

Measurement of Corrosive, Odorous and Potentially Harmful Gases from Imported and Domestic Wallboard



**Presentation for:
Technical Symposium on Corrosive
Imported Drywall
November 5th, 2009, Tampa FL**

Michael Tuday, Ku-Jih Chen, Hani Cherazaie,
Alyson Fortune, Wade Henton, Christopher Parnell,
Madeleine Dangazyan, and Chris Cornett



Presentation Outline

- Introduction/Questions Posed
- Jar Test: Blackening/Corrosion
- Elemental Sulfur
- Reduced Sulfur Gases
- Database Statistics
- Corrosive vs. Noncorrosive Samples
- Chamber Tests: Carboxylic Acid/Aldehydes/VOCs
- Jar Tests– Understanding Mechanism
- Summary/Conclusions
- Acknowledgements

Questions Posed

- Can tests be developed to differentiate Corrosive Drywall from Noncorrosive Drywall?
- What potentially harmful chemicals are emitted from the Corrosive Drywall?
- What chemicals cause the odor?
- What is in the Corrosive Drywall that causes copper and other metals to blacken and corrode? What is the mechanism?

Jar Test: Blackening/Corrosion



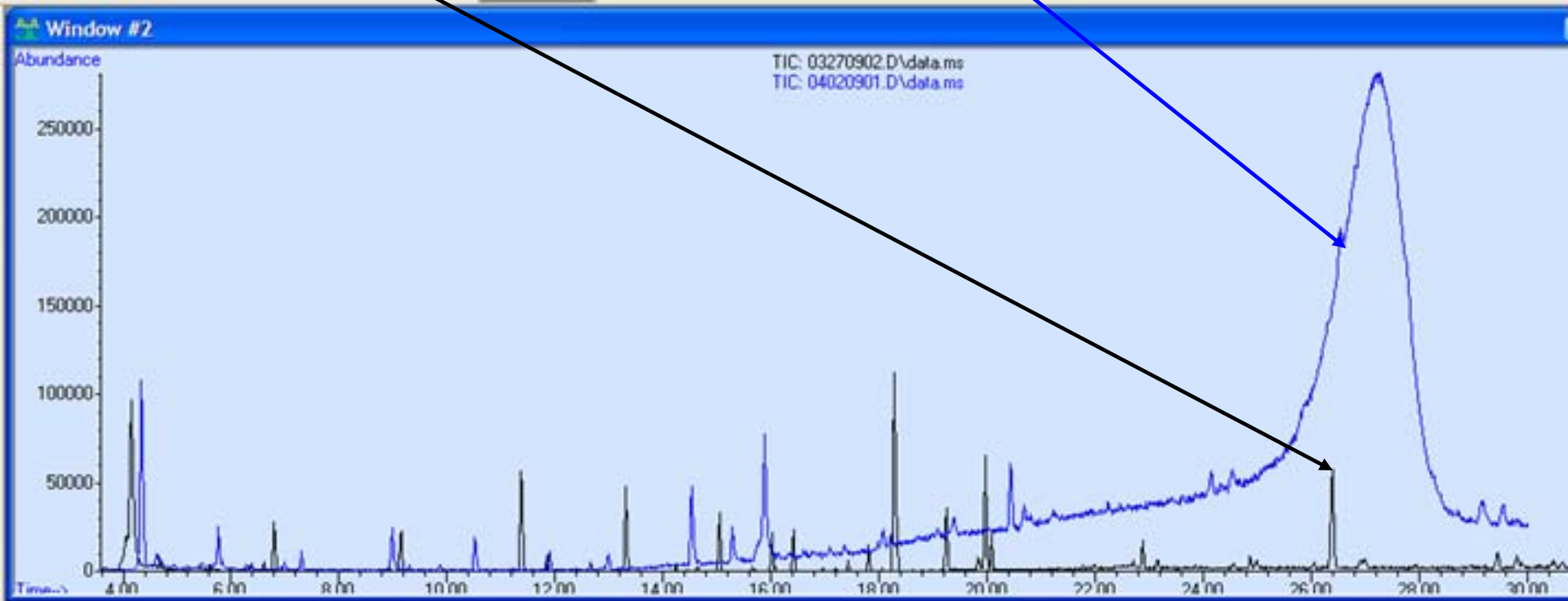
- 3" x 3" piece of drywall on platform in 1L glass jar
- 3 mL deionized water
- 3" length of 1/4" O.D. copper tubing (lightly sanded with extra-fine sandpaper to remove surface contaminants)
- "Hot Room" at 37°C
- Blackening/Corrosion evaluation after 21 days

Corrosive vs. Noncorrosive

Direct Thermal Desorption- Gas Chromatography/Mass Spectrometry

Noncorrosive

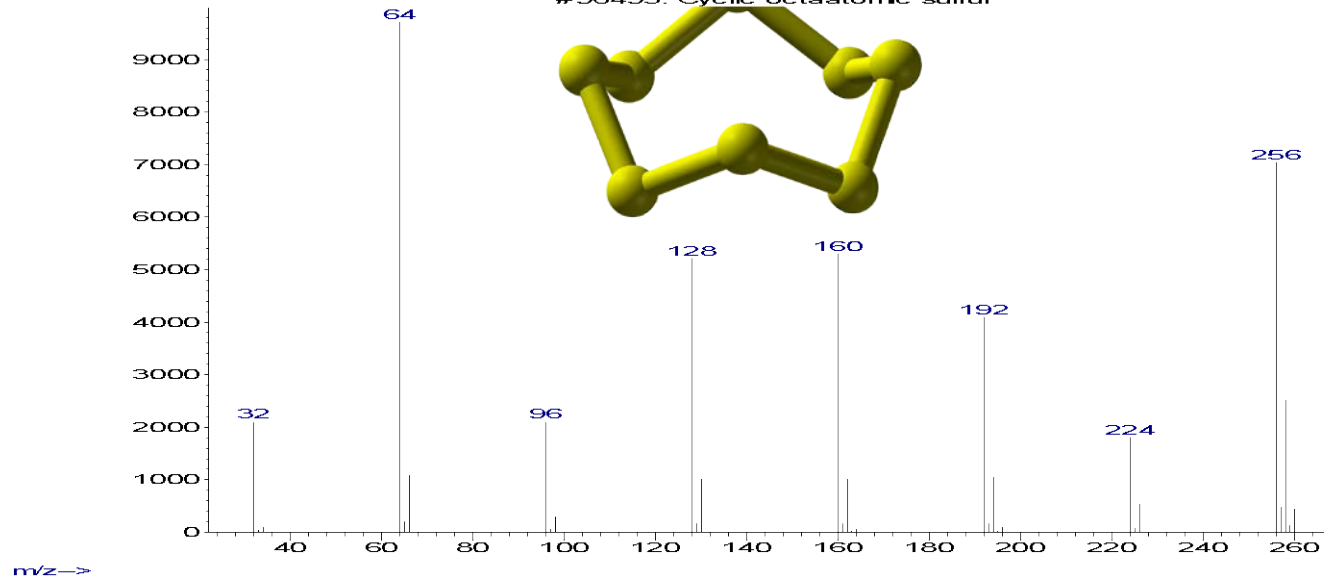
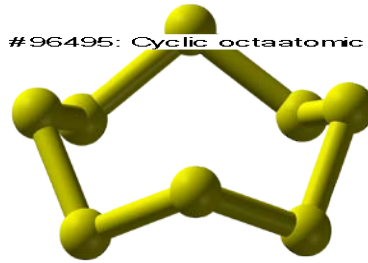
Corrosive



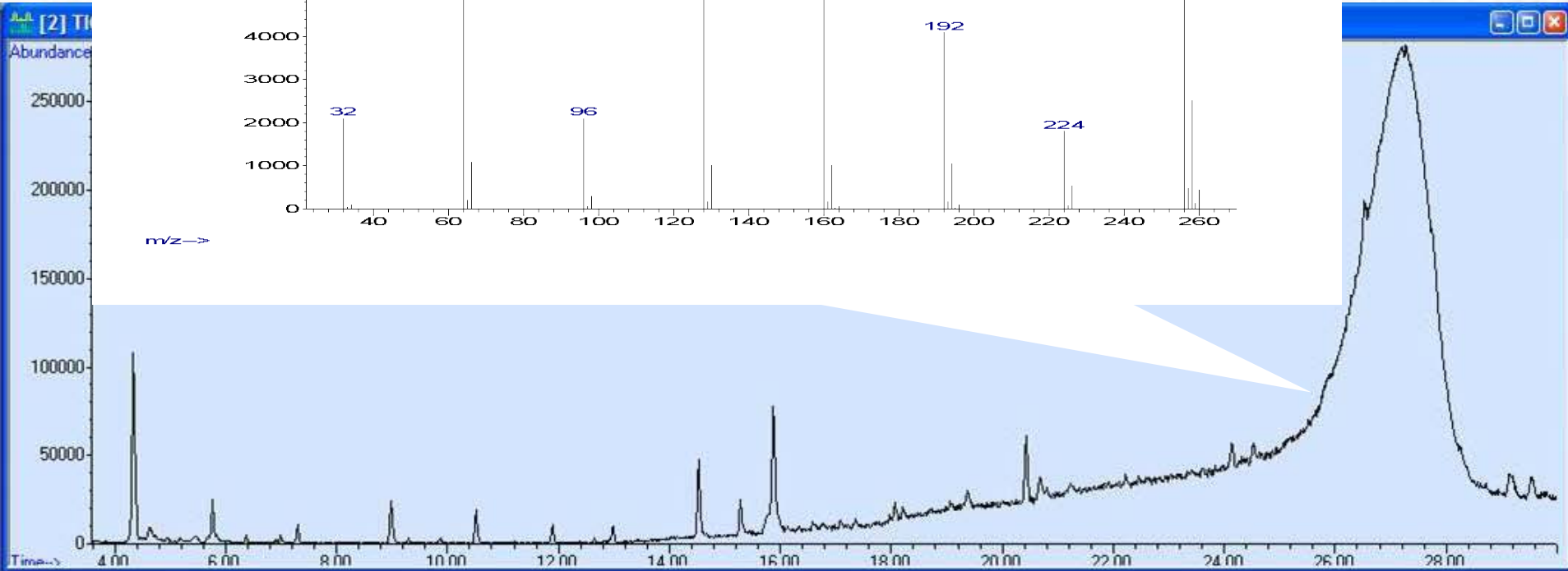
Corrosive Drywall Sample

Abundance

#96495: Cyclic octaatomic sulfur



m/z →



Elemental Sulfur Analysis

- Extraction of pulverized drywall
- Analysis for S₈ by Gas Chromatography/
Mass Spectrometry (GC/MS)
- Report in milligrams per kilogram (mg/Kg)
- Internal standard technique
- Added surrogate for Quality Control

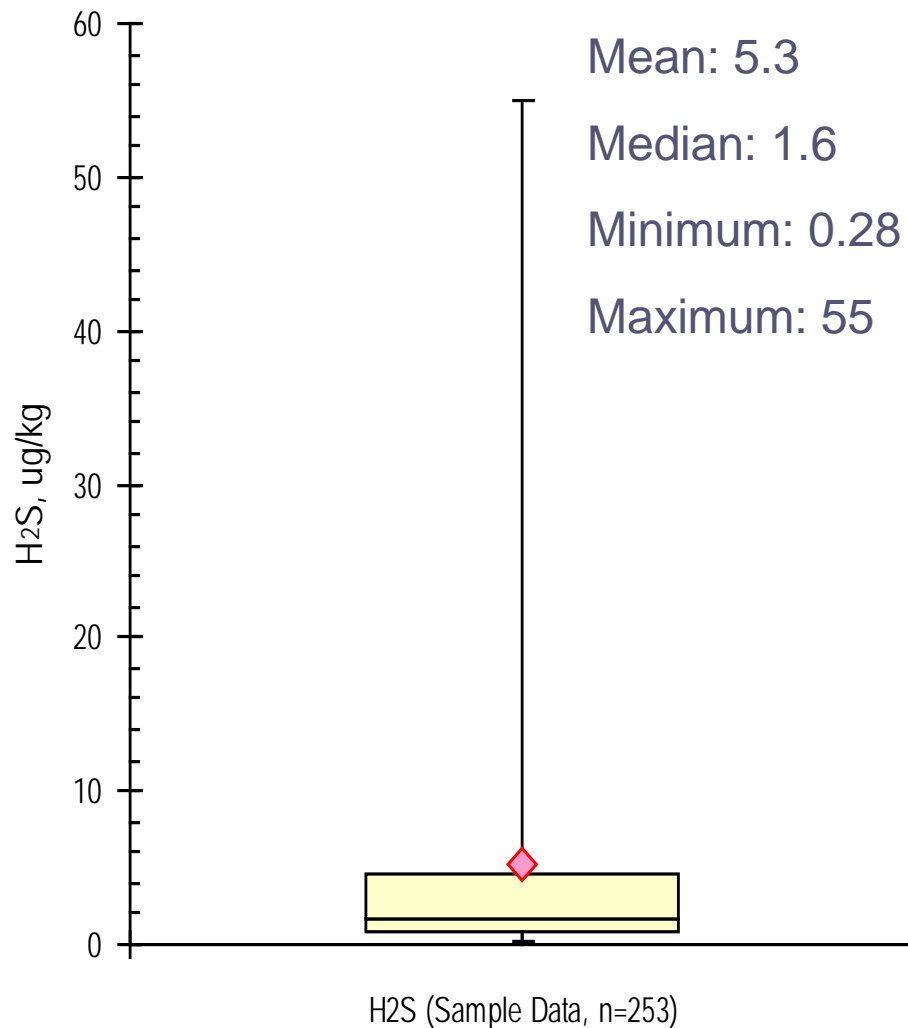
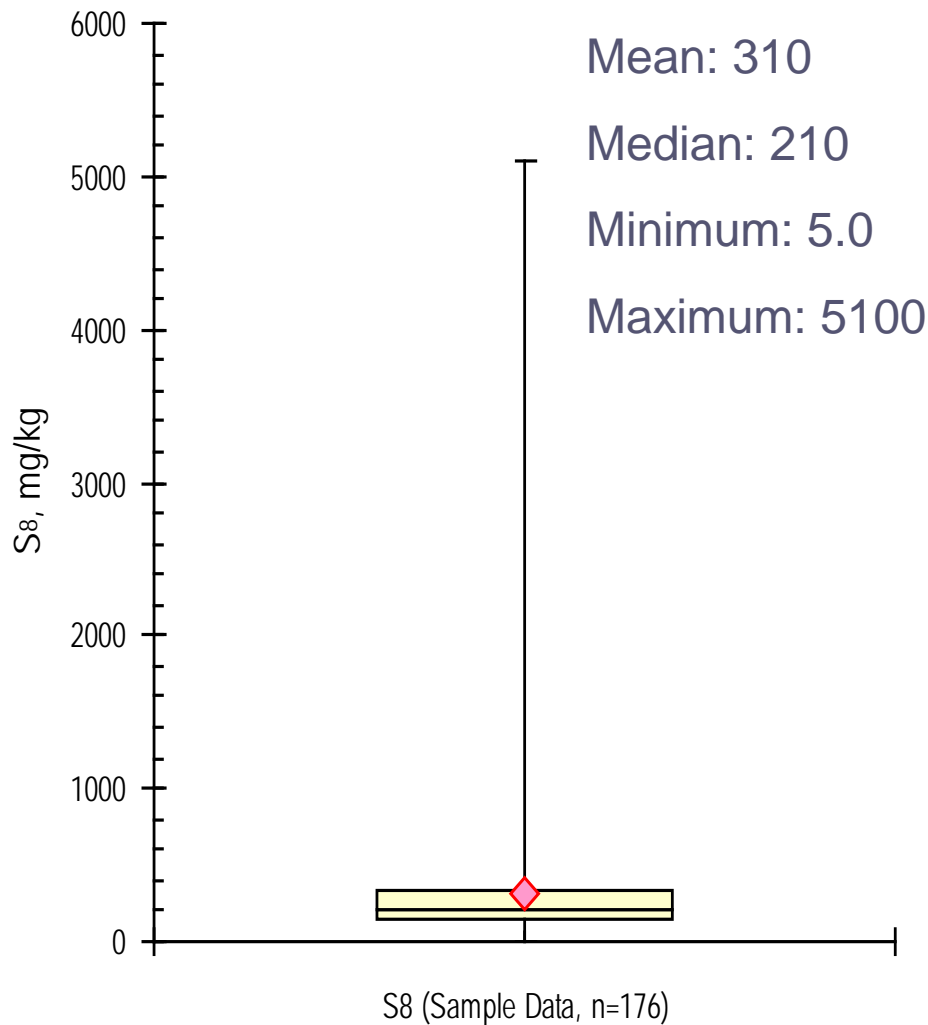
Analysis for Reduced Sulfur Gases

Static Chamber Technique

- 25g drywall in chamber
- 500 mL of humidified Zero-Grade Air
- Incubation period: 72 hours at 37°C
- Analysis by Gas Chromatography/Sulfur Chemiluminescence Detection (GC/SCD)
 - 20 target analytes including:
 - Hydrogen Sulfide (H₂S)
 - Carbonyl Sulfide (COS)
 - Carbon Disulfide (CS₂)
 - 2-5 ppbV Reporting Limit (convert to µg/Kg)

Database Summary (Positive Hits)

Compiled April 21, 2009 – October 8, 2009

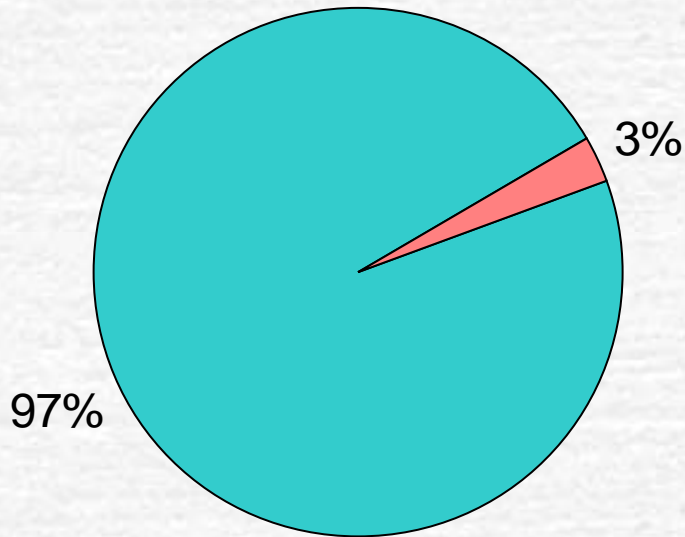


S₈ – Hydrogen Sulfide Relationship

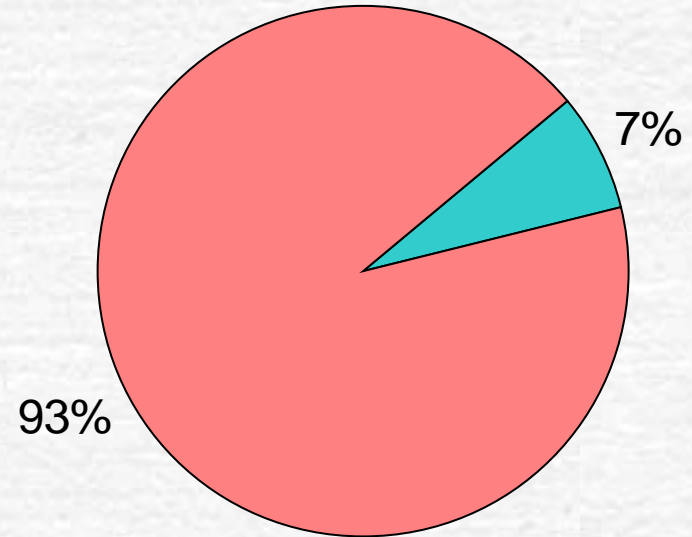
Drywall Samples
(n=228)

Positive S₈
(n=146)

Negative S₈
(n=82)

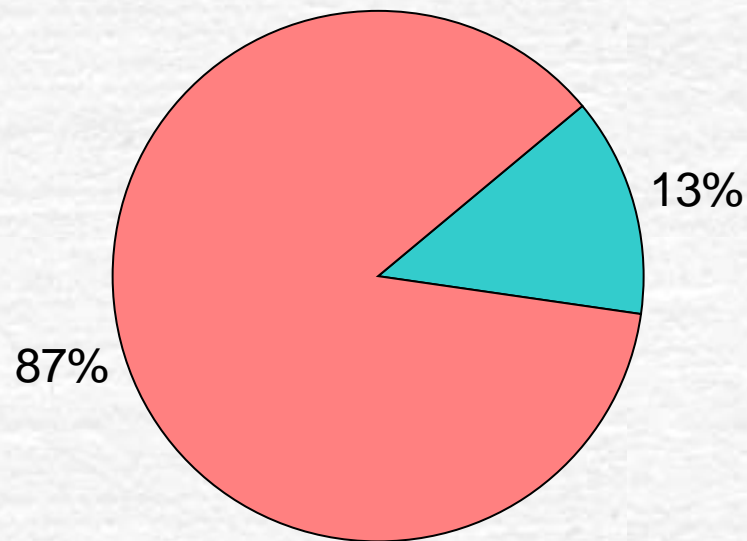
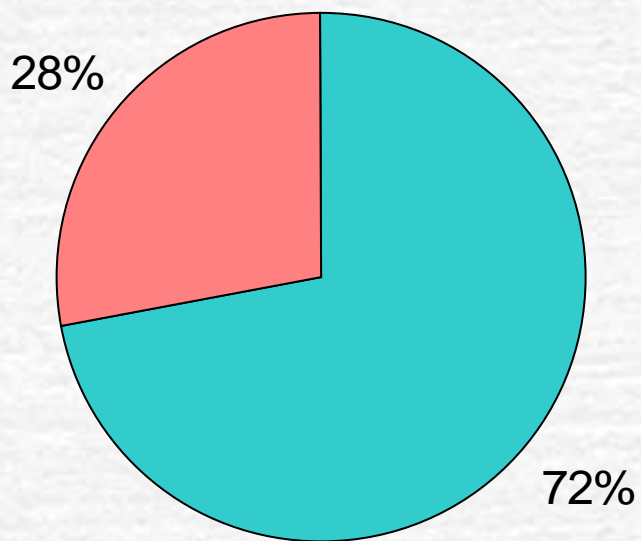
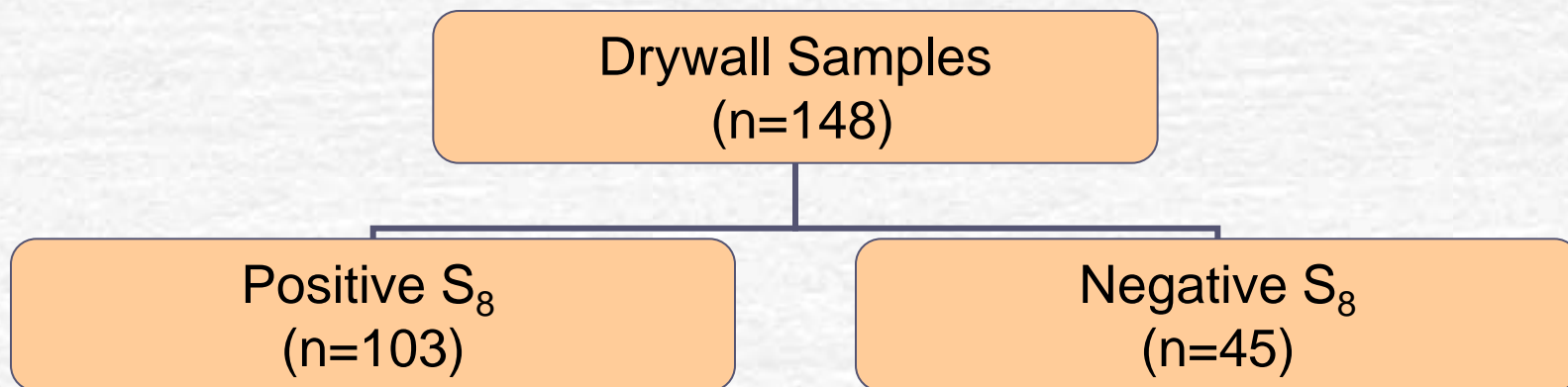


■ Positive H₂S
■ Negative H₂S



■ Positive H₂S
■ Negative H₂S

S₈ – Carbonyl Sulfide Relationship

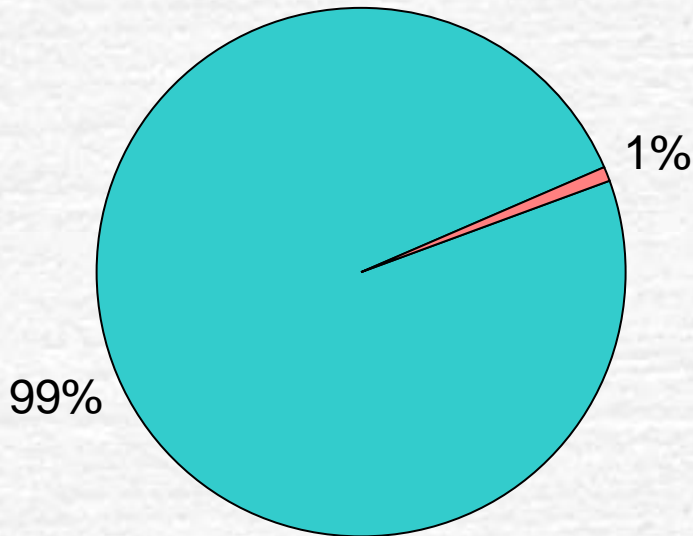


S₈ – Carbon Disulfide Relationship

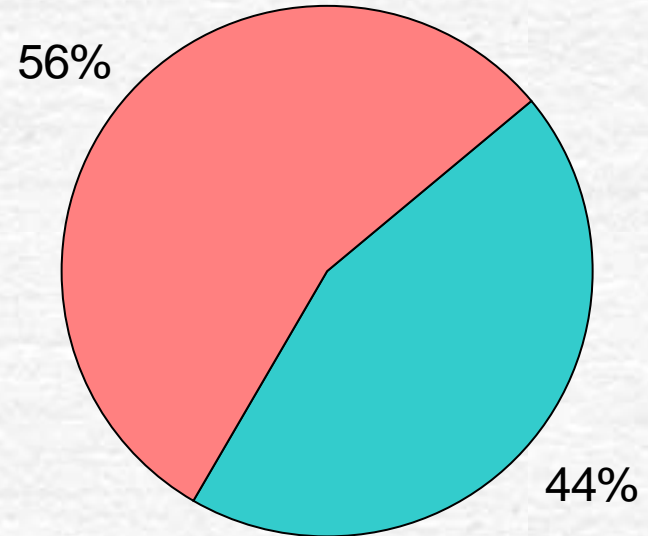
Drywall Samples
(n=148)

Positive S₈
(n=103)

Negative S₈
(n=45)



■ Positive CS₂
■ Negative CS₂



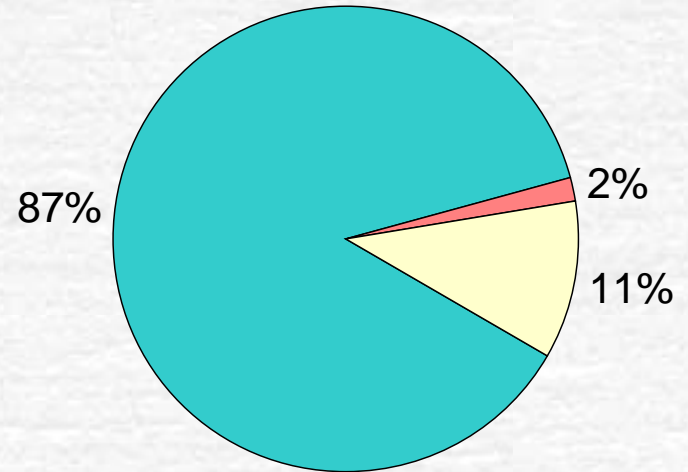
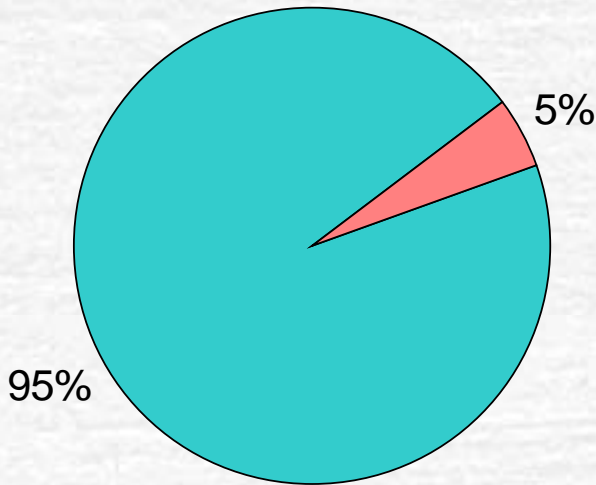
■ Positive CS₂
■ Negative CS₂

S₈ – H₂S – Blackening/Corrosion

Drywall Samples
(n=143)

Positive S₈
(n=87)

Negative S₈
(n=56)



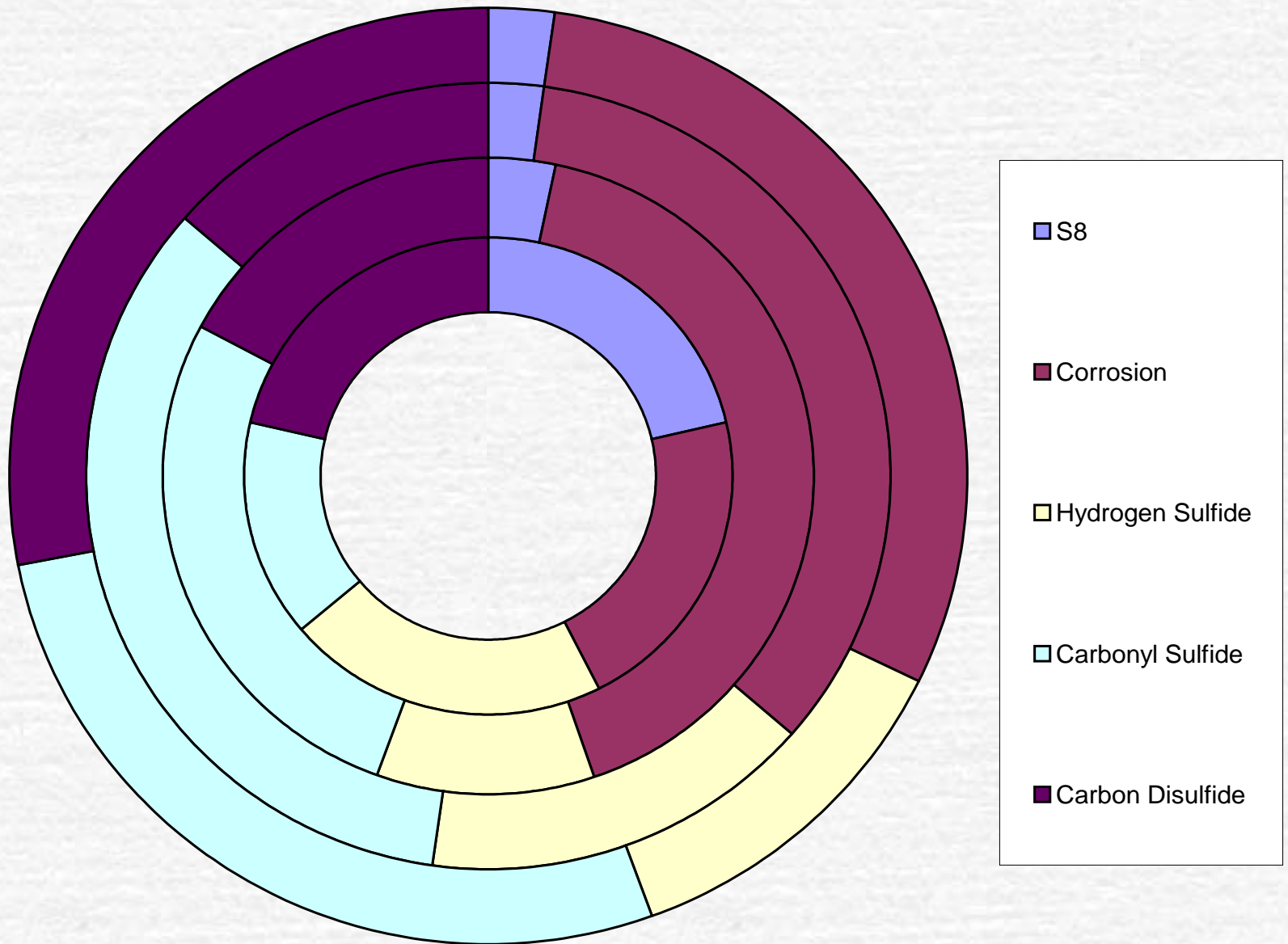
- Positive H₂S & Positive Blackening/Corrosion
- Negative H₂S & Positive Blackening/Corrosion

- Negative H₂S & Negative Blackening/Corrosion
- Negative H₂S & Positive Blackening/Corrosion
- Positive H₂S & Negative Blackening/Corrosion

Corrosive vs. Noncorrosive Drywall Samples

- Three samples of noncorrosive drywall
 - Domestic (2 brands)
 - Imported from Mexico
- Four samples of corrosive drywall
 - Imported
- Analysis:
 - Elemental Sulfur
 - Reduced Sulfur Gases
 - Jar Test: Blackening/Corrosion

Comparison of Four Corrosive Drywall Samples



Questions Posed

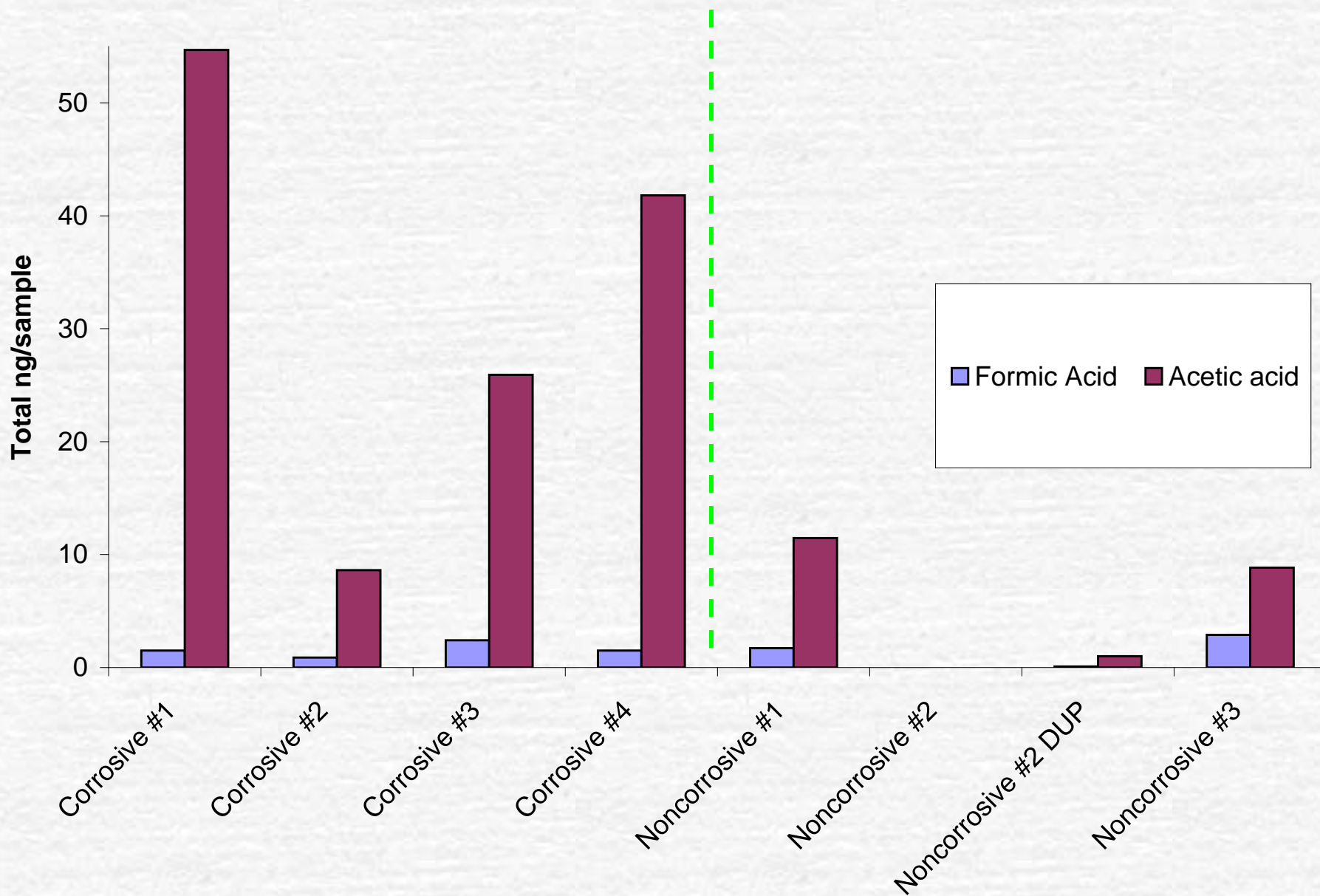
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72 hour Static Chamber Studies

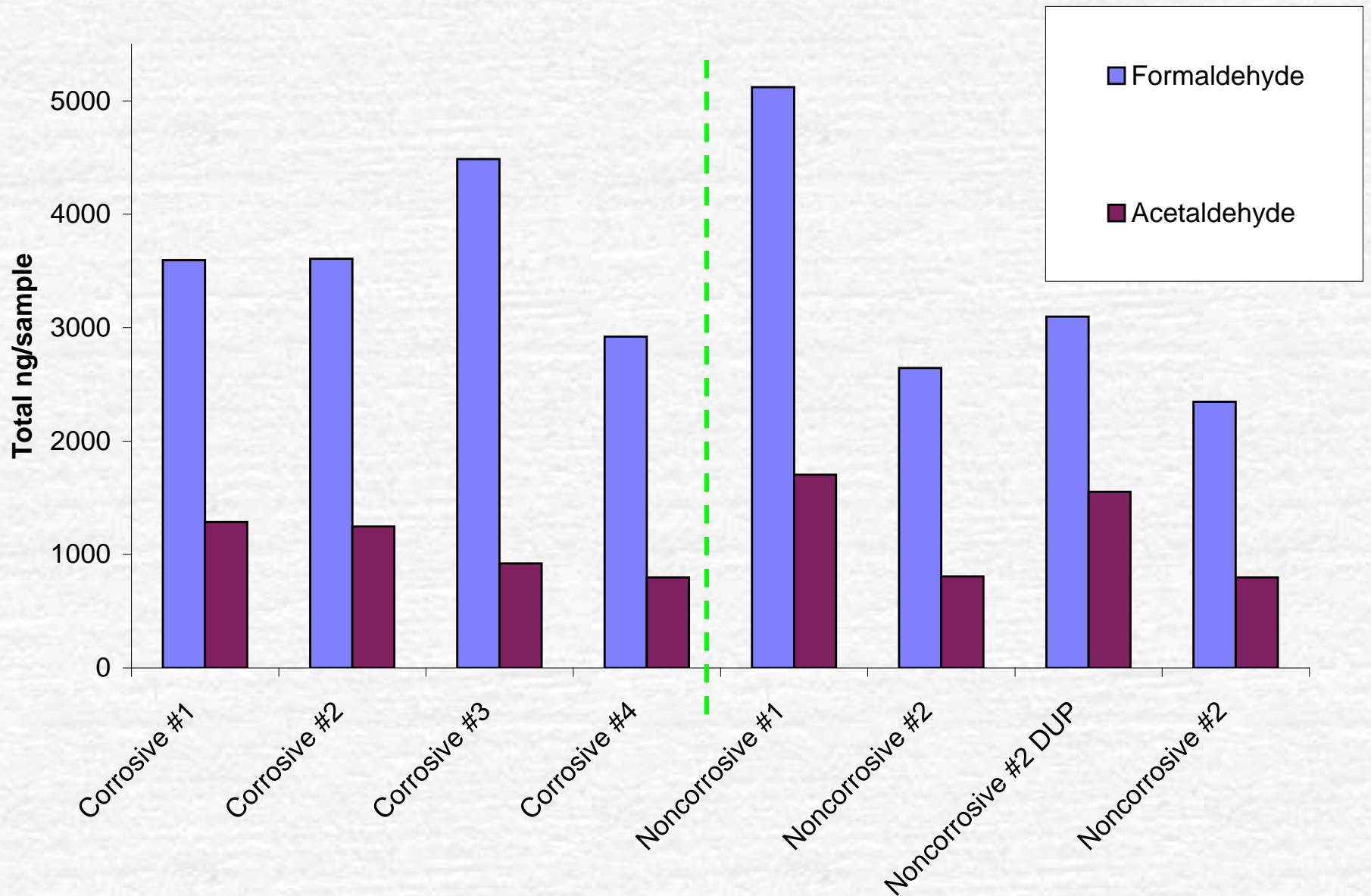
- Carboxylic Acids
 - In-House method (GC/MS)
- Aldehydes
 - EPA TO-11A (HPLC)
- VOCs
 - EPA TO-17 (GC/MS)



Formic Acid & Acetic Acid Concentration Summary



Formaldehyde & Acetaldehyde Concentration Summary



VOC Data Summary

Compounds seen in Corrosive Drywall Only

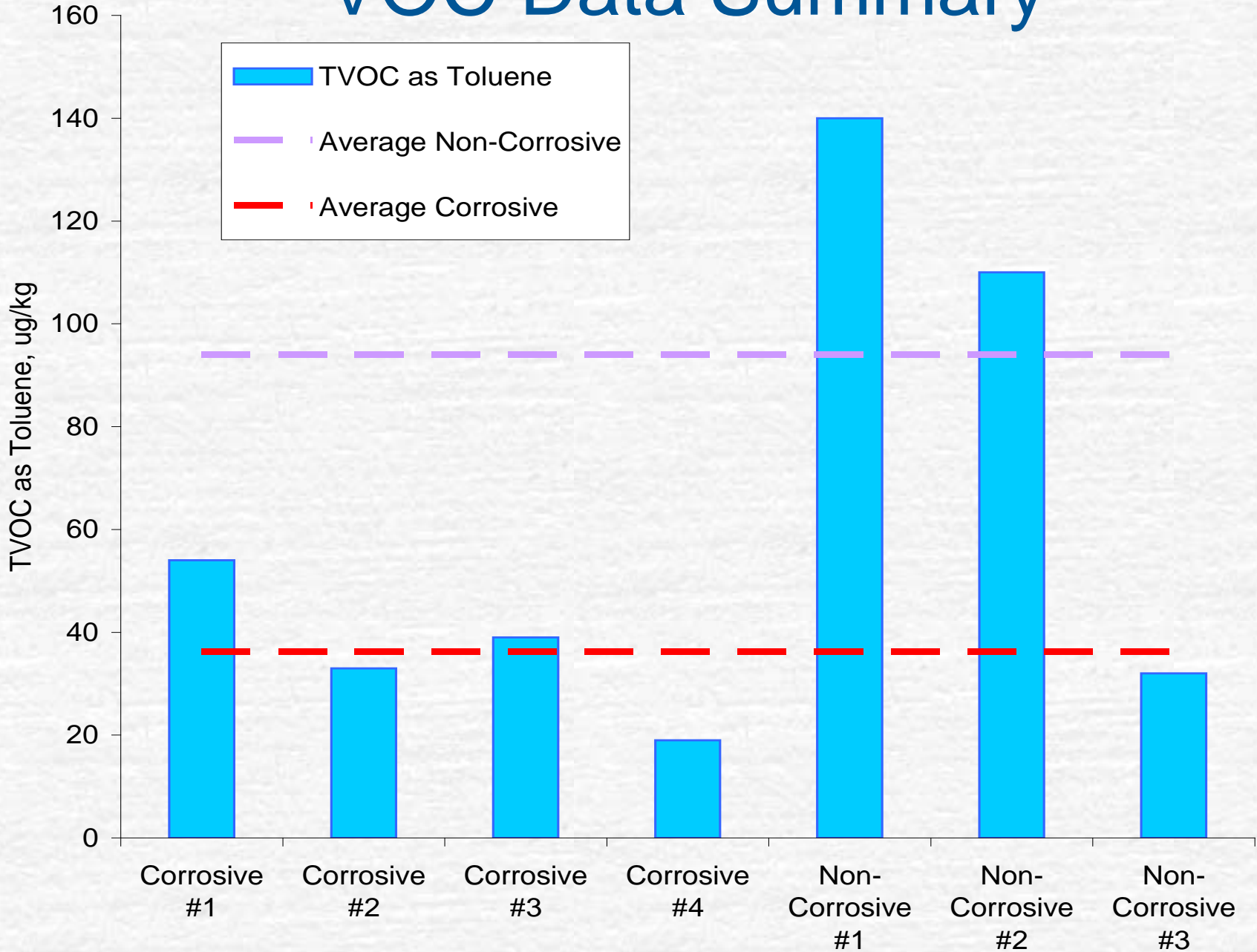
- Decanal
- Furfural
- Benzaldehyde
- Isobutyric acid
- Propionic acid
- Hexanoic acid
- alpha-Methylstyrene
- 2-Pentylfuran
- 2-n-Butylfuran
- d-Limonene
- 3-Carene
- Sesquiterpene hydrocarbons
- Isoparaffinic hydrocarbons
- Benzothiazole
- Propylene glycol
- Ethylene glycol
- 2-Butoxyethanol
- 3-Methoxy-3-methylbutanol

VOC Data Summary

Compounds seen in Noncorrosive Drywall Only

- Valeraldehyde
- Octanal
- Ethylbenzene
- Xylenes
- C₉H₁₂ Alkylbenzenes
- C₁₀H₁₄ Alkylbenzenes
- Indane
- p-Chloro(trifluoromethyl) benzene
- Undecane
- Dodecane
- Diethylene glycol
- 6-Methyl-5-hepten-2-one
- Propyl propionate

VOC Data Summary



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Odorous Compounds Detected in Corrosive Drywall

- Acetic acid
- Propionic acid
- Isobutyric acid
- Pyridine
- 2-Methylpyridine
- Hydrogen sulfide
- Dimethyl sulfide
- Carbon disulfide
- Tetrahydrothiophene
- Tetrahydro-2-methylthiophene
- Tetrahydro-3-methylthiophene
- Tetrahydro-2H-thiopyran
- cis-2,3-Dimethylthiophane
- Tetrahydro-2-methylthiopyran
- 3-(1-isopropyl)thio-1-Propene
- Ethyl isopropyl disulfide
- bis (1-isopropyl) Disulfide
- Ethyl isobutyl disulfide

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Jar Tests: Blackening/Corrosion



Jar Tests: Blackening/Corrosion



Elemental Sulfur & Carbon Monoxide

Summary/Conclusions

- Elemental Sulfur test can be used as a reliable marker for corrosive drywall
- Blackening of copper is consistent with sulfide attack
- Corrosion phenomenon appears to be a two pronged mechanism: sulfide attack + formicary (ant's nest) corrosion
- Based on the results of our chamber tests, hydrogen sulfide, carbonyl sulfide and acetic acid appear to be the main culprits



Acknowledgments

- Reinhold Rasmussen, Professor Emeritus, Oregon Science and Health University
- Dr. Thomas Gauthier, ENVIRON International Corp
- Dr. Jack McCarthy and Mr. David Shore, Environmental Health and Engineering, Inc.,
- Mr. Jay Field, The TRANE Company

Acknowledgments, continued

- Mr. Robert Griffin, Shield Engineering
- Mr. Brian Kokoska, Dragas Management Company
- Mr. Robert De La O, Mr. Al David, Ms. Jessica Bonthius, Ms. Lauren Humphrey, Ms. Kelly Horiuchi, Columbia Analytical Services, Inc.



Questions?

Michael Tудay

Director of Research & Development

Columbia Analytical Services

mtuday@caslab.com

805-526-7161