

ICAD IN SITU ANALYSERS

PATENTED, DIRECT NO_2 AND / OR HONO DETECTION - NITROGENMONOXIDE (NO) MEASUREMENT VIA O_3 TITRATION CONVERTER - HIGH PRECISION - EASY OPERATION - CALIBRATION NOT REQUIRED



$\text{NO}_2/\text{NO}/\text{HONO}$ MEASUREMENT - PPT RANGE - HIGH TIME RESOLUTION - LOW POWER CONSUMPTION

HIGH SENSITIVITY, LARGE DYNAMIC RANGE & MOBILITY

The ICAD features typical advantages of high accuracy, instrumental stability, long maintenance intervals and low consumables. Further, the high dynamic range allows measurements from high polluted conditions e.g., at high traffic roads or industrial monitoring to very low concentrations in clean environments. If even ultra-low NO_x concentrations down to 15 ppt are of interest, the special ICAD high-grade versions “*L” are the perfect tool. The measurement can easily be controlled with a tablet connected to the ICAD via WiFi.



WORK SPACE NO_2 / NO_x MONITORING OR INDUSTRIAL MONITORING



The high mobility, rugged design, and low maintenance effort make ICAD instrument the ideal instrumentation for reliable monitoring NO_x levels in workplace environments such as mines, constructions site or industrial production places. Further, ICAD instruments can be applied to measure and monitor the NO_x emissions of industrial machines. Multiple data interfaces enable optional integration of ICAD instruments with industrial processes.

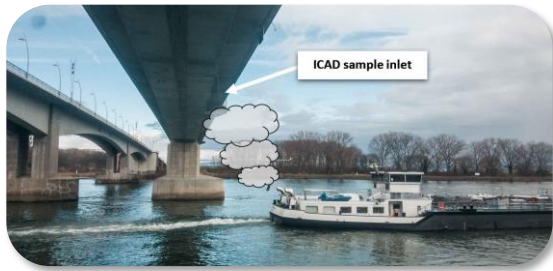
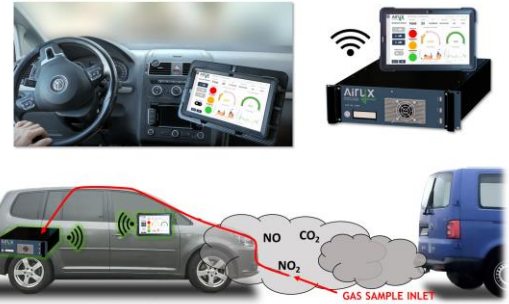
MOBILE MEASUREMENTS

The low power consumption, compact size, moderate weight and insensitivity to vibrations allow easily mobile measurements at different locations. The short set-up and warm-up time gives a lot of flexibility. Customized, ICAD versions for applications on drones are also available.



MOBILE APPLICATIONS - ON-ROAD REAL DRIVING EMISSIONS

ICAD for emissions “*E” (equipped with additional internal CO₂ sensor) allow on-road real driving emissions via the so-called Plume Chasing method. A vehicle with the ICAD, follows target vehicles to measure the gases in the diluted plume. Within seconds the system derives the specific NO_x emission signature from the vehicle. In short times, high emitting vehicles due to defects or exhaust manipulations are identified. The tool allows authorities to enhance inspection efficiency or researchers to perform a vehicle emission screening.



FLEXIBLE DEPLOYMENT - EXTENDED APPLICATION

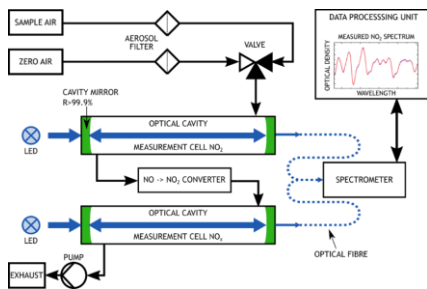
The fast response time of the ICAD instrument enables monitoring and assignment of NO_x emissions from water vehicles (e.g., at bridges or at the shoreline). With the ICAD emission configuration, NO_x emission factors (mg NO_x/kWh) are similar derived like for the real driving application. The calculation is independent from dilution of exhaust gases and thus, influence of meteorology.

NO DRIFTS, NO CROSS-INTERFERENCES

The selective detection of NO₂, NO_x or HONO, high measurement sensitivity and negligible drift makes the ICAD perfectly suitable for stationary air quality monitoring as well as scientific studies of chemical processes, e.g., atmospheric studies or simulation experiments. Further, the absence or cross-interferences to other gas species, enables measurements also of complex mixture (e.g., containing high concentration of CO₂, N₂O, H₂O or hydrocarbons).



TECHNIQUE



- Direct measurement by differential absorption spectroscopy
- High sensitivity and accuracy by use of ICAD algorithm (insensitive to intensity variations and aging of light sources)
- No cross-interference, spectral separation from other gases like water vapour (H₂O), Glyoxal (C₂H₂O₂), oxygen (O₂)
- No calibration gases required; no pre-drying of sample air required
- High dynamic detection range of low ppt to ppm
- Fast response time of 2 seconds

ICAD MODEL OVERVIEW

| | NO2-200 | NOx-200D | NOx-200DE | NO2-200L | NOx-200DL | HONO-200L |
|--|-----------------|----------------------|---|-----------------|----------------------|--|
| Detectable gases | NO ₂ | NO ₂ / NO | NO ₂ / NO / CO ₂ | NO ₂ | NO ₂ / NO | HONO / NO ₂ |
| Range | 5 ppm | 5 / 5 ppm | 5 / 5 / 2000 ppm | 2 ppm | 2 ppm / 2 ppm | 0.5 / 2 ppm |
| Limit of detection at 2s, 30s, 300s in ppt | 350,100,30 ppt | 350,100,30 ppt | 350,100,30 ppt CO ₂ : 4 ppm | 200,50,15 ppt | 200,50,15 ppt | HONO: 500,120,40 ppt NO ₂ : 600,150,50 ppt |
| Precision (1σ) at 2s, 30s, 300s in ppt | 175,50,15 ppt | 175,50,15 ppt | 175,50,15 ppt CO ₂ : 2 ppm | 100,25,8 ppt | 100,25,8 ppt | HONO: 250,60,20 ppt NO ₂ : 300,75,25 ppt |
| Available also as mobile “M”-version | ✓ | ✓ | ✓ | ✗ | ✗ | ✗ |

ICAD SPECIFICATIONS

| | | | |
|--|---|--------------------------|---|
| Detection of NO ₂ , HONO | Direct spectroscopic measurement | Power consumption | Less than 40 W at 12 V (typ.) |
| Detection of NO (NO _x) | By conversion to NO ₂ | Start-up time | Less than 1 min (typ.) |
| Response Time (10% to 90%) ^{(*)2} | 2s at 1 l/min or 1s at 2 l/min | Temp. range of operation | -10 to +25 °C (+40 °C with cooling option) |
| Zero drift | Less than 0.1 ppb/month ^{(*)3} | Temperature sensitivity | Less than 0.01 ppb/ °C |
| Sample flow | 1 to 2.5 l/min | Cross sensitivity | No significant cross sensitivity ^{(*)5} |
| Calibration | Target calibration gas not needed ^{(*)4} | Mechanical stability | Insensitive to vibrations |
| Path length characterization | Helium gas (1 to 2 years interval) | Consumable gases | No gases needed for operation |
| Housing Size 19" Rack | 43.6 x 13.2 x 36.5 cm ³ (WHD) | Other detectable gases | Glyoxal ^{(*)6} (respected by spectral analysis) |
| Housing Size 19" Rack "L" | 43.6 x 13.2 x 61 cm ³ (WHD) | Processing unit | Internal embedded PC (WIN10) |
| Housing Size "M" | 40.0 x 13.2 x 30 cm ³ (WHD) | Data communication | LAN/WiFi/RS232/M2M/OPCUA; Bayern-Hessen Protocol; Voltage/Current Output (for rack version, on request) |
| Weight 19" Rack | < 12 kg (depending on config) | | |
| Weight Rugged "M" version | < 10 kg (depending on config) | | |

(*1) Custom specifications with different measurement range are possible. By reducing the measurement range better precision and LOD can be achieved. (*2) Response: Different measurement cell types are available, allowing different response times. (*3) Upper limit. Drift is negligible due to regularly automated reference measurements. (*4) Literature absorption data for target gas is used for gas quantification. (*5) No significant spectroscopic cross sensitivity found for: water, ozone, Glyoxal, Carbon Oxides, Methane, Formaldehyde, Hydrogen, Sulphide, Sulphur Dioxide, Chlorine, Chlorine Dioxide, Hydrogen Cyanide, Hydrogen Chloride, Phosphine, Hydrogen, Ammonia, Acetylene, Nitromethane, Ethylene, Ethanol, Methyl Mercaptan, Ethyl Mercaptan. (*6) For NO₂-200 and NO_x-200 models.



19" Rack housing front and back side



Mobile "M"-version housing

HIGHLIGHTS

BENEFITS

High measurement accuracy

INNOVATION

- Direct spectroscopic gas measurement
- High sensitivity, low measurement error
- Fast measurement response
- No zero-point or calibration drift, 100% reproducibility, no interferences
- No sample pre-dryer needed

Simple and low costs operation

- No calibration with target gas (NO₂, HONO) required
- Parallel NO measurement (with ozone titration converter)
- No consumable gases needed
- Robust setup, long lifetime

Flexible application

- High stability (not sensitive to shocks, vibration, temperature)
- Compact design, mobile application
- Low power consumption and 12 V operation
- Data Interfaces: WiFi, LAN, Machine2Machine, RS232, Analogue Volt./Cur.
- Internal memory for up to 2 years of data

Patents: DE102015000423; EP3329251; US15/748,923; China ZL201680057099.6