Application Review – G&M
Why choose GE Gas & Moisture solutions?

Single manufacturer for moisture, oxygen and hydrogen analysis

Multiple sensing technologies available to deliver right choice for application
“a round peg for a round hole” no need to force fit a solution

Design and manufacture customized sample systems to mitigate the effects of the harsh furnace gas atmosphere to deliver representative sample to sensors

Multi-function, multi-variable capability in a single electronics package to reduce overall installation cost

Global calibration and service centers providing local training, start-up, and calibration support
GE Moisture & Gas Measurement Instruments & Sampling Systems for Metal Heat Treating

Feed Gases

Furnace Atmosphere Monitoring
Various gases are produced from air separation and products of combustion.

Typical Gases:

- Pure N2 (-80 deg C; 0-10ppm)
- Pure H2 (-90 deg C; 0-10ppm)
- HNX Mixes (-60 deg C, 0-1000ppm)
- Argon (-75 deg C, 0-100ppm)
- Clean Dry Air (-80 to –10 deg C)

Compressed air used for instrument (pneumatic controls) or tool air and for furnace atmosphere control.

“What is the cost of shutting down your compressed air for 1 day?”
# Gases Used in Metal Heat Treating

<table>
<thead>
<tr>
<th>Gases Used</th>
<th>Properties/Uses</th>
<th>Temperature and Oxygen Limitations</th>
</tr>
</thead>
</table>
| **Argon**  | • Provides an excellent inert atmosphere.  
             • Shield gas for arc welding  
             • Heat treatment of “exotic” alloys | Td<- 60°C  
                                      O₂<20 PPM |
| **Blast Gas** | Used in the steel industry to oxidize the coke that melts the iron ore  
                    • Blast gas has to be moist in order to keep the heat from exhaust gasses in the furnace and to maintain burn efficiency | Range: 7-60 g/m³  
                                      (3-22 grains/Ft³) |
| **Hydrogen Nitrogen Blend** | Nitrogen & Hydrogen use for a dry, carbon-free source of reducing gas  
                                           • Bright copper and silver brazing  
                                           • Bright heat treating of carbon steels and selected nickel and copper alloys,  
                                           • Annealing of electrical components.  
                                           • Nitriding | <300 PPM NH₃  
                                      Td<-60°C |
| **Hydrogen** | • Annealing stainless and low-carbon steels, electrical steels,  
                        • Sintering “hard metals” such as tungsten carbide and tantalum carbide,  
                        • Brazing nickel, stainless steel, and copper, for annealing metal powders and sintering powder metallurgy (P/M) parts  
                        • Direct reduction of metal ores. | 98-99% pure |
| **Nitrogen (Commercial)** | • Pure dry inert gas that can provide for purging and blanketing.  
                                   • Carrier gas for carbon control atmospheres  
                                   • Mixed with hydrogen in a 90-10 blend for reducing | Td<-60 °C |
Most companies are trending away from utilizing disassociated Ammonia to make Hydrogen & Nitrogen on site.
Annealing Furnaces

Annealing is the heating and cooling of metal in order to soften it and make it less brittle. Annealing in a protective atmosphere gives the product a bright, clean, attractive surface appearance. The annealing atmosphere can be either pure hydrogen or a hydrogen-nitrogen mix.

Hydrogen is also used as a cooling gas referred to as “jet cooling”.

The reducing potential of the atmosphere is not by the absolute hydrogen percentage, but by the ratio of partial pressure of water to partial pressure of hydrogen.

The partial pressure of water is determined from a dew point sensor and the partial pressure of Hydrogen is determined by measuring % Hydrogen with a thermal conductivity analyzer.

Trace Oxygen in the ppm level is also measured with an electrochemical cell.

Contaminants in the process gas such as very small metal and metal oxide particles may cause wetted sensors to drift over time. Most sensors are also very slow to respond. Since the Aurora has no wetted moisture sensor and has the fastest response of any trace moisture technology.
# Typical Annealing Furnace Atmosphere Specification

<table>
<thead>
<tr>
<th>Moisture Content</th>
<th>&lt;(-60^\circ)C Dew Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>PPM level</td>
</tr>
<tr>
<td>Temperature:</td>
<td>550 to 1400°C</td>
</tr>
<tr>
<td>Pressure</td>
<td>-1 to 30 PSIG</td>
</tr>
<tr>
<td>Contaminants</td>
<td>Submicron Carbon &amp; Metallic Particles</td>
</tr>
<tr>
<td></td>
<td>Metallic Vapors</td>
</tr>
<tr>
<td></td>
<td>Detergent Vapors (from metal pre-cleaning steps)</td>
</tr>
<tr>
<td></td>
<td>Oil vapors (from metal shaping steps)</td>
</tr>
</tbody>
</table>

![Diagram of annealing furnace atmosphere](image-url)
Brazing, Galvanizing & Aluminizing Furnaces

**Brazing**
- A metal-joining process
- Filler metal is heated above melting point and distributed between two or more close-fitting parts by capillary action

**Galvanization**
- Process of applying a protective zinc coating to steel or iron, to prevent rusting.
- Hot-dip galvanization: parts are submerged in a bath of molten zinc
- Newer powder deposition technology

**Aluminized Steel**
- Steel that has been hot-dip coated with aluminum-silicon alloy.
- Aluminized steel has superior resistance to corrosion

These metal treatment processes are performed in an atmosphere at low dew point and oxygen concentration.

The process has metallic particulate and oxides (zinc oxide & aluminum oxide) that interferes with AlOx sensors requiring them to be cleaned and recalibrated frequently
Blast gas is used to oxidize (burn) the coke to melt the "heat" of ore to produce the metal.

This gas has to be moist in order to keep heat from the exhaust gases into the furnace and to keep the burn efficient.

The blast gas dew point is higher than the ambient temperature, therefore a heated sampling system must be used.

**Product Solutions:** MMR series humidity or heated chilled mirrors.
Inert “shield gas” protect the welding area from atmospheric gases which can cause fusion defects, porosity, and weld metal embrittlement if they come in contact with the electrode, the arc, or the welding metal. Argon is used in TIG and MIG welding.

**Product Solutions:** Our Al₂O₃ sensors & trace oxygen sensors are used extensively to assure that no moisture or oxygen is contained in the shield gas.
Sampling Systems

Heat Treating furnaces are not ideal environments for moisture and gas sensors.

The test gas must be cooled (but not below the dew point), filtered and the flow rate controlled.

Depending on the process pressure a vacuum pump or aspirator might have to be required.

An oil-bath filter utilizes mineral oil to effectively filter out slag and fines.

Oxygen and moisture sensors can be combined in a single sampling system and integrated with a multifunction analyzer such as the MIS-1.
Aurora for Metal Heat Treatment Furnaces

Turnkey cabinet with sampling system
- Filter Train (Oil bath or Lanolin/Wool) + Sintered Steel Guard
- Vacuum pump
- Rotameter
- Valves & Fittings
- Purge/Test gas inlet
- Electrical Junction Box

Options
- Multiple zone switching
- Oxygen Sensor/Transmitter
- Hydrogen Sensor/Transmitter (XMTC)
- Onsite training + commissioning

The Aurora has no sensor to drift. Only light comes in contact with the process gas.

Fast response - no waiting for measurement system to “dry down”

The Aurora systems have higher initial costs than other sensors but lower cost of ownership to operate.
Acelor Mittal recently purchased a custom designed system consisting of:

- Aurora-H20 Moisture Analyzer
- XMO2 – TPM Oxygen Transmitter (% Levels)
- OXY.IQ – Galvanic Cell Oxygen Transmitter (ppm level)
- Moisture.IQ Analyzer/Data Logger
- Sample conditioning system
- FAT
- Training, Start-up and Commissioning Service

Pictures at the right is the system set up for a FAT at Billerica
Control of Humidification of Blast Gas Used in Steel Making

Location: Germany

Application: Steam injection into pressurized blast gas used in steel making. The blast gas is at high humidity. A heated sampling system is required. Range 40-80 g/m$^3$

Product: MMR-101

Value Propositions:

• Supplied turn-key heated sampling system with thermostatically controlled enclosure, filter, heated sample line and flow cell

• MMR-101 directly transmits absolute humidity in g/m$^3$ (this is calculated from %RH and temperature)
Moisture, Oxygen and Hydrogen Analysis in Steel Production

Location: Burns Harbor, Indiana

Customer: ArcelorMittal Steel

Major Products: Full line of high quality flat rolled steels, including (AHSS) Advanced High Strength Steels and (UHSS) Ultra High Strength Steels

Application
- System upgrades for process control at the hot dip galvanizing line and continuous annealing line.
- In both applications, furnace atmosphere is critical to the quality of the steel strip product.
- Atmosphere is 96% nitrogen, 4% hydrogen, with trace amounts of oxygen.
- Trace (ppmv) and percent oxygen measurements in H2/N2 gases.
- Trace moisture measurement in H₂/N₂ gases.
- Percent hydrogen in nitrogen measurement.
Turnkey Instrument Panel & Sampling Systems for Metal & Glass Heat Treating

Systems for dew point, trace Oxygen, & Hydrogen available from GE.

The system above pulls a sample with an eductor and is equipped with valves for calibration and purge gases.
Furnace Atmosphere Control for Tantalum Capacitor Manufacturing

Value Propositions

• 4-20mA signal is “frozen” when unit is running the PACER self-cleaning & optical balancing...does not upset their control loop

• No drift as with polymer humidity sensors. Precise dew point, 10X better than polymer

• Data logging provides trend data. Ethernet port enables hygrometers to be monitored remotely via internet.

• BTU also buys AlOx trace moisture analyzers for low dew point applications

• The anode of these capacitors are manufactured by pressing Tantalum powder into a pellet and “sintering” at high temperature.

• A lead wire is welded into the Tantalum.

• The tantalum is dipped into manganese then carbon & silver conductive resins to form the cathode.

Pusher furnaces used for capacitor production may be zoned into various atmospheres by using either a “flame” or “gas” curtain.

High absolute humidity is required for the sintering process...since the humidity is > the ambient dew point a heated sampling system and chilled mirror is required.
In this application a vacuum pump draws a sample from 1 of 18 zones from a brazing furnace.

The furnace is purged with dry nitrogen.

Due to the fast response the Aurora is more economical than installing 18 individual sensors.
OXY.IQ, XMTC, MTS6 & Delta-F analysers in CGL and CAL furnaces

Customer: Fives Stein France

Products: %OXY.IQ/ XMTC /MTS6 / DF153E Delta-F

Project/site: BAOSTEEL ZHANJIANG- CHINA

Two different lines (BZ3 CGL & BZ2 CAL)

Fives Stein is a Furnace Manufacturer. For this job, they selected our solution with multi-stream cabinets, PLC supplied for each multi-stream cabinet and Profibus communication type

Total: 29 points of measurement with H2% (4 XMTC) O2 PPM (5 DF-153E), O2 % (4 OXY.IQ) and Moisture (6 MTS6 + 6 M2) + spare parts
Some photos during inspection

Front doors