Measuring Process Oxygen with Truepeak TDLS In Lieu of Paramagnetic Technology

Tunable Diode Laser Spectrometers (TDLS200 and TDLS220)

Process oxygen is a desired measurement in the production of many materials. It is measured for process control in manufacturing ethylene oxide (EO), formaldehyde, VCM/EDC, isopropyl alcohol (IPA), TiO_2, isocyanates, acrylonitrile, acetonitrile, PTA, refining etc. It 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. Oxygen for these processes has been traditionally measured using paramagnetic technology, but the advent of Truepeak TDLS has proven the paramagnetic measurement to be inferior.

Measurement Principle and Molecular Interference

The paramagnetic measurement of oxygen is considered second principle due to the fact that 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 back 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 which 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 light from the laser is absorbed by the molecules 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 will cause an undefinable false-high reading in process oxygen if any moisture was 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 which utilize a "Wheatstone bridge" rely on not only compensating for temperature, but compensating for thermal conductivity values of the sample gas as well. 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 what is known as "magnetic wind". Thermistors are then used to measure oxygen concentration by detecting the rate of heat loss. The heat capacity of the sample gas 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 which must be disassembled for cleaning in 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, which is filled with an 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 as filters clog in an extractive sample system, response time will suffer proportionally. In-situ TDLS maintains a constant response time which is unaffected by the fouling of filters and maintains a typical response time of five seconds. Filter failure can result in measurements which 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 in all cases, and to prevent sensor damage in some cases. The Truepeak TDLS measurement is immune to 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 14 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.