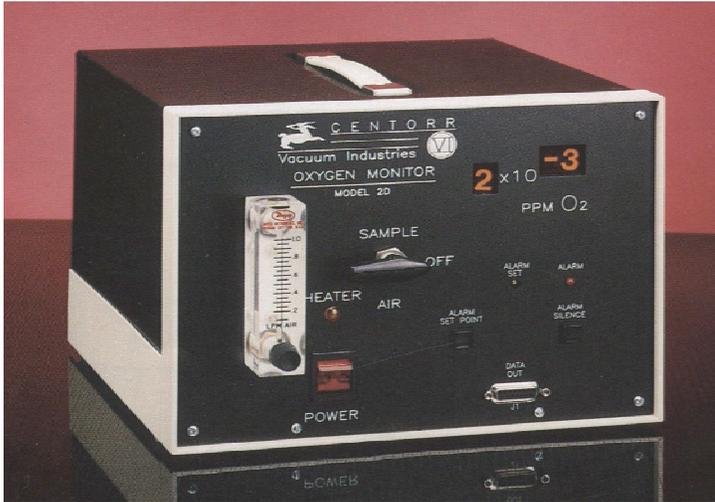


PRODUCT

INFORMATION



OXYGEN MONITORS AND INERT GAS PURIFIERS



Model 2D Portable oxygen level monitor with digital display

INTRODUCTION

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 MONITORS

- Solid State ZrO₂ Sensor
- Detects O₂ levels from 1x10⁻¹⁵ to 2x10⁵ ppm O₂
- Rapid Sensor Response
- Adjustable Alarm Output
- Integrated vacuum pump draws sample from gas stream
- Digital LED Display of O₂ 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 (ZrO₂). At elevated temperatures (800°C) the mobility of oxygen in the ZrO₂ 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 ZrO₂ 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.

PRINCIPLES OF OPERATION - INERT GAS 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. 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 1x10⁻⁶ppm. 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 or 2G 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.

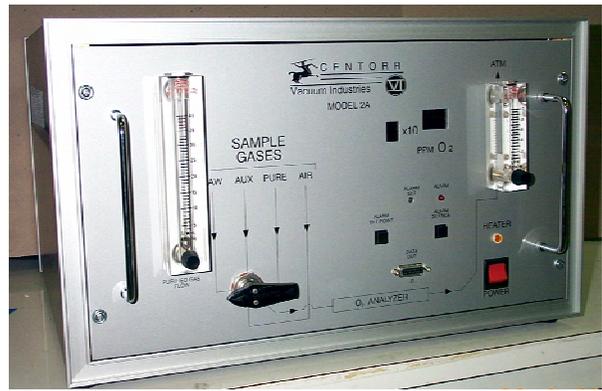
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Model 2H-200-SS Inert gas purifier / oxygen monitor



Model 2A-SS Inert gas purifier / oxygen monitor

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	2G-100-SS-120 2G-100-SS-220	2F-200-SS-220
Weight	13.75 lbs (6.25 kg)	58 lbs (26.3 kg)	100 lbs (45.4 kg)	15 lbs (6.8kg)	58 lbs (26.3 kg)	100 lbs (45.4 kg)
Dimensions (wxhxd)	11-1/16"x8-3/8"x11" (281x213x279 mm)	21"x13"x22" (530x330x560 mm)	20.75"x15.75"x18.5" (527x400x470 mm)	8.5"x9.5"x13" (220x240x330 mm)	21"x13"x22" (530x330x560 mm)	20.75"x15.75"x18.5" (527x400x470 mm)
Electrical Utility	120 or 220 ±10% VAC 50 or 60 Hz Single Phase		220 ±10% VAC 50 or 60 Hz Single Phase	120 or 220 ±10% VAC 50 or 60 Hz Single Phase		220 ±10% VAC 50 or 60 Hz Single Phase
Power	300 Watts	1.4 KWatt		600 Watts	1.4 KWatt	2.8 KWatt
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)	40 slpm (85 scfh) 120 slpm (254 scfh) 30 slpm (64 scfh) 30 slpm (64 scfh)	70 slpm (158 scfh) 210 slpm (445 scfh) 50 slpm (106 scfh) 50 slpm (106 scfh)
Max. Inlet Pressure ‡		73 psig (500kPa)	73 psig (500kPa)	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	0.2 lbs (90g) Titanium, Copper, or Pt coated Alumina	0.4 lbs (180g) Titanium, Copper, or Pt coated Alumina
Charge Container		Stainless Steel	Stainless Steel	Fused Quartz	Stainless Steel	Stainless Steel

* A diaphragm pumping 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 ZrO₂ cell.

† Level of 2x10⁵ is equivalent to air.

‡ High pressure models (up to 500psig) are available upon request.

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 O_2) can be reduced to less than 1×10^{-6} ppm O_2 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 (less than 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 nitrogen up to partial pressures of 10^{-34} torr at 800°C, nitrogen process gas is not considered "inert", as it forms nitrides with several elements (ie - ammonia, and Silicon Nitride). 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 contaminants 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 auxiliary" gas inputs, and will only operate when the gas is over 1 atmosphere positive pressure. The auxiliary input can optionally be connected to a spare chamber port for sensing O₂ 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 O₂ monitor).

Inert Gas Purifiers

Model 2B - The smallest model offered with the smallest gettering charge. Effective for flow rates up to 10slpm (21 scfh) or argon or nitrogen, and up to 30 slpm (64 scfh) of helium.

Model 2G - A medium sized unit effective for flow rates up to 40 slpm (85 scfh) of argon or nitrogen, and up to 120 slpm (254scfh) of helium.

Model 2F - The largest size unit which only runs off of 220 voltage. Effective for large flow rates of up to 70 slpm (158 scfh) of argon or nitrogen, and up to 210 slpm (445 scfh) of helium, and up to 50 slpm (106 scfh) or oxygen using a platinum catalyst.

Oxygen Monitors and Inert Gas Purifiers

Model 2A - This unit integrates the oxygen monitor (Model 2D) with a Model 2G 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.