

DELTA F CORPORATION **Technical Bulletin No. 1**

M-Series Sensor

The M-Series oxygen sensor from Delta F Corporation solves oxygen contamination issues in applications where other analytical techniques fail. Processes across semiconductor, petrochemical and air separation industries are continuing to demand more stringent purity levels in process gases. Oxygen contaminant levels are trending even lower, from parts-per-million levels down to even parts-per-billion levels. Delta F answered the call for users in need of reliable trace-level process oxygen analytical capability with the introduction of the M-Series oxygen sensor. Three common applications where the M-Series sensor is used to solve oxygen contamination issues are:

1. Semiconductor - Rapid Thermal Processing

A combination of the high temperature environment in an RTP chamber with even ppb oxygen levels in the gas phase creates ideal conditions for undesirable oxidation reactions to occur on the surface of a semiconductor wafer. Zirconia oxide oxygen analyzers have traditionally been used in RTP applications to detect oxygen contamination and monitor purge cycles because of their rapid speed of response and wide dynamic range. Zirconia oxide analyzers, however, are not very reliable for measuring oxygen at ppm concentrations due to their susceptibility to giving false low readings in the presence of reducing gases (such as H₂, CO, NH₃ and all hydrocarbons). Delta F's M-Series sensor offers users the speed-of-response associated with zirconia analyzers along with the immunity to reducing gas interference associated with Delta F's proven non-depleting electrochemical oxygen sensing technology.

2. Petrochemical - Olefins Purity

It is critical to know the instant a high oxygen excursion occurs in olefins purity applications. The presence of oxygen in a reactor feed stream to a polymerization reactor can potentially accelerate catalyst poisoning. Oxygen in the reactor feed stream can also broaden molecular weight, composition distribution and tacticity of final product. The typical tolerable oxygen contaminant level of olefins streams is less than 100ppb. Galvanic/fuel-cell analyzers are prone to give false low readings that can lead operators to believe the oxygen contaminant level is below specification when high oxygen levels can be causing poor product quality. Delta F's M-Series sensors do not produce false low readings and can be relied upon to indicate oxygen changes in seconds while offering 3ppb sensitivity.

3. Air Separation Cryogenic Fractional Distillation Product Purity

High purity air separation units (ASU's) that separate air via cryogenic fractional distillation generally deliver separated gases from the ASU over to customer's plant through a network of pipelines. The oxygen content of high purity gases in this application varies, less than 1ppm is typical. Low-end sensitivity, accuracy and reliability are needed in these applications to ensure that product is being separated to the specified purity requirements. Also, it is paramount that cryogenic ASUs have an analyzer that responds instantaneously to oxygen changes to protect the customer's pipeline from contamination, which, if undetected, can contribute to reduced yields in the end-user's process. Both Delta F non-depleting electrochemical and galvanic/fuel-cell electrochemical analyzers are used in this application. The slower response time, inferior sensitivity and low accuracy of galvanic/fuel-cell electrochemical sensors are further reduced as the sensors age because the anode is consumed in the measurement of oxygen and the electrolyte in the sensor dries out over time. The M-Series sensor, like all Delta F non-depleting electrochemical sensors, is not consumed in the measurement of oxygen so it can be relied upon to provide reliable, sensitive, accurate, fast measurement of oxygen endlessly.

Delta F's M-Series sensor has enabled users to accurately monitor and maintain high purity gases in many applications in addition to those detailed above. The M-Series sensor is only available in high-resolution 0-50ppm ranges of both the DF-350 Platinum Series Process Oxygen Analyzer and the DF-310 Oxygen Analyzer designed with flexibility to suit a wide variety of application needs. The M-Series sensor offers several benefits in comparison to alternative oxygen sensing technologies:

- Increased Sensitivity...Designed to make accurate and reliable measurements from 10ppb up to 50ppm, where changes as small as 3ppb can be detected
- Instantaneous Speed-of-Response...It takes less than 10 seconds to read 90% of a change in

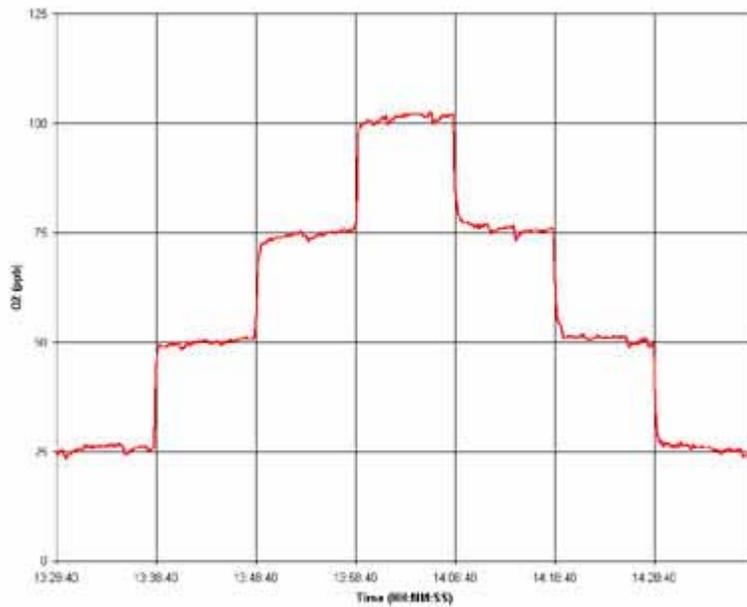
the O₂ level of a sample gas

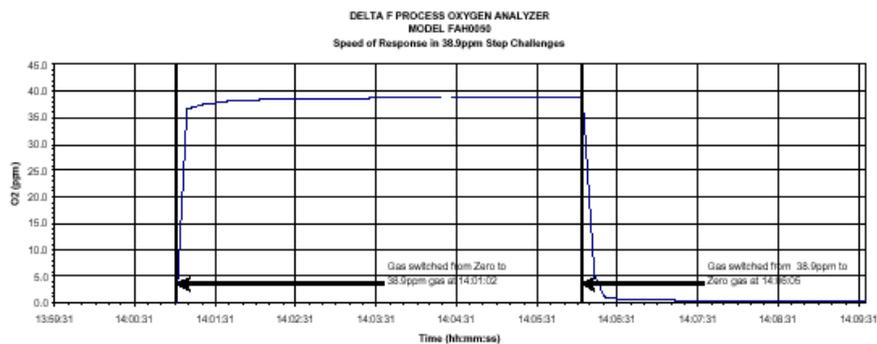
- Improved Stability...No need for zero calibrations; only annual span calibrations are recommended
- Better Accuracy...The greater of +/-10ppb or +/-3% of reading

The M-Series 0-50ppm sensor can be purchased with a V-Series option for faster recovery times in upset prone applications. The V-Series option is specifically intended for tank/trailer filling applications where upsets frequently occur. For applications where acids and ionic impurities are present, the M-Series sensor can also be purchased with the Stab-EI™ option that is specifically designed to neutralize trace contaminants including acids such as CO₂, H₂S, CL₂, NO_x, and SO_x.

Like all Delta F oxygen analyzers, all sensors are backed by our 5-Year Sensor

Warranty and are calibrated traceable to NIST.





Delta F Oxygen Analyzers can be ordered with a full scale range of 0-2 parts per billion (ppb) to as high as 0-25 percent. For specific product recommendations, contact Delta F Corporation, 4 Constitution Way, Woburn, MA 01801-1087, Tel. (781)935-4600, FAX (781)938-0531, e-mail marketing@delta-f.com.

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