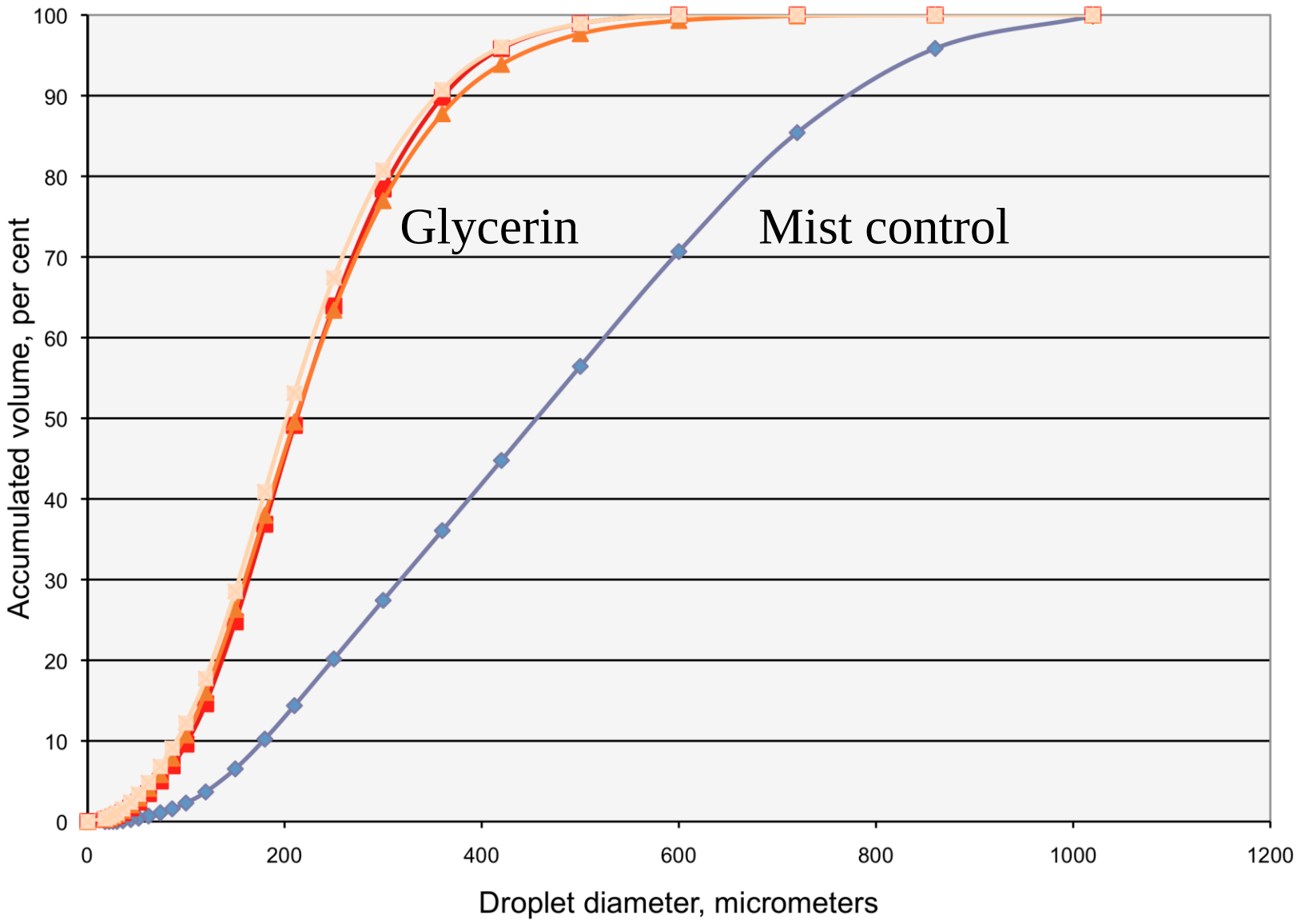
Vibration - vmd relationship

Fluid	Vibration 7-9 kHz		D5 vmd	D5-45 vmd	CP vmd
	TTJ11004 + 11005		um	um	um
Water	107		156	256	185
SI-100 surfactant	236		133	240	165
Mist Control polymer	21		185	351	215
Si-100 + Mist Control	149		153	257	155

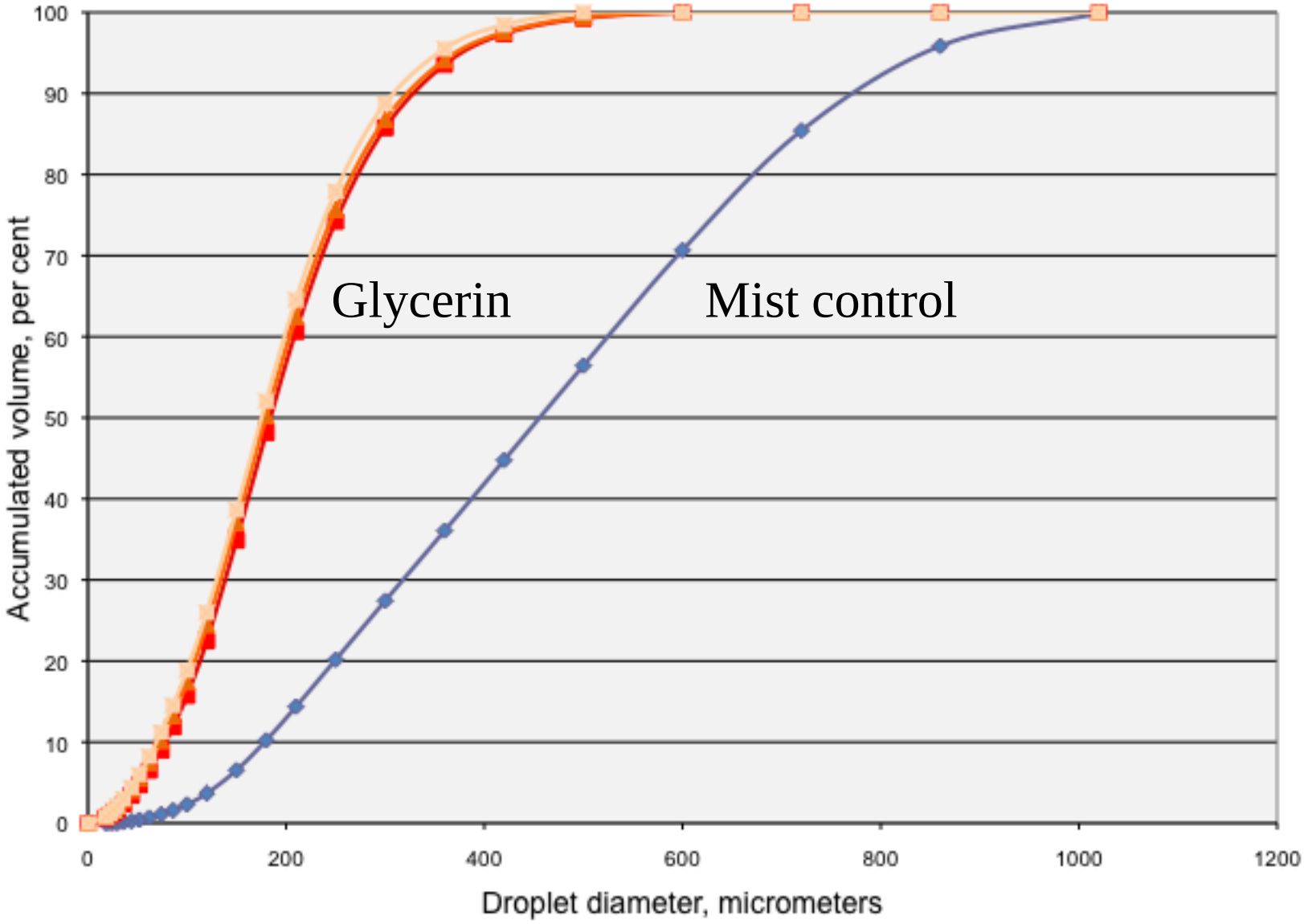
Predicting vmd from vibration



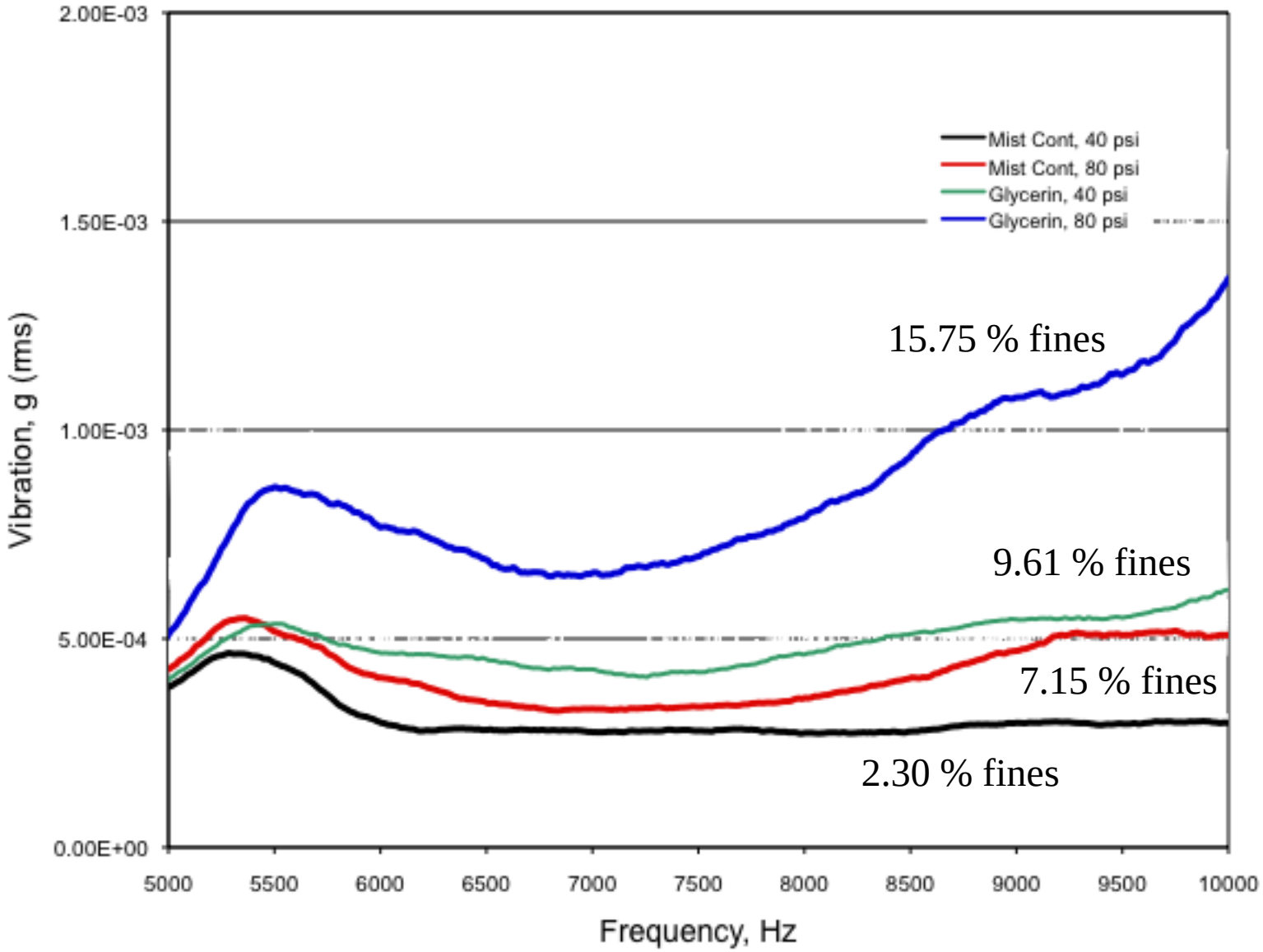
Effect of polymer – 40 psi

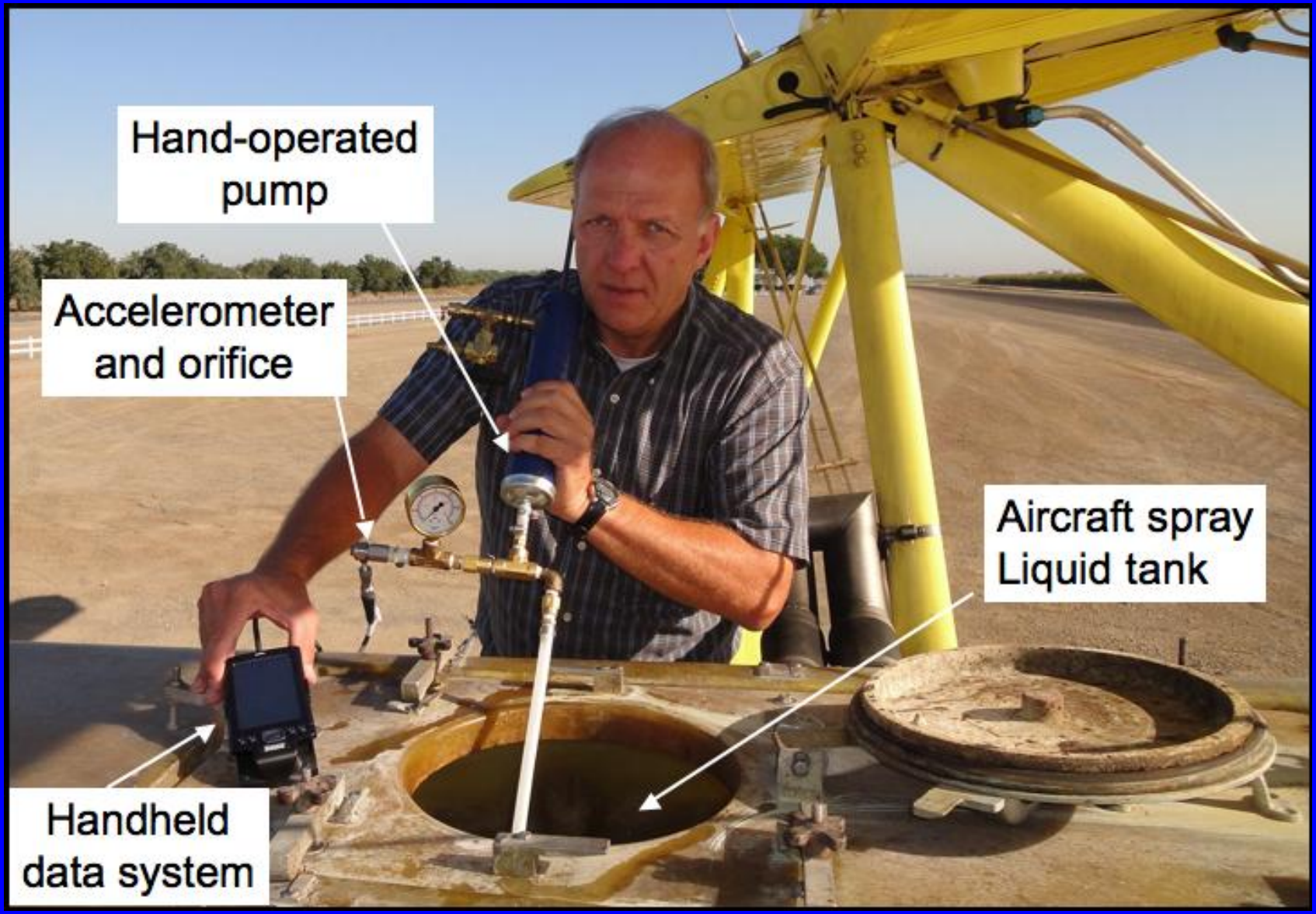


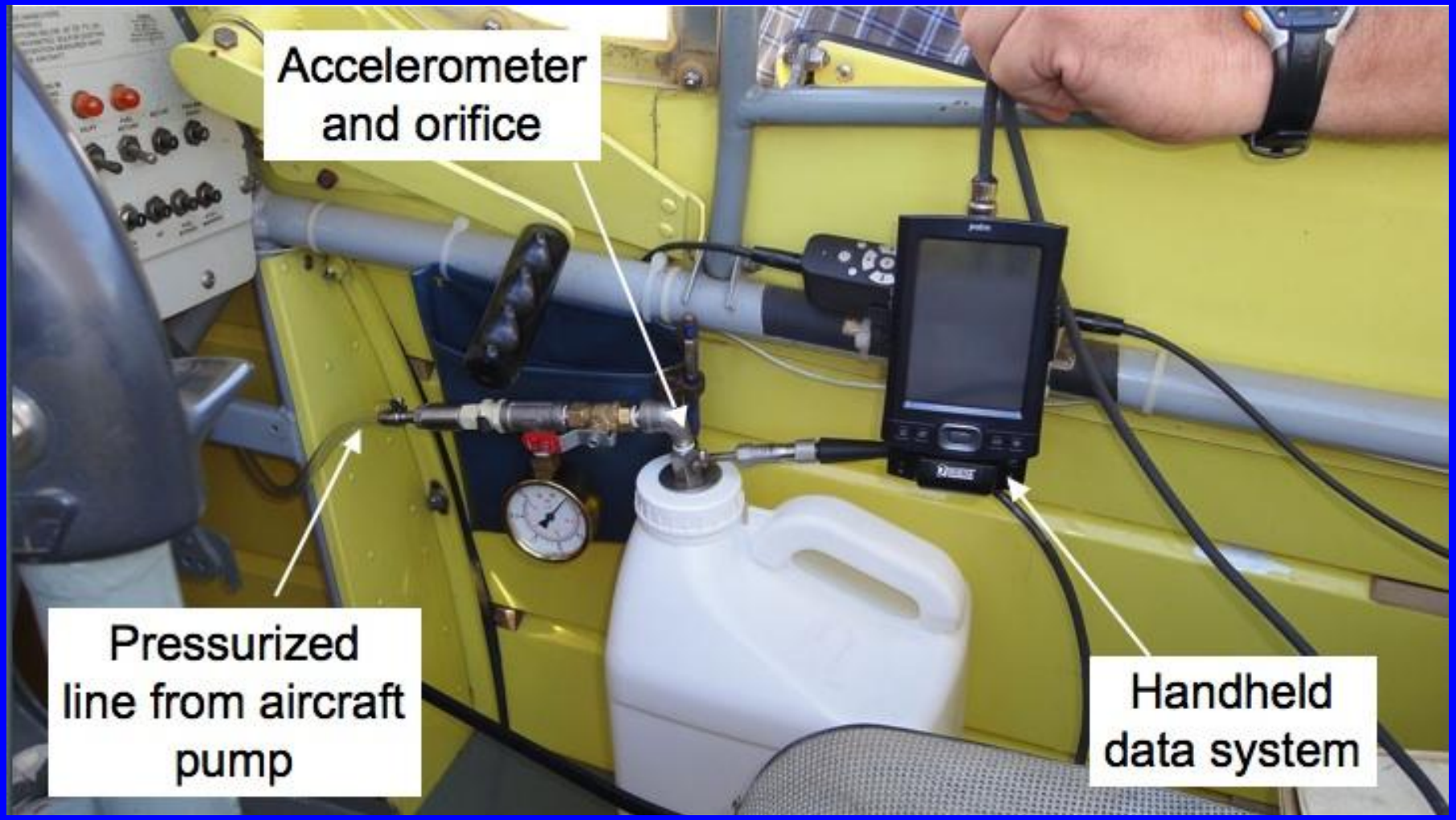
Effect of polymer – 80 psi



Vibration of test fluids




Hand-operated pump
Accelerometer and orifice
Aircraft spray Liquid tank
Handheld data system


Accelerometer and orifice
Pressurized line from aircraft pump
Handheld data system

Conclusions

- As already known, tank mix properties affect the droplet size spectra produced by ag spray nozzles.
- Fluid properties affect the vibration of spray from nozzles.
- There are repeatable trends between vibration measurements and droplet size produced by tank mixes.

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"Field Device for Determining Atomization Properties of Agrochemical Tank Mixes"

Grant No. 2008-02295

Appreciation is expressed to Bob's Flying Service, Knights Landing, CA

Thank You

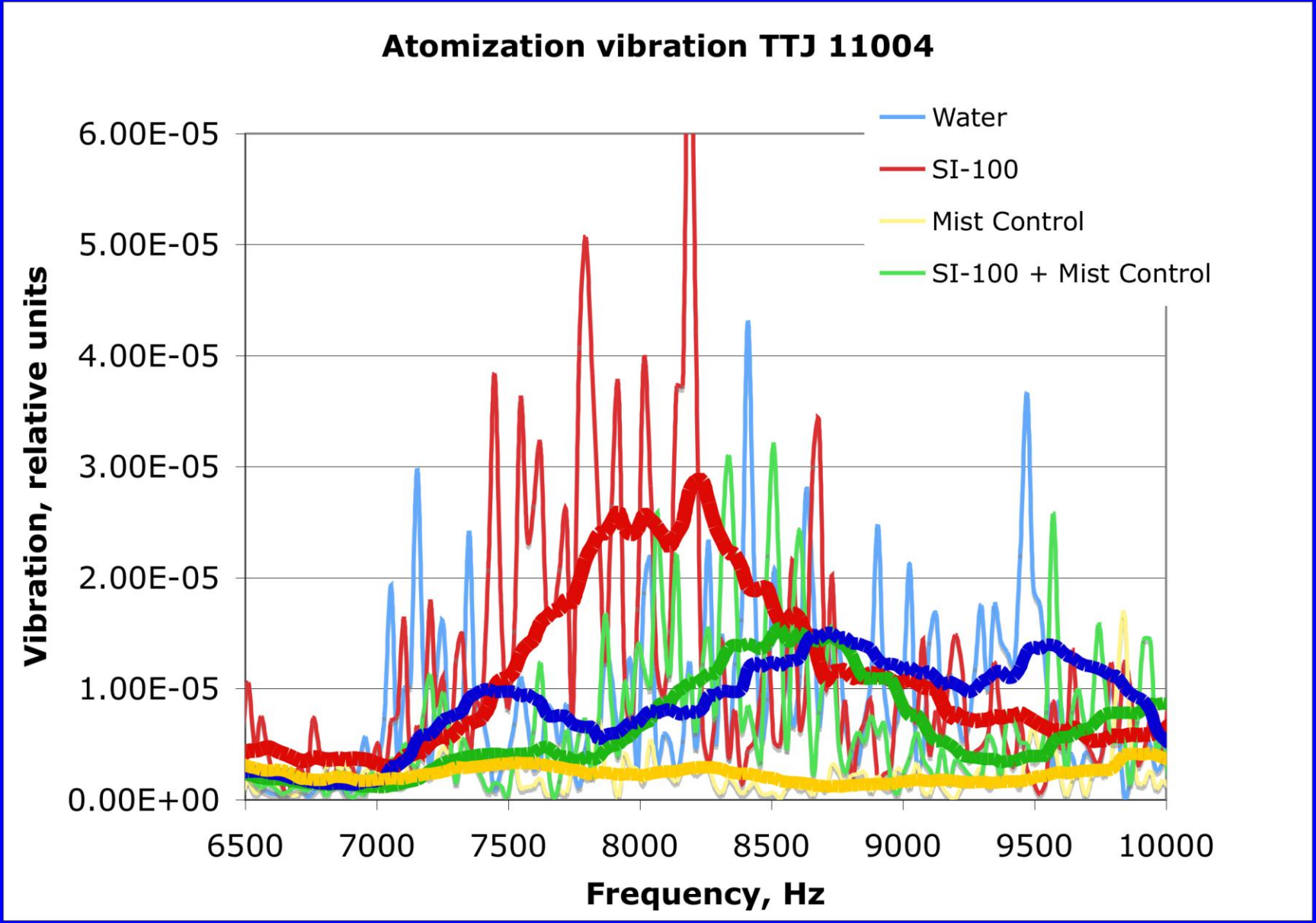
N8347K

Instruments, apparatus and procedures

- Static test stand
- Wind tunnel
- Vibration measured with ICP tri-axial accelerometer (20 kHz sampling, 10 kHz cut off, FFT analysis)
- Nozzle test stand with pressure and flow instruments.

Vibration Test Combinations

- 6 Nozzles
  - 11005
  - AI11003
  - AI11004
  - TTJ11004
  - TX-6
  - ULD120-02
  - XR1105
  - TT11004

- Four Pressure Settings 20, 40, 60 and 80 psi

Nozzle vibration