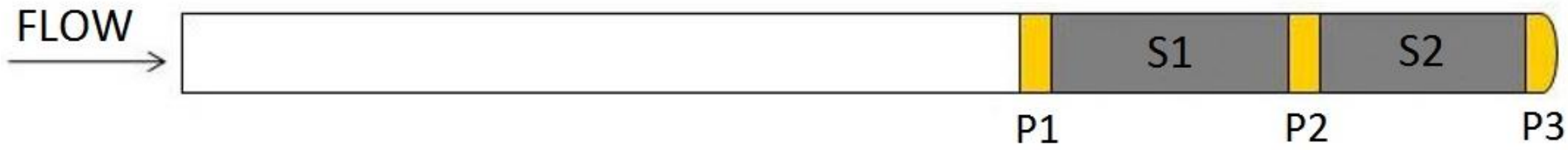
Ammonia Sorbent Traps – Brief Overview

OHIO LUMEX – JONATHAN CROSS

Trap Basics – Advantages over Existing Methods

- **Designed to be superior alternatives to impinger train methods (M26, M29, M8A, CTM027)**
  - Highly portable
  - Simpler Sampling Procedures
  - Performance-based QA/QC modeled after EPA 30B
  - No hazardous chemical exposure
  - Rugged enough for almost all sampling environments, not designed just for stacks

Trap Basics – Core Concepts



- Sampled in-situ
- Sampled in pairs
- At least two sections
  - Section 1 is primary capture, and can be spiked
  - Section 2 is breakthrough
- Must be sampled in specific ranges of temperature, flow, vacuum, and duration
- May have static pre-filters or other custom filters or sections
- May be sampled isokinetically
- Built-in QA/QC
  - Pair Agreement
  - Breakthrough
  - Spike Recovery

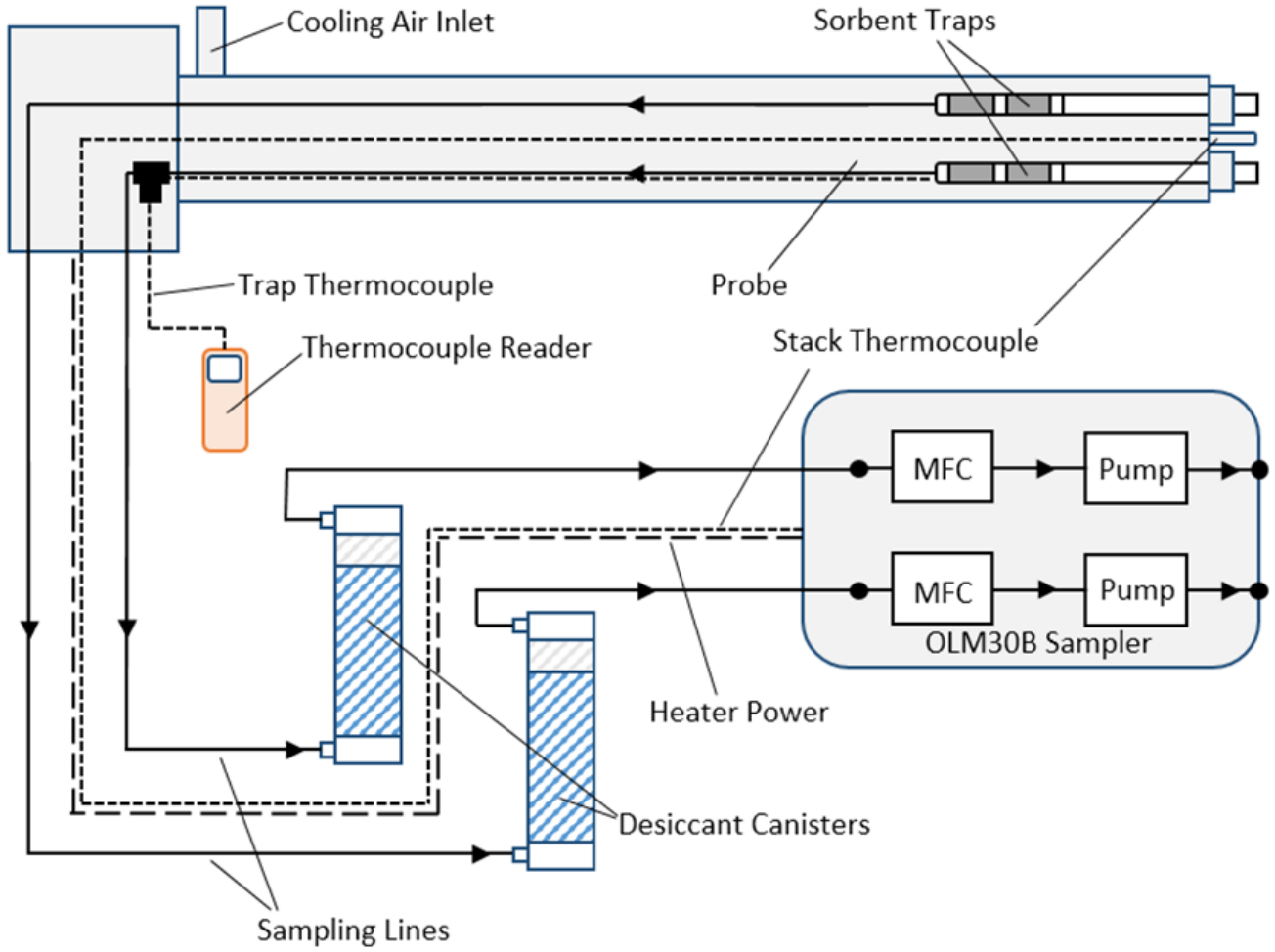
Trap Basics – Sampling Fundamentals: Equipment [1]

Standard OLM30B sampling system includes:

- 6-foot stainless steel probe
  - Two trap liners for 10mm OD traps
  - Cooling air inlet with 1” internal tube
  - Stack thermocouple
  - 750W heater

- **Desiccant Canisters ($CaSO_4$ and Na_2CO_3)**
  - Includes acid gas scrubber. Desiccant will change from blue to pink- needs to be replaced/refurbished periodically

- **Sampling Console**
  - Two mass flow controllers, two pumps
  - Range of flow from 0.02-2.0 lpm, common operating range is 0.2-1.0 lpm



Trap Basics – Sampling Fundamentals: Parameters/Variables

Source Gas Characteristics

- **Estimated Concentration**
  - Determines sampling duration
  - Captured mass = (concentration **x** volume)
- **Temperature**
  - Determines approach for temperature control
- **Particulate Matter**
  - Determines approach for filtration (static pre-filters vs. sintered filter tips vs. no filtration)
- **Moisture**
  - Special attention must be paid to sampling technique, and a probe shield may be necessary in the stack

Sampling Considerations

- **Trap Type**
  - Most important consideration. Each trap type comes with its own set of parameters
- **Temperature**
  - Exceeding nominal range could result in breakthrough, too low could result in condensation. NH_3 sorbent traps require a specific sampling temperature.
- **Flow Rate**
  - Determined by trap type, exceeding could result in high vacuum and breakthrough
- **Vacuum**
  - Should not be too high (varies with flow rate and trap type)

Trap Basics – Measurement Units

- Ohio Lumex generally calibrates by mass, so raw data is usually in units of mass.
- Concentration is calculated as µg/L, ng/L, or µg/m^3
  - All easy to convert from one to another
- For some methods, **ppmv** is the most convenient way to express concentration
- Note: With mass flow controllers, you do not need to correct for pressure or temperature

Concentration = mass / volume

$C_{ppmv} = C_{\mu g/L}$ * molar volume / molar mass

(Molar volume = 24.056 at 1atm and 20°C)

NH_3 Traps – Overview [1]

Method Status

- Well-developed for engineering purposes
- Have been used across a wide range of sources

Applications

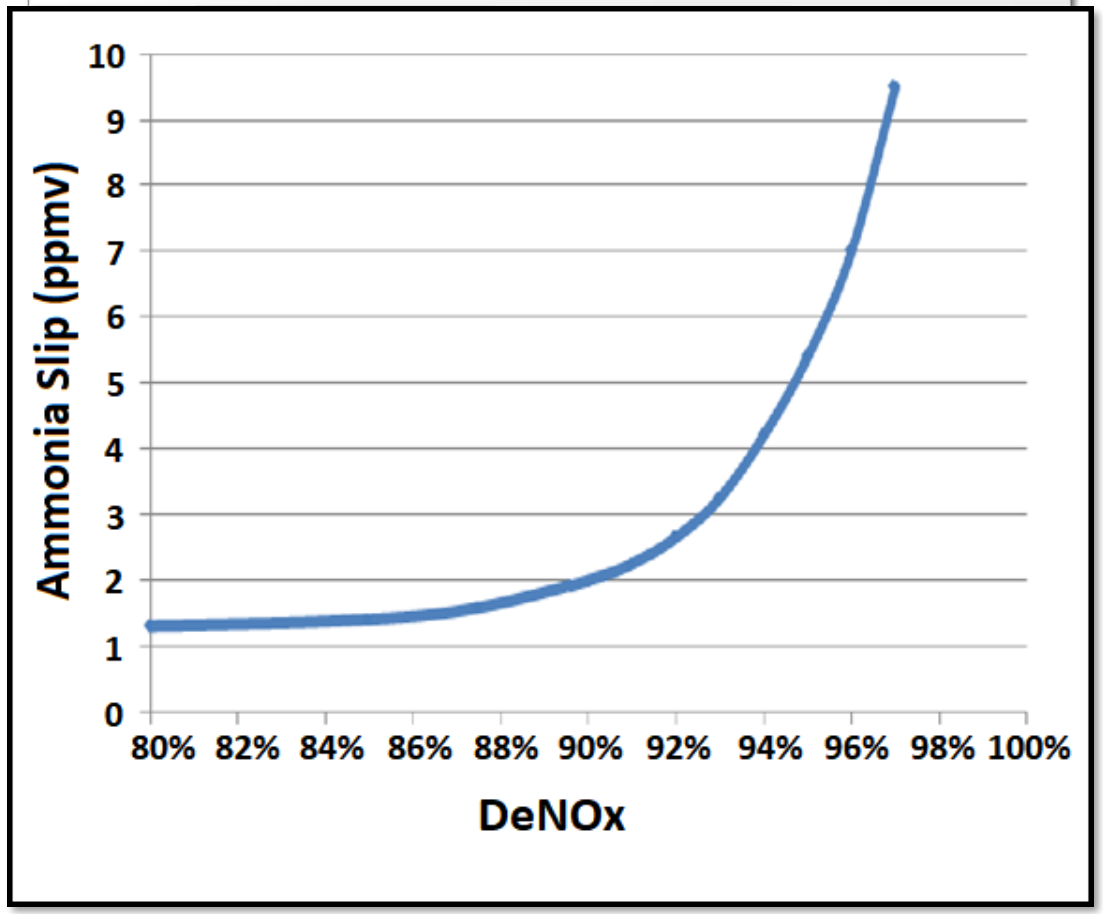
- Comparing predicted ammonia slip (from $DeNO_x$ calculations) with real ammonia slip
- Studying suppression of Hg oxidation by ammonia

Competing Methods

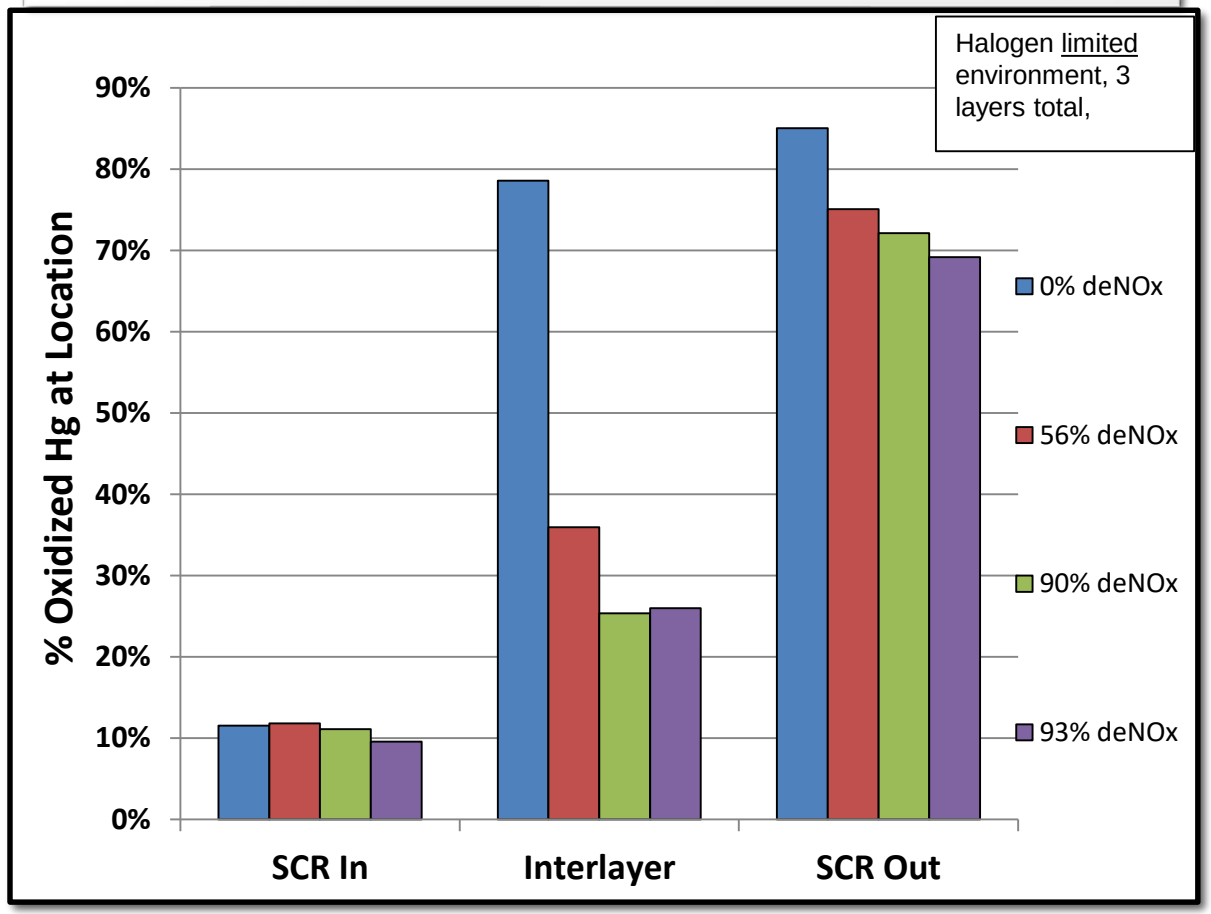
- CTM-027
- EPA Method 320

NH_3 Traps – Overview [2]

Effect of $DeNO_x$ Target on Ammonia Slip

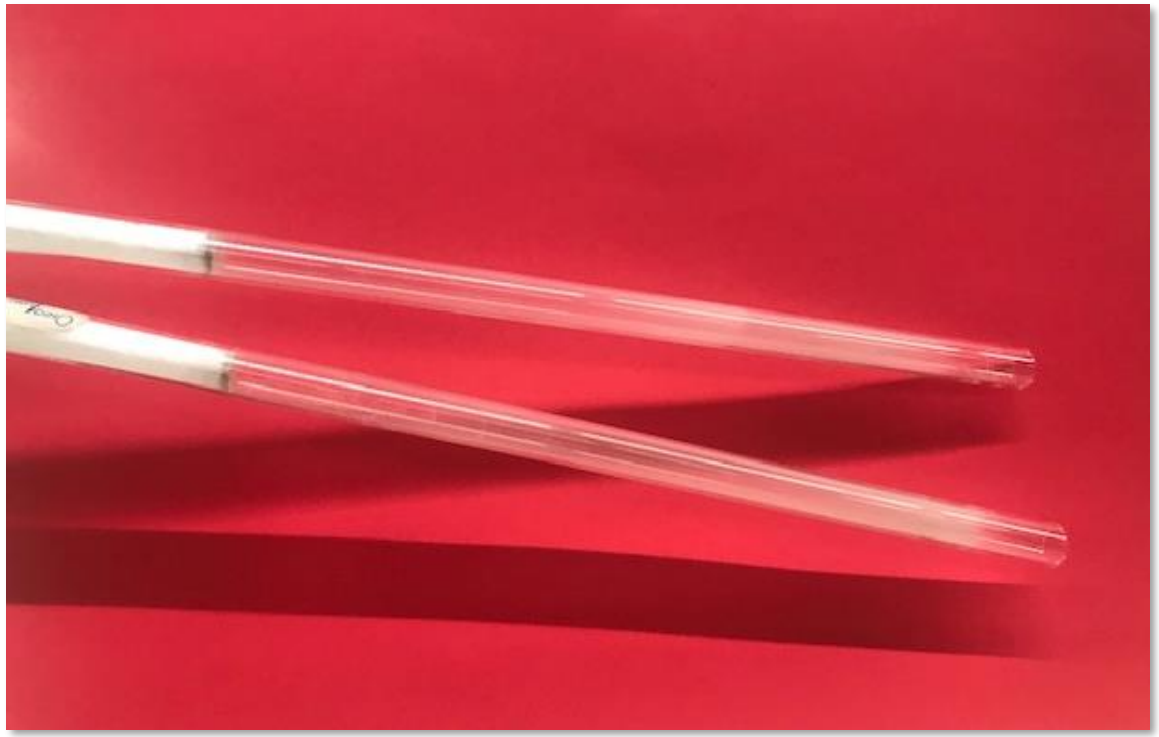


Suppression of Hg Oxidation by Ammonia



NH_3 Traps – Analyte Chemistry Considerations

- Ammonia is basic – it will react with acid gases in combustion gas to form ammonium salts such as ammonium bisulfate, ammonium sulfate, ammonium chloride, etc.
- Ammonium compounds are volatile, so traps must be sampled at very low temperatures to prevent breakthrough – **we force condensation to occur**
- All NH_3 from condensation is included in the total



NH_3 Traps – Sampling Equipment

- **Temperature**
  - NH_3 traps have the lowest sampling temperature of all traps – the fine temperature control kit is absolutely necessary

- **Particulate**
  - Use static pre-filters or sintered steel filter tips – success has been had with both (static pre-filters are preferred)
  - Isokinetic sampling should not be necessary
    - If any aerosols are present in the flue gas, they are ammonium salts – we don't want to include those unless they're formed **INSIDE** the trap

NH_3 Traps – Sampling Parameters

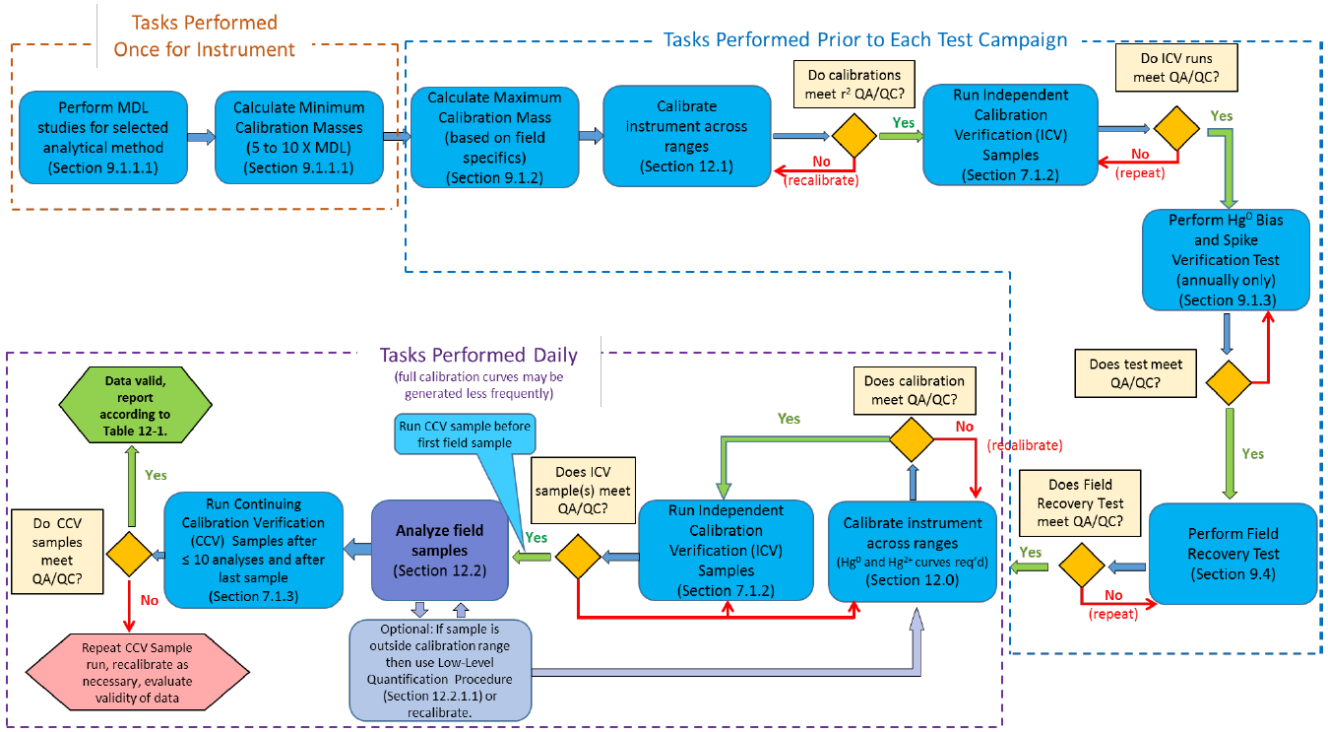
PARAMETER	RANGE
Temperature (°C)	100-120
Flow Rate (lpm)	0.25-1.0
Sample Volume (liters)	15-30
Isokinetic Sampling Required?	NO

NH_3 Traps – Analysis Instrumentation

- **Ion Chromatography**
  - Dissolve sections in water
  - Analyze using a cation column (vs. the anion column used for Cl^- and Br^-)
  - Analysis done in batches and takes at least 1 day
  - Not a destructive method, re-analysis is possible
- **Error/Uncertainty**
  - Expected RSD is 5%, allowable error is 10%, which is verified by calibration criteria, ICV, and CCV
- **Measurement Limits (based on 30 minute run):**
  - **MDL ≈ .03 µg/L LOQ ≈ 0.3 µg/L**

NH_3 Traps – Validation Strategy

- Well-tested for engineering purposes.
- Recommend spiked/unspiked pairs to verify measurement data quality – follow 30B QA/QC approach
- Relies on self-validating criteria, as there are limited comparisons
  - No tests against CTM-027, limited comparison against IR
  - Need more comparison data



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