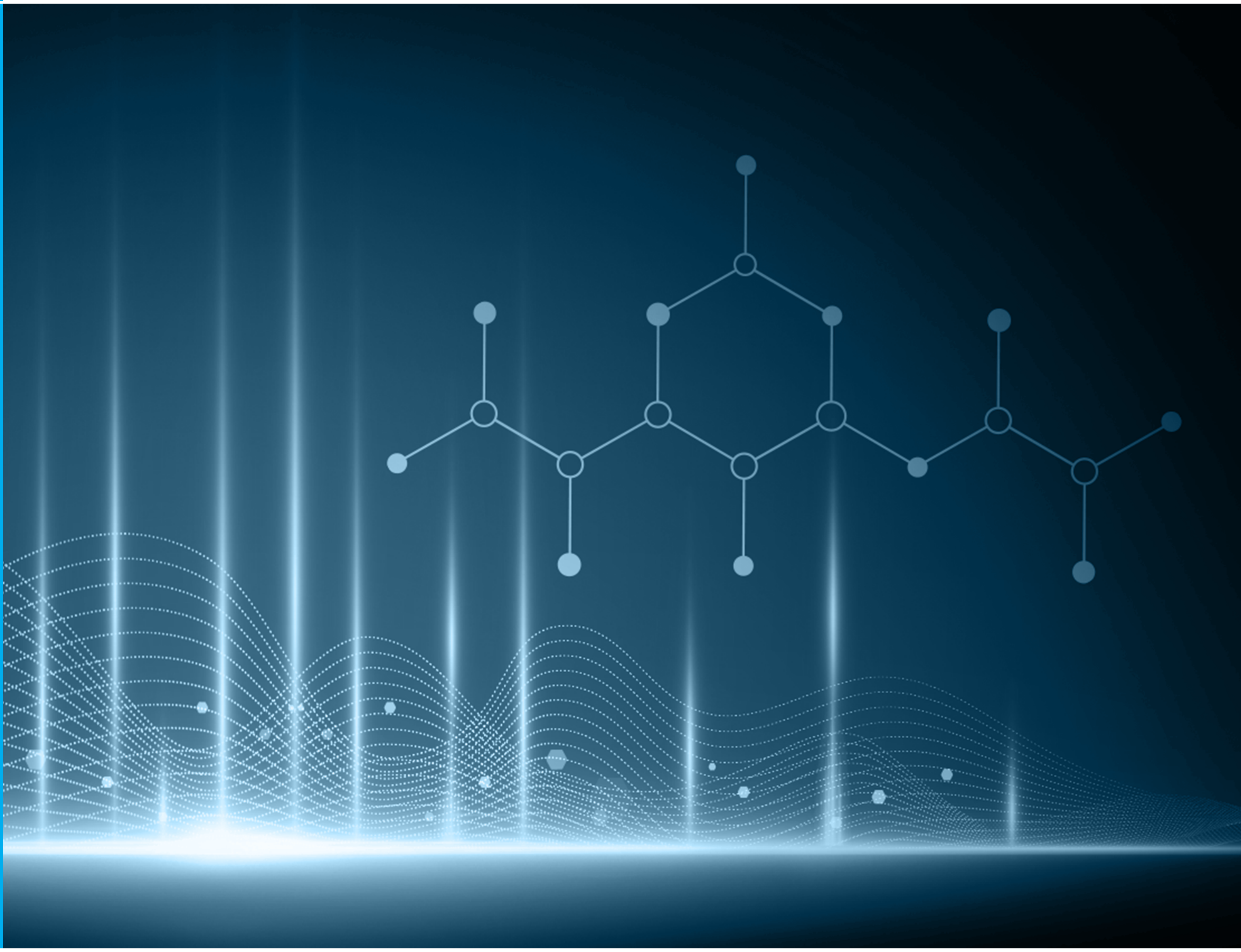
TDLAS and QF analyzers technology guide

Principle of operation, configurations, and certification information



Endress+Hauser
People for Process Automation

TDLAS and QF process gas analyzers

Advanced spectroscopic technologies for challenging applications

This guide provides descriptions of the principle of operation of tunable diode laser absorption spectroscopy (TDLAS) and quenched fluorescence (QF) analyzers, along with information on analyzer configurations and certifications.

TDLAS technology TDLAS analyzers perform on-line, real-time measurements of impurities in process gas streams from sub-ppm levels to percentage levels. The technology is widely used for measurements of moisture (H_2O), carbon dioxide (CO_2), hydrogen sulfide (H_2S), ammonia (NH_3), acetylene (C_2H_2) and other compounds.

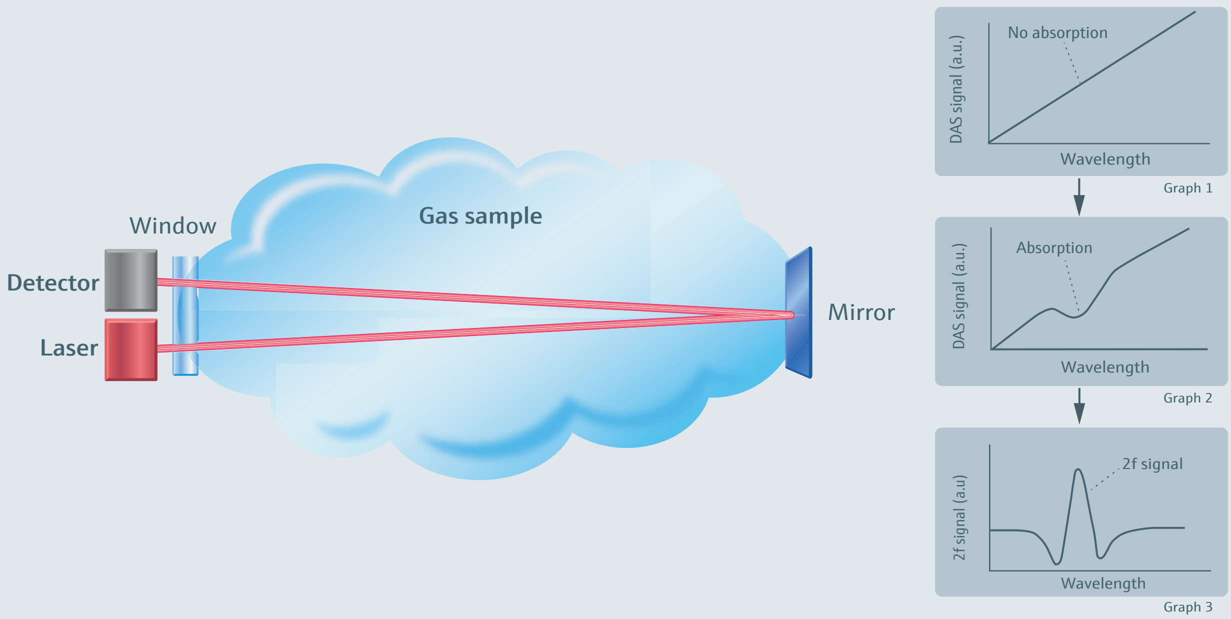
Principle of operation, TDLAS technology

In operation, process gas from a sampling probe is introduced to the sample cell of the TDLAS analyzer. A tunable diode laser emits a light with a specific near-infrared (NIR) or visible wavelength that can be absorbed by the target analyte. The laser light enters the sample cell, passes through the gas, gets reflected by one or more mirrors, and is finally aimed into a photodiode detector.

A window isolates the laser and detector from the process gas. This design allows measurements to be performed with absolutely no contact between the process gas (and entrained contaminants) and critical analyzer components.

Analyte molecules in the gas sample absorb and reduce the intensity of light in direct proportion to their concentrations according to the Lambert-Beer law.

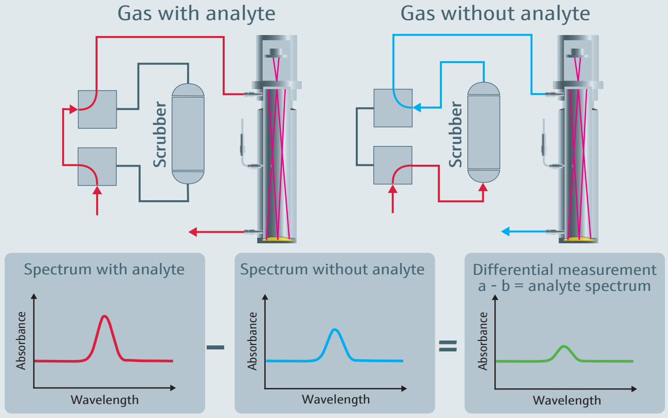
The system measures the transmitted laser intensity as a function of the scanned laser wavelength as depicted in Graph 1 and 2, below. Graph 1 has no absorption and Graph 2 has significant absorption as indicated by the “dip” in intensity at a specific wavelength. To improve detection sensitivity over simple direction absorption spectroscopy (DAS), wavelength modulation spectroscopy (WMS) with second harmonic (2f) detection is employed. The 2f signal is illustrated in Graph 3. WMS-2f can be 1-2 orders of magnitude more sensitive than DAS because it uses a lock-in amplifier to pick up the 2f signal in a narrow bandwidth while eliminating lower and higher frequency noises. This approach significantly improves the signal-to-noise ratio supporting high-sensitivity measurements. The 2f signal is processed using advanced algorithms to calculate analyte concentration in the process gas.



Differential spectroscopy Endress+Hauser TDLAS analyzer systems, powered by SpectraSensors TDLAS technology, include a patented spectral subtraction technique that enables trace-level (sub-ppm) measurements of H_2O, H_2S, or NH_3 to be made when a process gas sample contains very low levels of an analyte and background gas interferences.

Principle of operation, differential spectroscopy

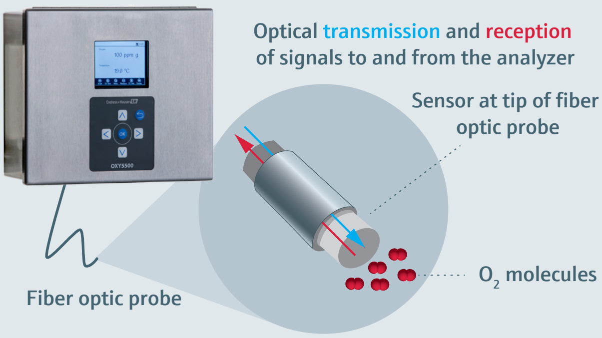
In operation, the TDLAS analyzer performs a sequence of steps to obtain a "zero" or "dry" spectrum and "process" or "wet" spectrum that are used to calculate analyte concentration by spectral subtraction as depicted in the figure at right. The dry spectrum is obtained by passing the process gas sample through a high-efficiency scrubber or dryer which selectively removes the trace analyte without altering the process gas composition and background absorbance. The analyzer records the resulting dry spectrum of the process gas and automatically switches the sample gas flow path to bypass the scrubber and collect the wet spectrum. Subtraction of the recorded dry spectrum from the wet spectrum generates a differential spectrum of the trace analyte which is free of background interferences. The analyte concentration is calculated from the differential spectrum.



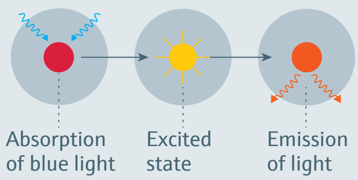
Quenched fluorescence (QF) technology QF analyzers perform on-line, real-time measurements of oxygen (O_2) in gas streams from ppm levels to percentage levels. The technology has been rapidly adopted by natural gas companies and is used in a host of gas processing applications.

Principle of operation, quenched fluorescence (QF)

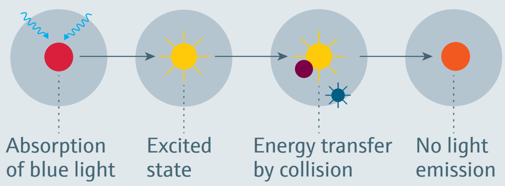
The sensor is selective and specific for oxygen measurement in natural gas and hydrocarbon streams, and is unaffected by the presence of H_2S and other compounds which cause interferences and measurement biases in electrochemical oxygen sensors. Quenching of the fluorescent light emitted from the sensor occurs instantaneously, providing a fast response to changes in oxygen concentration.



1. Blue LED light is transmitted to the sensor tip causing it to emit "fluorescence."



2. When the sensor tip comes into contact with oxygen, the O_2 molecules absorb energy, preventing the emission.



The amount of oxygen is inversely proportional to the intensity and duration of the luminescence.

TDLAS and QF analyzer portfolio

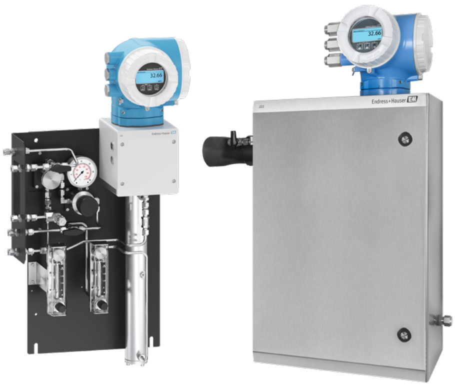
① OXY5500
QF optical oxygen analyzer

② SS2100
TDLAS gas analyzer

③ SS2100a
TDLAS gas analyzer

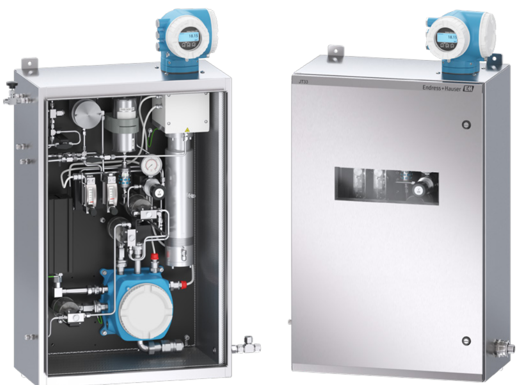
④ SS2100i-1
TDLAS gas analyzer
(1-box configuration)

⑤ SS2100i-2
TDLAS gas analyzer
(2-box configuration)



⑦ J22 TDLAS gas analyzer

⑥ SS500
TDLAS H_2O analyzer



⑧ JT33 TDLAS gas analyzer

Technical specifications

The matrix below provides information to assist in selection of an Endress+Hauser analyzer for measurement of H_2O (moisture), H_2S (hydrogen sulfide), CO_2 (carbon dioxide), NH_3 (ammonia), C_2H_2 (acetylene), and O_2 (oxygen) in hydrocarbon gas streams.

QF = Quenched fluorescence
TDLAS = Tunable diode laser absorption spectroscopy
● = Standard
○ = Optional

Analyzer model		OXY5500	SS2100	SS2100a	SS2100 i-1	SS2100 i-2	SS500	J22	JT33
Photo locator number		1	2	3	4	5	6	7	8
Measurement channels per system		1	1, 2, or 3*	1	1	1	1	1	1
Measurement principle		QF	TDLAS	TDLAS	TDLAS	TDLAS	TDLAS	TDLAS	TDLAS
Analyte & measurement ranges									
H_2O (Moisture)	0-10 to 0-100 ppmv		●	●	●	●			
	0-100 to 0-6000 ppmv							●	
	5-2110 ppmv						●		
H_2S* (Hydrogen sulfide)	0-10 to 0-500 ppmv								●
	0-10 to 0-1000 ppmv		●	●	●	●			○
	0-5000 ppmv to 0-5%		●	●	●	●			
CO_2 (Carbon dioxide)	0-100 to 0-500 ppmv		●	●	●	●			
	0-5% to 0-20%		●	●	●	●			
O_2 (Oxygen)	0-100 ppmv to 0-20%	●							
NH_3 (Ammonia)	0-5 ppmv		●	●	●	●			
C_2H_2 (Acetylene)	0-5; 0-3000 ppmv		●	●	●	●			
Environmental temperature range									
-20 to 50 °C (-4 to 122 °F)		●	●	●	●	●	●	●	●
-10 to 60 °C (14 to 140 °F)			○	○		○		●	●
Controller power[a]									
100-240 VAC		●	●	●	●	●	●	●	●
24 VDC		●	●[a]				●[d]	●[a]	●[a]
Communication									
Number of digital outputs/inputs per channel		2/0	5/1	5/1	5/1	5/1	2/0	1/e	1/e
Quantity of 4-20 mA outputs per channel		2	1	3[b]	3[b]	3[b]	2	●[e]	●[e]
RS232C		●	●	○	○	○	●		
RS485		●		●	●	●		●	●
Ethernet		●	●	●	●	●		●	●
Ingress ratings and materials									
Type 3R - 304 stainless steel							●		
Type 4X 304 or 316 stainless steel enclosures		●	●					●	●
Type 4X/IP66 copper-free aluminum & 304 stainless steel								●	●
IP66 copper-free aluminum[c]				●	●	●			
Hazardous area approvals									
NEC/CEC Class I, Div 2[f]		●	●				●		
NEC/CEC Class I, Div 1								●	●
ATEX Zone 2 or IECEx/ATEX Zone 2		●		●					
ATEX, IECEx, and UKEx Zone 1					●	●		●	●
CNEx, KC, PESO, JPN					●	●		●	
EAC						●			
INMETRO								●	

*H_2S analyzer available in 1, 2, or 3 channel configuration (additional H_2O and CO_2 channels available)

a. Controller 24VDC may be combined with SCS 120/240VAC power
b. Three 4-20 mA signals = 2 outputs and 1 input (moisture only)
c. With 304 or 316 stainless steel sample system enclosure
d. 12VDC option also available
e. Optional 1 or 2 digital output or 4-20 mA input/output
f. Self-certified by manufacturer

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