Gas Analysis of N_2O, CH_4 und CO_2 in Wastewater Plants using INFRA.sens®

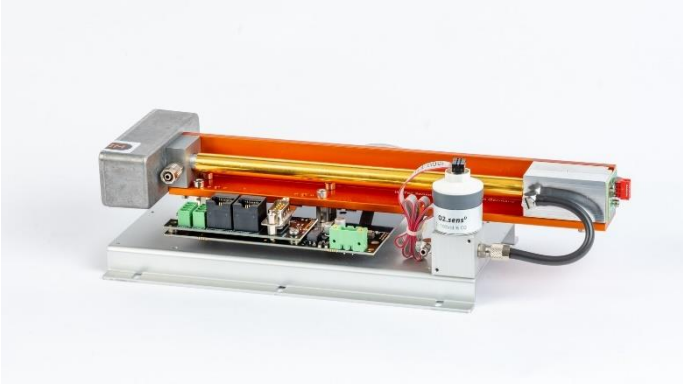
Nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2) are greenhouse gases that can be produced in large quantities during wastewater treatment. Wi.Tec-Sensorik GmbH has developed a highly accurate and long-term stable multi-channel NDIR gas analyser (INFRA.sens®) for this area of application.

N_2O emissions from wastewater treatment plants generally exhibit large daily and seasonal fluctuations. Due to the considerable spatial and temporal fluctuations in emissions, long-term online monitoring approaches are therefore required. Exhaust gas monitoring systems based on NDIR technology are best suited to measuring emissions due to their low maintenance costs and high temporal resolution. In addition, the monitoring of process emissions makes it possible to quantify the oxygen transfer in the biological treatment process, which leads to process optimization and thus considerable energy savings.

N_2O concentrations are normally between 0 and 300 ppm. However, during the high emission phases of certain plants, concentrations of up to 3000 ppm N_2O can be detected. The N_2O gas analyser must therefore have a high dynamic range.

NDIR INFRA.sens®

The highly selective gas analysis is carried out using NDIR technology (INFRA.sens®). The INFRA.sens® utilises the known absorption bands for methane, carbon dioxide and nitrous oxide in the 3µm - 5µm range. The radiation source is a blackbody radiator that can be modulated in the frequency range of 1-10Hz. To achieve the highest possible resolution, a 250 mm long analyser cuvette is used, which is coated with a special gold layer. The gold coating has a high reflectivity and leads to an optimum signal level on the detector side. The gold coating also protects against corrosion. The IR detector is located on the opposite side and consists of 4 elements. Interference filters are used to filter out the gas-specific spectral components for the respective detectors. The interference filters have a very narrow bandwidth and an efficient blocking factor. This leads to a very high selectivity and negligible cross-sensitivity to other gas components.

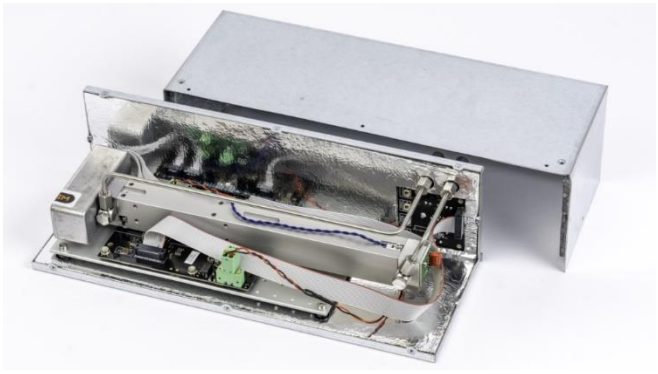


An additional reference measurement ensures drift-free measurement results. The detection limit of N_2O in this arrangement is <0.5ppm, so that even the smallest changes in concentration are reliably detected.

The entire signal processing takes place in an electronic evaluation unit (base board), which is located below the optical unit. Data is transmitted via an RS232 interface. CAN interface, MODBUS (option) and analogue output 0-10V (option) are also available.

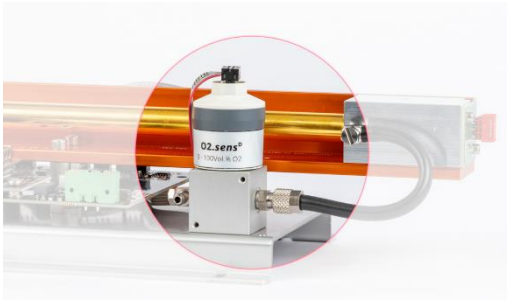
Thermobox

The sample cell is thermostatically controlled to 50°C to prevent condensation of water vapour inside the analysis cell. The entire assembly is integrated into a galvanised sheet steel housing, which is insulated on the inside to shield it from external temperature influences. The gas analyser is specified for an ambient temperature of 5-45°C. The warm-up time is less than 45 minutes.



Oxygen-Measurement

This set-up also includes an electrochemical (EC) oxygen sensor (galvanic cell) for measuring the oxygen concentration in the gas mixture. The O2.sens[D] has a measuring range of 0-25 vol.% $_{O2}$ and is very selective for oxygen, even in the presence of other gases in high concentrations. Compared to physical gas sensors, the service life of electrochemical gas sensors is limited due to the chemical reactions in the sensor. The service life is therefore specified in vol.%-h. The typical sensor lifetime is >500,000 vol.%-h. In the presence of 10-20 vol.% oxygen, the calculated service life is approx. 3-6 years. The O2.sens[D] can communicate with the INFRA.sens electronics via an I²C interface. Compared to analogue transmission, the I²C interface ensures loss-free and high-resolution transmission of measured values.



Specificationen

General features	
Ranges	0-100ppm, 0-500ppm, 0-2000ppm, 0-5000 N_2O 0-1000ppm, 0-2000ppm CH_4 0-1 vol.%, 0-5vol.%, 0-20 vol.% CO_2 0-100 Vol.% O_2
Gas flow	0.1-1.5 l/min.
Dimensions	345mmx153mmx103mm (Thermobox)
Weight	app. 720g
Lifetime	>40 000h (NDIR) >500.000Vol.%·h (EC)
Warm-up time	<45min. (initial)
Response time t90	1.5s-15s (NDIR) <5s (EC)
Detection limit	<0.5ppm N_2O <5ppm CH_4 < 0.01 Vol.% CO_2 <0.1 Vol.% O_2
Linearity error	<1% F.S.
Supply voltage	15-30 VDC
Power consumption	<35 W@24VDC (Warm-up phase)
Output signal	RS232, Modbus or CANbus
Operating temperature	5-45°C
Air pressure	300-1200 hPa (mbar)
Ambient Humidity	<95% rel. Humidity

https://www.witec-sensorik.de/produkte/infrasens-ak250/

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