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Recovery of Gaseous Emission from Ground Level Area Sources of Ammonia and Hydrogen Sulfide Using Dynamic Isolation Flux Chambers

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Introduction

- NH_3 and H_2S emitted from AFO's are not regulated under NAAQS, but are perceived as nuisance and could contribute to ozone formation in the ambient air and the formation of $PM_{2.5}$.
- Diverse sampling protocol available to measure NH_3 and H_2S but no standard protocol in place
- This study uses isolation flux chambers to measure GLAS
- Flux chambers are perceived to have substantial adsorption loss during tests

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Hypothesis

- There is no adsorption loss
- Concentration differences could be accounted for during sampling tests
- A protocol was developed to establish adsorption behavior of NH_3 and H_2S onto flux chambers
- A gas recovery set-up was developed to measure recovery of NH_3 and H_2S gases

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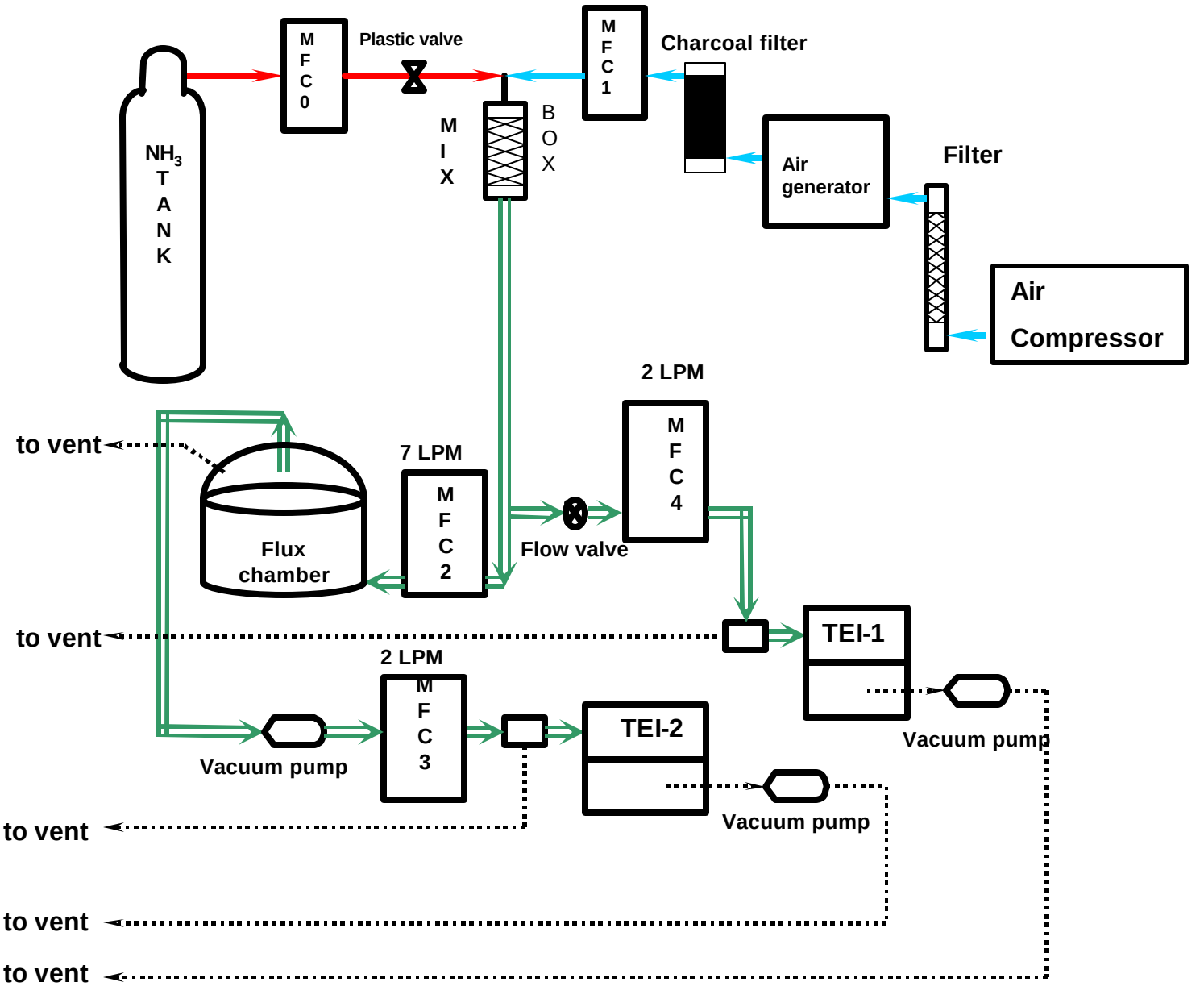
Sampling Protocol Development Overview

- Gas Sensing Equipment
  - Chemiluminescence NH_3 analyzer (TEI 17C)
  - Pulsed fluorescent H_2S analyzer (TEI 45C/450C)
- Flux Measuring Device
  - Dynamic isolation flux chamber (EPA Chamber)

Our main goal is to make an estimate of the TRUE and ACTUAL gaseous emission fluxes from GLAS

SCHEMATIC DIAGRAM



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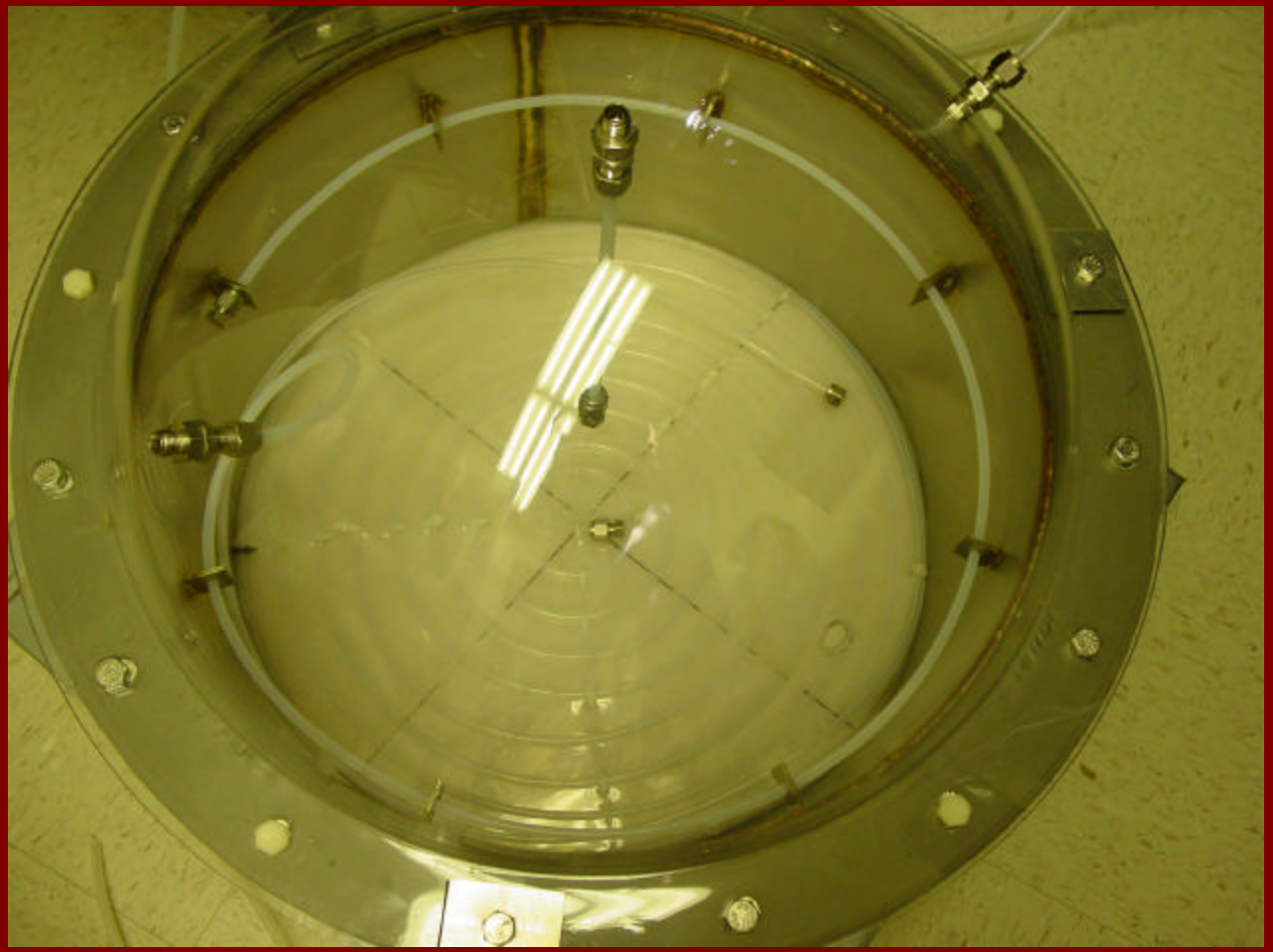
The Flux Chamber With Diffuser



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Methodology

- ***Stabilization*** of the instruments
- ***Calibration*** of gases
- ***Optimization*** of analyzers
- ***Experimental runs*** **and measurement of parameters** (T, RH, P, etc)
- ***Flushing*** with zero grade air at the end of each test
- ***Post calibration*** check

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Optimization of TEI Analyzer

- PMT Voltage Adjustment
  - 700 - 1200 V
- Converter Efficiency
  - 300 – 1000^{o}C
- Oxygen Requirement for Conversion
  - Zero-air generator free of HC's
- Calibration (before and after tests)
- Response time and error analysis

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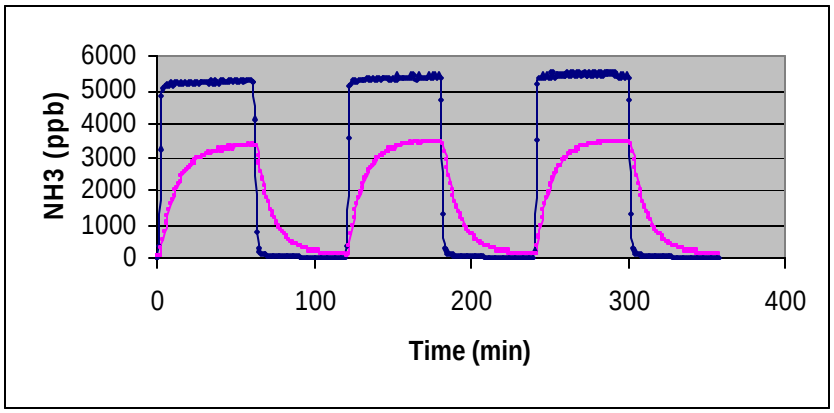
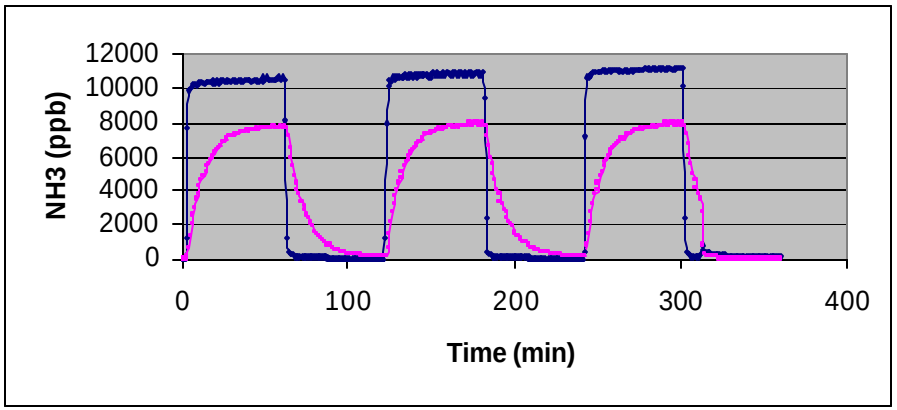
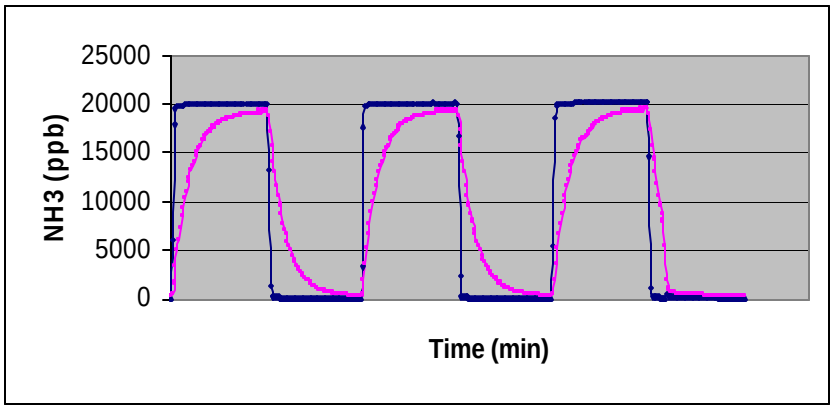
Isolation Flux Chamber

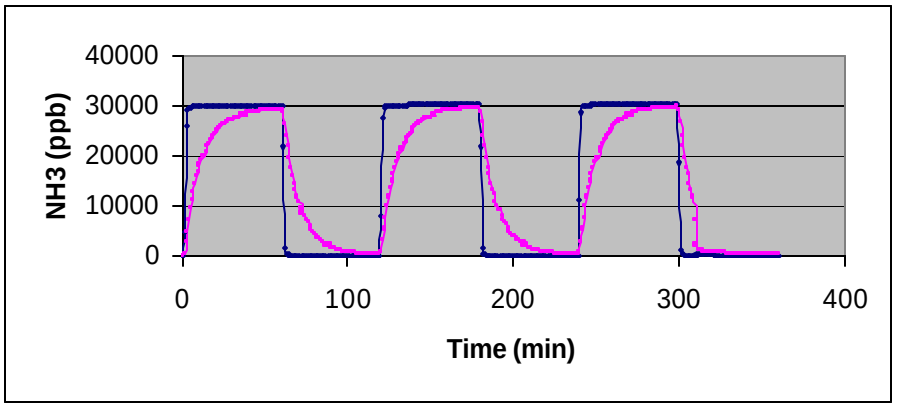
- Response Time (30 min sampling)
  = F (C_{in}, flow rates, material used, etc)
- Gas Emissions Recovery
  = F (varying C_{in} and flow rate at 7 lpm)
- Materials Used
  – Teflon tubing (150-300 ft, acrylic dome, stainless steel skirt)
- External factors (fixed T, RH and P)

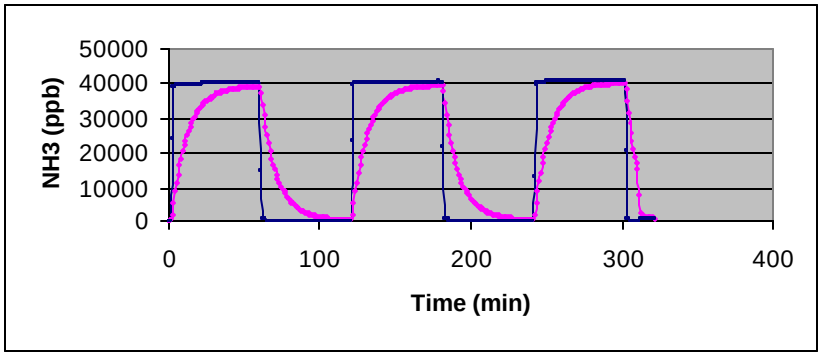
NH_3 Response Curves











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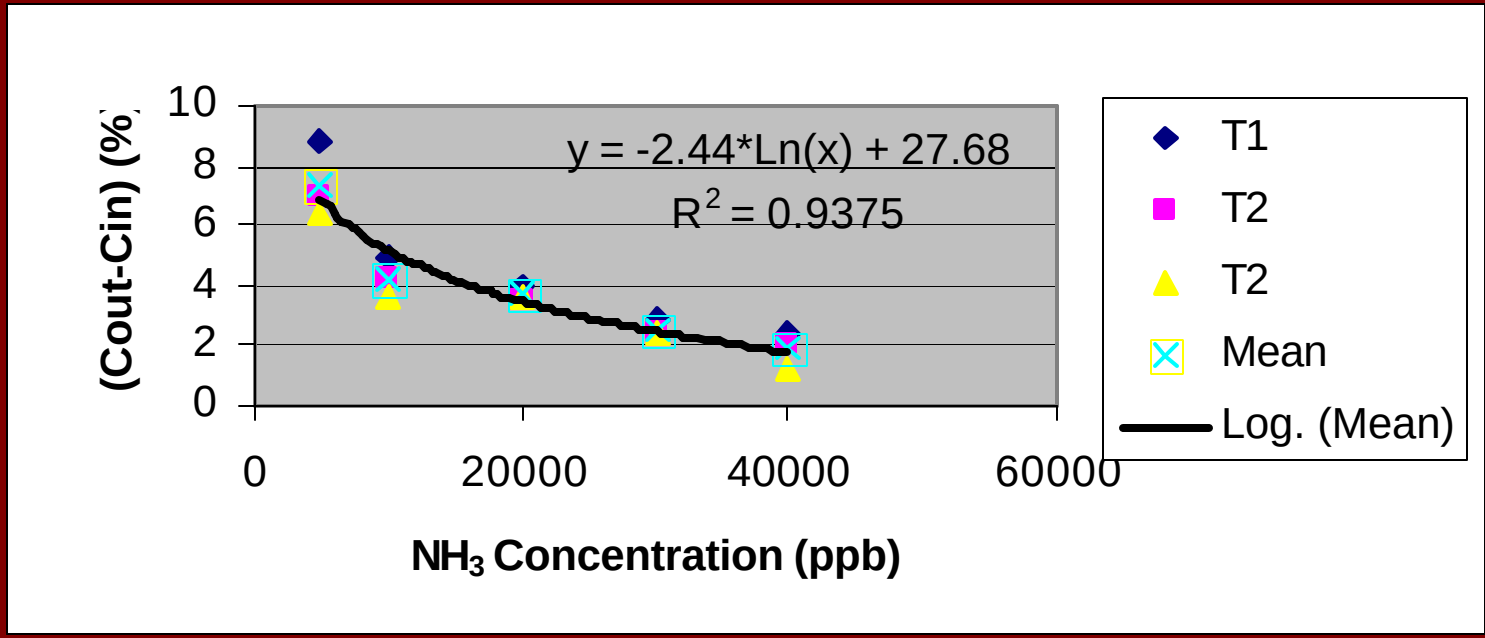
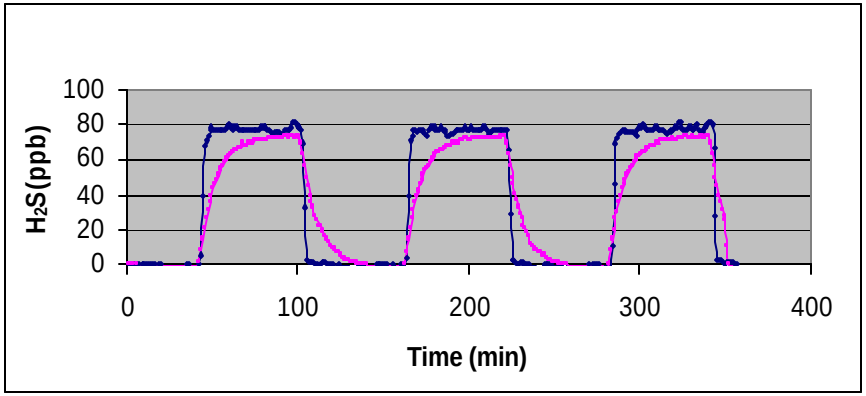
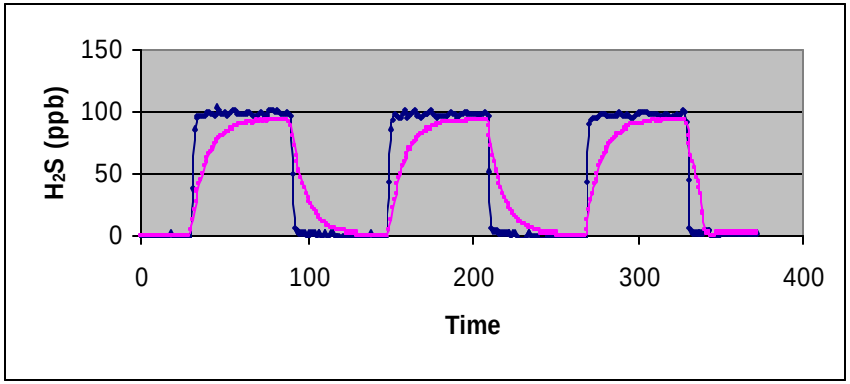
NH3 Recovery Tests

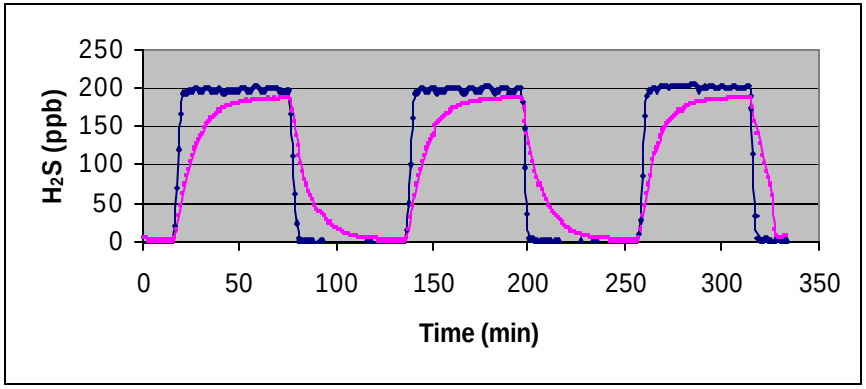


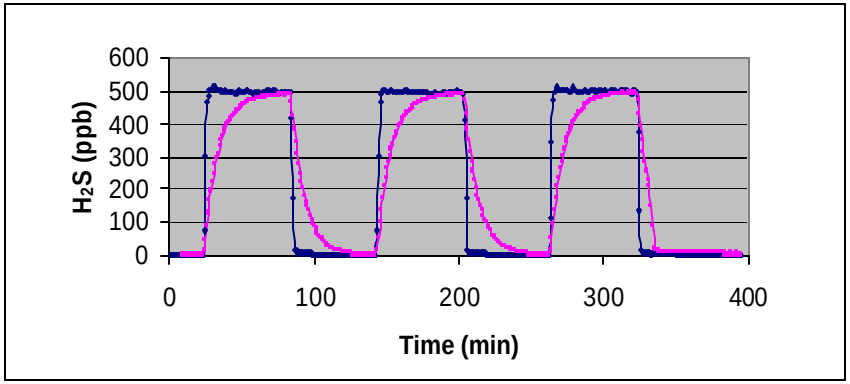
NH_3	T1	T2	T3	Mean
5000	8.79	7.02	6.33	7.38
10000	4.98	4.2	3.64	4.27
20000	4	3.44	3.64	3.69
30000	2.91	2.4	2.35	2.55
40000	2.36	2.04	1.23	1.88

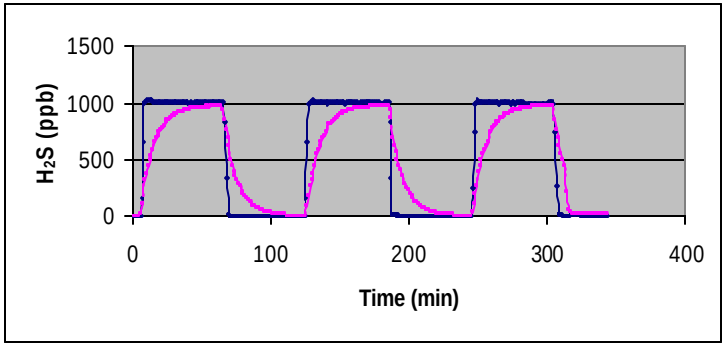
H_2S Response Curves

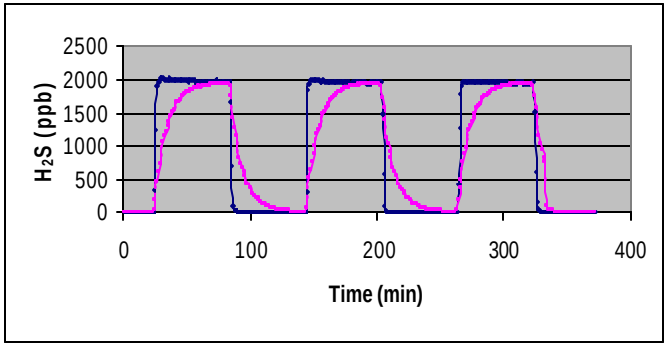












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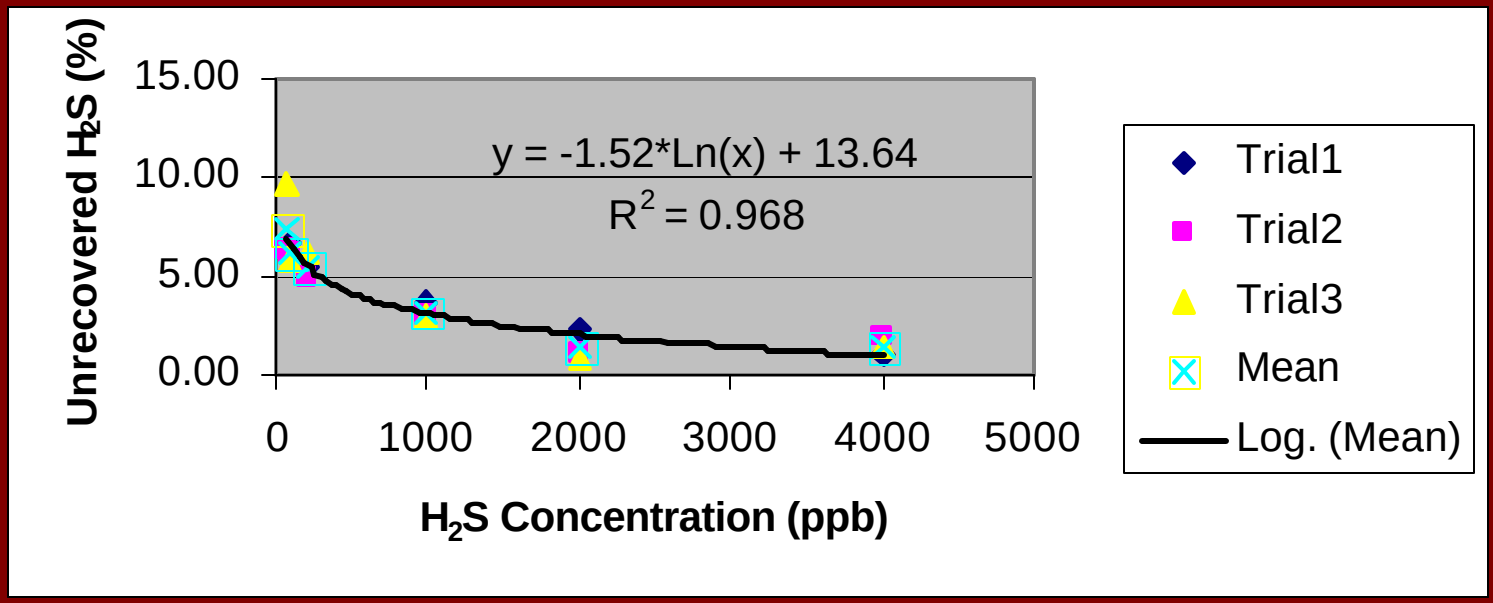
H_2S Recovery Tests



H2S (ppb)	Trial1	Trial2	Trial3	Mean
80	6.21	6.38	9.76	7.45
100	6.63	6.14	5.82	6.20
200	5.41	4.92	6.25	5.53
1000	3.75	3.01	2.92	3.23
2000	2.30	1.06	0.94	1.43
4000	1.12	1.88	1.39	1.46

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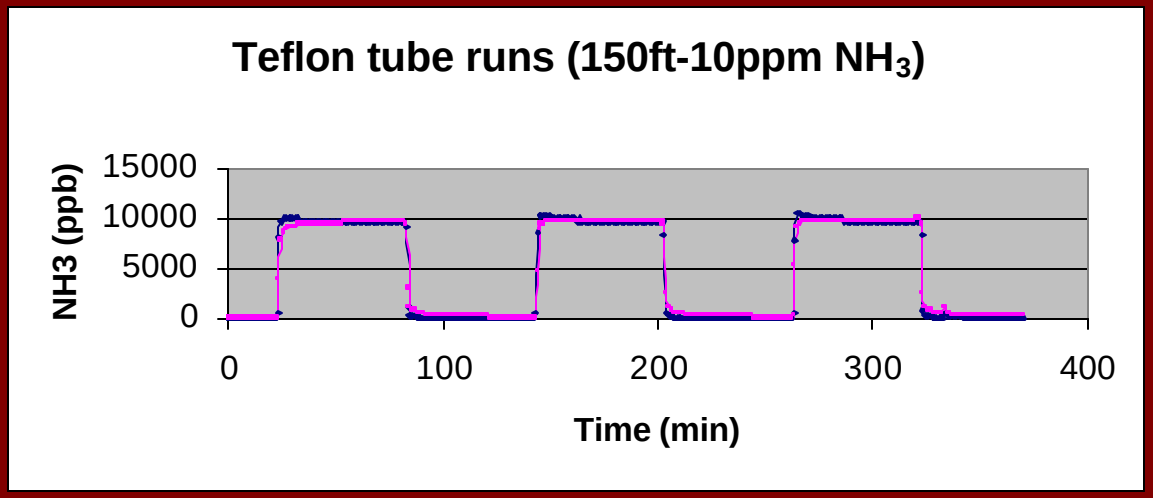
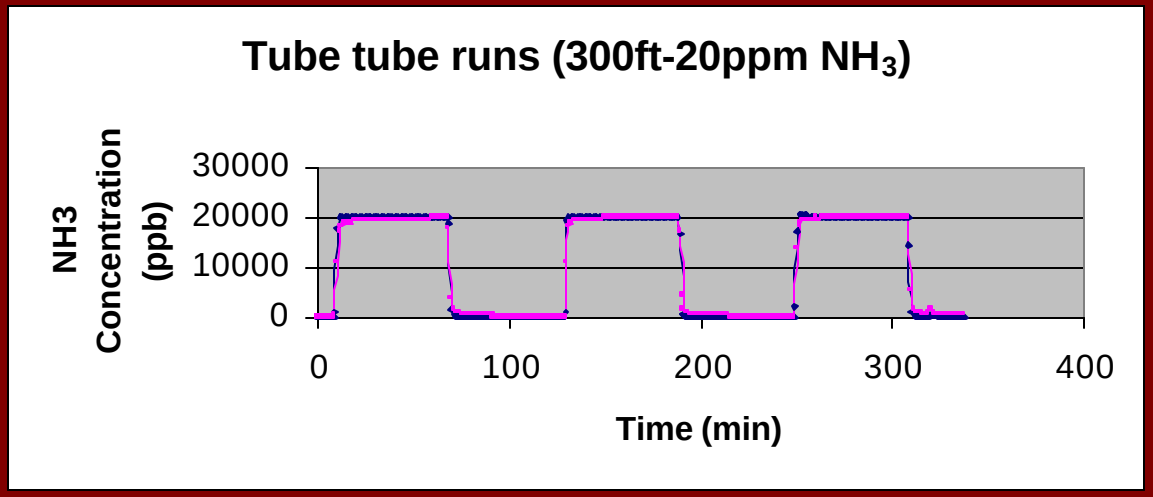
Teflon Tube Recovery Tests





Conclusion: No adsorption loss for tubing.

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Summary

- Gas sensing equipment (TEI) must be optimized to accurately measure correct gas concentrations
  - Optimization of PMT voltage
  - Converter efficiency
  - Improved calibration protocol
- Recovery Runs
  - No losses at higher concentrations
  - For lower concentrations, equilibrium period is longer to achieve full recovery

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Summary

- Predictive equation for NH_3

  % Unrecovered NH_3 = -2.44 * ln (NH_3) + 27.68

  (concentration range = 5 to 40 ppm)

- Predictive equation for H_2S

  % Unrecovered H_2S = -1.52 * ln (H_2S) + 13.64

  (concentration range = 80 to 2,000 ppb)

- Maximum Unrecovered NH_3 = 7.38%
- Maximum unrecovered H_2S = 7.45%

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Future Work

- Establish transfer functions for different sampling periods
- Establish effect of the following:
  - Flow rates, temperature, pressure, MC, RH
  - Source strength, wind speed, pH, etc
- Develop adsorption isotherms
- Mass balance approach
- Modeling approach

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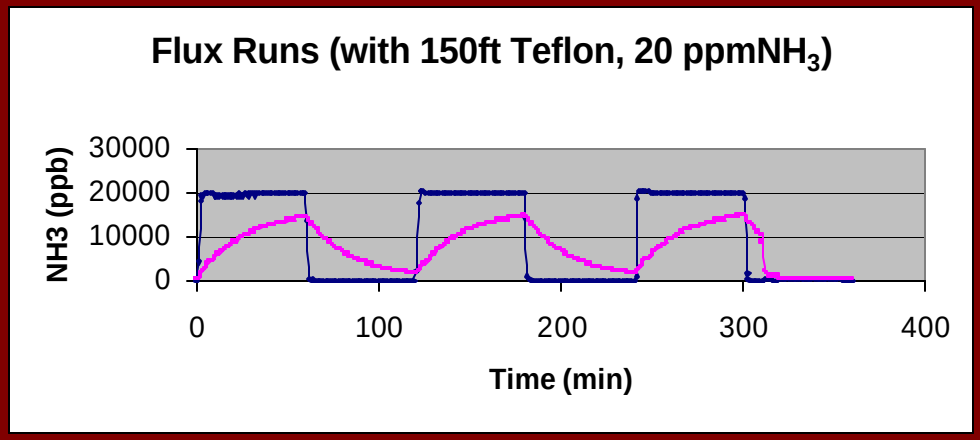
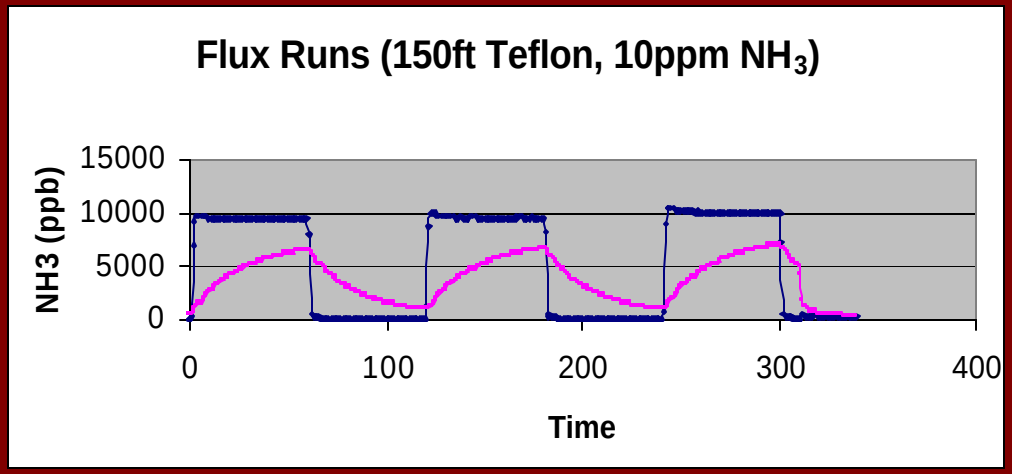
Combined Effect of Flow Rate (4LPM) on Chamber and tubing





Conclusion: Equilibrium period is longer

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Thank you!