SO_3-Monitoring in Flue Gas of a Power Plant
Application & Results

SO_3-Monitoring in Flue Gas

SICK Sensor Intelligence.

- Introduction
  - SO_3 / H_2SO4
  - The SO_3 Challenge
- Spectral evaluation
  - Components to be monitored
  - Calibration
- Analyzer Setup
- Field Test Results
- Benefits of real time monitoring
- Discussion

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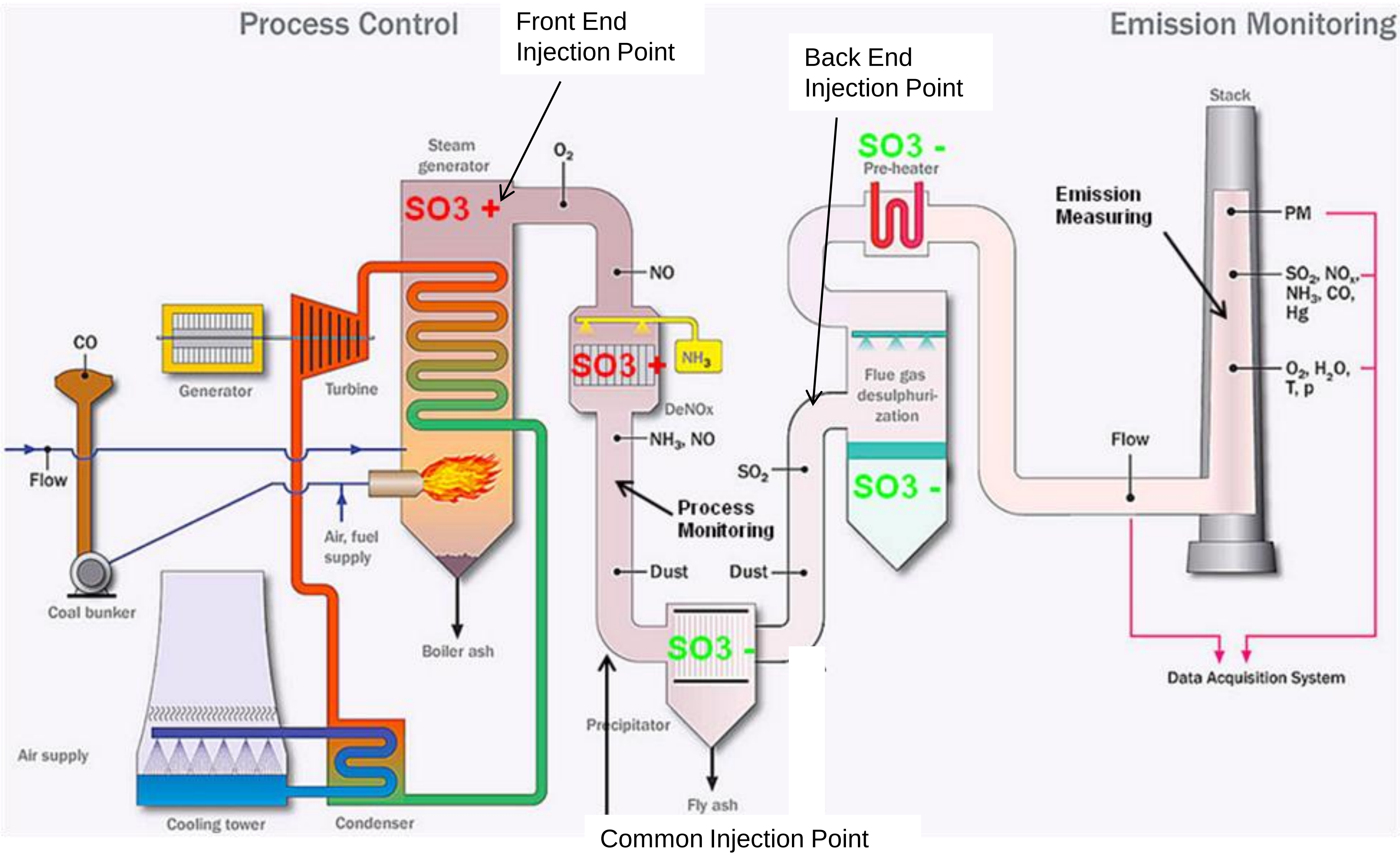

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- SO_3-presence in a coal fired power plant:

  - **SO_3-formation:**

    - In the furnace from Sulfur in coal (typ. 1 – 2% of SO_2):

$$S + O_2 \longrightarrow SO_2$$

$$2\ SO_2 + O_2 \rightleftharpoons 2\ SO_3$$

    - In the catalyst of a DeNOx plant (typ. + 1 – 2 % of SO_2):

$$2\ SO_2 + O_2 \rightleftharpoons 2\ SO_3$$

  - **Additional SO_3 in a power plant:**

    - Injection of SO_3 for improving dust removal efficiency in an ESP (although this is a dying technique in the US as most of these will be retired in the next few years, this is still prevalent in China and elsewhere)

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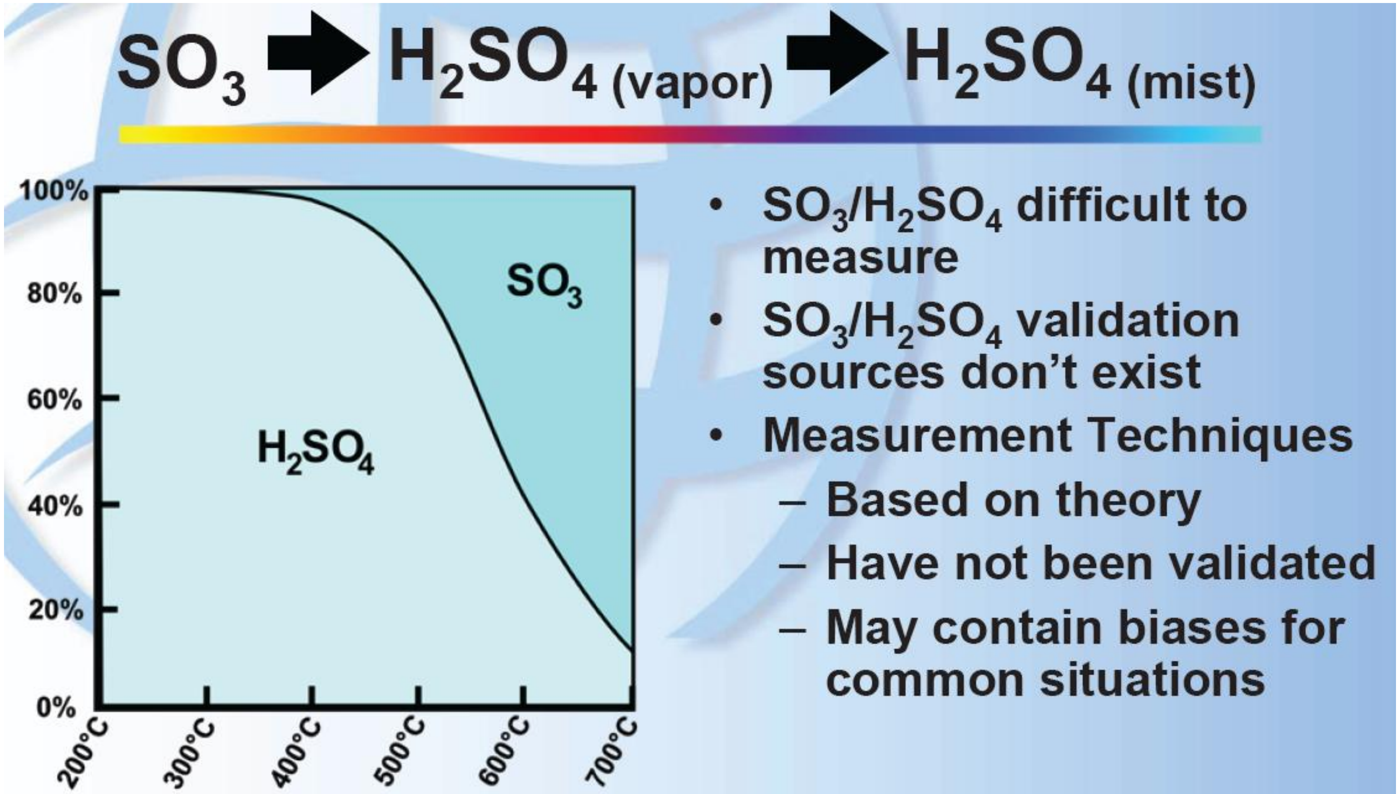
- SO_3 converts in humid gas into H_2SO_4:



Dale A. Lundgren, Paul Urone and Thomas Gundersn, "A Stack Gas Sulfate Aerosol Measurement Problem", In Workshop Proceedings on Primary Sulfate Emissions from Combustion Sources, Volume 1, EPA-600/9-78-02tia, (August 1978), pp. 161-178

- H_2SO_4-mist is generating corrosion problems and plumes at stack exit

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- SO3 is a problem because:
  - Increased stack opacity (blue plume)
  - Corrosive
    - Ductwork
    - Air Heater

- Companies inject compounds like Trona, hydrated lime or sodium bi-sulphate to reduce SO3 emissions.
- These are commonly referred to as dry sorbent injection systems (DSI).
- To date, this injection is uncontrolled.

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- Laboratory approach & spectral evaluation
  - Measurement of single components with FTIR spectrometer
    - SO_2
    - SO_3
    - H_2O
    - H_2SO_4
  - Selection of optimal measurement wavelengths
  - Design of MCS03 filter set up
  - Measurement with FTIR spectrometer and MCS03 photometer in parallel
  - Calibration of MCS03 photometer
  - Investigation interferences of other flue gas components
  - Compensation of interferences

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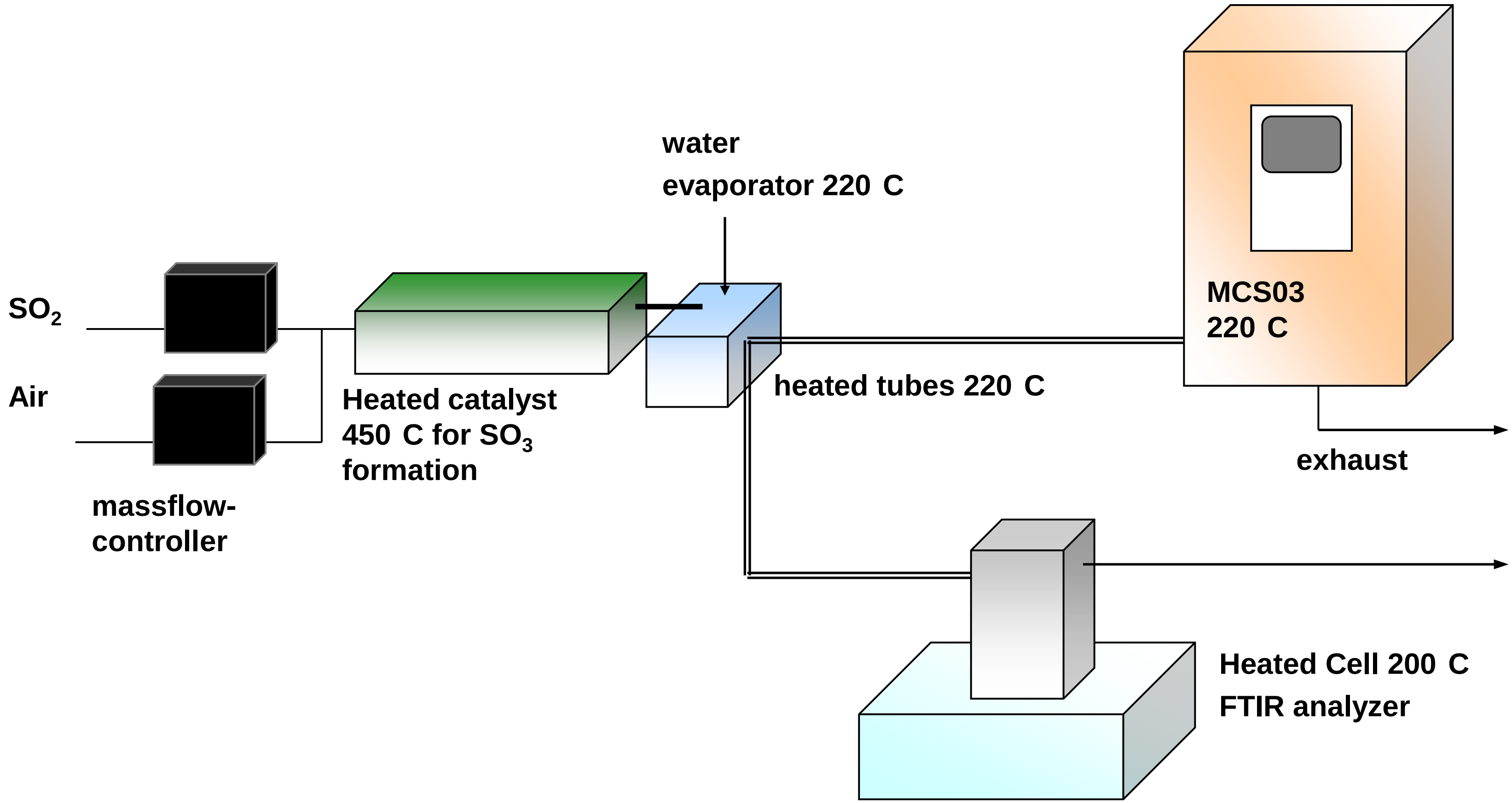
- SO_2/SO_3 measurement setup & calibration via catalyst



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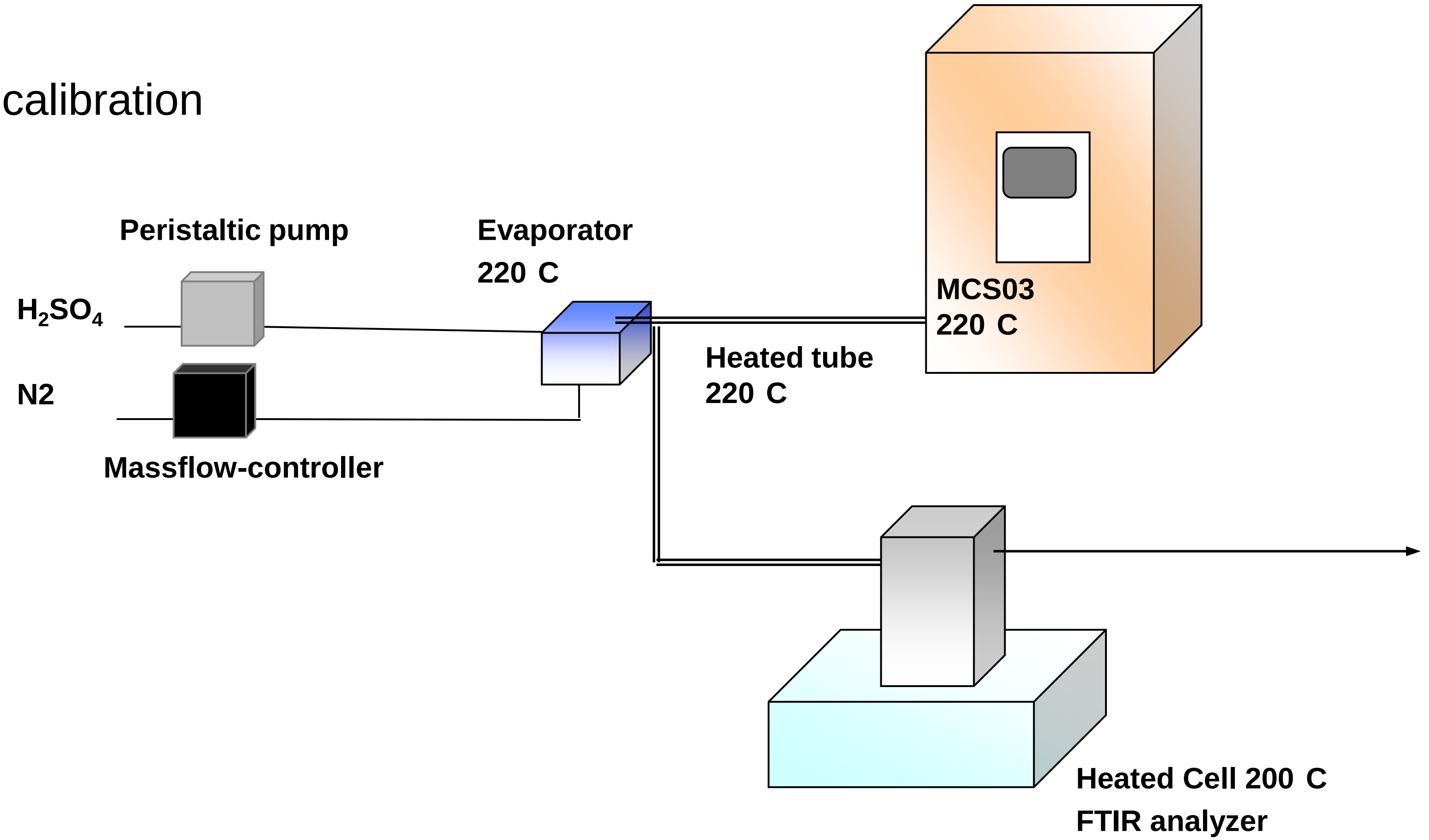
- H_2SO_4 Calibration via evaporator/steamer
  - Evaporator calibration



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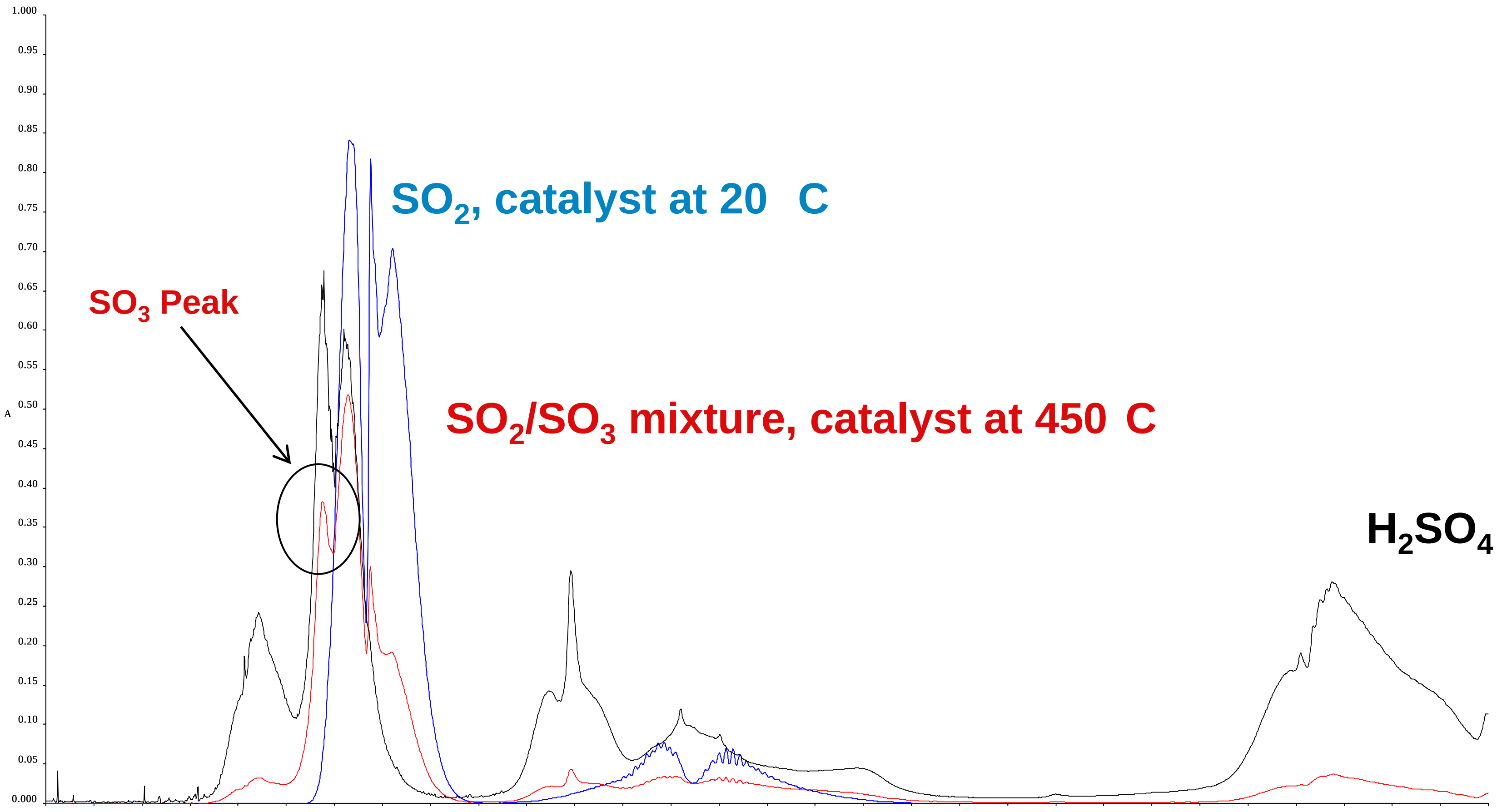
- Spectra of SO_2, SO_3, H_2SO_4



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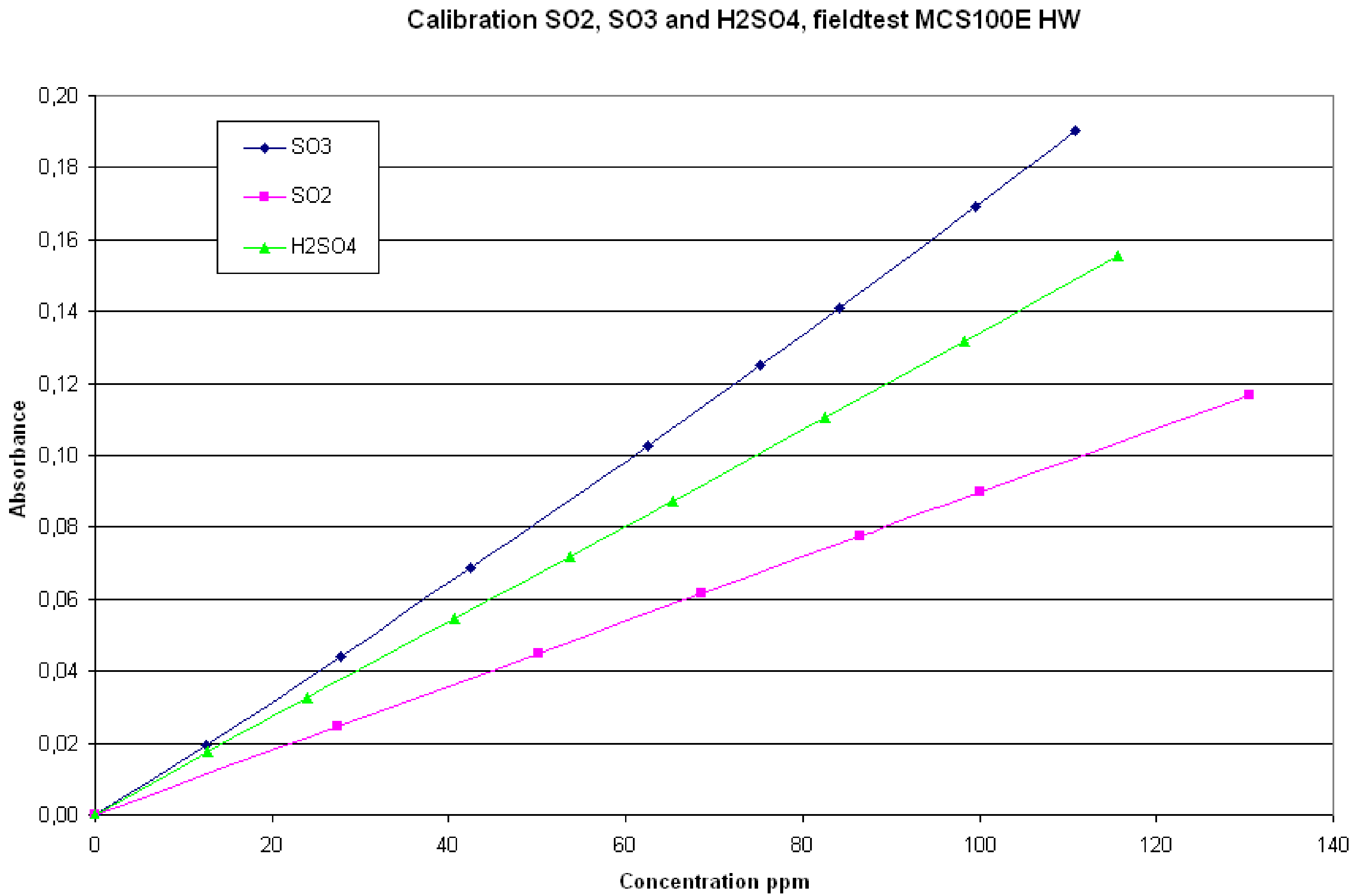
- Calibration results for MCS03



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- Results from Lab evaluation:
  - SO_2 , SO_3, H_2SO4 can be measured with one multi-component NDIR photometer
  - The 'real' result is the sum of SO3 + H_2SO_4
  - Parallel monitoring of SO_2, H_2O, CO_2, NO, NH3, HCl… gives a full picture
    - Control of SCR NH3 injection and slip, slurry injection for FGD
    - Reductions of HCl, Hg, SO2 and NOx.

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- The SO_3 monitoring system 'MCSO3'
  - MCS100E analyzer in HW system design
  - Equipped with
    - Heated sample probe
    - Heated sampling system
  - Measured gas components: SO_2, SO_3, H_2SO_4 and H_2O
  - SO_3 and H_2SO_4 are reported as SO_x
  - Other monitored components (optional): NO, CO_2, CH_4, O_2
  - Internal calibration filter for routine calibration w/o test gas

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- Field test installation with MCSO3
  - Coal fired power plant
  - Location: USA
  - In operation 18 months
  - Required quarterly maintenance on sample probe
  - Technical Details
    - Mounting Location: Stack (400')
    - Temp: 120 F
    - SO2: 20ppm
    - NOx: 10ppm

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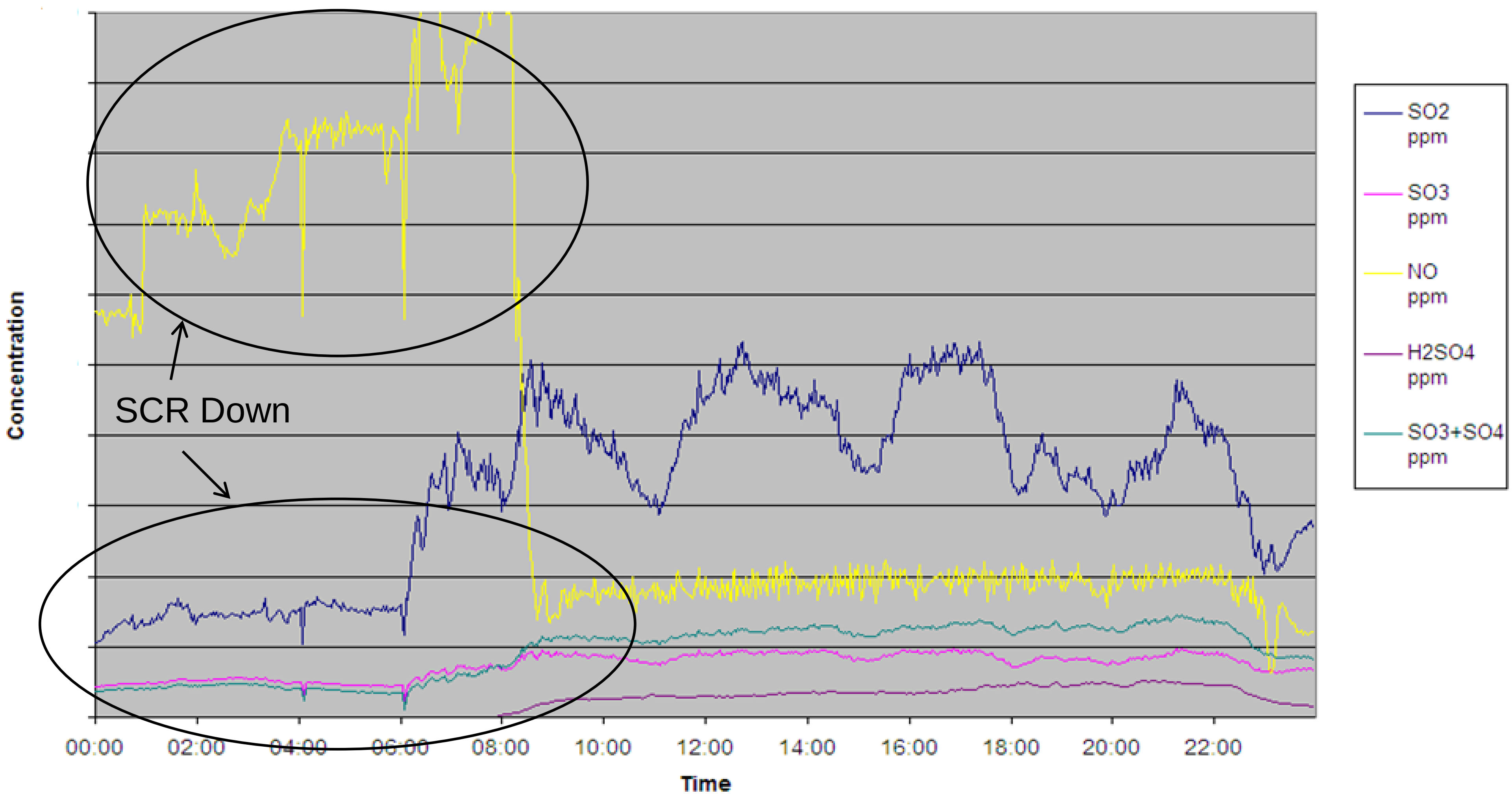
- 24-h data w/o SCR operation during night



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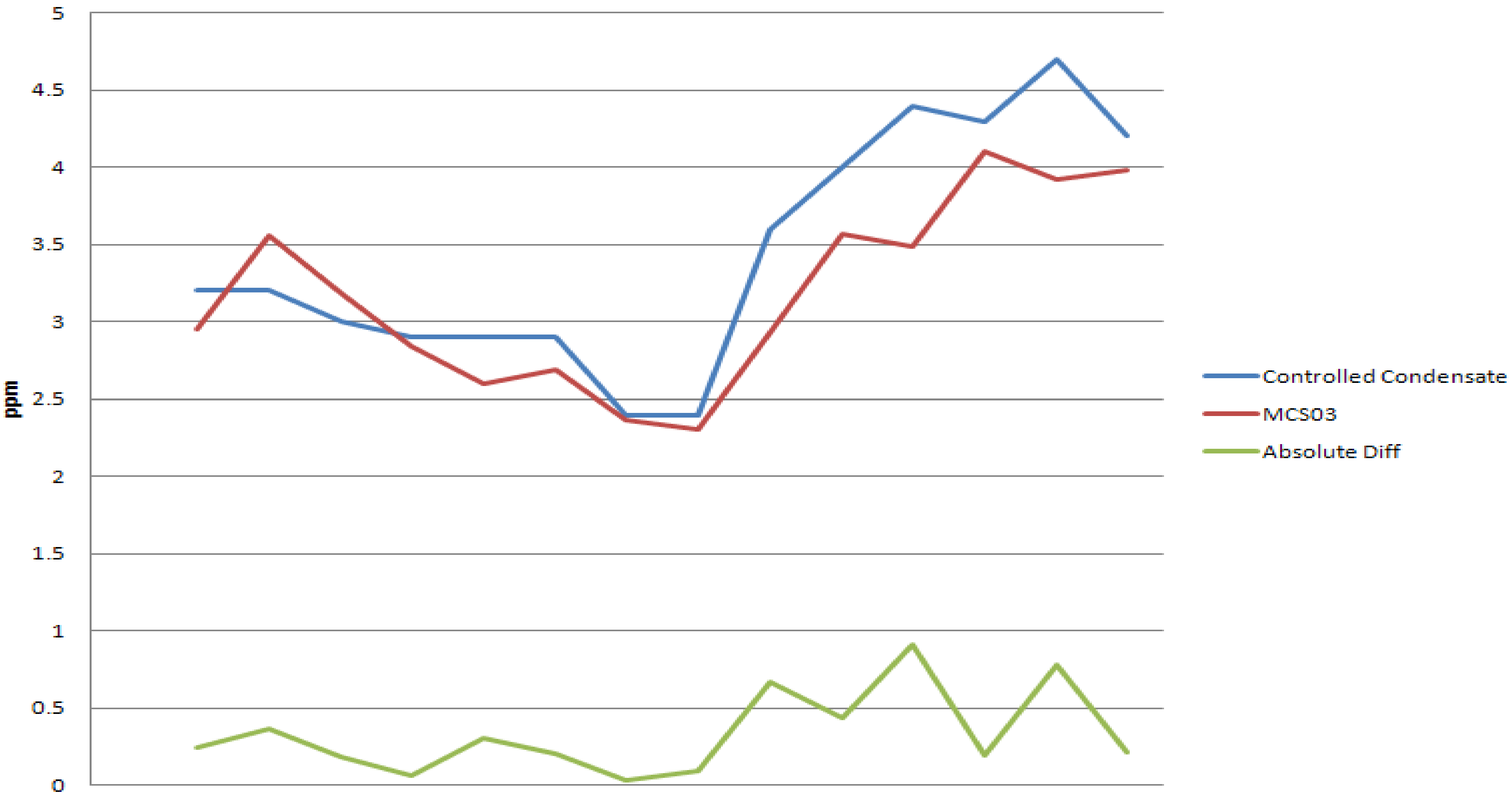
- Controlled Condensate comparison:



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- **Benefits of real time SO3 Monitoring:**
  - **Feed back control for the SO3 reduction system**
    - Cost savings in reduced trona/hydrated lime injection can be substantial
    - Reduced cost of fly ash disposal

Trona / Hydrated Lime Injection Rate	0.75	ton/hr
Trona / Hydrated Lime Cost	$220	$/ton
Total Usage / year	6570	tpy
Total Cost / year	$1,445,400	/year
Theoretical % efficiency increase	10%	/year
Theoretical $ Savings	**$144,540**	/year

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- Benefits of real time SO3 Monitoring (cont):
  - Reduced instances of “blue plume”
    - Currently only controlled by sight
  - Reduction of heat exchange exit temperature – higher process efficiency
  - Reduced corrosion in ductwork and air pre-heater
    - Lower maintenance costs
  - Increase efficiency of Hg removal
  - Additional integration of other “acid gas” and measurement components could provide a broad based “control loop” solution
    - NH3 – NOx for SCR control
    - HCl for DSI control

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Thank you for your attention.

Dan Kietzer – Business Development Mgr – SICK
Phone: 73-205-5664
Email: dan.kietzer@sick.com