OpreX™ Analyzers | Technical Note

YOKOGAWA
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Measuring Process Oxygen with Truepeak TDLS In Lieu of Paramagnetic

Truepeak Tunable Diode Laser Spectrometers | TDLS800, TDLS8220

Oxygen for the following processes and applications are traditionally measured using paramagnetic technology, but the advent of Truepeak TDLS has proven the paramagnetic measurement to be inferior.

Process oxygen is the desired process control measurement in many manufacturing processes, such as:

- Ethylene oxide (EO)
- Formaldehyde
- VCM/EDC
- Isopropyl alcohol (IPA)
- TiO2
- Isocyanates
- Acrylonitrile
- Acetonitrile
- PTA
- Refining, etc

Oxygen is also monitored for safety in areas such as:

- Vent headers
- Flare headers
- Tank gas blankets
- Ship/barge loading areas (marine vapor recovery)
- Chemical processing areas
- Refining areas
- Hydrogen purity areas (chlorine cells), etc

APPLICATIONS	
Heating furnace	Oil/ Petrochemical
Catalyst regeneration tower	
Ethylene cracking furnace	
Electrolysis plant	Chemical
Ethylene oxide plant	
Reducing furnace	
Ammonia plant	
Silicon manufacturing plant	
Air separator	Iron & Steel
Pulverized coal injection system for blast furnace	
Coke dry quenching (CDQ) plant	
Hot-blast furnace	
Converter	
Bright annealing furnace	
Annealing furnace	Nonferrous metal
Non-oxidizing furnace	
Heating furnace	
Plating furnace	Machinery
Cupola	
Cement kiln	Ceramic
Incinerator	Others
Sludge incinerator	
Activated sludge plant	
Hyperbaric oxygenation equipment	
Fuel cell	

Table 1: Oxygen process applications

Measurement Principle and Molecular Interference

The paramagnetic measurement of oxygen is considered the second principle since it produces oxygen concentration as a function of a measured magnetic effect.

In the case of the magnetodynamic, or “dumbbell,” analyzer, the oxygen concentration is obtained from the current required to return a magnetically deflected dumbbell to a neutral position. For thermodynamic, or “magnetic wind,” analyzers, sample convection measured by thermistors linked to a Wheatstone bridge gives a differential resistance, which is correlated with oxygen concentration. Differential-pressure type analyzers use the signal generated from a Wheatstone bridge, which measures the degree of cross-flow in reference gas channels connected in parallel. The cross-flow is produced as a result of one reference channel being introduced to the sample gas in the presence of an electromagnet; this creates reference gas flux, which is measured by a thermal flow sensor.

The result in all cases is a measurement that is susceptible to magnetic interference from other molecules. Lists of molecules are published and often listed in the manuals of various analyzer manufacturers. There are well over 100 known interfering molecules, and the list is steadily growing. Truepeak TDLS is unaffected by interfering molecules because it measures oxygen using first principles. The molecules absorb the laser's light it makes contact with, and the resulting light loss is measured.

Sampling System Effect on Wet Gas Analysis

Paramagnetic analyzers require the use of a sampling system to obtain a clean, dry sample. The dry measurement would cause an undefinable false-high reading in-process oxygen if any moisture were present in the original sample. When used in-situ, TDLS will give a wet measurement, which is more representative of process conditions. Extractive Truepeak TDLS is also capable of wet measurement as long as the sample gas is non-condensing.

Thermal Conductivity Compensation

Paramagnetic analyzers that utilize a "Wheatstone bridge" rely on compensating for temperature and compensating for the sample gas's thermal conductivity values. This is due to the nature of the "Wheatstone bridge" circuit design in which resistors heat an incoming sample; this leads to the gas losing some of its magnetism according to Curie's law. As a result, cooler, more magnetic oxygen is drawn toward the sensor, creating a "magnetic wind." Thermistors are then used to measure oxygen concentration by detecting the rate of heat loss. The sample gas's heat capacity must be determined by analyzing thermal conductivity to accurately measure the "magnetic wind." Thermal conductivity variations in the sample gas have no effect on the Truepeak TDLS measurement.

Reliability

There are internal moving parts that must be disassembled for cleaning in a paramagnetic analyzer. The TDLS analyzers have no moving parts, and isolation windows can be removed for cleaning during operation.

The magnetodynamic paramagnetic analyzer’s measuring cell is constructed of a precisely positioned glass dumbbell filled with inert gas and suspended with a taut platinum wire. This delicate arrangement is easily damaged by corrosive gases, pressure spikes, and liquids. Both extractive and in-situ TDLS measurements have only light contact with the measurement area, and as a result, are unsusceptible to damage.

Sample Filters

An important note is that response time will suffer proportionally as filters clog in an extractive sample system. In-situ TDLS maintains a constant response time, which is unaffected by the fouling of filters and keeps a typical response time of five seconds. Filter failure can result in measurements that can be not only costly but unsafe as well.

Flow Rates

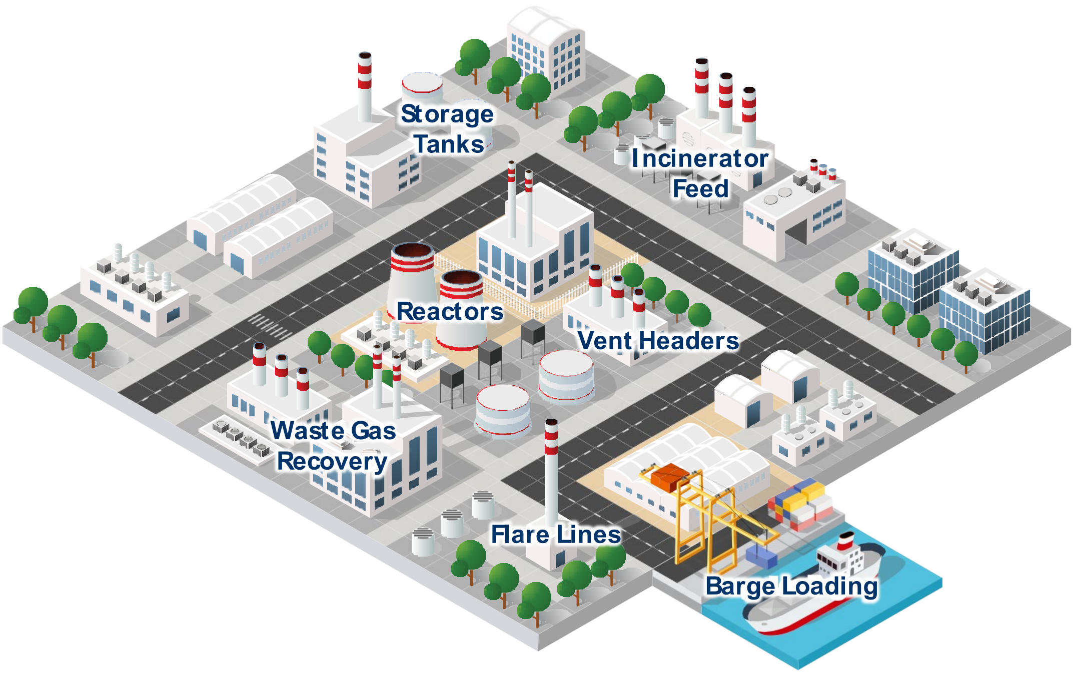
Low flow rates must be carefully metered in paramagnetic analyzers to get an accurate measurement and prevent sensor damage in some cases. The Truepeak TDLS measurement is immune to the error caused by flow variations and can accept much higher flow rates, which dramatically reduces response times in extractive systems.

Onboard Diagnostics and Calibration

Many paramagnetic analyzers offer no onboard diagnostic functions or data storage. Performing a validation check on a paramagnetic analyzer is only an indicator of current performance. Yokogawa’s TDLS offers onboard diagnostics to help catch problems before they occur and stores up to 50 days of historical data and spectra. This allows current, as well as past, analyzer data to be validated.

Calibration must be performed monthly on most paramagnetic analyzers. The Yokogawa TDLS offers online validation for in-situ systems and automated zero and span calibration checks for extractive systems.

PRODUCT FEATURES	Paramagnetic	TDLS
Interference Free Measurement	✗	✓
On-board diagnostics with 50 days of spectral and historical data	✗	✓
Solid state technology means virtually NO drift and NO routine calibration	✗	✓
NO moving parts and NO damage to the analyzer or sensor as there is NO process contact	✗	✓



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