Setting the Standard for Automation™

Process Analytics Using Quantum Cascade Laser

YT Koh

Director – Analyzers & Solutions

Standards

Certification

Education & Training

Publishing

Conferences & Exhibits

Presenter

Koh Yee Tiong

- Yee Tiong (YT), graduated with Chemical Engineering degree from the National University of Singapore in 1987, is Asia Pacific Business Development Director for the Rosemount line of Process Gas Analysers and Gas Chromatographs and Solutions.
- Worked with analyzers and analytical systems for the last 30 years and was formerly, Managing Director of a major System Integrator in Singapore

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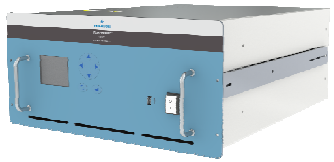
Typical Applications For Multi-Lasers Analyzer at a Glance

Higher Demand for Fast On-Line Analysis
Drives Need for New Technologies

Rosemount Quantum Hybrid Laser Analyzers for CEMs / Process Monitoring



CT5400 Continuous Gas Analyzer –Safe area

CT5100 Continuous Gas Analyzer - purged

CT5800 Continuous Gas Analyzer - Exd

- **Fast** – one second update for multiple measurements
- **Repeatable** – superior Limit of Detection
- **Low Maintenance** – Low drift, calibration rarely needed, high analyzer availability
- **Field serviceable** – repair on site, high analyzer availability
- **Cost efficient** – multiple measurements with one analyzer
- **High temperature** – operation allowing Hot/Wet measurement from 160 – 180°C for GP areas
- **Low cost of operation** – no consumables other than validation gas and purge air

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Hybrid Laser Gas Analyzer – Key Features

Plug & Play

- Modular design for **future-proof** measurement capability
- In case of process change in the future
  - Range could be adjusted on-site
    - E.g. 0-10% CO2 to 0-20% CO2
  - Additional measurements could also be included

Low Total Cost of Ownership

- **Minimal Maintenance**
- **No consumables**
- **No Moving parts**
- Single analyzer replaces multiple analyzers – **small footprint**
- Laser source MTBF **> 10 years**
- Minimal drift → **minimal calibration**

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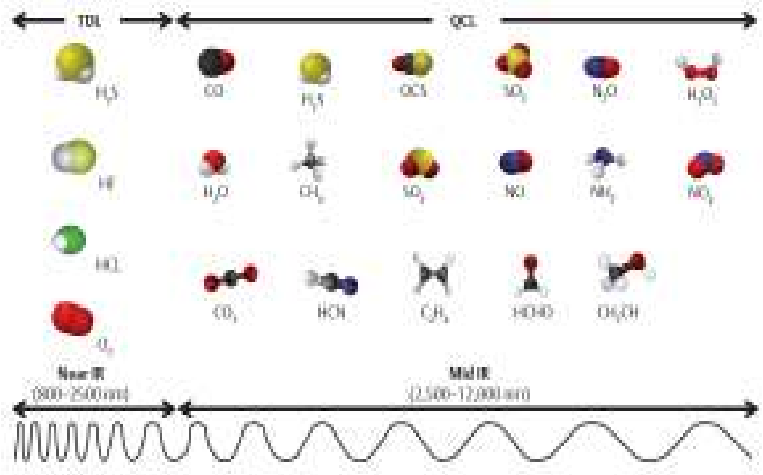
Hybrid Laser Gas Analyzer – Key Features & Benefits

Hybrid Design

- Combine both **QCL & TDL**
- **TDL – Near Infra-Red (NIR)**
- **QCL – Mid Infra-Red (MIR)**
- Opens up a lot more measurements capability compared to traditional analyzers

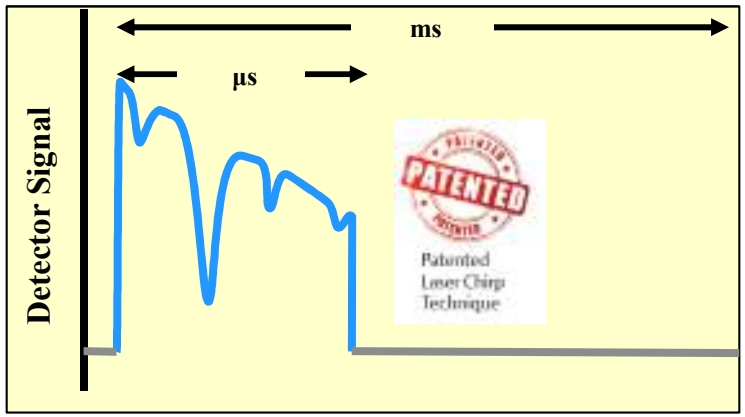
TDL = Tunable Diode Laser

QCL = Quantum Cascade Laser



Patented Laser "Chirp"

- Sequence and **stack multiple lasers (6 laser sources)** to measure multiple components in a single analyser, in real time
- Measurements in milliseconds
- Averaged hundreds of readings to 1 output per second, giving robust and reliable measurements



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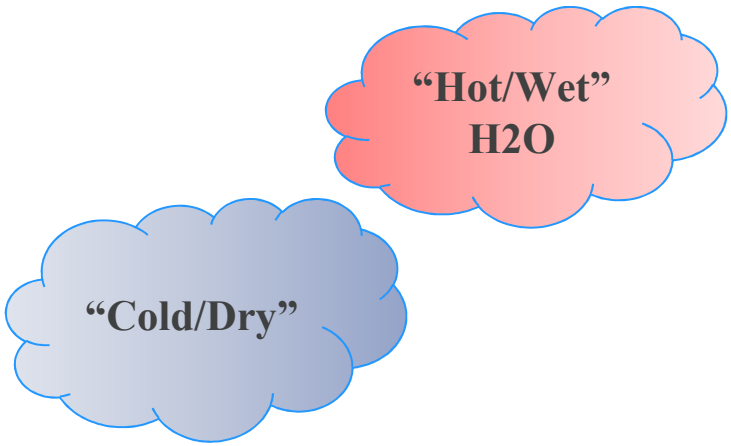
Cascade Gas Analyzer – Key Features & Benefits

Large Dynamic Ranges

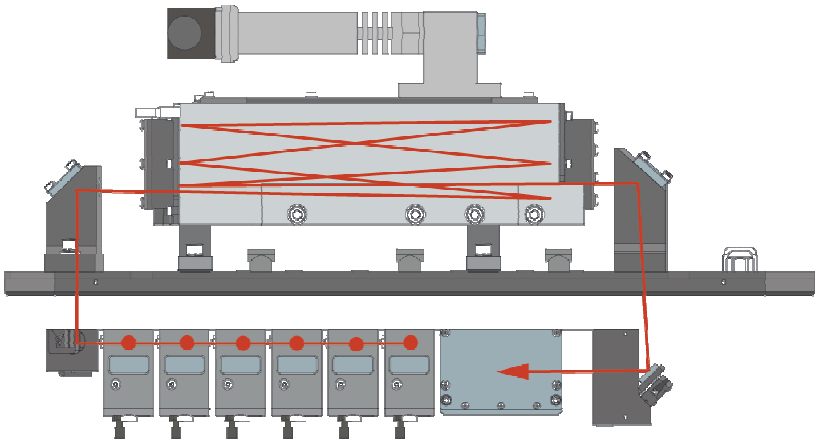
- Real time measurements in a large dynamic range
- **Sub-ppm to % levels**
- E.g. **0 – 5 ppm CO2** VS **0 – 100% CO2**
- **Dual ranges** of the same analyte can also be implemented
- Up to **12 measurements** per analyzer (application dependent)

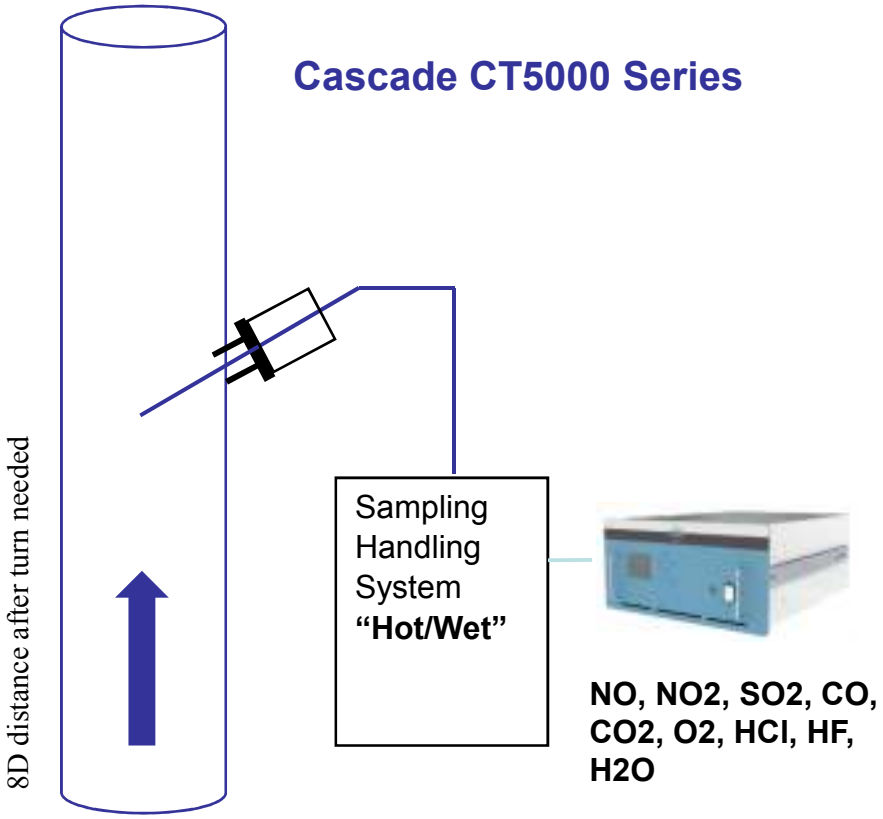


"Hot/Wet" Measurement

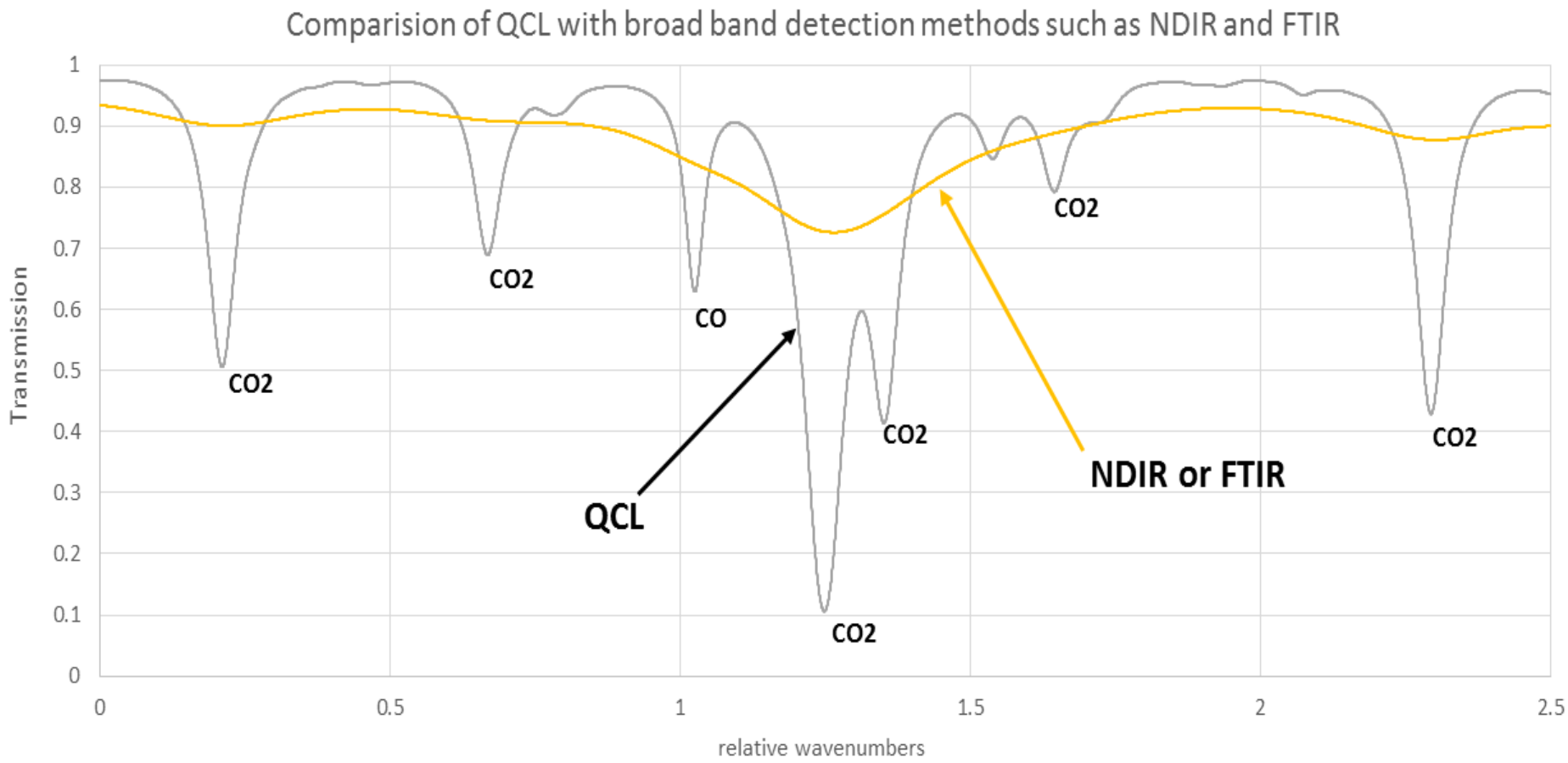
- Hot wet measurement means analyzing the sample on "as it is" basis, without removing water which may change the sample's composition.
- Helps maintain sample's integrity throughout measurement cycle, thereby provides a **True Representative Analysis**.
- Prevents **loss of measurements** of water soluble gases
- Heated measurement cell up to **160 – 180°C**
- Ex-proof areas – **80 - 120°C**
- Moisture Measurement is also possible (application dependent)
- **Prevents corrosion** with no condensation in the measurement cell

Hybrid Laser – CT5000 Optical Path & Basic Installation

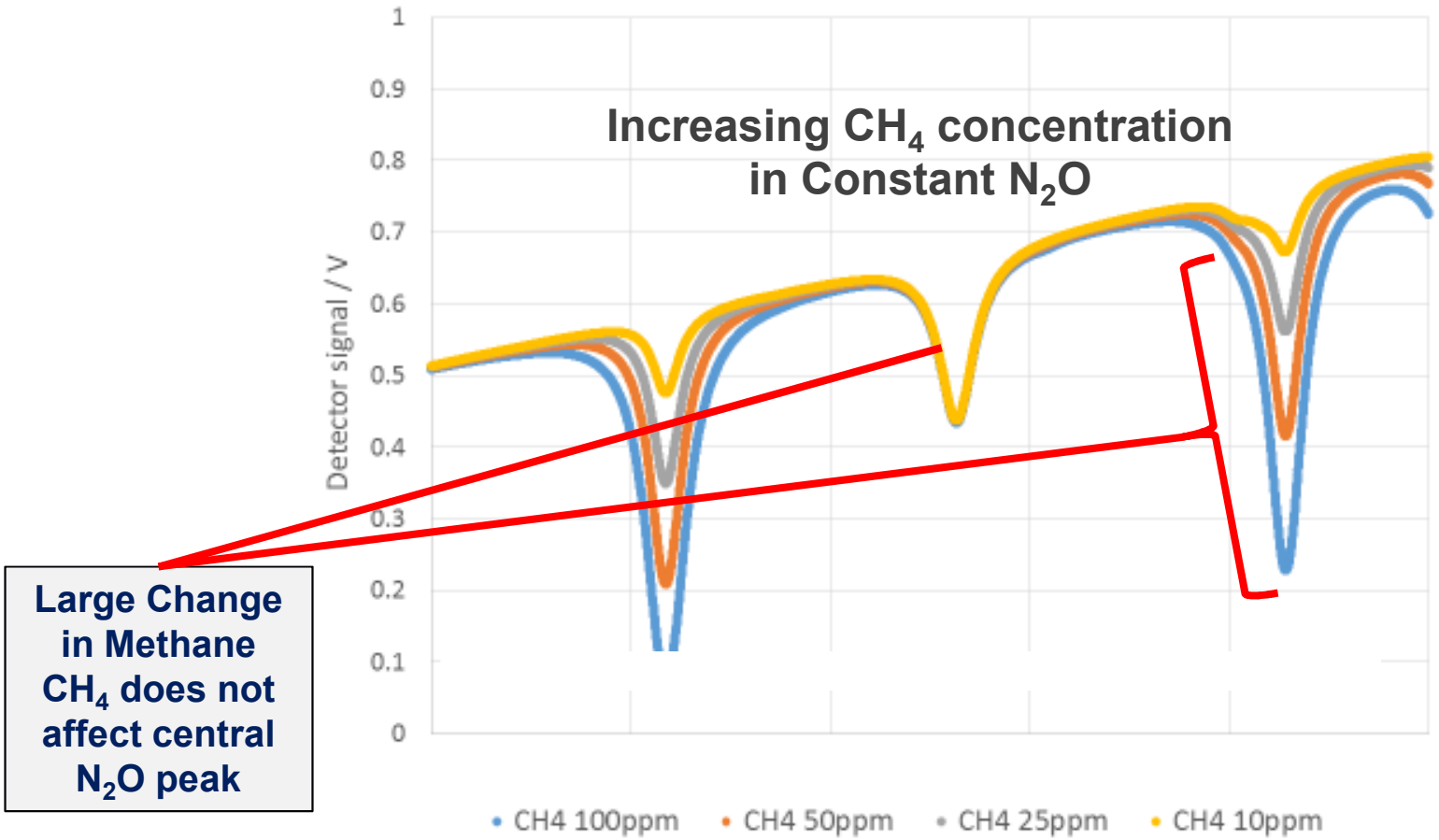




High Resolution Spectroscopy



Excellent Immunity To Cross Interference

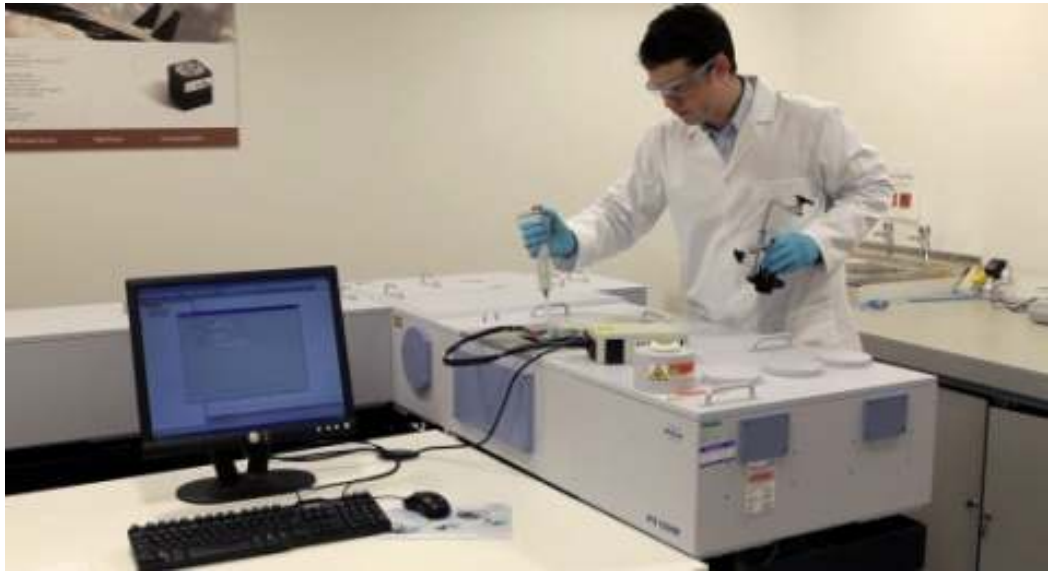


Large Change in Methane CH_4 does not affect central N_2O peak

High resolution allows detection of multiple absorption peaks in very narrow band

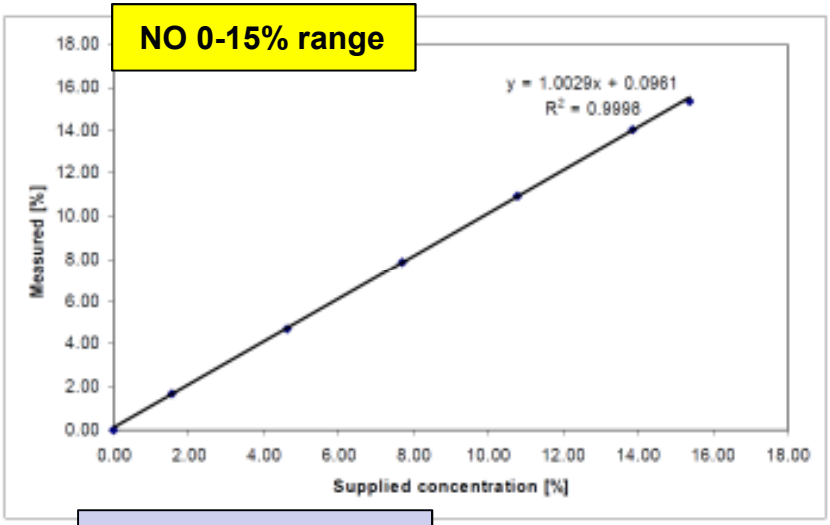
Application Review

- A routine is used against a database to select best spectrum fit
- Development stage:
  - High resolution FTS is used to record survey spectrum of the gases of interest plus other stream components
  - Suitable spectral region selected after application review
  - Temperature and pressure are monitored in the cell

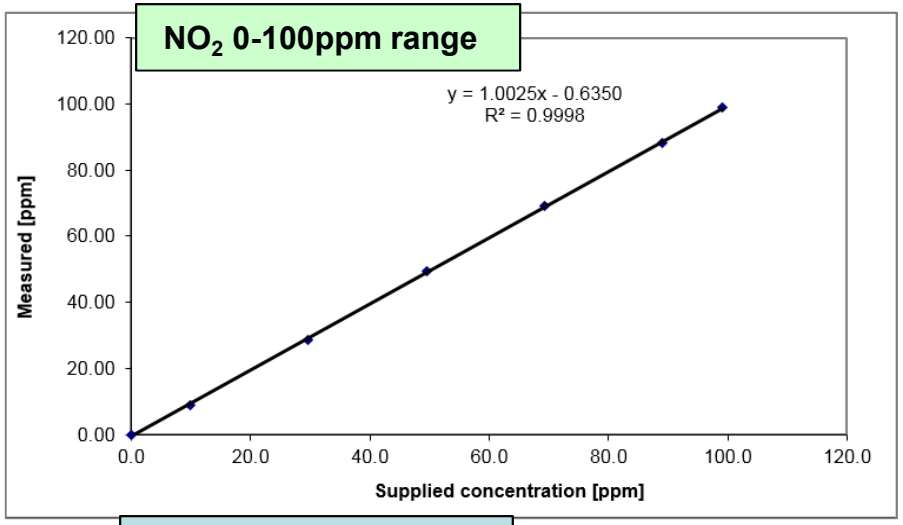


Large Dynamic Range
Linear Response from ppm to % ranges

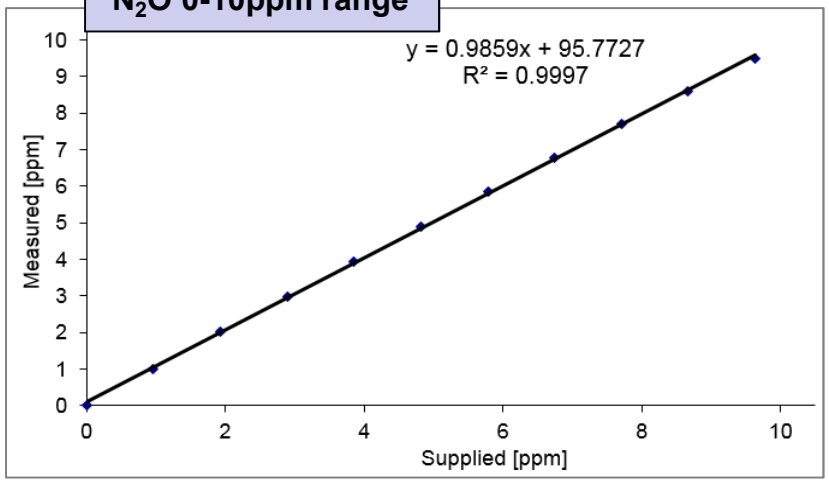
NO 0-15% range



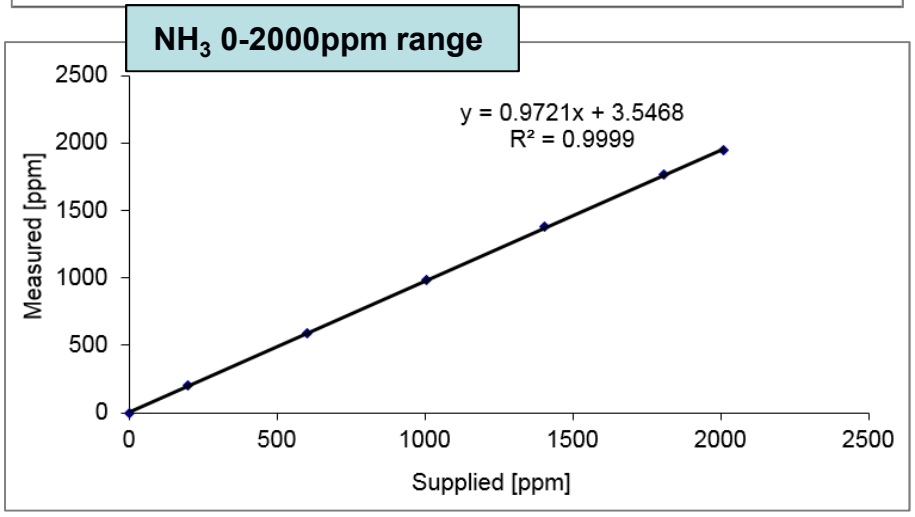
NO_2 0-100ppm range



N_2O 0-10ppm range



NH_3 0-2000ppm range



CEMS + Other Acidic / Alkaline Gases

Industry: Oil & Gas, Petrochemical, Power, Refining, Waste Incineration, Pulp & Paper

Challenge

- Ever increasingly stringent environmental regulations
- Moisture and acidic gases could bring corrosion issues if condensation occurs
- Low ppm acidic gases could lose measurement during moisture removal

Solution

- 1 or 2 QCL analyzers to meet your analytical requirements
- Fast response
- Low LOD values
- Hot/Wet Analysis without moisture removal
  - General Purpose 160 - 180°C
  - Ex areas 80 - 120°C
- Possible to tune measurement ranges on-site
- Low long term drift, minimizes calibration intervals

Component	Range	
	LOD	Span
NO	0.1 ppm	0 – 10ppm
NO2	0.05 ppm	0 – 10ppm
O2	0.04 %	0 – 25 %
CO	0.05 ppm	0 – 50ppm
CO2	0.01 %	0 – 12 %
SO2	0.2 ppm	0 – 200ppm
H2O	%	%
*NH3	Sub-ppm	Low ppm
*H2S	Sub-ppm	Low ppm
*HCl	Sub-ppm	Low ppm
*HF	Sub-ppm	Low ppm

CT5400

CT5100

De-NOx using Selective Catalytic Reduction (SCR)

Industry: Oil & Gas, Petrochemical, Power, Refining

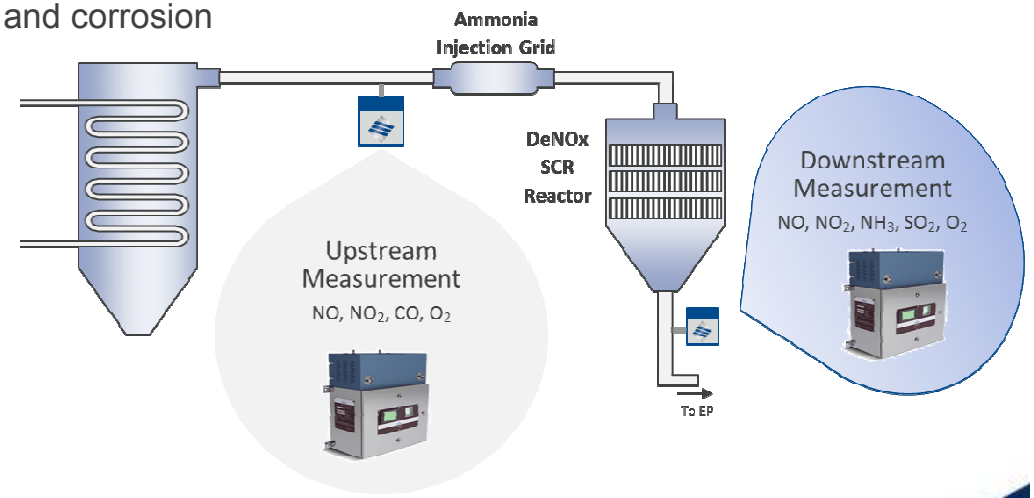
Challenge

- **If Insufficient Ammonia is Injected**
  - Inefficient use of catalyzer, NOx emissions uncontrolled
- **If Excess Ammonia Injected/Ammonia Slip**
  - Ammonia waste, Salt formation (side reaction leading to ammonium bisulphate formation)
- **Current solutions**
  - Plugging due to high dust content
  - High Maintenance costs
  - Higher down-time
  - "Cold/Dry" methods lead to NH3 measurement loss and corrosion

Component	Range	
	LOD	Span
NO	0.2ppm	0 – 200ppm
NO2	0.1 ppm	0 – 100ppm
N2O	0.2 ppm	0 – 200ppm
Ammonia	0.1ppm	0 – 50ppm
H2O	%	%

Solution

- 1 QCL analyzer for all components
- Faster response
- Very low LOD value for NH3
- Allows fast and precise control to reduce ammonia slippage
- Low, long term drift, minimizes calibration intervals
- Low maintenance, low total cost of ownership



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Hydrogen Purity in HYCO / PSA (Pressure Swing Absorption)

Industry: Petrochemical, Power, Refining

Challenge

- Final stage of H2 purification and cycling of PSA absorbers are very fast (typically less than 10 minutes), one active and another regenerating
- Typically separate analyzer is required for moisture
- Range for Methane by PGA may not be so low (0-10ppm) and low ppm reading require PGC
- Cycle time involved when using PGC

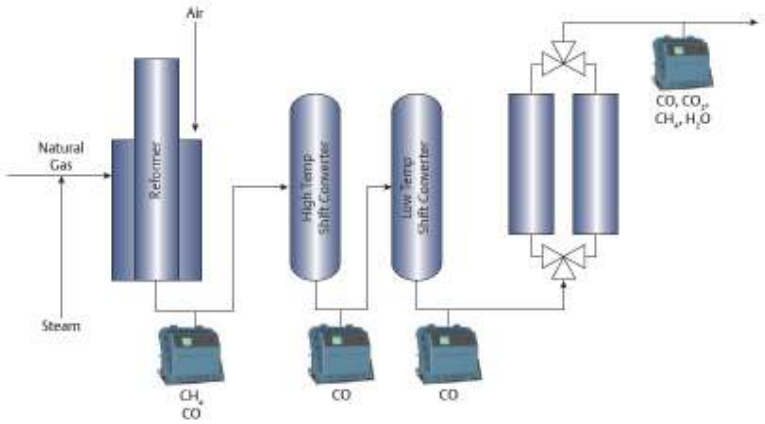
Component	Range	
	LOD	Span
Methane	0.2 ppm	0 - 50ppm
CO	0.05 ppm	0 - 10ppm
CO2	0.05 ppm	0 - 50ppm
H2O	0.1 ppm	0 - 10ppm
*C2H6	0.1 ppm	0 - 50ppm
*C3H8	0.1 ppm	0 - 50ppm

Solution

- 1 QCL analyzer can combine measurement with moisture
- Matches analysis of Gas Chromatograph with much faster response
- Can measure other low range contaminants

CT5800

Typical H_2 / N_2 Purity Process



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Thank You