

# **DELTA F CORPORATION**

## **APPLICATION NOTE NO.**

### **109**



## **Measuring Oxygen in a Soldering Process**

Maintenance of low oxygen concentration in solder furnaces will produce higher quality product, less product defect, and lower maintenance costs. This can save thousands of dollars per year.

### **The Role of Oxygen Analyzers**

In order to eliminate the use of environmentally difficult CFC's, companies often use an inert environment in the solder furnace to reduce oxygen concentration. The two common solder processes are wave and reflow soldering. In the wave process, the PC board is passed over a cylinder of molten solder. In the reflow process, the boards are pre-pasted with solder, and conveyed through a pre-heater to allow the solder paste to run onto the components and hold them in place. In the past, the boards were cleaned with CFC-based agents, however, with newer solders used in a nitrogen purged environment, the quality can be maintained without these agents. When oxygen is present in a solder furnace, it can compromise the wetting properties of the solder as it flows to the components. The result is poor solder joints. Oxygen compromise can be seen as gray solder joints which indicate oxidation has occurred as the solder joined the components. Measuring the level of oxygen in a furnace will result in consistent results. Also, metered nitrogen levels insure optimized soldering without excessive nitrogen consumption.

### **Conventional Approaches to Monitoring Oxygen**

#### ***Galvanic Sensor Technology***

The galvanic oxygen sensor technology uses two dissimilar metal electrodes, typically silver and lead, which are consumed in the process of measuring O<sub>2</sub>. The sensors have a relatively short life span of several months because:

- The lead anode is consumed
- The silver cathode is attacked by acid gases
- The electrolyte is sensitive to flux vapor contamination

The galvanic sensors operate on a battery principle where the life expectancy is a function of usage. They eventually read low due to a loss in sensitivity as electrode sites are depleted. Analyzers with replaceable battery-type galvanic sensors must also be recalibrated on a frequent basis because the silver cathode is poisoned by ppb level acid gases which are generated in the atmosphere by the flux on the PCB's. These trace contaminants oxidize the sites of the silver cathode and periodic sensor replacements are required. If analyzer calibration is not done frequently, the sensor can be reading falsely low resulting in poor quality or scrap product.

The depleting, battery-type sensors are covered by a permeable membrane which separates the gas sample from the electrolyte and allows the oxygen ions to migrate into solution. If the sensor is exposed to an over range condition, i.e. opening of the solder system hood, the membrane will saturate with oxygen from ambient air and it can take hours to return to PPM levels.

#### ***Zirconium Oxide Sensors***

Zirconium oxide (ZrO<sub>2</sub>) sensors, otherwise known as high temperature electrochemical sensors or hot probes, consist of a cell made of yttria stabilized zirconia ceramic, which operates at temperatures above 1200°F or 650°C. Reducing gas in the sample being measured by a ZrO<sub>2</sub> sensor significantly interferes with the accuracy of

its reading. (Reducing gases are any gases that can be oxidized by reaction with oxygen, such as CO, H<sub>2</sub>, NH<sub>3</sub>, and all hydrocarbons.) Due to the high temperature of the sensor, the oxygen is reacted with hydrocarbons that are given off by the flux in the furnace. Since this reacted oxygen is not being measured, the analyzer will continually give false low readings! In an 8 cu. Ft. solder furnace, this can mean up to 20,000 PPM oxygen is consumed by the hydrocarbons present. If the sensor is not used continually, for example if it is shut off in the evening, the sensor will develop stress cracks from the cycling of the temperature from ambient to its operating temperature.

## The Delta F Difference

Delta F has solved the problems associated with fuel cell and zirconium oxide sensors with its unique non-depleting coulometric sensor that has carbon electrodes which never under-go chemical change. It provides unmatched performance features such as:

- Extremely Stable, Long-term, Drift-Free Operation
- 5-Year Sensor Warranty
- Factory Calibration to NIST Traceable Standards
- Acid Gas Operation with STAB-EL™ Option
- Quick Start-up and Rapid Response
- No Sensitivity to O<sub>2</sub> Shock

Unlike other types of sensors, the Delta F sensor does not require periodic replacement and **does not produce false low readings** due to loss of measurement sensitivity or reaction with sample gas components. The sensor operates on a simple coulometric process whereby oxygen in the sample gas is reduced in an electrochemical reaction. Oxygen is reduced at the cathode to hydroxyl ions. Assisted by the potassium hydroxide electrolyte, the ions migrate to the anode, where they are oxidized back to oxygen which vents out the sensor. Whereas conventional electrochemical sensors use a consumable lead anode and a silver cathode. **The Delta F electrodes are made of carbon and are non-depleting, i.e. neither electrode under-goes chemical change.**

As a result, excellent measurement stability is achieved and the need for periodic sensor replacement is eliminated. In contrast to galvanic sensors which require frequent, usually bi-weekly, calibrations, the Delta F sensor may only require semi-annual span checks, not recalibrations, and addition of water. The fast speed-of-response of the Delta F sensor provides immediate indication of changes in the oxygen level whether they are caused by an ambient air leak or by an incorrect nitrogen purge rate.

Delta F's STAB-EL™ option is available to protect the analyzer from the harmful effects of trace acid gas contaminants, such as vapors emitted from the heated flux. The STAB-EL™ option counteracts electrolyte contamination and the carbon electrodes are highly resistant to acid gas poisoning.

## Delta F Analyzers

Delta F offers a full line of analyzers to meet your needs. Fully packaged analyzers or OEM style are available for mounting internally to the solder system. Analog outputs, adjustable setpoints with relays, and RS232 or RS 485 outputs are available to interface with your computer system to allow you to control alarms or purge flow. Delta F custom configures each of its analyzers to meet customer requirements.

## Recognized For Quality

Delta F's R&D, Manufacturing, and Customer Support functions are certified to ISO-9001 by Lloyd's Register Quality Assurance Ltd. This demonstrated compliance with an internationally accepted standard assures you of the highest quality in product design, manufacturing, and service.

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](mailto:marketing@delta-f.com).