



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

Presentation for:

Technical Symposium on Corrosive Imported Drywall November 5th, 2009
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Presentation Outline

- Introduction/Questions Posed
- Jar Test: Blackening/Corrosion
- Elemental Sulfur
- Reduced Sulfur Gases
- Database Statistics

Presentation Outline, continued

- 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?
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Jar Test: Blackening/Corrosion



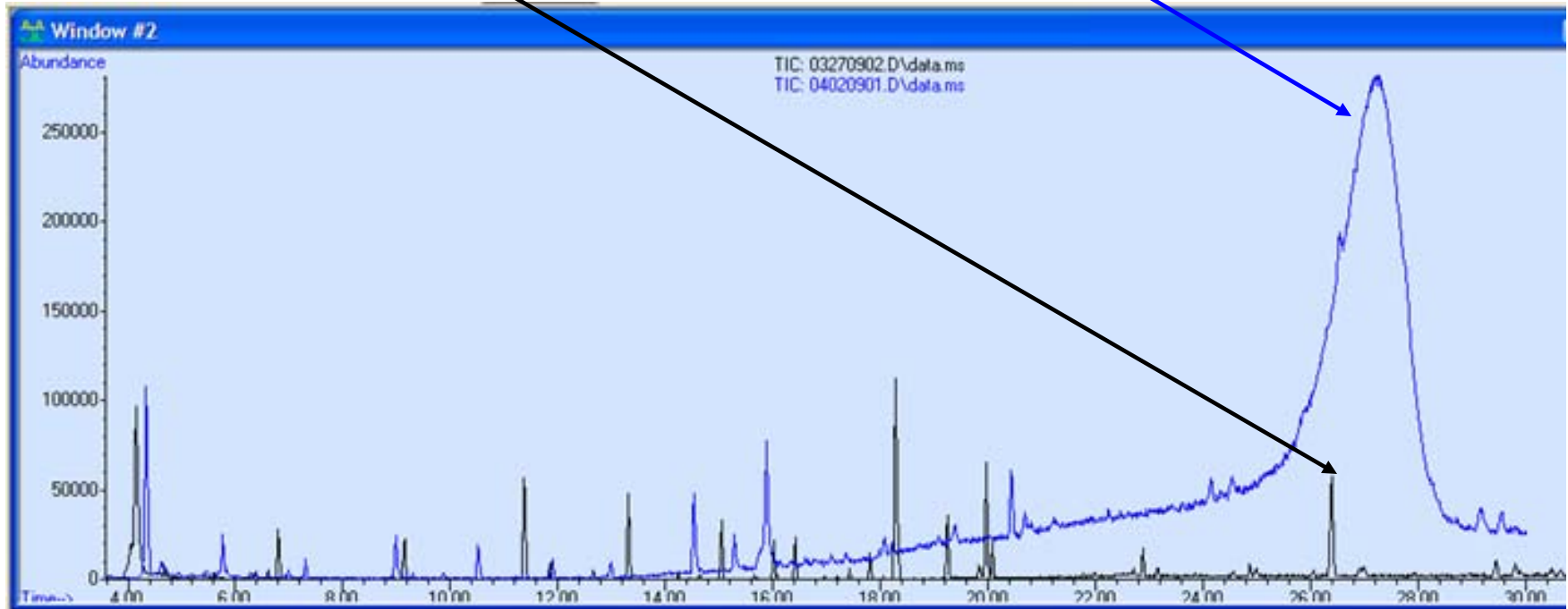
- 3" x 3" piece of drywall on platform in 1L glass jar
- 3 mL deionized water
- 3" length of 1/4" O.D. copper tubing (lightly sanded with extra-fine sandpaper to remove surface contaminants)
- "Hot Room" at 37°C
- Blackening/Corrosion evaluation after 21 days

Corrosive vs. Noncorrosive

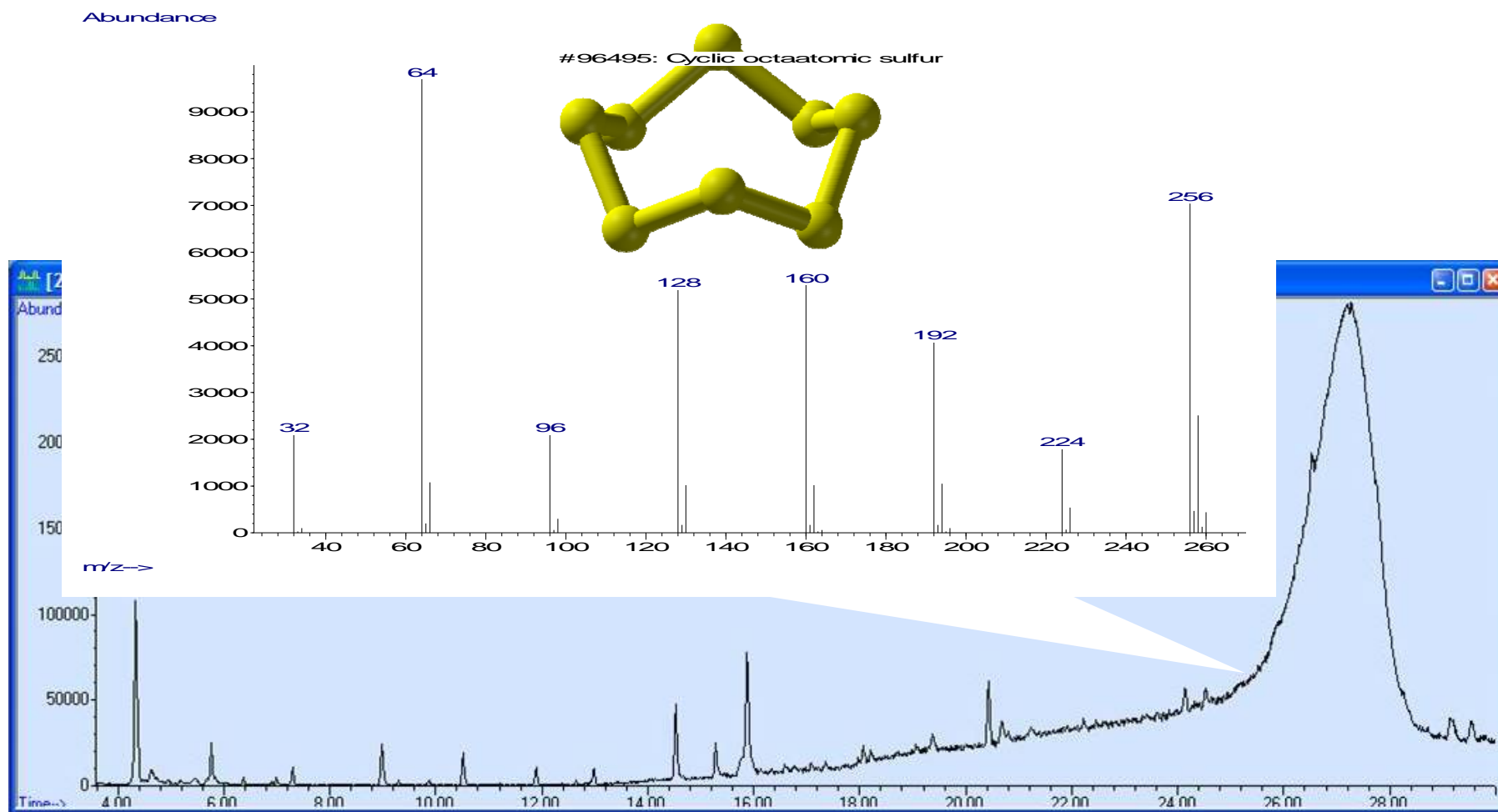
Direct Thermal Desorption- Gas Chromatography/Mass Spectrometry

Noncorrosive

Corrosive



Corrosive Drywall Sample



Elemental Sulfur Analysis

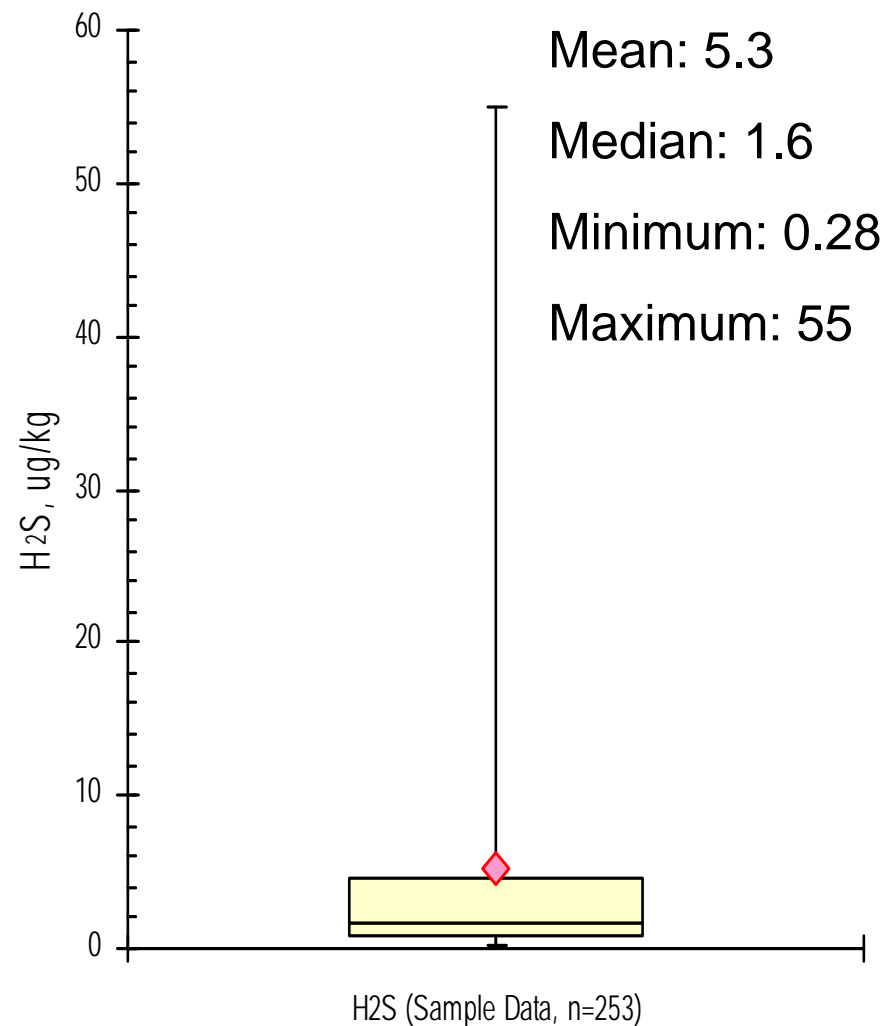
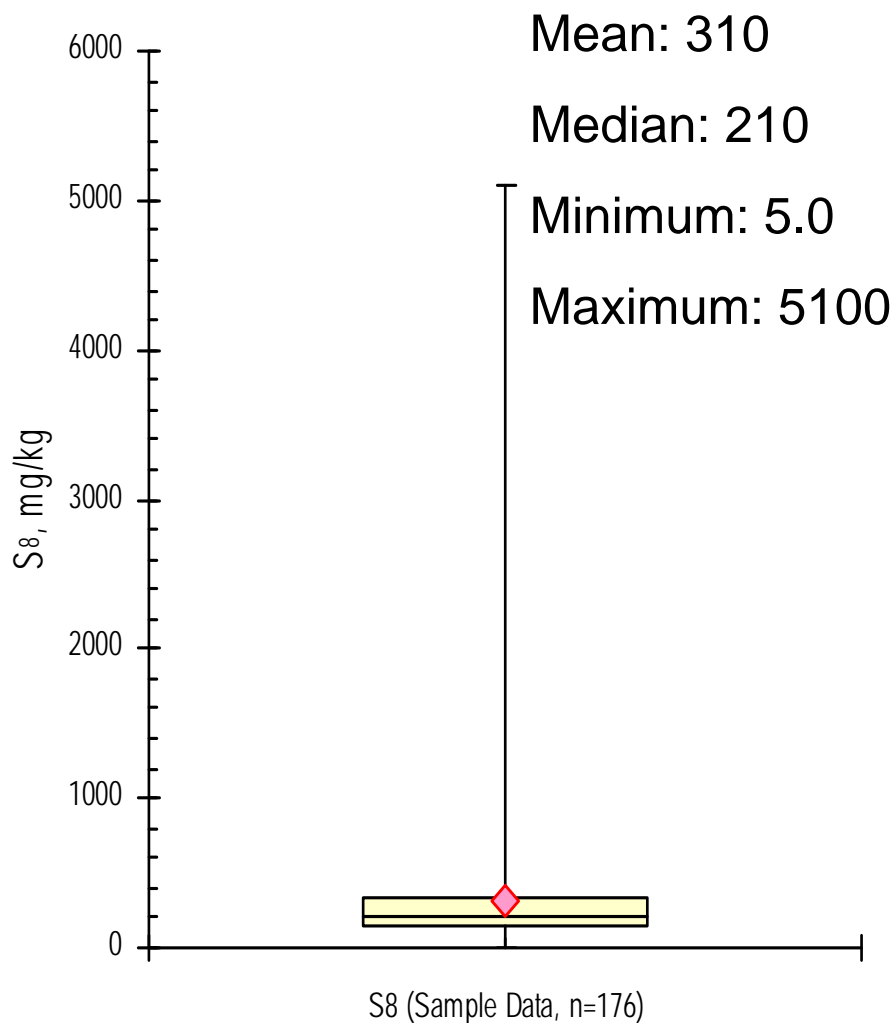
- Extraction of pulverized drywall
- Analysis for S₈ by Gas Chromatography/
Mass Spectrometry (GC/MS)
- Report in milligrams per kilogram (mg/Kg)
- Internal standard technique
- Added surrogate for Quality Control

Analysis for Reduced Sulfur Gases

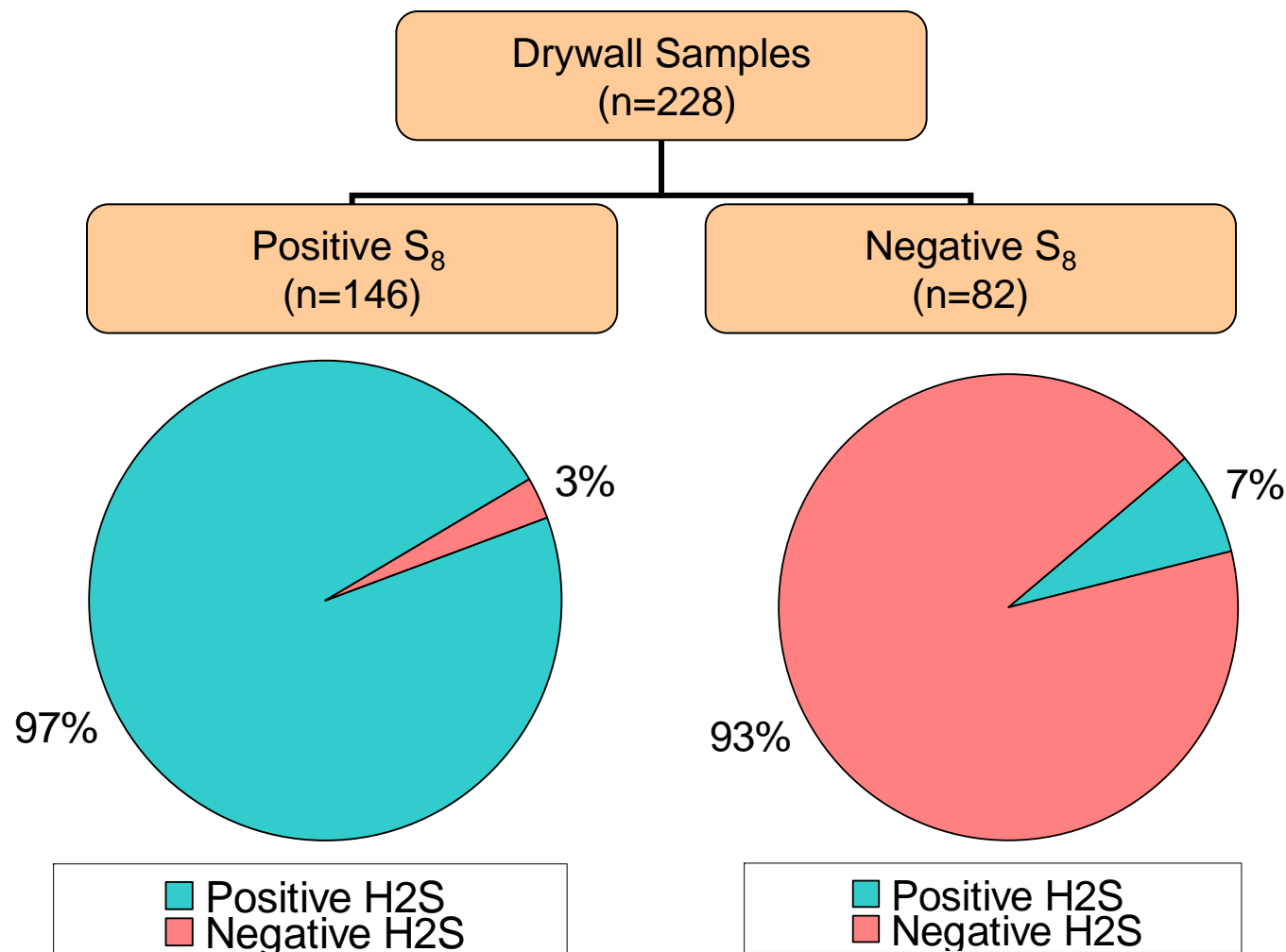
- Static Chamber Technique
 - 25g drywall in chamber
 - 500 mL of humidified Zero-Grade Air
 - Incubation period: 72 hours at 37°C
 - Analysis by Gas Chromatography/Sulfur Chemiluminescence Detection (GC/SCD)
 - 20 target analytes including:
 - Hydrogen Sulfide (H₂S)
 - Carbonyl Sulfide (COS)
 - Carbon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

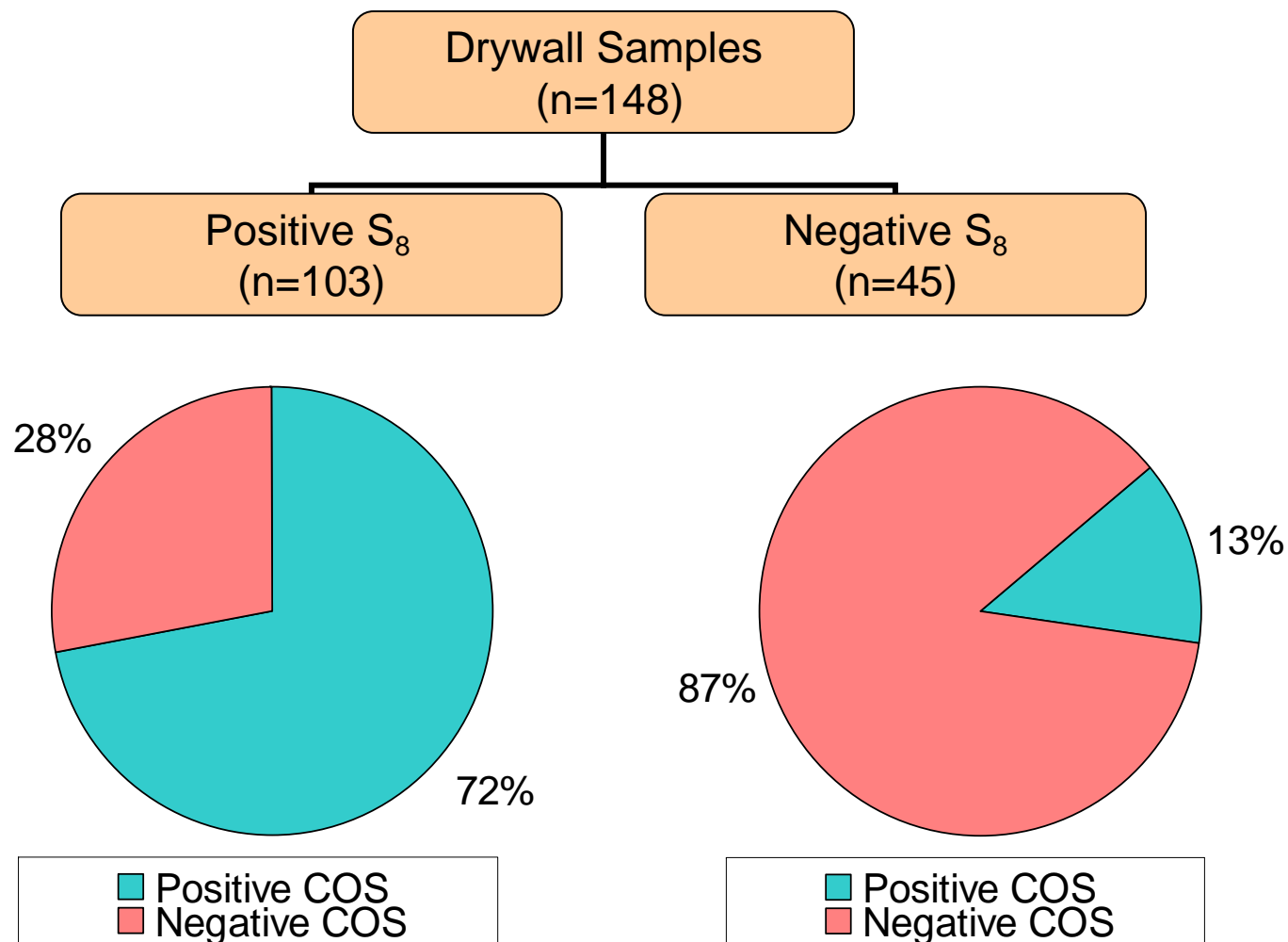
Compiled April 21, 2009 – October 8, 2009



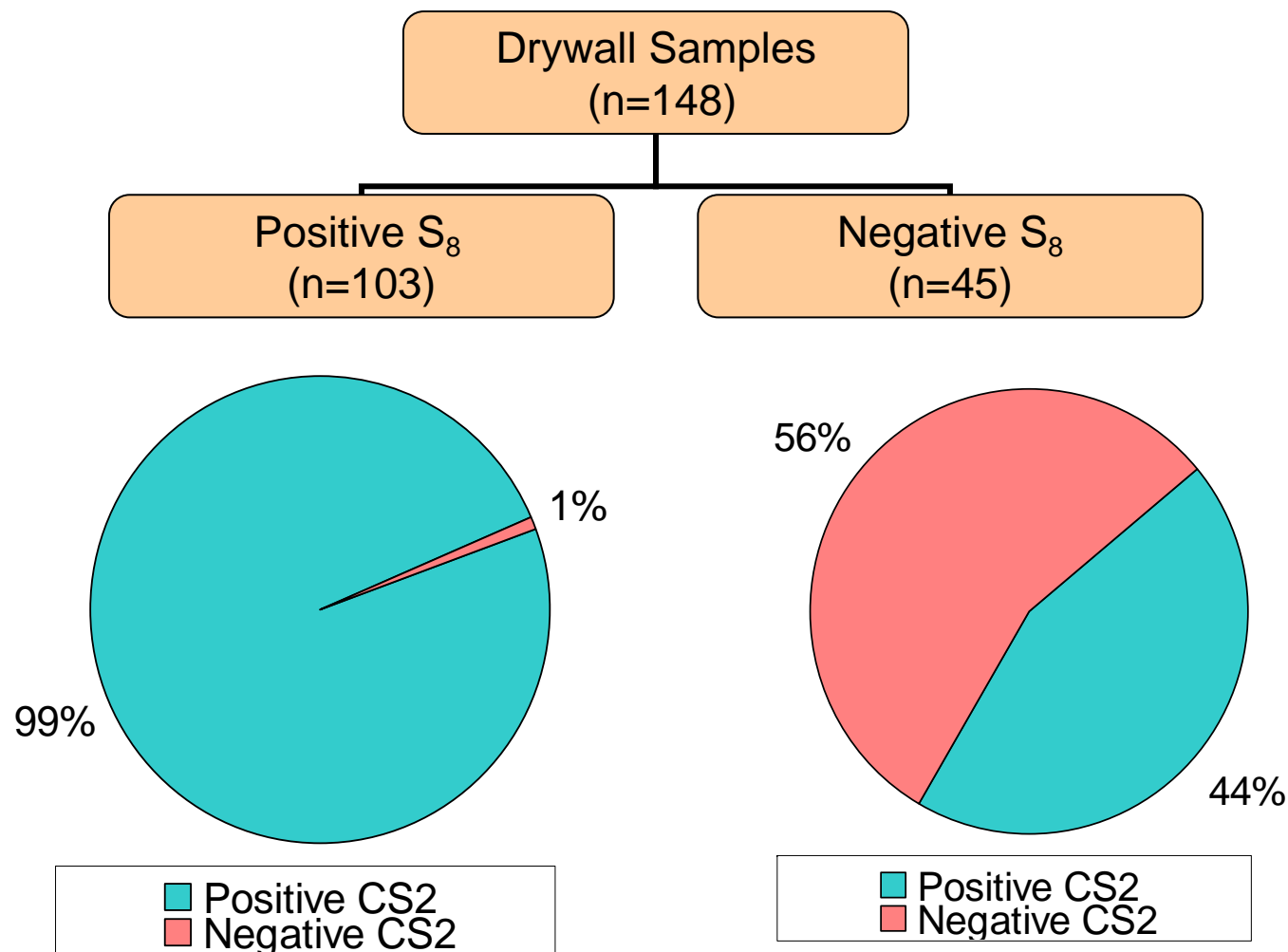
S₈ – Hydrogen Sulfide Relationship



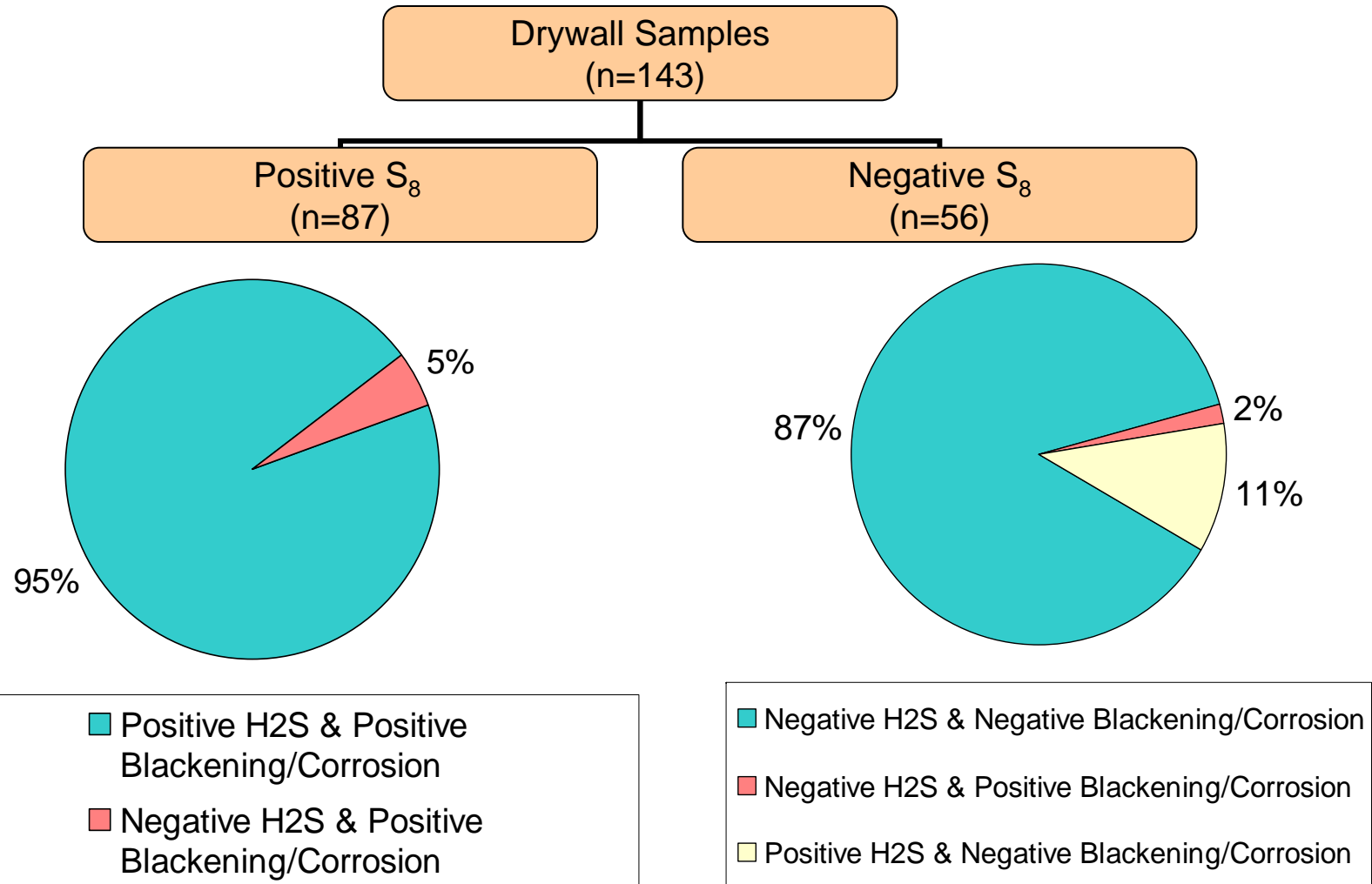
S₈ – Carbonyl Sulfide Relationship



S₈ – Carbon Disulfide Relationship



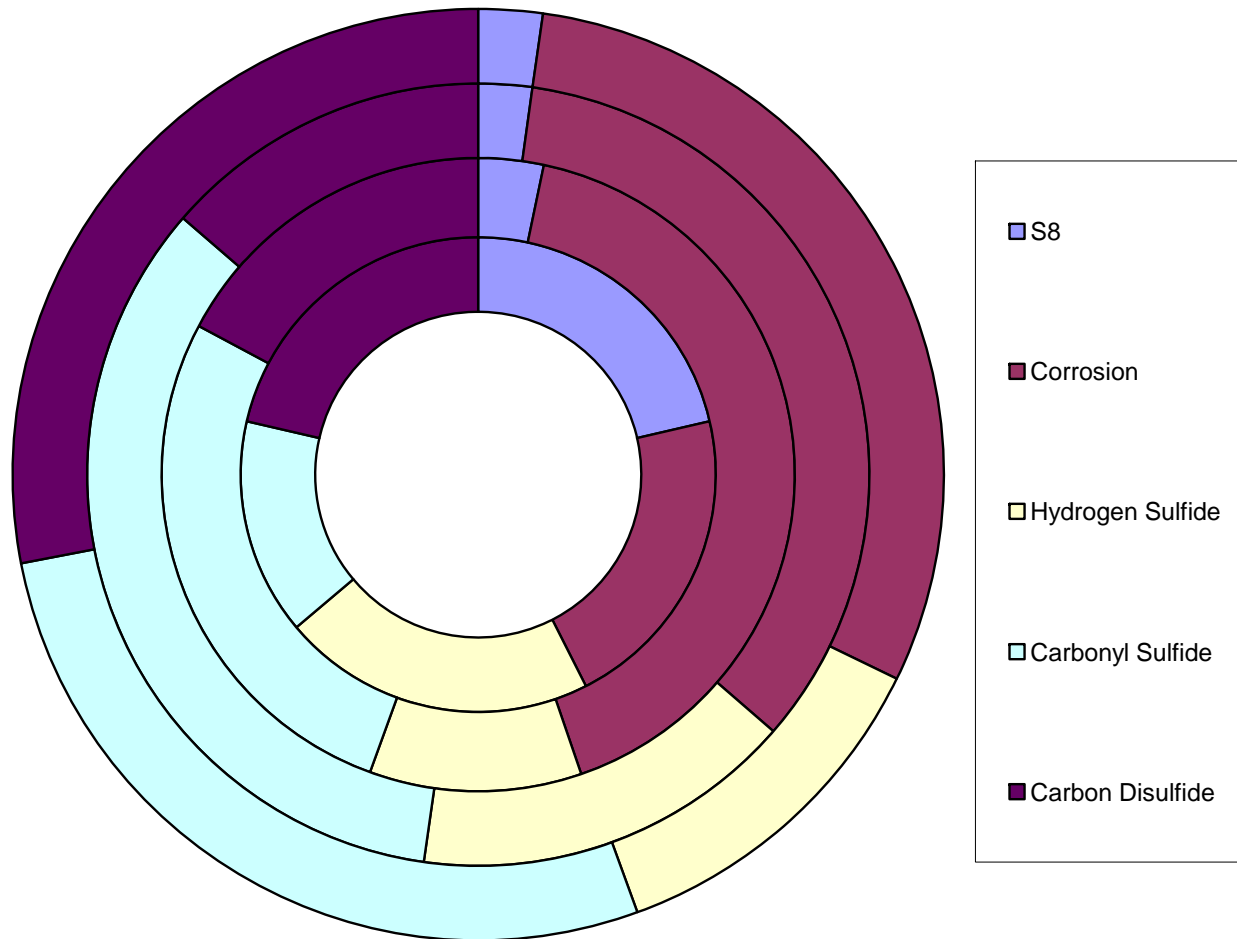
S₈ – H₂S – Blackening/Corrosion



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
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Comparison of Four Corrosive Drywall Samples



Questions Posed

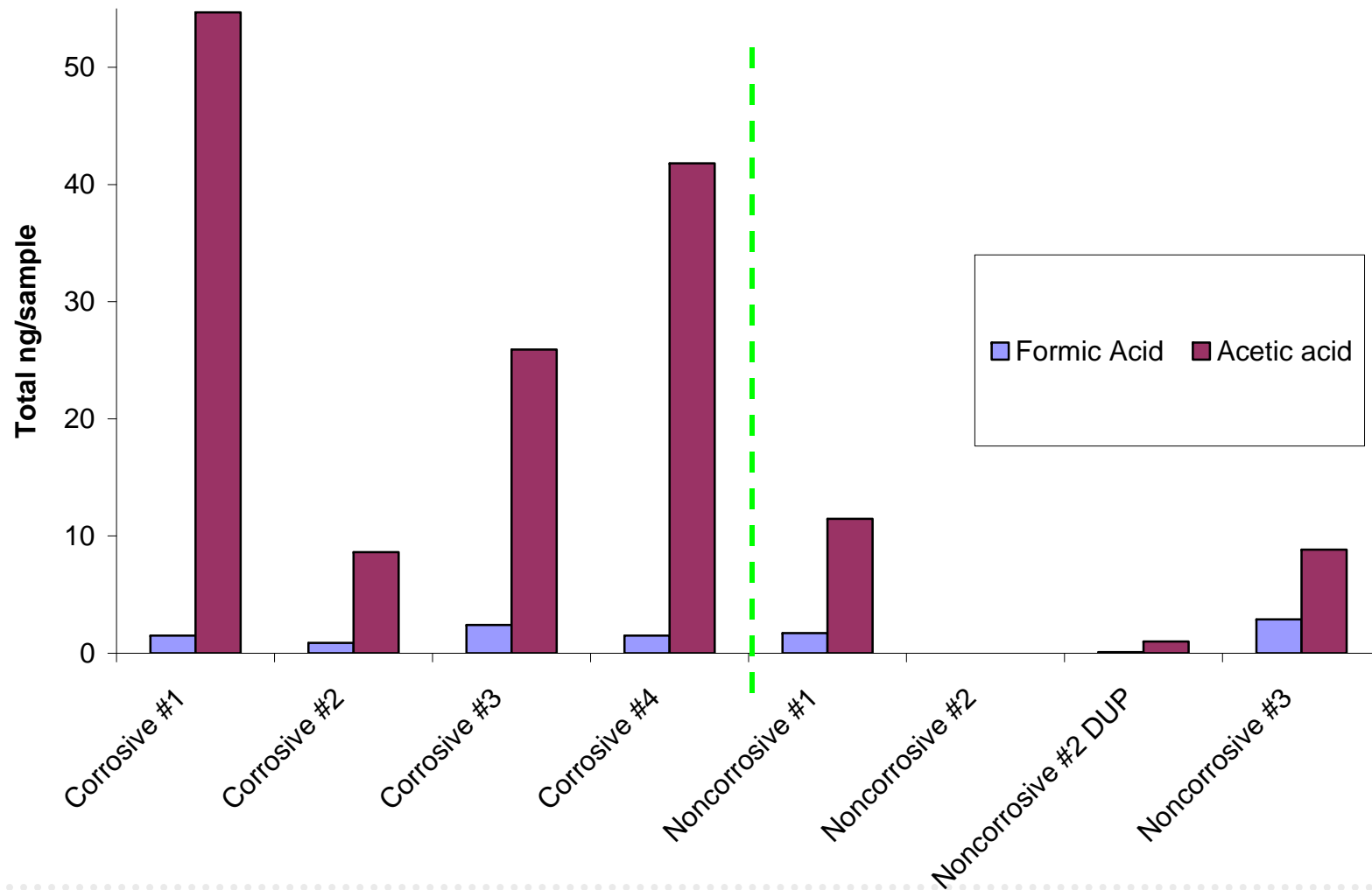
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 - What chemicals cause the odor?
 - What is in the Corrosive Drywall that causes copper and other metals to blacken and corrode? What is the mechanism?
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72 hour Static Chamber Studies

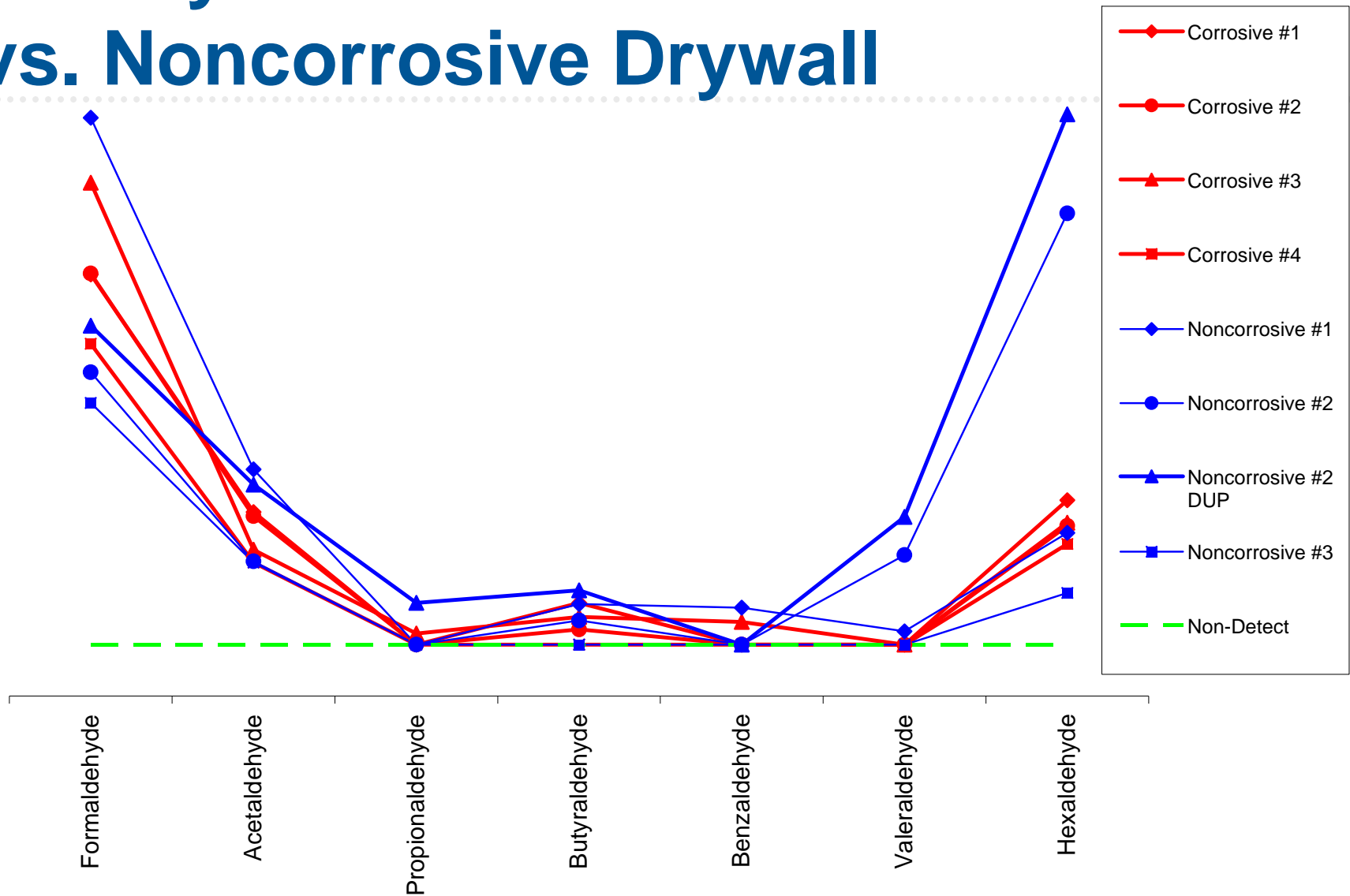
- Carboxylic Acids
 - In-House method (GC/MS)
- Aldehydes
 - EPA TO-11A (HPLC)
- VOCs
 - EPA TO-17 (GC/MS)



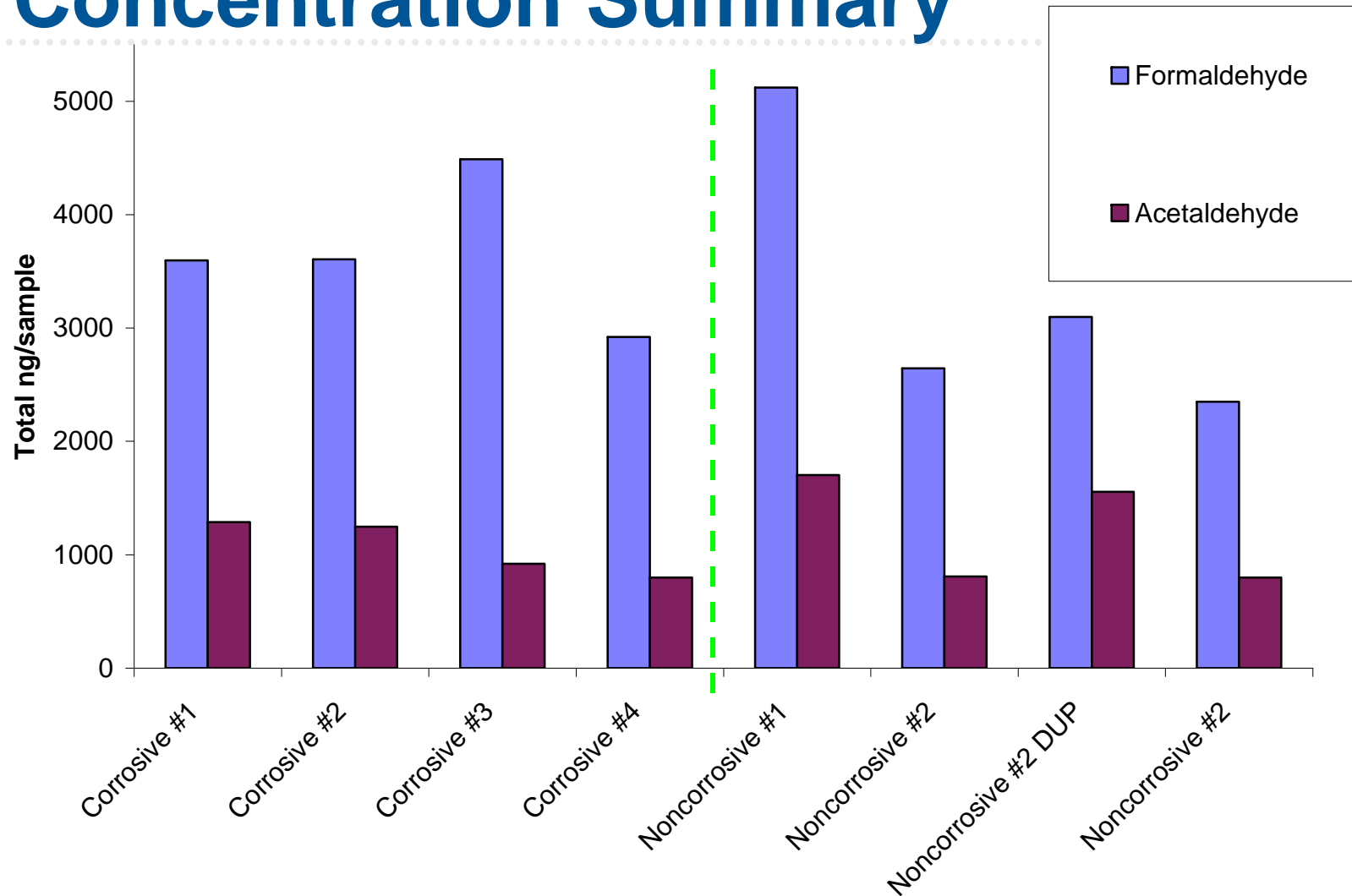
Formic Acid & Acetic Acid Concentration Summary



Aldehyde Abundance: Corrosive vs. Noncorrosive Drywall



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

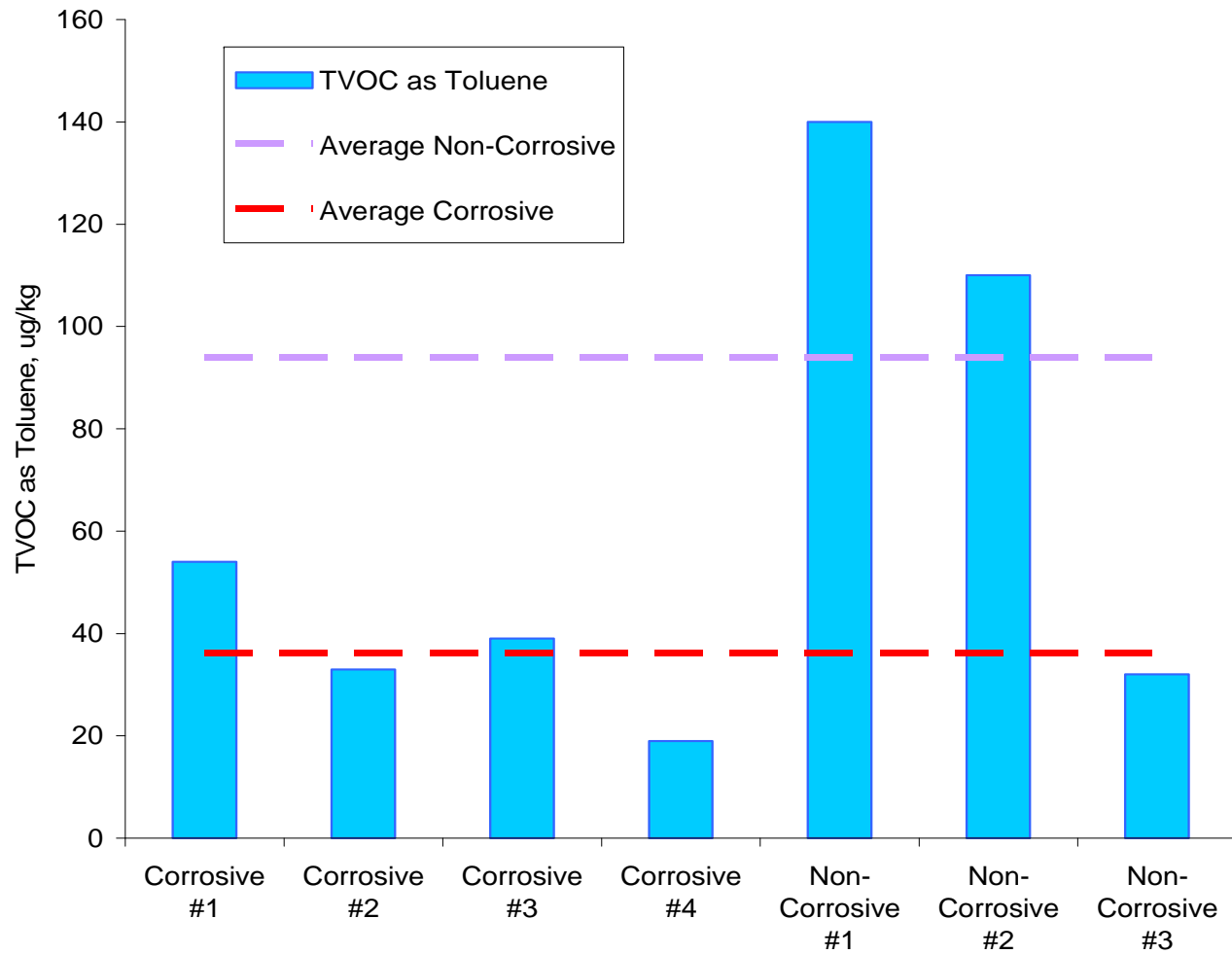
- Valeraldehyde
- Octanal
- Ethylbenzene
- Xylenes
- C₉H₁₂ Alkylbenzenes
- C₁₀H₁₄ Alkylbenzenes
- Indane
- p-Chloro(trifluoromethyl) benzene
- Undecane
- Dodecane
- Diethylene glycol
- 6-Methyl-5-hepten-2-one
- Propyl propionate

VOC Data Summary

Compounds Seen in Both Drywall Types

- Acetone
- Acetic Acid
- 1-Butanol
- Toluene
- Hexanal
- Texanol
- Texanol Isobutyrate
- Nonanal

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



Summary/Conclusions

- Elemental Sulfur test can be used as a reliable marker for corrosive drywall
- Blackening of copper is consistent with sulfide attack

Summary/Conclusions, continued

- 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



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