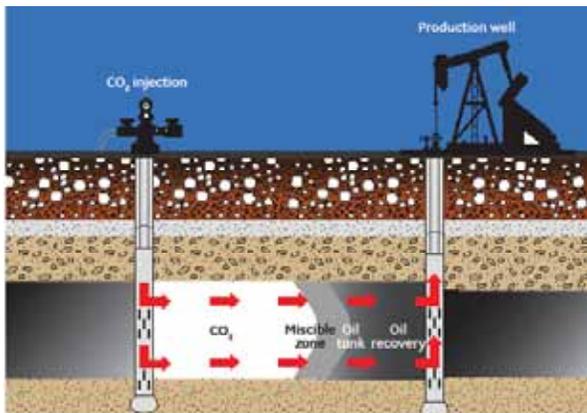


Aurora Moisture Analyzer

New Light for Moisture Measurement in Carbon Dioxide

GE's Aurora analyzer uses tunable diode laser absorption spectroscopy (TDLAS) to rapidly and accurately measure moisture in CO₂. The analyzer is suitable for installation in hazardous areas and operates over a wide range of environmental conditions. Aurora's fast response immediately alerts when moisture concentrations are out of specification; once corrected, gas can be quickly cleared for re-entry to the process.

Enhanced oil recovery (EOR) is a generic term for techniques for increasing the amount of crude oil that can be extracted from an oil field. Using EOR, an additional 30 – 60% of the reservoir's original oil can be extracted. Gas reinjection with Carbon Dioxide is presently the most commonly used approach to EOR. In addition, CO₂ can be sequestered in oil wells as opposed to being released into the atmosphere. Most global governments are supporting the development of EOR and carbon capture projects to reduce emissions and produce more energy.



The CO₂ used in this process must be dried to levels of -40°C dew point, about 130 ppmv, or lower. GE's Aurora offers the most reliable and fastest responding moisture analyzer for this application. The analyzer has no wetted moisture sensor and utilized a light energy to instantly measure the moisture content. The Aurora is designed to provide years of operation without user intervention or maintenance.

GE's experience in moisture measurement includes aluminum oxide, polymer capacitance and chilled mirror sensors. GE's heritage also includes the development of the first injection diode laser in 1962 by Dr. Robert Hall in Schenectady, NY. The compact and inexpensive diode laser made it possible for compact discs, laser printers and fiber optic telecommunications. The Aurora TDLAS hygrometer enables EOR and carbon sequestration facilities to monitor moisture content in real time with high precision and reliability.



Features and Benefits

- Optical response <2 seconds
- Direct readout in lbs/mmscf, mg/m³, dew point or ppmv
- Turnkey sampling system for measurement integrity
- Hot permit not required with through-the-glass programming
- Analog and digital communications available
- Aurora View software enable remote service, trend graphing and diagnostics
- Five years of continuous, reliable service before first factory service
- Patented calibration process to meet variety of composition applications

Theory of Operation

The Aurora TDLAS hygrometer fundamentally measures the partial pressure of water vapor (water in the gas state). With the simultaneous measurement of pressure and temperature, the Aurora provides all of the commonly used moisture units, including:

- Volume ratio in parts per million by volume (ppm_v)
- Absolute humidity in lbs per million standard cubic feet (lbs/mmscf) or milligrams per cubic meter (mg/m³)
- Dew point temperature in °C or °F
- Pressure dew point in °C or °F

The fundamental water vapor pressure measurement is based on the Beer-Lambert Law:

$$A = \ln \left(\frac{I_0}{I} \right) = SLN$$

A = Absorbance

I₀ = Incident light intensity

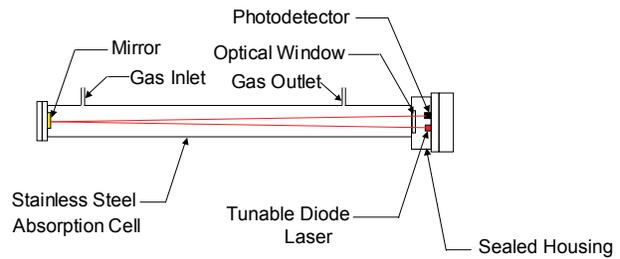
I = Light intensity transmitted through sample gas

S = Absorption coefficient*

L = Absorption path length (a constant)

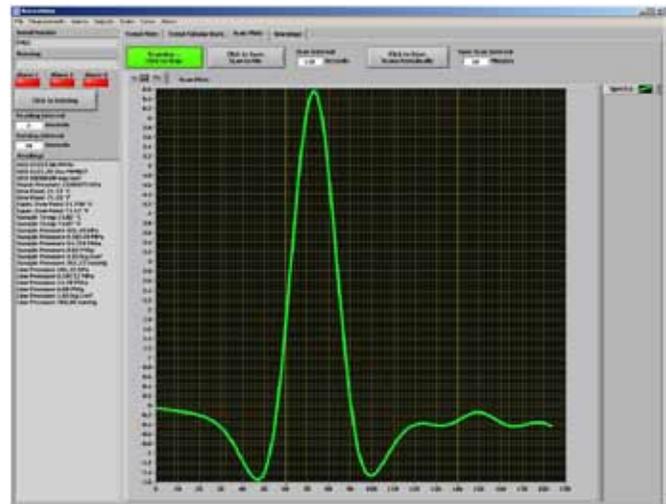
N = Concentration of water vapor (directly related to the ratio of the partial pressure of water and the total pressure)

*The absorption coefficient is a constant for a specific gas composition at a given pressure and temperature.



Cross-section of absorption cell

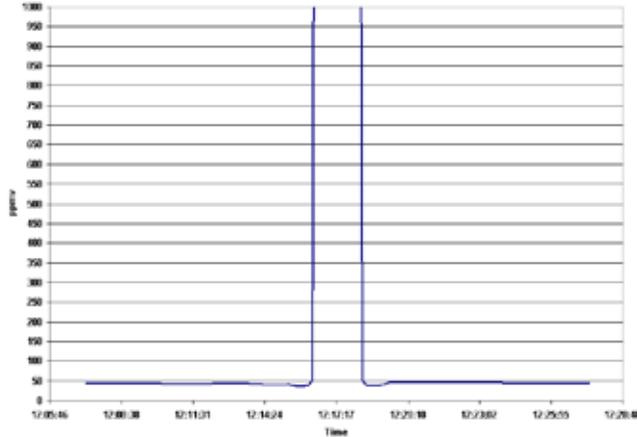
At certain specific frequencies the water molecule will absorb light energy, while at other frequencies the gas is practically transparent. At a given absorbing frequency, as the concentration of water vapor increases, the absorption also increases. Aurora utilizes a diode laser that is swept through a narrow frequency band in the near infrared spectrum. The laser is also modulated at high frequency. By measuring the laser light intensity with a photodetector, the Aurora is able to provide direct measurement of the partial pressure of water by correlation of laser light lost to the incident light. The light loss or absorption signal is reduced by looking at the second harmonic signal known as the 2F signal. The magnitude of the 2F signal is related to the partial pressure of water, which is divided by the total pressure and multiplied by 10⁶ yields ppmv (parts per million by volume).



The location of the peak on the X-axis confirms the identity of water. The y-axis is related to the partial pressure of water and therefore the concentration. The system is equipped with AuroraView software, which enables users to capture the absorption spectrum and export it to other application programs such as Excel™.

Built to Last

The absorption cell of the Aurora is constructed for proven reliability. The laser light is transmitted through an optical window made of proprietary material, reflected off a gold plated mirror, and then returned through the window where it is measured by a photo detector. Since only light comes in contact with the process gas and all wetted components are made of inert non-corrosive materials, this technology provides fast response without drift associated with sensor based hygrometers.



Example of Aurora's response time after a process upset. Water was injected into a sample of natural gas that had a concentration of 50 ppmv. Within a few seconds the Aurora indicated the increase. The Aurora recovered back to 50 ppmv within three minutes.

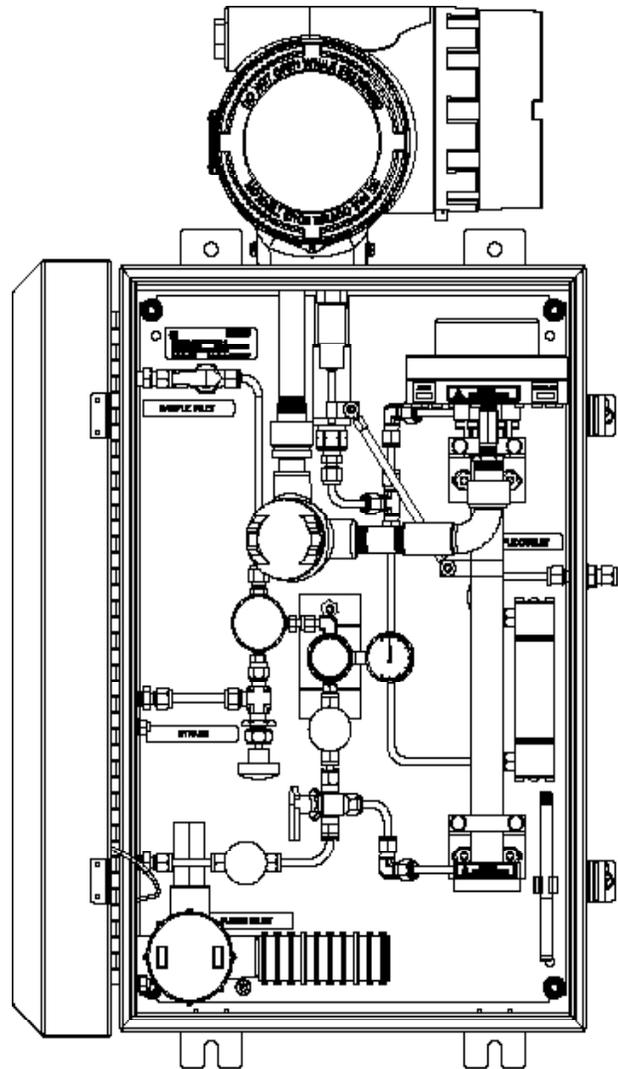
The complete system is certified for use in hazardous areas. The laser power supply, controller and digital signal conditioning circuitry are assembled in an explosion proof, flameproof enclosure. A backlit three parameter LCD provides direct readout of user-programmable parameters as well as indication of system status. The Aurora utilizes induction keys and a magnetic stylus eliminating the need for a hot permit to program or access the unit.



The Aurora is equipped with magnetic induction keys that enable "through-the-glass" programming. The unit may be operated in a hazardous area without the requirement for a "hot permit."

Aurora is equipped with three programmable analog outputs (0/4-20 mA), two digital RS485/232 ports and an optional Ethernet port. The unit is equipped with an auxiliary 4-20 mA input channel for connection to a process pressure transmitter which enables real-time calculation of process dew/frost point. MODBUS RTU communication protocol makes the Aurora ideal for connection to a data acquisition system or SCADA system for long term monitoring of process moisture concentration.

An adequate sample system is critical for accurate moisture measurement. For high pressure applications, the Aurora is equipped with a two stage turnkey sample system. An optional first stage consists of a membrane filter and regular installed directly in the pipeline reduce pressure while preventing any liquid (hydrocarbon, glycol or water) from entering the sample line. As the gas enters the second stage it flows through a coalescing filter and a pressure further reduces the pressure to near atmospheric. The flow rate is adjusted with a needle valve. In cold climates, an optional heater may be installed in the enclosure to keep the sample in the gas phase. The Aurora sample system is 100% customizable; experienced GE application engineers are committed to finding the best solution for every application.



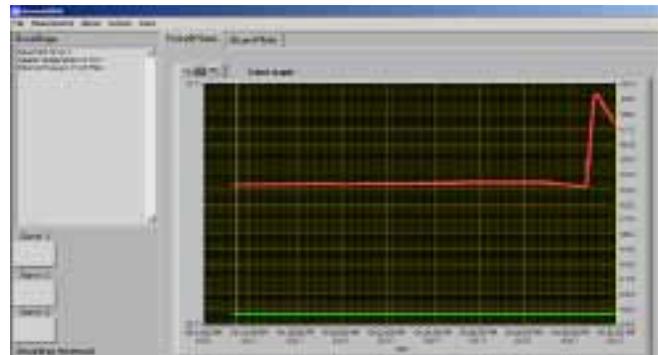
Sampling system—US and Canada

Each Aurora unit is calibrated against a NIST (or other national metrological institute) traceable moisture generator and reference hygrometer. A certificate of calibration with functional test data is supplied with every unit. Calibration is performed using nitrogen as the background gas, then verified by using carbon dioxide background gas. This innovation enables users to verify the Aurora using nitrogen with a known concentration of water.

AuroraView® PC Software is supplied with every Aurora. The utility enables the simple interface to a remote computer. AuroraView enables remote configuration user selected parameters, trend graphing, diagnostics and capturing of spectral scans. Trend data and spectral scans can be saved as ASCII text files, facilitating the ability to export and share the data in other application software such as Excel™.

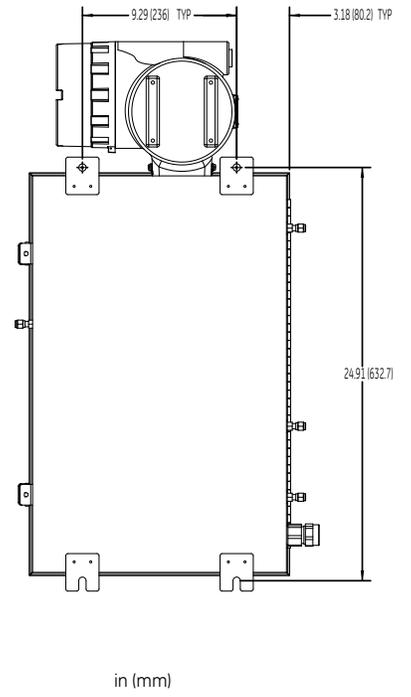
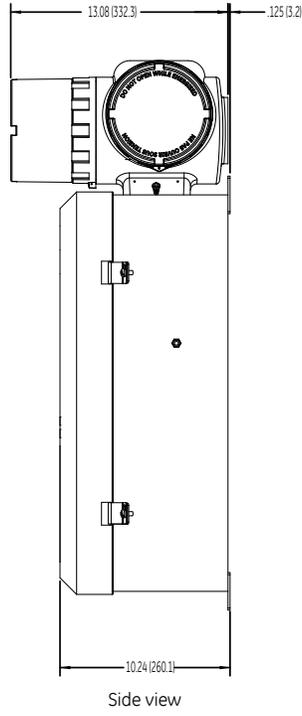
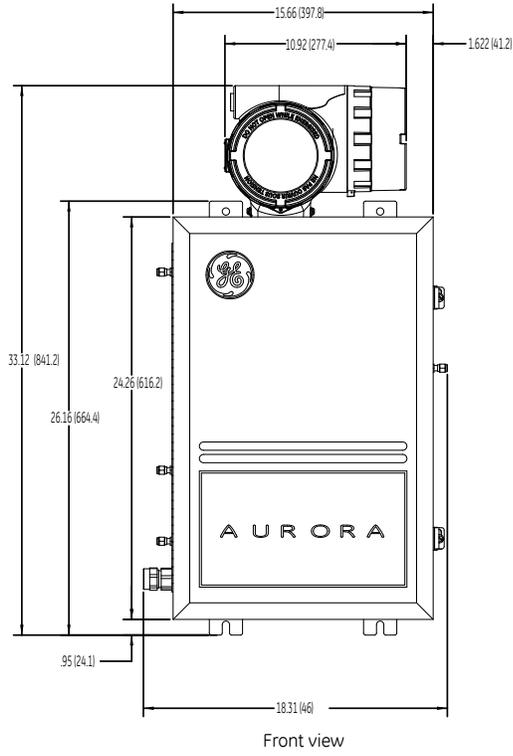


AuroraView has intuitive pull-down menus for setting up the parameters to be displayed, graphed and data logged.



AuroraView software displays direct readings of moisture, temperature and pressure, as well as trend graphs. The data trends can be exported as ASCII text and opened in spreadsheet programs such as Excel™.

Dimensions



Specifications

Range

Parts Per Million by Volume

50 to 5000 ppm_v

Lower Detect Level

50 ppm_v

Dew/Frost Point¹

-48° to -2.6°C frost point

Dew/Frost Point¹

-56° to 27.3°F frost point

Process Dew/Frost Point¹

Process or equivalent dew point/frost point by calculation with process pressure signal (4-20 mA) or constant

Absolute Humidity

38 to 3,803 mg/m³

Absolute Humidity

24 to 237 lbs/MMSCF

¹ Readings below 0°C (32°F) are in "frost point," temperature and above 0°C (32°F) are in "dew point" temperature.

Accuracy

Parts Per Million by Volume

±2% of reading or 4 ppmv
(Accuracy of other parameters derived from ppmv.)

Response Time

Optical response

<2 seconds

System response

The system response is dependent on the length of sample tubing, sample system components, flow rate and pressure, as well as the change in moisture concentration.

Operating Pressure

Operating sample cell pressure

69 to 172 Kpa (10 to 25 psia)

Maximum Pressure

1380 KPa (200 psi)

Process Pressure

10,342 KPa (1500 psig) maximum²

² Higher pressure available with application of additional sampling system components.

Flowrate

Sample Cell Flowrate

10 to 60 SLH (0.4 to 2 SCFH); 30 SLH (1 SCFH) nominal

Coalescer By-pass Fast Loop

5 to 10X of flowrate through sample cell

Display

Backlit LCD. Three programable simultaneous parameters. Alphanumeric status and diagnostic display. LEDs for power, laser temperature stability, keypad lockout.

I/O

Analog Outputs

Three programmable 0/4-20 mA; 500 Ohm max load

Analog Input

Loop powered 4-20 mA input for remote pressure transmitter. Aurora supplies 24 VDC.

Digital Interface

Two programmable digital communications ports RS232, RS485 with multidrop capability and assignable address, MODBUS RTU protocol

User Interface

Programmable "through-the-glass" via magnetic stylus

Laser

Class 1 product. Conforms to IEC 60825-1. Edition 2.0 Safety of Laser Products



Warning! Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous laser exposure.

Enclosure

Ingress Protection

IP-66

Net Weight

37 Kg (100 lb)

Temperature

Operating

-20 to 65°C (-4 to 149°F)

Storage

-20 to 70°C (-4 to 158°F)

Optional Heater/Thermostat Set Point

20°C/68°F ±5°C/9°F for US/Canada

10°C/50°F ±5°C/9°F EU and Elsewhere

Hazardous Area Certification

USA/Canada



Explosion-proof for Class I, Division 1, Groups C&D

EU and Elsewhere



ATEX and IEC Ex:

Ex de IIB T6 -20°C to +65°C

Flameproof with increased safety compartment

European Certification

CE

Complies with EMC Directive 2004/108/EC, Low Voltage Directive 2006/95/EC and Pressure Directive 97/25/EC for DN/25

Calibration

Recommended Factory Verification/Service

Five years



www.ge-mcs.com

920-581C