

# SERIES AP

AP1 Probe



## In-Situ Carbon Probe For Carbon Control Systems

- High temperature carburizing heat treating
- Carbonitriding
- Endothermic gas generators
- High accuracy and repeatability
- High efficiency, low maintenance
- Energy cost savings
- Rapid response
- Compatible with all carbon controllers
- Reference air supply and burnoff enclosures

### Introduction

The AP1 In-Situ Carbon probe, one of the Series AP probes, is a direct and continuous carbon potential probe. Its unique patented design features a cylinder of special zirconium oxide formulation, welded into the end of an alumina tube by means of an eutectic welding process. The resultant homogenous structure provides the most rugged element design. The superstructure is a high temperature special alloy with a flow through tip design to minimize soot collection. Internal connections are protected by a high quality connecting head. External connections are made with a quick disconnect plug. The probe can measure very low oxygen partial pressures with extreme accuracy and repeatability. It will control furnace atmospheres and generator gas supplies over the full range of carburizing hardening applications.

### Energy Cost Savings

Using the AP1 Carbon probe, operating conditions can be achieved more rapidly and better atmosphere control can be maintained. The carburizing gas supply is used more efficiently, resulting in energy savings and reduction in furnace burnouts. Leakage of furnace seals or firing tubes are detected, notably improving furnace efficiency.

### Maintenance

This Series AP carbon probe does not require frequent maintenance and cleaning. No calibration is required. The only part subject to

wear is the outer electrode, which can be renewed at the factory. A special purge fitting just below the head of the probe allows filtered air to enter the sheath of the probe for burnoff. Probe burnoff is initiated manually or by the carbon controller. The protection tube has excellent resistance to corrosion and carburization at high temperature, good mechanical strength, and is not affected by hydrogen embrittlement.

### Operation

The AP1 Probe is suitable for high temperature carburizing heat treating, carbonitriding and endothermic gas generators. It should not be used for nitriding applications.

Zirconia is a solid state electrolyte, which conducts oxygen ions at temperatures above 1400°F. The ion conduction results in a voltage between the two electrodes. Two connections to the zirconia cell conduct the voltage to the four pin connector.

$$\begin{aligned} \text{probe Vdc} &= 0.0215 \times T \times \ln(O_1/O_2) \\ \text{probe Vdc} &= \text{sensor output in mV;} \\ T &= \text{sensor temperature in} \\ &\quad \text{degrees Kelvin (}^\circ\text{K);} \\ O_1 &= \text{oxygen concentration} \\ &\quad \text{on inside surface of} \\ &\quad \text{the sensor - ambient} \\ &\quad \text{air which is 20.9\%} \\ &\quad \text{oxygen;} \\ O_2 &= \text{sample oxygen} \\ &\quad \text{concentration} \\ &\quad \text{on outside surface of} \\ &\quad \text{the sensor - furnace} \\ &\quad \text{atmosphere.} \\ \ln &= \text{natural logarithm} \end{aligned}$$

