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SERIES O_2 – Oxygen Monitors and Inert Gas Purifiers

Description

For many materials processing applications, controlled composition atmospheres are mandatory. In both research and production, undesired impurities at even very low concentrations can cause serious materials processing problems, as typical oxygen levels found in bottled inert gas can be as high as 5 to 10 ppm. Other contaminants include water vapor and Carbon. These Oxygen Monitors and Inert Gas Purifiers help overcome these issues and are designed for both laboratory size and full production use.

Key Features – OXYGEN MONITOR

- Solid State ZrO_2 Sensor
- Detects O_2 levels from $1x10^{-15}$ to $2x10^{5}$ ppm O2
- Rapid Sensor Response
- Adjustable Alarm Output
- Integrated vacuum pump draws sample from gas stream
- Digital LED Display of O_2 levels

Key Features – OXYGEN MONITORS / INERT GAS PURIFIERS

- Purifier with an Integral Oxygen Monitor
- Produces gas purities of better than $1x10^{-6}$ at high flow rates
- Applicable with all noble gases (Ar, He, Xe, Ne), and Nitrogen
- Alarm with adjustable setpoint, electrical relay, audible and visible indication when setpoint is exceeded.
- Solid State Control System
- Integrated vacuum pump draws sample from gas stream
- Linear voltage output from sensor can be monitored via 15 pin 'D' connector and used for furnace interlocks or alarms.

Principles of Operation – Oxygen Sensor

A voltaic cell of the concentration type is used to measure the oxygen concentration in the gas stream being monitored. The voltaic cell is a solid electrolyte composed of stabilized Zirconium Dioxide (ZrO_2). At elevated temperatures (800°C) the mobility of oxygen in the ZrO_2 cell is high. This allows oxygen ions to migrate through the solid electrolyte when driven by differences in the oxygen concentrations. The migration of oxygen results in a voltage difference between the two electrodes. The magnitude of the voltage difference increases as the ratio of the oxygen concentration inside and outside the cell is increased.

The concentration of oxygen in air establishes the potential for the reference electrode. The voltage difference increases as the sample gas decreases in oxygen content. A high impedance electronic circuit continuously monitors the voltage present at the solid electrolyte. The signal is then translated into parts per million (ppm) and displayed on the digital monitor.

The ZrO_2 solid electrolyte has proven to be the most reliable oxygen sensor available with much greater useful life and dependability than other less expensive monitors available. The response of the sensor does not change over years of usage therefore recalibration of the sensor is not required.

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Principles of Operation – Inert Gas Purifiers

The purification process of inert gases (ie – Ar and He), takes place by reacting the gaseous impurities present in the gas stream with an active metal. This method of impurity removal is commonly called gettering. The gettering charge consists of high purity titanium or copper contained in a vacuum tight stainless steel canister. When an inert gas, such as argon or helium, is allowed to flow through hot titanium, oxygen, nitrogen, carbon, and water vapor impurities are removed. Tests utilizing an oxygen analyzer have shown that it is possible to purify argon having 2-10 ppm of initial impurities to less than $1x10^{-10}$ ppm O2 and Nitrogen gas down to $1x10^{-6}$ppm. Although no comparable test method exists for carbon, its equilibrium pressures over titanium is correspondingly low and is removed quantitatively. A gettering charge of 90 grams, such as is used in the Model 2A will purify between 250 and 300 tanks of argon gas (approx. 2.8 million liters or 100,000 cu ft.) containing a 10 ppm O2 initial impurity level.

Product Specifications

Style	O_2 Monitor Only	O_2 Monitor/Purifier		Inert Gas Purifier Only
Model	2D	2A-100-SS-120 2A-100-SS-220	2H-200-SS-220	2B-20-Q-120 2B-20-Q-220
Weight	13.75 lbs (6.25 kg)	58 lbs (26.3 kg)	100 lbs (45.4 kg)	15 lbs (6.8kg)
Dimensions (wxhxd)	11-1/16"x8-3/8"x11" (281x213x279 mm)	21"x13"x22" (530x330x560mm)	20.75"x15.75"x18.5" (527x400x470mm)	8.5"x9.5"x13" (220x240x330mm)
Electrical Utility	120 or 220 ±10% VAC 50 op 60 Hz Single Phase		220 ±10% VAC 50 or 60 Hz Single Phase	120 or 220 ±10% VAC 50 or 60 Hz Single Phase
Power	300 Watts	1.4 KWatt		600 Watts
Gas Inlet Connection	1/4" (6.4 mm) Stainless steel Swagelock™ Compression fitting			
Oxygen Sensor	Zirconium Dioxide	Zirconium Dioxide		
O_2 Monitoring Range†	$1x10^{-15}$ to $2x10^5$ ppm O_2	$1x10^{-15}$ to $2x10^5$ ppm O_2		
O_2 Alarm Range	$1x10^{-15}$ to $2x10^5$ ppm O_2	$1x10^{-15}$ to $2x10^5$ ppm O_2		
Response Time	≤ 50 sec from $1x10^{-15}$ to $2x10^5$ ppm O_2			
Sample Flow Rate *	0.8 - 1.0 slpm (1.8 - 2.4 scfh)	0.9 slpm (2 scfh)	0.9 slpm (2 scfh)	
Inert Gas Purifiers				
Furnace Temperature	800°C (1472°F)	600-800°C (1112-1472°F)		600-800°C (1112-1472°F)
Gettered Gas Purity		Better than $1x10^{-6}$ ppm		Better than $1x10^{-6}$ ppm
Gas Flow (Charge) Argon (Titanium) Helium (Titanium) Nitrogen (Copper) Oxygen (Platinum)		40 slpm (85 scfh) 120 slpm (254 scfh) 30 slpm (64 scfh) 30 slpm (64 scfh)	70 slpm (158 scfh) 210 slpm (445scfh) 50 slpm (106 scfh) 50 slpm (106 scfh)	10 slpm (21 scfh) 30 slpm (64 scfh) 7.5 slpm (16 scfh) 7.5 slpm (16 scfh)
Max. Inlet Pressure ‡		73 psig (500kPa)	73 psig (500kPa)	73 psig (500kPa)
Purification Charge		0.2 lbs (90g) Titanium or Copper, or Pt coated Alumina	0.4 lbs (180g) Titanium, Copper, or Pt coated Alumina	0.066 lbs (30g) Titanium, Copper, or Pt coated Alumina
Charge Container		Stainless Steel	Stainless Steel	Fused Quartz

* A diaphragm pump module is contained within the Model 2D, 2A, and 2H. This pump extracts the gas to be monitored from the sampling source and draws the sample through the ZrO_2 cell.

† Level of $2x10^5$ is equivalent to air. ‡ High pressure models (up to 500psig) are avail upon request.

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PURIFIER TECHNOLOGY

ARGON AND HELIUM PURIFIER - The purification process of Inert gases such as argon and helium takes place by reacting the gaseous impurities present in the gas stream with an active metal consisting of high purity titanium contained in a vacuum tight stainless steel canister. When an inert gas, such as argon or helium is allowed to flow through hot titanium, oxygen, nitrogen, carbon, and water vapor impurities are removed.

Because of the titanium charges' strong affinity for oxygen and lower vapor pressure, this device is capable of operating at partial pressures down to 10-37 torr of oxygen at 800°C (the recommended operating temperature).

However, you give up the ability to regenerate the getter charge by using a reducing gas, and the getter charge must be replaced periodically.

NITROGEN PURIFIER - Nitrogen gas is also purified by a gettering process. The oxygen impurities typically present in nitrogen (2-10 ppm O2) can be reduced to less than $1x10^{-6}$ ppm O2 when passed over hot copper. During the purification process the base metal (Copper), which is contained within a vacuum tight canister, is gradually converted to a stable copper oxide (CuO). The copper charge can be regenerated by passing small quantities of hydrogen (< 5%) mixed with nitrogen gas through the purifier. The copper oxide layer is then reduced to the base metal and its ability to purify regained. Due to the high vapor pressure of the oxide forms of copper, this device is only capable of removing oxygen to a partial pressure of 10^{-9} torr at equilibrium at 600°C (the recommended operating temperature). Copper getters will also not remove water vapor from a gas stream. As a result a molecular sieve (Model 4A-2B-0010) is recommended for installation in the gas stream entering or exiting the gettering furnace. While Titanium charges can be used to remove N_2 up to partial pressures of 10-34 torr at 800°C, N_2 process gas is not considered "inert", as it forms nitrides with several elements (ie - ammonia, and Si_3N_4). This poses a problem with reactive metals like titanium which will form nitrides as well as oxides. Therefore, the use of titanium charges in purifying a nitrogen gas stream results in the removal of both oxygen and some nitrogen, shortening the life of the titanium charge. A metal such as copper which selectively reacts with oxygen, but not nitrogen is a better choice for nitrogen gas.

OXYGEN PURIFIER

A catalytic convertor used in automobiles converts unburned hydrocarbons and excess oxygen in the exhaust stream to carbon dioxide and water vapor. In similar fashion, a small furnace and the appropriate catalyst can be used to convert undesired impurities in a process gas to more benign impurities. In many cases, the catalytic process can be used to produce a chemical which is far less reactive toward the materials being processed than is the original impurity.

One material well-known for its catalytic properties is platinum metal. Platinum reacts only with difficulty with many materials. As a catalyst it does not itself react chemically, but serves as a "template" for the alignment of gas molecules which then react with each other. Thus the platinum neither removes or adds anything to the gas. The gas stream which is treated is not any more "pure" than the incoming gas stream - the contaminates have just been made more harmless. Sometimes the new molecules present can be more readily removed from the gas stream than the original impurity.

A molecular sieve or cryogenic trap placed in the gas outlet stream from the purifier are effective for removing the oxidation products formed in the purifier.

Care should be taken to prevent the catalyst from being irreversibly damaged or "poisoned" by coming in contact with certain impurities.

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PRODUCT SUMMARY

Oxygen Monitors

Model 2D - The only standalone model offered for oxygen monitoring. Can be portable, or integrated into existing furnace equipment. System is designed to operate using "raw, purified, or auxilliary" gas inputs, and will only operate when the gas is over 1 atmosphere positive pressure. The auxilliary input can optionally be connected to a spare chamber port for sensing O_2 content in the furnace chamber. The chamber has to be above 1 atmosphere positive pressure of inert gas and the chamber temperature must be below 400°C (optional water cooled heat exchanger is available to chill gas sample prior to entering O_2 monitor).

Inert Gas Purifiers

Model 2B - Effective for flow rates up to 10slpm (21 scfh) or argon or nitrogen, and up to 30 slpm (64 scfh) of helium.

Oxygen Monitors and Inert Gas Purifiers

Model 2A - This unit integrates the oxygen monitor (Model 2D) with a higher flow inert gas purifier, all in one housing. A medium sized unit effective for flow rates up to 40 slpm (85 scfh) of argon or nitrogen, and up to 120 slpm (254 scfh) of helium.

Model 2H - A larger version of the unit above capable of flow rates of up to 70 slpm (158 scfh) of argon or nitrogen, and up to 210 slpm (445 scfh) or helium, or up to 50 slpm (106 scfh) of oxygen. This unit is also only available in 220 voltage.

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