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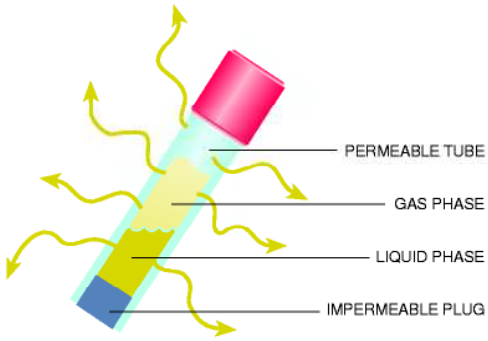
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Analytical Components & Systems

VICI Metronics Inc.

Dynacal® Permeation Tubes

- PPB to high PPM range
- Accurate, stable concentrations
- Safe and convenient
- Economical, flexible alternative to bulky bottled mixtures
- NIST traceable



Description

Dynacal permeation devices are small, inert capsules containing a pure chemical compound in a two phase equilibrium between its gas phase and its liquid or solid phase. At a constant temperature, the device emits the compound through its permeable portion at a constant rate.

Permeation devices are typically inserted into a carrier flow to generate test atmospheres for calibrating gas analyzer systems, testing hazardous gas alarms, or conducting long-term studies of effects on materials or biological systems – in short, any situation requiring a stable concentration of a specific trace chemical.

Accuracy

The purpose of a calibration gas standard is to establish a reference point for the verification of an analysis. Permeation tube rates can be certified using standards traceable to NIST by the most basic and accurate laboratory procedure – measuring the gravimetric weight loss over a known period of time at a known temperature.

Availability and Delivery

Permeation rate data is already established for hundreds of different compounds, and rates for new compounds can be easily certified using NIST-traceable standards. Their small size and inherent stability allow us to inventory thousands of devices for delivery from stock, and because of the size and the limited quantity of chemical fill, we can offer overnight delivery via air express.

Advantages Over Bottled Standards



Calibration devices from VICI Metronics offer several key advantages over cylinder-supplied gas calibration standards.

Economy is always a major consideration; customers who have done the arithmetic, factoring in the cost of cylinder purchase, rental fees, shipment, and disposal, typically discover that the purchase of a Dynacalibrator and a supply of permeation devices will start to save them money in the second year of use.

Multicomponent mixtures can be easily generated with a Dynacalibrator and the appropriate combination of permeation devices. This technique also allows the removal of a single component from a gas mixture by simply removing the appropriate permeation device. Alternative methods require expensive custom mixtures or a large number of gas cylinders, which consume valuable lab space as well.

Bottled standards can also have problems arising from degradation of the standard within the cylinder, from changes in the concentration levels as the cylinder pressure changes, and from interaction of calibration components and surfaces.

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Types of Devices







Tubular Device

The tubular device, a sealed permeable tube containing the desired permeant gas, is the most widely used of the various permeation devices. Release of the chemical fill occurs by permeation through the wall of the Teflon tube for the entire length between the impermeable plugs. A wide range of rates can be achieved by varying the length and thickness of the tube, with typical rates ranging from 5 ng/min to 50,000 ng/min. We can supply tubular permeation devices with active lengths (the length of the permeable section) ranging from 0.5 cm to 20 cm.

Extended Life Tubular Device

Our unique extended life tubular (XLT) device is essentially a standard tubular device coupled to an impermeable stainless steel reservoir. This design offers a range of permeation rates corresponding to a tubular device, but with significantly enhanced lifetime – by a factor of 3 for a 5 cm (active length) device or a factor of 12 for a 1 cm device.

Wafer Device

Wafer devices have only a small permeable window, or wafer, so permeation rates are typically lower than rates for tubular devices by an order of magnitude. Since permeation occurs only through the polymeric wafer, the permeation rate is controlled by varying the wafer material, the thickness of the wafer, and the diameter of the permeation opening. Gases whose high vapor pressure at normal permeation temperatures prevent their containment in a tubular device can be contained in a wafer device. Wafer devices are available in different styles to allow use in calibrators made by various manufacturers.

Typical Compounds

Literally hundreds of compounds are available in permeation devices. Some of the most typical compounds include:

Ammonia	Isopropyl Alcohol
Benzaldehyne	Mercury
Benzene	Methanol
Carbon Disulfide	Methyl Bromide
Chlorine	Nitrogen Dioxide
Dimethyl Sulfide	Phenol
Ethanol	Sulfur Dioxide
Formaldehyde	Sulfur Hexafluoride
Freons	Toluene
Hydrogen Fluoride	Water
Hydrogen Sulfide	Xylene

More Information

More useful information can be found in TechNote 1001: *Generating Calibration Gas Standards with Dynacal Permeation Devices*, and TechNote 1002: *Generating a Part Number for a Dynacal Permeation Device*. These can be found in the support section of www.vici.com.

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VICI Metronics Inc.

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PB-023 permtube

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Analytical Components & Systems

VICI Metronics Inc.

G-Cal Permeation Devices*



- Excellent for use in the field
- Operate at room temperature
- Available with arsine and phosphine

Description

Patented G-Cal permeation tubes offer a proven and repeatable means of generating a desired gas or vapor concentration. The permeant gas escapes through the proprietary membrane system and mixes with a carrier gas at a controlled flow rate to obtain a known mixture in ppm or ppb. Applications include calibration of gas monitoring systems and chromatographs, accuracy check of gas detectors, and generation of known test atmospheres for a specific application.

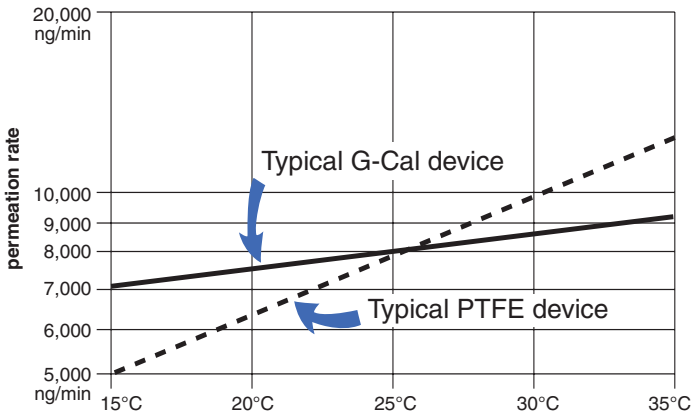
G-Cal devices exhibit the lowest temperature sensitivity among available similar products. The permeation rate of the polymer used in G-Cal devices changes only 1-3% per degree C, eliminating the need for a temperature-controlled chamber.

Over 100 different substances are available, including arsine, phosphine, and gas phase devices such as CO, NO, and methane. Available permeation rates range from less than 200 ng/min to 30,000 ng/min. Each G-Cal device is individually calibrated and verified to generate a given output (ng/min) vs. temperature. A graph which shows permeation rate vs. temperature from 0 to 50°C is included with each device.

Model number (last digit)	Rate range (ng/min)	Size (approximate)
0	100 to 2,999	1 1/2" diameter x 9" long
1	10 to 99	1" x 4 1/2" *or* 1" x 3 1/2"
2	100 to 4,999	1" x 4 1/2" *or* 1" x 3 1/2"
3	5,000 to 14,999	1" x 6 1/2"
4	15,000 to 50,000	1 1/2" x 6 1/2"

Permeation rates and sizes shown are approximate. Overlapping may occur.

Temperature Sensitivity



Comparison of G-Cal permeation devices and Dynacal PTFE permeation devices

Device Selection

Devices for most substances are available with various permeation rates as indicated by the model number digits in the table at left. Use this formula to calculate the permeation rate your application requires:

$$\text{Permeation rate P in ng/min} = \frac{C \times F}{K}$$

where C is the desired concentration in ppm, F is the carrier gas flow rate in ml/min, and K is the molar constant from the substance charts on the next page.

For example, if a concentration of 20 ppm of H_2S (Model GC23-700_) is desired with a flow rate of 300 ml/min of air:

$$\frac{20 \times 300}{0.718} = 8356 \text{ ng/min.}$$

Therefore, G-Cal Model GC23-7003 with a permeation rate in the range of 5,000 to 14,999 is the appropriate choice.

US Patent No. 4,399,942

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Substance	K	Model	Notes
Acetone	.421	GC23-7762,3	
* Acetonitrile	.596	GC23-7912,3	
Ammonia	1.437	GC23-7011,2,3,4	
Arsine	.313	GC23-7620	*(a,b)*
Benzene	.313	GC23-7162,3	
Boron Trichloride	.209	GC23-7882	
Bromine	.153	GC23-7482	
* iso-Butyl Alcohol	.330	GC23-7952,3	
iso-Butyl Mercaptan	.271	GC23-7191,2,3	
* Carbon Dioxide	.556	GC23-7380	*(b)*
Carbon Disulfide	.321	GC23-7231,2,3,4	*(a)*
Carbon Monoxide	.874	GC23-7040	*(b)*
Carbon Tetrachloride	.159	GC23-7242,3	
Carbonyl Sulfide	.406	GC23-7141,2,3,4	
Chlorine	.346	GC23-7032,3	*(a)*
Chloroform	.346	GC23-7032,3	
Di-Methyl Methyl Phosphonate	.197	GC23-7082	
Dichloromethane	.288	GC23-8021,2	
Dimethyl Disulfide (DMDS)	.259	GC23-7091,2,3	
Dimethyl Formamide	.334	GC23-7332	
Dimethyl Sulfide (DMS)	.394	GC23-7101,2,3,4	
Ethanol (Ethyl Alcohol)	.531	GC23-7822	
Ethyl Benzene	.230	GC23-8061,2	
Ethyl Chloride	.379	GC23-7642,3	
Ethylene	.872	GC23-7130	*(b)*
Ethylene Oxide	.555	GC23-7471,2,3	
Ethyl Mercaptan	.394	GC23-7201,2,3	
Ethyl Methyl Sulfide	.322	GC23-7461,2	
Formaldehyde-para	.814	GC23-7942	*(c)*
Hexane	.284	GC23-7302,3	
Hydrogen Chloride	.671	GC23-7870	*(b)*
Hydrogen Fluoride	1.223	GC23-7612	*(a)*
* Hydrogen Sulfide	.718	GC23-7001,2,3,4	*(a)*
Hydrazine	.763	GC23-7932	*(a)*
Menthol	.195	GC23-7962,3	
Methane	1.526	GC23-7070	*(b,e)*
Methanol (Methyl Alcohol)	.763	GC23-7832	
Methyl Bromide	.257	GC23-7992,3	
Methyl Chloride	.484	GC23-7652,3	
Methyl Ethyl Sulfide	.322	GC23-7461,2	
Methyl Mercaptan	.509	GC23-7111,2,3,4	
Methyl Iodide	.172	GC23-7591,2	*(a)*
* Nitric Oxide	.815	GC23-7060	*(a,b,f,g)*
Nitrogen Dioxide	.532	GC23-7052,3,4	*(a)*
* Nitrous Oxide	.556	GC23-7670	*(a,b,f)*
* Oxygen	.764	GC23-7580	*(b,f)*
Phosgene	.247	GC23-7891,2	*(a)*
* Phosphine	.719	GC23-7630	
iso-Propyl Alcohol	.407	GC23-7852	
Propylene Oxide	.421	GC23-8002	
iso-Propyl Mercaptan	.321	GC23-7221,2,3	
n-Propyl Mercaptan	.321	GC23-7211,2,3	
Sulfur Dioxide	.382	GC23-7021,2,3,4	
Sulfur Hexafluoride	.167	GC23-7401,2,3	
Thiophene	.290	GC23-7901,2,3	
Toluene	.266	GC23-7312,3	
Vinyl Chloride	.392	GC23-8051,2	*(a)*
Water	1.358	GC23-7322,3,4	*(d)*
m-Xylene	.230	GC23-7772,3	
o-Xylene	.230	GC23-8081,2	
p-Xylene	.230	GC23-8091,2	

Notes

(a) Shipped by surface freight only
(b) Gas phase device
(c) Requires heating to 80°C
(d) Requires heating: 50° to 80°C, depending on desired rate
(e) Maximum rate 500 ng/min
(f) Maximum rate 1000 ng/min
(g) Requires the use of Oxygen-free gas

* Available only in G-Cal permeation tubes; not available in Dynacal tubes or devices

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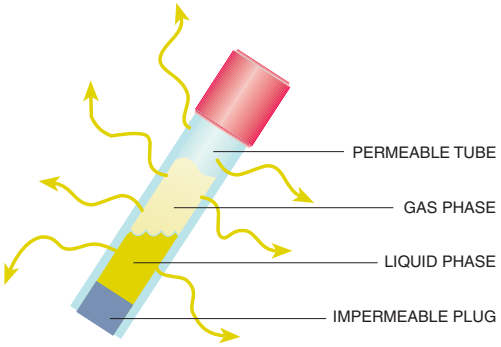
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Permeation devices are typically inserted into a carrier flow to generate test atmospheres for calibrating gas analyzer systems, testing hazardous gas alarms, or conducting long-term studies of effects on materials or biological systems – in short, any situation requiring a stable concentration of a specific trace chemical.

Accuracy

The purpose of a calibration gas standard is to establish a reference point for the verification of an analysis. Permeation tube rates can be certified using standards traceable to NIST by the most basic and accurate laboratory procedure – measuring the gravimetric weight loss over a known period of time at a known temperature.

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CALIBRATION GAS STANDARDS



Permeation Tubes and Devices from VICI Metronics

Overview

Permeation tubes

- Dynacal®
- G-Cal

Calibration gas generators

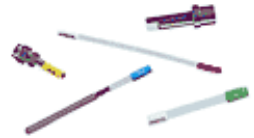
Permeation devices provide a stable concentration of a specific trace chemical, including those with low vapor pressures.

Dynacal® permeation tubes

- Ideal for lab environments
- Smaller than G-Cal devices
- More accurate than G-Cal devices
- Require a temperature-controlled environment
- Inexpensive calibration solution

Dynacal permeation devices are small, inert capsules containing a pure chemical compound in a two phase equilibrium between its gas phase and its liquid or solid phase. At a constant temperature, the device emits the compound through its permeable portion at a constant rate.

- Product information



G-Cal permeation devices

- Excellent for use in the field
- Can be operated at room temperature
- Can handle arsine and phosphine
- Longer life than Dynacal devices



Patented G-Cal permeation tubes offer a proven and repeatable means of generating desired gas or vapor concentrations. The permeant gas escapes through the proprietary membrane system and mixes with a carrier gas (nitrogen is the most common) at a controlled flow rate to obtain a known mixture in ppm or ppb.

- Product information

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Our expertise in perm tube technology also makes VICI Metronics the leading manufacturer of the IMS dopants for narcotics and explosives detection employed by security (ammonia, DCM, BHT), law enforcement, border patrol, military, correctional, and other trace detection industry professionals.



Permeation tubes and devices

Permeation devices provide a stable concentration of a specific trace chemical, including those with low vapor pressures.

- Dynacal® permeation tubes
- G-Cal permeation tubes



Calibration gas generators

Calibration gas generators, used with their respective permeation devices, generate known concentrations of various gases and liquid vapors.

Applications include air pollution monitoring, industrial hygiene surveys, odor surveys, and analyses in chemical, petrochemical, paper, power, and related industries.

- Dynacalibrators®
- G-Calibrators



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CALIBRATION GAS STANDARDS



Dynacal® Permeation Tubes and Devices from VICI Metronics

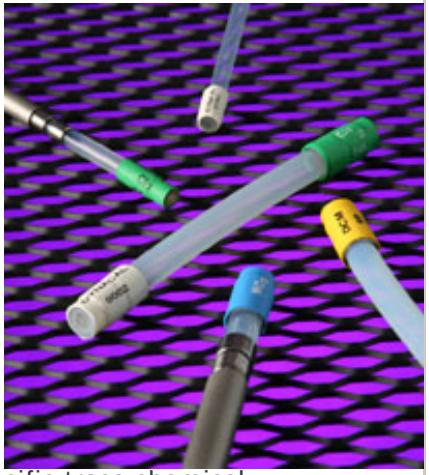
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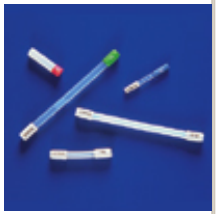


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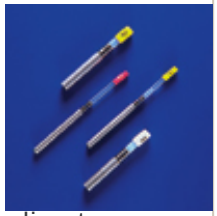
Request a quote



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Release of the chemical occurs by permeation through the walls of the Teflon® tube for the entire length between the impermeable plugs. A wide range of rates can be achieved by varying the length and thickness of the tube, with typical rates ranging from 5 ng/min to 50,000 ng/min.

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Wafer device

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MORE INFORMATION

- Permeation devices vs. bottled trace level standards
- Partial list of available compounds
- On-line permeation tube quote request
- Product brochure
- Dynacal perm tube part numbering system (PowerPoint)

TECHNICAL NOTES

- Technical Note 1001: Generating Calibration Gas Standards with Dynacal® Permeation Devices
- Technical Note 1002: Generating a Part Number for a Dynacal® Permeation Device

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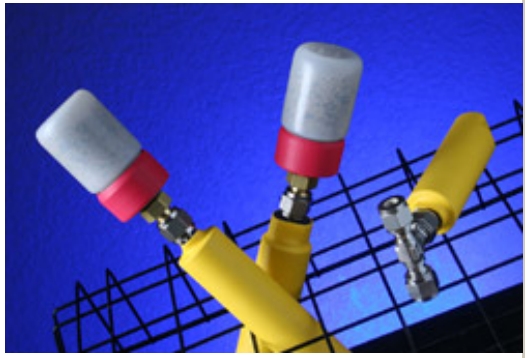
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- G-Cal

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G-Cal devices exhibit the lowest temperature sensitivity among available similar products. The permeation rate of the polymer used in G-Cal devices changes only 1-3% per degree C, eliminating the need for a temperature-controlled chamber. Most G-Cal devices are guaranteed for 12 months operating life.

Over 100 different substances are available, including arsine, phosphine, and gas phase devices such as CO, NO, and methane. Available permeation rates range from less than 200 ng/min to 30,000 ng/min and over. Each G-Cal device is individually calibrated and verified to generate a given output (ng/min) vs. temperature. A graph which shows permeation rate vs. temperature from 0 to 50°C is included with each device.

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CALIBRATION GAS STANDARDS



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- Permeation tubes
- Calibration gas generators
  - Dynacalibrators®
    - Model 120
    - Model 150
    - Model 230
    - Model 340
    - Model 450
    - Model 500
  - G-Calibrators

Calibration gas generators, used with their respective permeation devices, generate known concentrations of various gases and liquid vapors.

Applications include air pollution monitoring, industrial hygiene surveys, odor surveys, and analyses in chemical, petrochemical, paper, power, and related industries.

Dynacalibrators®



Using Dynacal permation devices as the trace gas source, Dynacalibrators deliver precise concentrations from ppb to high ppm for hundreds of different compounds. Portable and lab bench models.

Model 120	Stand-alone portable calibrator
Model 150	Ultra-compact calibrator
Model 230	Flexible flow metering system
Model 340	Front panel mode control switch
Model 450	Through-port feature
Model 500	Two independent permeation chambers

G-Calibrators



In these rugged portable units with G-cal permeation devices, since the permeation rate remains fairly stable over changing temperatures, temperature controlled ovens aren't required for most applications. G-Calibrators operate in ambient temperatures from 15°C to 45°C.

- Product information

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Valco Instruments Co. Inc.
VICI AG International

CALIBRATION GAS STANDARDS



Permeation Devices vs. Bottled Trace Level Standards

Overview

Permeation tubes

Calibration gas generators

Advantages of permeation devices	Disadvantages of bottled standards
• Use pure substance in an inert matrix • Precise concentrations • Easily generated with NIST traceablity using established EPA and ASTM protocols • Removal and/or addition of a single component is simple • Wide range of concentrations easily generated by varying the dilution flow rate and/or the set point temperature	• Expensive • Balanced in another medium • Large number of gas cylinders needed for calibrations requiring multiple components over a wide range of concentrations • Consume valuable lab space • Possible degradation of standard with the cylinder • Mutually reactive chemicals cannot be used

Summary

Calibration devices from VICI Metronics offer several advantages over cylinder-supplied gas calibration standards. Multi-component gas mixtures can be easily generated with NIST traceability using established EPA and ASTM protocols by using the appropriate combination of permeation devices. The technique also allows the removal of a single component from a gas mixture by simply removing the appropriate permeation device. A wide range of concentrations can easily be generated by simply varying either the dilution flow rate and/or the set point temperature.

By contrast, bottled trace level (ppb and ppm) standards can be very expensive, and calibrations requiring multiple components over a wide range of concentrations require a large number of gas cylinders, consuming valuable lab space as well. Problems can also arise from degradation of the standard within the cylinder, from changes in the concentration levels as the cylinder pressure changes, and from interaction of calibration components and surfaces.

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VICI AG International

CALIBRATION GAS STANDARDS



Explosives and Narcotics Dopants from VICI Metronics

- Overview
- Permeation tubes
- Calibration gas generators

- Direct from the manufacturer
- In stock for immediate delivery via air or ground
- Drop shipped globally for no additional fee
- No minimum order
- Volume discounts -- call for quote



VICI Metronics is the leading manufacturer of explosives, narcotics, and chemical warfare dopants for security (ammonia, DCM, BHT), law enforcement, border patrol, military, correctional, and other trace detection industry professionals.

The explosive dopant kit is a small permeable, inert tube containing dichloromethane (DCM), packaged in a sealed leak tight plastic cylinder. The narcotic dopant kit consists of three small permeable, inert tubes packaged in a leak tight plastic cylinder inside a metal cylinder. The extended life version lasts from 5 to 7 months.

Our team is eager to assist you with special applications.

Dopant kit		Compound	Product No.
Explosives		Dichloromethane (DCM)	100-100-4201-U30
Narcotics	Standard lifetime	Ammonia	110-100-0140-U30KT
	Extended lifetime (5-7 months)	Ammonium carbamate	100-100-3121-U30

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CALIBRATION GAS STANDARDS



Model 150 Dynacalibrator® from VICI Metronics

Overview

Permeation tubes

Calibration gas generators

- Dynacalibrators®
  - Model 120
  - Model 150
  - Model 230
  - Model 340
  - Model 450
  - Model 500
- G-Calibrators



- CE-certified
- Temperature control with an accuracy of ±0.01°C from 5° C above ambient to 110°C
- Ultra compact
- PPB to high PPM range

At only 6" wide x 15" deep x 7" high and 10.5 pounds, the Dynacalibrator 150 is a compact, full-featured calibrator capable of delivering the precise concentrations you require. A passivated glass-coated permeation chamber houses the permeation device(s), with measured inert carrier gas sweeping the calibration gas/vapor from the chamber. The digital temperature controller maintains the chamber temperature at a set point with an accuracy of ±0.01°C, traceable to NIST standards. The wide range of temperature settings (5°C above ambient to 110°C) means the end user can generate a wide range of volumetric concentrations for both low and high vapor pressure chemical compounds, establishing or changing the desired volumetric concentration by simply varying the carrier flow.

MORE INFORMATION

- Product brochure (pdf format)
- Instruction manual (pdf format)
- Declaration of CE compliance
- Dynacalibrator part numbering system

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Valco Instruments Co. Inc.
VICI AG International

CALIBRATION GAS STANDARDS



Dynacalibrator® Calibration Gas Generators from VICI Metronics

- Overview
- Permeation tubes
- Calibration gas generators
  - Dynacalibrators®
    - Model 120
    - Model 150
    - Model 230
    - Model 340
    - Model 450
    - Model 500
  - G-Calibrators



- Deliver precise concentrations from ppb to high ppm
- Use Dynacal® permeation devices as the trace gas source
- Proprietary constant temperature system controls chamber temperature at a set point with 0.1°C accuracy (0.01°C with Model 150)
- Front panel access to permeation chamber
- Choice of plumbing and flow configurations

VICI Metronics Dynacalibrators allow you to verify the accuracy of analytical data from air pollution monitoring, industrial hygiene surveys, odor surveys, and other instruments measuring gas concentration. All models enable calibrations traceable to NIST standards for almost any gas analyzer, in the lab or in the field.

The design takes full advantage of all the conveniences inherent in our Dynacal® permeation devices to generate and deliver precise concentrations ranging from ppb to high ppm for hundreds of different compounds. Standard features on all our models facilitate accurate, reproducible, trouble-free calibrations time after time.

Model 120

Stand-alone portable calibrator



Model 150

Ultra-compact calibrator



Model 230

Flexible flow metering system





Model 340

Front panel mode control switch

Model 450

Through-port feature

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Flexible flow metering system

Model 340	Model 450
Front panel mode control switch	

Model 500
Two independent permeation chambers

MORE INFORMATION

- Dynacalibrator part numbering system

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CALIBRATION GAS STANDARDS



G-Calibrator Calibration Gas Generators from VICI Metronics

- Overview
- Permeation tubes
- Calibration gas generators
  - ·Dynacalibrators®
    - Model 120
    - Model 150
    - Model 230
    - Model 340
    - Model 450
    - Model 500
  - ·G-Calibrators



G-Calibrators are rugged portable units specifically designed to be used with our patented Series 23 G-Cal permeation devices to generate known concentrations (ppb to ppm) of various gases and liquid vapors. This combination offers the easiest method of calibrating toxic gas detection equipment, gas analyzers, and chromatographs commonly used in chemical, petrochemical, paper, power, and related industries.

Due to its patented permeation technology, the permeation rate of a G-Cal device remains fairly stable when exposed to changing temperatures. For most applications, this feature eliminates the need for a temperature-controlled oven.

Two basic series are available - the Model 2301 (without oven) and the Model 2330 (with oven). Models with an oven have a single fixed temperature point (35° - 50°C). All have stainless steel fittings and PTFE tubing throughout.

Flow range	Oven*	Battery	Product No.
100-1000 cc/min	no	1.5 VCD	2301
	no	12 VCD NiCad	2310-10
	yes	12 VCD NiCad	2330-10
200-4000 cc/min	no	12 VCD NiCad	2310-20
	yes	12 VCD NiCad	2330-20

* Single fixed tempterature point (35° 50°C)

SEE ALSO

- G-Cal permeation tubes

MORE INFORMATION

- Product brochure (pdf format)

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GAS MONITORS

Toxic Gas and Oxygen Monitors from VICI Metronics

Overview

VICI Metronics offers the complete G-Cal line of small, portable monitors/alarms which utilize patented GCI electrochemical sensors for the detection of O_2 and toxic gases such as CO, H_2S, SO_2, NO_X, and NO_2. These low-cost, battery-powered units are ideally suited as a personal monitor for field use, but have a sensor cable option for remote sampling. Monitors feature a preset audible and visible alarm, with the gas concentration displayed in ppm or as a percentage.



Monitors for:	CO	NO_2	O_2	Also available:	Remote cables
	H_2S	NO_X	SO_2		Vinyl monitor case

Oxygen monitors/alarms

Range	Sensor	Description	Product No.
0-25%	Internal	Monitor/alarm	GC-501
		Spare sensor	GC33-200
	External *	Monitor/alarm	GC-502
		Spare sensor	GC33-475
0-100%	Internal	Monitor/alarm	GC-501X
		Spare sensor	GC33-250
	External *	Monitor/alarm	GC-502X
		Spare sensor	GC33-445

Oxygen monitors above include a sensor, instruction booklet, recorder plug, and screw driver.
* One remote cable is included with monitors with external sensors.

Top

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Toxic gas monitors/alarms

Gas	Description	Product No.
CO	Monitor/alarm	GC-401
	Spare sensor	GC44-300
H_2S	Monitor/alarm	GC-701
	Spare sensor	GC44-700
NO_2	Monitor/alarm	GC-952
	Spare sensor	GC44-500
NO_X	Monitor/alarm	GC-901
	Spare sensor	GC44-900
SO_2	Monitor/alarm	GC-801
	Spare sensor	GC44-800

All monitors above include a sensor, instruction booklet, screw driver, and span gas flow cup and tubing.

Top

Remote cables and vinyl case

Description	For use with	Product No.
Remote cable	Oxygen monitors with internal sensor	GC501-RC
	Oxygen monitors with external sensor	GC502-RC
	CO, NO_X, NO_2, SO_2	GC401-RC
	H_2S	GC401-RC3
Vinyl case		GC501-505

Top

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Valco Instruments Co. Inc.
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CALIBRATION GAS STANDARDS



Model 120 Dynacalibrator® from VICI Metronics

Overview

Permeation tubes

Calibration gas generators

- Dynacalibrators®
  - Model 120
  - Model 150
  - Model 230
  - Model 340
  - Model 450
  - Model 500
- G-Calibrators

MORE INFORMATION

- Product brochure (pdf format)
- Dynacalibrator part numbering system

- Completely portable
- Pump powered by rechargeable battery or run it from your car battery!
- Available temperature control from 5°C above ambient to 100°C
- DC to AC inverter for use in an automobile

Standard features on Model 120 include a glass or PTFE permeation chamber with screw cap access, solid state proportional temperature controller with digital readout of set point and chamber temperature, heater switch with LED indicator, flowmeter and flow control valve, span and overflow outlets, 12 VDC internal pump, activated charcoal scrubber, and molded fiberglass case.



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VICI AG International

CALIBRATION GAS STANDARDS



Model 230 Dynacalibrator® from VICI Metronics

Overview

Permeation tubes

Calibration gas generators

- Dynacalibrators®
  - Model 120
  - Model 150
  - Model 230
  - Model 340
  - Model 450
  - Model 500
- G-Calibrators

With a flexible flow metering system to maintain a constant carrier flow through the permeation chamber, the Model 230 allows the dilution flow to be varied over a wide range, generating the spectrum of concentrations required for checking analyzer linearity. Like all Dynacalibrators, its large permeation chamber is big enough to accomodate several permeation devices, for higher output concentrations or multi-component mixtures.



MORE INFORMATION

- Product brochure (pdf format)
- Instruction manual (pdf format)
- Dynacalibrator part numbering system

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Valco Instruments Co. Inc.
VICI AG International

CALIBRATION GAS STANDARDS



Model 340 Dynacalibrator® from VICI Metronics

Overview

Permeation tubes

Calibration gas generators

- Dynacalibrators®
  - Model 120
  - Model 150
  - Model 230
  - Model 340
  - Model 450
  - Model 500
- G-Calibrators

The Model 340 adds a front panel mode control switch to select among zero, span, or remote calibration modes. In the zero mode, scrubbed air is delivered to the stream outlet. In the remote mode, the Model 340 can be externally programmed to deliver a zero and a span reference on command.

MORE INFORMATION

- Product brochure (pdf format)
- Dynacalibrator part numbering system

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CALIBRATION GAS STANDARDS



Model 450 Dynacalibrator® from VICI Metronics

- Overview
- Permeation tubes
- Calibration gas generators
  - ·Dynacalibrators®
    - Model 120
    - Model 150
    - Model 230
    - Model 340
    - Model 450
    - Model 500
  - ·G-Calibrators

Ordinarily, the plumbing connections between the sample manifold, analyzer, and calibrator must be changed for each calibration. The Model 450's unique "through-port" feature eliminates this chore. The mode control switch selects among standby, zero, span 1 (low concentration), span 2 (high concentration), and remote modes. In the remote mode, the Model 450 can be externally programmed to operate in all of its functional modes.



MORE INFORMATION

- Product brochure (pdf format)
- Instruction manual (pdf format)
- Dynacalibrator part numbering system

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Analytical Components & Systems

VICI Metronics Inc.

Dynacalibrator® Model 150 Calibration Gas Generator

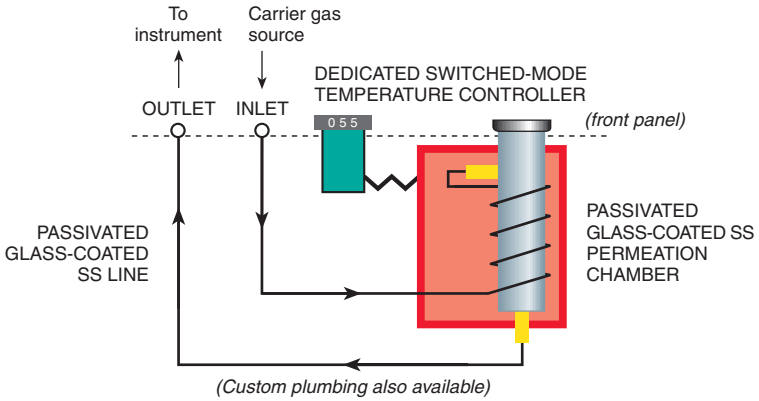


- PPB to high PPM range
- Temperature control with an accuracy of ±0.01°C
- Economical, flexible alternative to bulky bottled gas mixtures

Description

The Dynacalibrator® Model 150 is a constant temperature system designed to generate precise ppm or ppb concentrations of chemical compounds in a gas stream, using permeation devices as the trace gas source. It is used as a reference for the calibration of instruments in the field of gas chromatography, verifying the accuracy of analytical data generated from air pollution monitoring, industrial hygiene surveys, odor survey programs, and tracer studies, and in other instruments that measure gas concentrations.

A passivated glass-coated permeation chamber houses the permeation device(s), with measured inert carrier gas sweeping the calibration gas/vapor from the chamber. A digital temperature controller maintains the chamber temperature at a set point with an accuracy of ±0.01°C, traceable to NIST standards. The wide range of temperature settings (5°C above ambient to 110°C) allows the end user to generate a wide range of volumetric concentrations for both low and high vapor pressure chemical compounds, establishing or changing the desired volumetric concentration by simply varying the carrier flow.



Advantages Over Bottled Standards



Permeation devices from VICI Metronics offer several key advantages over cylinder-supplied gas calibration standards.

Economy is always a major consideration; customers who have done the arithmetic, factoring in the cost of cylinder purchase, shipment, and disposal, typically discover that the purchase of a Dynacalibrator and a supply of permeation devices will start to save them money in the second year of use.

Multicomponent mixtures can be easily generated with a Dynacalibrator and the appropriate combination of permeation devices. This technique also allows the removal of a single component from a gas mixture by simply removing the appropriate permeation device. Alternative methods require expensive custom mixtures or a large number of gas cylinders, which consume valuable lab space as well.

Bottled standards can also have problems arising from degradation of the standard within the cylinder, from changes in the concentration levels as the cylinder pressure changes, and from interaction of calibration components and surfaces.

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Specifications

Features	Passivated glass-coated stainless steel chamber Stainless steel cap Dedicated switched-mode temperature controller with front panel and serial port control Digital readout for set point and chamber temperature Power switch with LED indicator light Stainless steel inlet and outlet fittings for 1/16" tubing Universal power input 110 VAC/230 VAC Cooling fan
Permeation chamber	Stainless steel, passivated with Inertium® and Ultradeactivation® coating Screw cap access 9.5" long by 0.875" ID (24 cm x 2.2 cm)
Permeation device	
Maximum total length	24 cm (9.5")
Maximum diameter	1.6 cm (0.62")
Temperature control	
Range	30°C to 110°C
Accuracy	±0.01°C at a set point from 5°C above ambient to 110°C
Accessories	Power cord for 110 VAC power source (220 VAC Model 150-C) Forceps for removing and inserting permeation devices Tool for removing and securing permeation chamber cap
Carrier flow	Recommended range of 100 - 1200 ml/min
Dimensions	6" wide x 15" deep x 7" high (15.4 cm x 38.1 cm x 17.7 cm)
Weight	10.5 lbs. (4.8 kg)

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Dynacalibrator® Part Numbering System

Model ___-___-___-_

Instrument Model
230 - Basic
340 - Intermediate
450 - Most versatile
500 - Dual chamber*

Basic Plumbing Configuration
0 - No pump, single gas supply inlet
1 - No pump, dual gas supply inlets (carrier & dilution)
2 - Internal pump, no gas stream bypasses*
3 - Internal pump, single gas stream bypass (carrier)*
4 - Internal pump, single gas stream bypass (dilution)*
5 - Internal pump, dual gas stream bypasses (carrier & dilution)*

Dilution Gas Flow Capacity
3 - 1 L/min
4 - 2 L/min
5 - 5 L/min
6 - 10 L/min
7 - 15 L/min
8 - 20 L/min
9 - special flow

Carrier Gas Flow Capacity
a - 80 cc/min
b - 175 cc/min
c - 350 cc/min

Rack Mount Options
R - Fixed rack mount package (19")
T - Slide-mount package with pull handles (19")

Additional Options
C - 220V/50Hz operation
D - Flowmeter with fully calibrated dual floats; second float gives full scale reading at ~50% capacity
M - Constructed for use with moisture and moisture-sensitive compounds
S - Any non-standard option (contact factory for quote)

Chamber Material
I - 150 Inertium
N - Inconel (for HCl, HF, and Cl)

* Internal pump options (2 through 5) not available on Model 500

Accessories

Name	Description	Product No.
PFA	Low-pressure-drop particulate filter assembly for Dynacalibrators with an internal pump which will be operated in dusty environments	50-02-102
FC	Replacement filter cartridge for PFA	07-10-016
CSU	Replacement charcoal scrubber unit	50-02-041
PD	Replacement pump diaphragm	07-05-001
LF	Replacement 5 micron line filter element, with gaskets	07-13-005

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Analytical Components & Systems

VICI Metronics Inc.

G-Calibrator Portable Calibration Gas Generators



- PPB to high PPM range
- No oven required for most applications
- Economical, flexible alternative to bulky bottled mixtures

Description

G-Calibrators are rugged portable units specifically designed to be used with our patented Series 23 G-Cal permeation devices to generate known concentrations (ppb to ppm) of various gases and liquid vapors. This combination offers the easiest method of calibrating the toxic gas detection equipment, gas analyzers, and chromatographs commonly used in chemical, petrochemical, paper, power, and related industries.

Due to its patented permeation technology, the permeation rate of a G-Cal device remains fairly stable when exposed to changing temperatures. This eliminates the need for a temperature-controlled oven for most applications.

All G-Calibrators feature Teflon® tubing and stainless steel fittings throughout. Models powered by a 12 VDC NiCad rechargeable battery also include a 110 VAC external charger.

Model	Oven*	Battery	Flow range
2301		1.5 VDC	100-1000 cc/min
2310-10		12 VDC NiCad	100-1000 cc/min
2310-20		12 VDC NiCad	200-4000 cc/min
2330-10	•	12 VDC NiCad	100-1000 cc/min
2330-20	•	12 VDC NiCad	200-4000 cc/min

**Single fixed temperature point (35° - 50°C)*

Advantages Over Bottled Standards



Calibration devices from VICI Metronics offer several key advantages over cylinder-supplied gas calibration standards.

Economy is always a major consideration; customers who have done the arithmetic, factoring in the cost of cylinder purchase, shipment, and disposal, typically discover that the purchase of a G-Calibrator and a supply of permeation devices will start to save them money in the second year of use.

Multicomponent mixtures can be easily generated with a G-Calibrator and the appropriate combination of permeation devices. This technique also allows the removal of a single component from a gas mixture by simply removing the appropriate permeation device. Alternative methods require expensive custom mixtures or a large number of gas cylinders, which consume valuable lab space as well.

Bottled standards can also have problems arising from degradation of the standard within the cylinder, changes in the concentration levels as the cylinder pressure changes, and interaction of calibration components and surfaces.

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rev 3/06
PB-025 g-calib

Specifications

Range
- H_2S, SO_2, NO_2 ..... 0-100 ppm
- CO, NO_x ..... 0 - 1,999 ppm

Alarm (high)
- H_2S, SO_2, NO_2 ..... Audible and visible at 100 ppm
- CO, NO_x ..... Audible and visible at 200 ppm

Display ..... LCD, 1 ppm increments
Linearity ..... ± 2 ppm
Accuracy ..... ± 10 ppm full range
± 5 ppm if used up to 100 ppm maximum
Calibration ..... Two point required:
ZERO adjust with clean air or N_2;
SPAN adjust with ~50% full scale calibration gas

Case material ..... High impact polystyrene
Case dimensions ..... 5.25" x 2.5" x 1.25"
Weight ..... 250 grams
Recorder output ..... Not provided
Temp limits ..... 0 to 40°C
Power source ..... One 9V alkaline battery
Battery life, continous ..... 1500 hours, with no alarm
Low battery indicator ..... LCD 'B' Display
Response time ..... 90% in < 20 seconds
Sensor mounting .....Internal (optional external cable)
Sensor life ..... Warranted: 6 months
Expected: 9 months

Ordering information

All monitors below include a sensor, instruction booklet, screw driver, and span gas flow cup and tubing.

For detection of	*Model*	*Spare sensor*	*Remote cable*	*Vinyl case*
CO	GC-401	GC44-300	GC401-RC	GC501-505
H_2S	GC-701	GC44-700	GC401-RC	GC501-505
SO_2	GC-801	GC44-800	GC401-RC	GC501-505
NO_x	GC-901	GC44-900	GC401-RC	GC501-505
NO_2	GC-952	GC44-500	GC401-RC	GC501-505

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Europe, Asia, and Africa contact:
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Analytical Components & Systems

Dynacalibrator® Portable Calibration Gas Generator

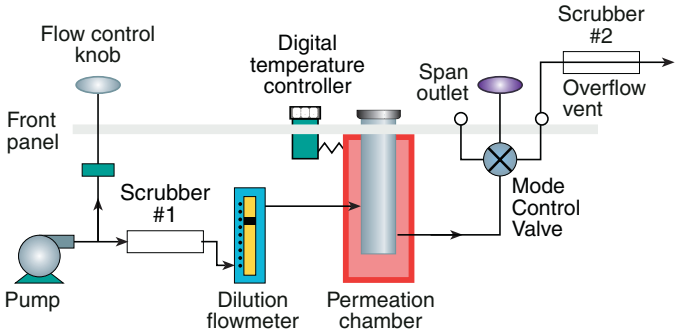


- Low PPB to high PPM range
- Temperature control to 100°C
- Internal 4 LPM pump
- Rechargeable 8 hour battery

Description

VICI Metronics Dynacalibrators enable calibrations traceable to NIST standards for almost any gas analyzer, in the lab or in the field. They are ideal for verifying the accuracy of analytical data from air pollution monitoring, industrial hygiene surveys, odor survey programs, and other instruments measuring gas concentration.

The design takes full advantage of all the conveniences inherent in our Dynacal® permeation devices to generate and deliver precise concentrations ranging from ppb to high ppm for hundreds of different compounds. The portable Model 120 features a glass or Teflon® permeation chamber with screw cap access, solid state proportional temperature controller with digital readout of set point and chamber temperature, heater switch with LED indicator, flowmeter and flow control valve, span and overflow outlets, 12 VDC internal pump, activated charcoal scrubber, and molded fiberglass case.



Advantages Over Bottled Standards



Calibration devices from VICI Metronics offer several key advantages over cylinder-supplied gas calibration standards.

Economy is always a major consideration; customers who have done the arithmetic, factoring in the cost of cylinder purchase, shipment, and disposal, typically discover that the purchase of a Dynacalibrator and a supply of permeation devices will start to save them money in the second year of use.

Multicomponent mixtures can be easily generated with a Dynacalibrator and the appropriate combination of permeation devices. This technique also allows the removal of a single component from a gas mixture by simply removing the appropriate permeation device. Alternative methods require expensive custom mixtures or a large number of gas cylinders, which consume valuable lab space as well.

Bottled standards can also have problems arising from degradation of the standard within the cylinder, from changes in the concentration levels as the cylinder pressure changes, and from interaction of calibration components and surfaces.

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Specifications

Panel features	Permeation chamber access (screw cap) Digital readout for chamber temperature Flowmeter with flow control valve Span and overflow outlet (1/4" tube fitting) Power switch with LED indicator light Power receptacle for 110 VAC operation and recharging Solid state proportional temperature controller Digital readout for set point and chamber temperature Teflon® mode select valve – Standby or Span Heater switch with LED indicator light
Permeation chamber	Glass: 0.85" ID x 7.75" (2.1 cm x 19.7 cm) Teflon: 0.69" ID x 7.75" (1.7 cm x 19.7 cm)
Temperature range	5°C above ambient to 100°C Solid state proportional temperature controller
Flowmeters	Precision graduated rotometers Model 120-1 1.0 L/min Model 120-2 2.4 L/min Model 120-4 4.0 L/min
Pump	Internal Pump (12 VDC) Single head 2.4 L/min Dual head 4.0 L/min
Scrubbers	Activated charcoal
Power Supply	Internal rechargeable gel-type battery (12V) with up to 24 hour capacity
Accessories	Power cord for 110 VAC operation and recharging Adapter for 12V vehicle system Forceps for device insertion and removal
Case	Molded fiberglass with handle for field use 10.5" wide x 9.5" deep x 13" high (27 cm x 24 cm x 33 cm)
Instrument weight	24 lbs. (11 kg)

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VICI Metronics Inc.

Europe, Asia, and Africa contact:
VICI VICI AG International

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VICI Analytical Components & Systems

VICI Metronics Inc.

Dynacalibrator® Calibration Gas Generators



- PPB to high PPM range
- Precise temperature control to 110ºC
- Economical, flexible alternative to bulky bottled gas mixtures

Description

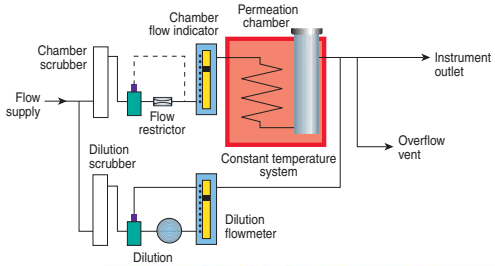
VICI Metronics Dynacalibrators enable calibrations traceable to NIST standards for almost any gas analyzer, in the lab or in the field. The design takes full advantage of all the conveniences inherent in our Dynacal® permeation devices to generate and deliver precise concentrations ranging from ppb to high ppm for hundreds of different compounds. Standard features on all our models, from the most basic Model 230 to the most fully equipped Model 450, facilitate accurate, reproducible, trouble-free calibrations time after time.

Standard features include our proprietary constant temperature system, a front-access permeation chamber large enough to accomodate several permeation devices, and a flexible flow metering system traceable to NIST standards. Dynacalibrators can be supplied with internal pumping systems, eliminating the cost and inconvenience of external pumps, gas cylinders, regulators, and special plumbing. Units with pumps can be equipped with accessory bypass loops that provide for external modification of the carrier and/or dilution gas streams.

Models

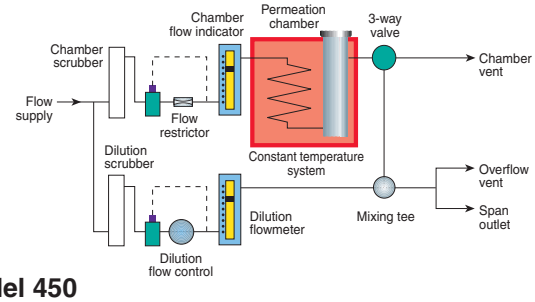
Model 230

The Model 230 is our basic calibration instrument, offering all the standard features and configurations.



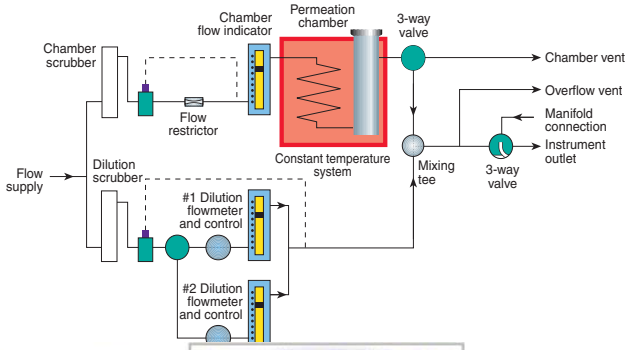
Model 340

A front panel MODE CONTROL switch selects ZERO, SPAN, or REMOTE calibration modes. In the REMOTE mode, the Model 340 can be programmed to deliver a ZERO and a SPAN reference on command. In the ZERO mode, scrubbed air is delivered to the STREAM OUTLET.



Model 450

Our most versatile calibration instrument incorporates a second channel of dilution gas flow and a unique "through-port" feature which eliminate the necessity of changing plumbing connections between the sample manifold, the analyzer, and the calibrator for each calibration. Also included is a front panel MODE CONTROL switch to select STANDBY, ZERO, SPAN 1 (low concentration gas), SPAN 2 (high concentration gas), and REMOTE. In the REMOTE mode, the Model 450 can be externally programmed to operate in all of its functional modes.



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Specifications

Permeation device	
Maximum length	24 cm (9.5")
Maximum diameter	1.6 cm (0.62")
Permeation chamber	Teflon® or Pyrex® Will accomodate multiple devices
Flowmeters	High resolution 15 cm graduated scale. Certified ±1% accuracy full scale, NIST traceable. Full scale ranges of 1,2,5,10, 15, and 20 L/min.
Flowmeter calibration accuracy (max % deviation from float setting)	
At maximum flow	1 %
At minimum flow	3 %
Ambient operating temperature	10°C - 40°C
Temperature indicator	Digital display
Temperature controller	Solid state proportional with 0.1°C set point accuracy, NIST traceable.
Temperature control range	5°C above ambient to 110°C
Permeation chamber temperature equilibration time	< 1 hr
Pumps	Diaphragm pumps for continuous operation. Available for 10 or 20 L/min capacity
External gas stream supply and modification	Instruments with separate stream inlets or stream bypasses have provision for connecting dehydrators, special scrubbers, filters, etc. in series with the carrier and/or dilution gas streams
Case dimensions	17" wide x 23.75" deep x 10.5" high (43.2 cm x 60.3 cm x 26.7 cm)
Instrument weight	
Units with internal pumps	
Model 230	55 lbs. (25.0 kg)
Model 340	56 lbs. (25.4 kg)
Model 450	59 lbs. (26.8 kg)
Units without internal pumps	
Model 230	43 lbs. (19.5 kg)
Model 340	44 lbs. (20.0 kg)
Model 450	47 lbs. (21.3 kg)
Power consumption	
Units with internal pumps	
Model 230	290W
Model 340	300W
Model 450	340W
Units without internal pumps	
Model 230	100W
Model 340	110W
Model 450	145W
Instrument noise emission (at 3 ft)	
Units with internal pumps	55 - 60 dBa
Units without internal pumps	45 - 50 dBa

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VICI Analytical Components & Systems

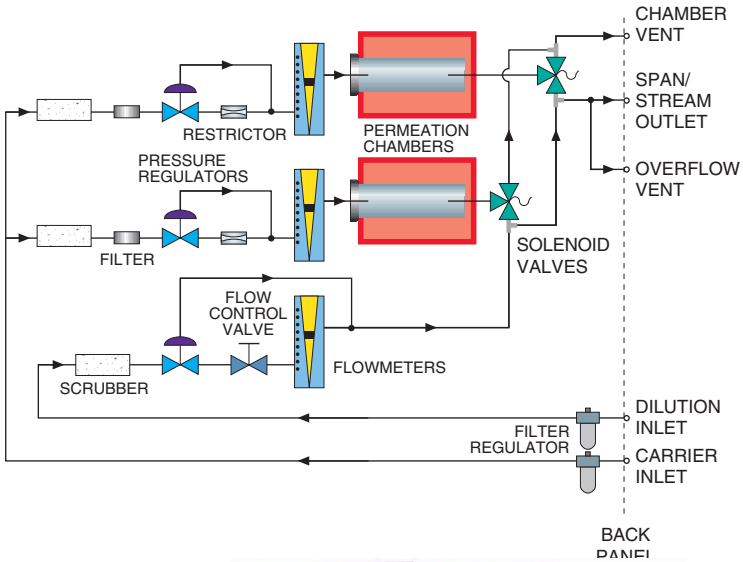
Dynacalibrator® Model 500 Calibration Gas Generator

- PPB to high PPM range
- Switchable carrier flow – dilution or vent
- Two separate permeation chambers with independent temperature control

Description

VICI Metronics Dynacalibrators enable calibrations traceable to NIST standards for almost any gas analyzer, in the lab or in the field. They are ideal for verifying the accuracy of analytical data from air pollution monitoring, industrial hygiene surveys, odor survey programs, and other instruments measuring gas concentration.

The design takes full advantage of all the conveniences inherent in our Dynacal® permeation devices to generate and deliver precise concentrations ranging from ppb to high ppm for hundreds of different compounds. The innovative Model 500 features two separate permeation chambers with independent temperature control systems. The chambers can be used independently, or together to combine concentrations of trace components. Separate solenoid valves allow the carrier flows to be switched from the dilution flow to a vent port.



Advantages Over Bottled Standards



Calibration devices from VICI Metronics offer several key advantages over cylinder-supplied gas calibration standards.

Economy is always a major consideration; customers who have done the arithmetic, factoring in the cost of cylinder purchase, shipment, and disposal, typically discover that the purchase of a Dynacalibrator and a supply of permeation devices will start to save them money in the second year of use.

Multicomponent mixtures can be easily generated with a Dynacalibrator and the appropriate combination of permeation devices. This technique also allows the removal of a single component from a gas mixture by simply removing the appropriate permeation device. Alternative methods require expensive custom mixtures or a large number of gas cylinders, which consume valuable lab space as well.

Bottled standards can also have problems arising from degradation of the standard within the cylinder, from changes in the concentration levels as the cylinder pressure changes, and from interaction of calibration components and surfaces.

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Specifications

Front panel features	Wide-neck Pyrex® chambers for easy access Digital thermometer (0-110°C) for precise chamber temperaturereadout Long-life LED indicators
Permeation chamber	Pyrex® (standard) .85" ID x 9.4" (2.1 cm x 24 cm) Teflon® (Option P) .69" ID x 9.4" (1.8 cm x 24 cm) Stainless steel (Option H) .875" ID x 9.25" (2.2 cm x 23.5 cm)
Permeation device	
Maximum total length	23.5 cm (9.25")
Maximum diameter	1.6 cm (0.62")
Temperature controller	Solid state proportional with 0.1°C set point accuracy, NIST traceable, and stability of ±0.01°C
Temperature control range	Standard unit: 2°C above ambient to 50°C Expanded temperature unit: 2°C above ambient to 110°C
Output pressure	0 - 5 psi standard; 50 psi optional (Option H)
Flowmeters	High resolution 15 cm graduated scale. Certified ±1% accuracy full scale (1% at maximum flow, 3% at minimum flow, NIST traceable. Full scale ranges of 1, 2, 5, 10, 15, and 20 L/min.
Dimensions	17" wide x 23.75" deep x 10.5" high (43.2 cm x 60.3 cm x 26.7 cm)
Chamber temperature equilibrium time	Less than 1 hour
External gas stream supply and modification	Separate inlets for connecting external gas supply for carrier and dilution streams
Weight	74 lbs. (33.3 kg)
Accessories	Power cord for 110 VAC power source (220 VAC w/option C) Forceps for removing and inserting permeation devices Reference manual
Options	Option C 220 VAC Option H High pressure stainless steel chamber Option T Expanded temperature range

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VICI Analytical Components & Systems

VICI Metronics Inc.

Oxygen and Toxic Gas Monitors/Alarms



- For O_2, CO, H_2S, SO_2, NO_x, or NO_2
- Pocket-sized and lightweight
- Audible and visible alarms
- Powered by a single 9-volt battery
- Wide concentration range

VICI Metronics offers the complete GC Industries line of small, portable monitors/alarms for the detection of O_2 or specific toxic gases. Patented GCI electrochemical sensors provide maintenance-free operation, long operating life, selectivity, and easy field replacement. The monitors' small size, light weight, and battery operation make them the ideal personal monitors for field use.

Oxygen Monitors/Alarms

Specifications

Range
- GC-501, 502 ..... 0-25%
- GC-501X, 502X 0-100%

Display ..... LCD, 0.1% increments
Accuracy ..... ± 2% full scale
Calibration ..... Single point in air at 20.9%
Case material ..... High impact polystyrene
Case dimensions ..... 5.25" x 2.5" x 1.25"
Weight .....225 grams
Recorder output.....10 millivolts / %O_2
Alarm (low oxygen)..... Audible and visible at 19.5%
Temp limits ..... 0 to 45°C
Power source ..... One 9V alkaline battery
Battery life, continous ..... 2000 hours, with no alarm
Low battery indicator..... LCD 'B' Display
Response time ..... 90% in < 20 seconds
Sensor mounting
- GC-501, 501X..... Internal (optional external cable)
- GC-502, 502X ..... External, via coiled cable

Sensor life ..... Warranted: 6 months
Expected: 12 months

Ordering information

Oxygen monitors are available in a choice of two ranges, with either external or internal sensors. The monitors below include a sensor, instruction booklet, recorder plug, and screw driver.

Specifications	*Model*	*Spare sensor*	*Remote cable*	*Vinyl case*
0-25% range, internal sensor	GC-501	GC33-200	GC501-RC	GC501-505
0-100% range, internal sensor	GC-501X	GC33-250	GC501-RC	GC501-505
0-25% range, external sensor	GC-502	GC33-475	GC502-RC (included)	GC501-505
0-100% range, external sensor	GC-502X	GC33-445	GC502-RC (included)	GC501-505

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CALIBRATION GAS STANDARDS



Chemicals Available from VICI Metronics

Overview
Permeation tubes
- Dynacal®
- G-Cal
Calibration gas generators

Hundreds of compounds are available in our permeation devices. Contact us if you don't see what you're looking for.

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

A

Chemical	Dynacal designator	G-Cal designator
Acetaldehyde	2301	
Acetamide	5401	
Acetic acid	2851	
Acetic anhydride	3050	
Acetone	2500	776
Acetonitrile	5301	791
Acetylene	0951	
Acrolein	2351	
Acrylonitrile	5340	791
Allyl alcohol	2102	
Allyl sulfide	6240	
Ammonia	0140	701
n-Amyl mercaptan	6008	
tert-Amyl mercaptan	6014	
Aniline	5250	
Anthracene	1701	
Arsine		762

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B

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Chemical	Dynacal designator	G-Cal designator
Benhydrol	2265	
Benzaldehyde	2400	
Benzene	1400	716
Benzene-D6	1400D	
Benzene sulfonyl chloride	8710	
Benzonitrile	5370	
Benzophenone	2595	
Benzyl alcohol	2255	
1,3-bis(isocyanatomethyl)cyclohexane	7477	
Boron trichloride		788
Bromine	0003	748
1-Bromobutane	4514	
Bromochlorodifluoromethane	4900	
Bromoform	4502	
1,3-Butadiene	0704	
n-Butane	0503	
1-Butanol	2004	
2-Butanol	2005	
1-Butene	0701	
cis-2-Butene	0702C	
trans-2-Butene	0702T	
2-Butoxyethanol	2823	
Butyl acetate	3104	
Butyl acrylate	3144	
Butyl benzene	1420	
Butyl carbitol	2833	
n-Butyl ether	2754	
n-Butyl formate	3154	
Butyl glycidyl ether	2835	
n-Butyl mercaptan	6004	
sec-Butyl mercaptan	6005	
tert-Butyl mercaptan	6007	
Butyl propionate	3130	
Butylated hydroxy toluene	2257	
Butyraldehyde	2303	
Butyric acid	2853	

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C

Chemical	Dynacal designator	G-Cal designator
Caprylic acid	2862	
Carbon dioxide		738
Carbon disulfide	6300	
Carbon monoxide		704
Carbon tetrachloride	4203	724
Carbonyl sulfide	7600	714
Cellosolve acetate	3117	
Chlorine	0002	703
Chlorine trifluoride	0190	
Chloro acetyl chloride	7345	
α-Chloroacetophenone	7351	
p-Chloroacetophenone	7350	
Chlorobenzene	4400	
Chloroethane	4204	764
2-Choroethyl ether	7322	
2-Choroethyl ether sulfide	8010	
Chloroform	4202	786
Chloromethane	4200	765
Chloro methyl methyl ether	7320	
Chloroprene	4350	
1-Chloropropane	4213	
2-Chloropropane	4214	
1-Chloroproprene	4305	
2-Chloroproprene	4306	
3-Chloroproprene	4307	
α-Chlorotoluene	4416	
m-Chlorotoluene	4414	
o-Chlorotoluene	4413	
p-Chlorotoluene	4415	
Chrysene	1706	
Coronene	1713	
m-Cresol	2253	
o-Cresol	2252	

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p-Cresol	2254	
Crotonaldehyde	2352	
Cyclobutane	1001	
Cyclohexane	1003	725
Cyclohexanol	2160	
Cyclohexanone	2580	
Cyclohexylamine	5200	
Cyclopentane	1002	
Cyclopentanone	2578	
Cyclopropane	1000	
m-Cymene	1431	
p-Cymene	1432	

Top

D

Chemical	Dynacal designator	G-Cal designator
Decane	0571	
Deuterium chloride	0160d	
Deuterium oxide	0079	734
Diazinon		766
1,2,5,6-Dibenzanthracene	1709	
Diborane		799
1,4-Dibromobutane	4515	
Dibromodifluoromethane	4806	
Dibutyl sulfide	6212	726
Dibutyl tert-sulfide	6310	
1,2-Dichlorobenzene	4401	
1,3-Dichlorobenzene	4402	
1,4-Dichlorobenzene	4403	
1,1-Dichloro-2,2-difluoroethylene	4660	
1,1-Dichloroethane	4205	
1,2-Dichloroethane	4206	8011
1,2-Dichloroethene	4302	
cis-1,2-Dichloroethene	4302C	
trans-1,2-Dichloroethene	4302T	
1,1-Dichloroethylene	4301	
Dichlorodifluoromethane	4651	729

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Dichlorofluoromethane	4653	755
1,6-Dichlorohexane	4224	
Dichloromethane	4201	802
Dichloromethylether	7321	
1,5-Dichloropentane	4223	
1,1-Dichloropropane	4215	
1,2-Dichloropropane	4216	
1,3-Dichloropropane	4217	
1,1-Dichloropropene	4308	
1,2-Dichloropropene	4309	
cis-1,2-Dichloropropene	4309C	
trans-1,2-Dichloropropene	4309T	
1,3-Dichloropropene	4312	
cis-1,3-Dichloropropene	4312C	
trans-1,3-Dichloropropene	4312T	
Dicyclopentadiene	1220	
Diethanolamine	7419	
Diethyl amine	5051	
Diethyl disulfide	6302	709
Diethyl ethanolamine	7422	
Diethyl ether	2751	
Diethyl maleate	3180	
Diethyl mercury	0332	
Diethyl methyl phosphonate	7848	
Diethyl sulfide	6202	
Diethylene glycol	2210	
Diethylenetriamine	5061	
1,1-Difluoroethane	4004	
2,3-Dihydro perfluoropentane	4016	
Diisopropyl methyl phosphonate	7846	
Diisopropyl phosphite	7852	
Diisopropyl sulfide	6211	
Dimethyl amine	5050	
Dimethyl disulfide	6301	
Dimethyl ether	2750	
n,n-Dimethyl formamide	5415	733
Dimethyl mercury	0330	
Dimethyl methylphosphonate	7845	708

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2,2-Dimethyl-1-propanol	2015	
Dimethyl sulfide	6200	710
Dimethyl sulfone	7648	
Dimethyl sulfoxide	7610	
Dimethyl trisulfide	6304	
n,n-Dimethylacetamide	5416	
2,3-Dimethylbutane	0542	
1,2-Dimethylcyclohexane	1023	
n,n-Dimethylethanolamine	7421	
2,2-Dimethylhexane	0525	
2,3-Dimethylhexane	0527	
2,4-Dimethylhexane	0528	
2,5-Dimethylhexane	0529	
3,3-Dimethylhexane	0526	
3,4-Dimethylhexane	0530	
2,2-Dimethylpentane	0514	
2,3-Dimethylpentane	0515	
2,4-Dimethylpentane	0516	
3,3-Dimethylpentane	0517	
m-Dinitrobenzene	7451	
2,4-Dinitrotoluene	7464	
3,4-Dinitrotoluene	7465	
3,5-Dinitrotoluene	7466	
1,4-Dioxane	3516	
Diphenyl	1470	
Diphenylamine	5260	
Dipropyl sulfide	6210	
Dipropylene glycol methyl ether	2822	
4,4'-Dipyridyl	5710	
1,4-Dithiane	6308	
Ditnitrobenzene-1,3	7451	
Dodecane-n	0610	
tert-Dodecylmercaptan		100

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E

Chemical	Dynacal designator	G-Cal designator

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Enflurane	7310	
Epichlorohydrin	7340	
1,2-Epoxybutane	3502	
1,2-Epoxyhexane	9999	
Ethane	0501	874
Ethanol	2001	782
Ethanolamine	7418	
Ethenol	2100	
Ethyl acetate	3101	
Ethyl amine	5001	
Ethyl benzene	1405	806
3-Ethyl biphenyl	1472	
4-Ethyl biphenyl	1473	
n-Ethyldiethanolamine	7423	
o-Ethyl s-ethyl methyl phosphonothiolate	9210	
3-Ethyl hexane	0524	
2-Ethyl hexanol	2030	
Ethyl isopropyl sulfide	6206	
Ethyl mercaptan	6001	720
3-Ethyl pentane	0518	
Ethyl n-propyl ether	2802	
Ethyl n-propyl sulfide	6205	
Ethylene		713
Ethylene dibromide	4505	803
Ethylene glycol dimethyl ether	2820	
Ethylene glycol dinitrate	7840	
Ethylene oxide	3500	747
Ethylidene norbornene	9999	

Top

F

Chemical	Dynacal designator	G-Cal designator
Fluorene	1704	
1-Fluoro-2-iodobenzene	4955	
Fluoro benzene	4020	
Fluorinert FC-72	4076	
Fluorinert FC-84	4078	

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Fluorinert FC-104	4080	
Formaldehyde (para)	2300	794
Formamide	5400	
Formic acid	2850	
Freon-11	4650	755
Freon-13	4652	
Freon-13b1	4805	
Freon-22	4654	
Freon 113	4658	
Freon 114	4659	
Freon 123	4662	
2-Furaldehyde	2370	
Furan	3510	

Top

G

Chemical	Dynacal designator	G-Cal designator
Glutyraldehyde	2375	
Glycolic acid	2870	
Glyoxylic acid (50%)	2871	

Top

H

Chemical	Dynacal designator	G-Cal designator
Halothane	4910	
Heptanal	2309	
Heptane	0511	
Heptanoic acid	2861	
2-Heptanol	2025	
3-Heptanol	2028	
1-Heptene	0735	
Heptyl mercaptan	6025	
Hexachloro-1,3-butadiene	4352	
Hexachlorobenzene	4412	
Hexachloroethane	4212	

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n-Hexadecane	0660	
Hexafluoroethane	4663	
Hexamethyl disiloxane	9930	
Hexamethyl disilazane	9935	
Hexamethylene diisocyanate	7476	
Hexamethylene tetramine	5070	
Hexanal	2308	
trans-2-Hexanal	2312	
n-Hexane	0507	730
Hexanoic acid	2858	
1-Hexanol	2016	
2-Hexanol	2017	
3-Hexanol	2018	
2-Hexanone	2505	
3-Hexanone	2506	
1-Hexene	0726	
Hexyl mercaptan	6015	
Hydrobromic acid (48%)	0162	
Hydrochloric acid (20.2%)	0161	
Hydrogen bromide	0060	
Hydrogen chloride	0050	787
Hydrogen cyanide	5300	
Hydrogen fluoride	0040	761
Hydrogen sulfide	0110	700
Hydriodic acid	0164	
Hydroxy acetone	2520	
Hydroxy propyl acrylate	3147	

Top

I

Chemical	Dynacal designator	G-Cal designator
Indene	1703	
Indole	9999	
Iodine	0004	
Isobutane	0504	
Isobutanol	2006	795
Isobutyl mercaptan	6006	719

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Isobutyl nitrate	9999	
Isobutylene	0703	
2-Isocyanatoethyl methacrylate	7491	
Isoflurane	7311	
Isopentane	0506	
Isoprene	0705	
Isopropyl alcohol	2003	785
Isopropyl benzene	1414	
Isopropyl disulfide	6309	
Isopropyl ether	2753	
Isopropyl mercaptan	6003	722
Isopropyl nitrate	7470	
Isopropyl sulfonyl chloride	9700	
Isovaleric acid	2857	

Top

L

Chemical	Dynacal designator	G-Cal designator
Lactic acid	2881	
Lexsol	9999	
(r)-(+)-Limonene	1855	
Linalool	2261	

Top

M

Chemical	Dynacal designator	G-Cal designator
Maleic anhydride	3065	
Mercury	0030	
Mercury(I) chloride	0052	
Mercury(II) bromide	0056	
Mercury(II) chloride	0053	
Mesityl oxide	2600	
Methacrylic acid	2860	734
Methane	0500	707
Methanesulfonic acid	7645	

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Methanol	2000	796
Methyl acetate	3100	
Methyl acetylene		749
Methyl acrylate	3140	735
Methyl amine	5000	
2-methyl aminoethanol	7417	
Methyl bromide	4500	
2-Methyl-3-buten-2-ol	2110	
2-Methyl-1-butanol	2011	
2-Methyl-2-butanol	2013	
3-Methyl-1-butanol	2012	
3-Methyl-2-butanol	2014	
3-Methyl-2-butanone	2504	
Methyl t-butyl ether	2810	
Methyl butyl sulfide	6207	
Methyl sec-butyl sulfide	6208	
Methyl tert-butyl sulfide	6209	
Methyl carbitol	2830	
Methyl Cellosolve	2819	
Methyl Cellosolve® acetate	3115	
Methyl cholanthrene	1711	
Methyl ethyl ether	2800	
Methyl ethyl ketone	2501	851
2-Methyl-3-ethylpentane	0531	
3-Methyl-3-ethylpentane	0532	
Methyl ethyl sulfide	6201	746
Methyl formate	3150	
Methyl iodide	4600	759
Methyl isocyanate	7473	
Methyl isopropyl sulfide	6204	
Methyl mercaptan	6000	711
2-Methyl-2-pentanal	2307	
2-Methyl-2-pentenal	2306	
2-Methyl pentane	0508	
3-Methyl pentane	0509	
2-Methyl-1-pentanol	2019	
2-Methyl-2-pentanol	2022	
3-Methyl-1-pentanol	2020	

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3-Methyl-2-pentanol	2023
3-Methyl-3-pentanol	2027
4-Methyl-1-pentanol	2021
4-Methyl-2-pentanol	2024
2-Methyl-3-pentanone	2509
3-Methyl-2-pentanone	2507
4-Methyl-2-pentanone	2508
2-Methyl propanal	2304
2-Methyl-2-propanol	2007
Methyl n-propyl ether	2801
Methyl n-propyl sulfide	6203
Methyl pyrrolidone	7410
Methyl salicylate	3160
α-Methyl styrene	1501
2-Methyl thiophene	6611
Methyl vinyl ketone	2550
Morpholine	7440

Top

N

Chemical	Dynacal designator	G-Cal designator
Napthacene	1705	
Napthalene	1700	
Nickel carbonyl	0470	
Nitric acid (70%)	0160	
Nitric oxide		706
Nitrobenzene	7450	950
Nitrogen dioxide	0081	863
2-Nitrotoluene	7460	
3-Nitrotoluene	7461	
4-Nitrotoluene	7463	
Nitrous oxide	0084	767
Nonanal	2311	
n-Nonane	0538	
Nonanoic acid	2863	

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O

Chemical	Dynacal designator	G-Cal designator
Octafluorotoluene	4152	
Octanal	2310	
n-Octane	0520	
n-Octanethiol	6035	
1-Octanol	2032	
2-Octanol	2033	
Oxygen		758

Top

P

Chemical	Dynacal designator	G-Cal designator
Parathion		768
Pentacene	1708	
Pentachlorobenzene	4411	
Pentachloroethane	4211	
1,1,1,3,3-Pentachoropropane	9999	
n-Pentadecane	0655	
n-Pentanal	2305	
n-Pentane	0505	
1-Pentanol	2008	
2-Pentanol	2009	
3-Pentanol	2010	
2-Pentanone	2502	
3-Pentanone	2503	
1-Pentene	0710	
2-Pentene	0711	
n-Pentyl acetate	3108	
Perfluoro-1,3-dimethylcyclohexane	4052	
Perfluoro cyclobutane	4664	
Perfluoro cyclopentane	4048	
Perfluoro cyclohexyl sulfur pentafluoride	8050	
Perfluoro decalin	4056	
Perfluoro dimethylcyclobutane	4047	

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Perfluoro isobutylene	4040	
Perfluoro methylcyclohexane	4050	
Perfluoro(methylcyclopentane)	4049	
Perylene	1712	
Phenanthrene	1702	
Phenethyl alcohol	2256	
Phenol	2250	
Phenyl ether	2825	
Phosgene	7301	789
Phosphine		763
Phthalic anhydride	3070	
Picene	1710	
Pinacolone	2511	
Pinacolyl methylphosphonate	7847	
(+)-α-Pinene	1850	
(-)-β-Pinene	1851	
Propane	0502	712
1,2-Propanediol	2201	
i-Propanenitrile	5303	
n-Propanenitrile	5302	
Propanol	2002	
Propionaldehyde	2302	
Propionic acid	2852	
Propyl amine	5002	
n-Propyl ether	2752	
Propyl mercaptan	6002	721
Propylene	0700	751
Propylene glycol methyl ether	2821	
Propylene oxide	3501	800
Pyrene	1707	
Pyridine	5703	
Pyrrole	5700	

Top

S

Chemical	Dynacal designator	G-Cal designator
Selexol	2212	

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Silane		797
Silicon tetrachloride		780
Skatole	9999	
Styrene	1500	
Styrene oxide	3600	
Sulfur dioxide	0082	702
Sulfur hexaflouride	0045	740
Sulfur trioxide	0083	
Sulfuric acid	0163	
Sulfuryl chloride	0181	
Sulfuryl fluoride	0182	

Top

T

Chemical	Dynacal designator	G-Cal designator
1,2,3,4-Tetrachlorobenzene	4408	
1,2,3,5-Tetrachlorobenzene	4409	
1,2,4,5-Tetrachlorobenzene	4410	
1,1,1,2-Tetrachloroethane	4209	
1,1,2,2-Tetrachloroethane	4210	
Tetrachloroethylene	4304	804
1,1,2,3-Tetra chloro-1-propene	4321	
1,1,2,3-Tetra chloro-2-propene	4322	
Tetrachlorosilane	9914	775
n-Tetradecane	0640	
1,1,1,2-Tetraflouroethane	4005	
Tetrahydrofuran	3511	769
1,2,4,5-Tetramethylbenzene	1417	
2,2,3,3-Tetramethylbutane	0537	
Tetramethyllead	0380	
Tetramethyltin	0340	
Thionyl chloride	0180	
Thiophane	6602	741
Thiophene	6600	790
1,4-Thioxane	7660	
Titanium tetrachloride	9951	
Toluene	1401	731

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Toluene-D8	1401D	731D
Toluene-2,4-diisocyanate	7480	
Toluene-2,6-diisocyanate	7481	
1,2,3-Trichlorobenzene	4404	
1,2,4-Trichlorobenzene	4405	
1,3,4-Trichlorobenzene	4406	
1,3,5-Trichlorobenzene	4407	
2,3,4-Trichlorobutene	4335	
1,1,1-Trichloroethane	4207	492
1,1,2-Trichloroethane	4208	
Trichloroethylene	4303	752
1,1,1-Trichloropropane	4218	
1,1,2-Trichloropropane	4219	
1,1,3-Trichloropropane	4220	
1,2,2-Trichloropropane	4221	
1,2,3-Trichloropropane	4222	
1,1,2-Trichloropropene	4315	
1,1,3-Trichloropropene	4316	
1,2,3-Trichloropropene	4317	
1,1,3-Trichloro-2-propene	4320	
Trichlorosilane	9913	
n-Tridecane	0625	
Triethanolamine	7420	
Triethyl amine	5101	
Triethyl phosphate	7850	
Triethyl phosphite	7851	
Triethylene glycol	2211	
Trifluoroacetic acid	7360	
Trimethyl amine	5100	
1,2,4-Trimethylbenzene	1410	
1,3,5-Trimethylbenzene	1409	
2,2,3-Trimethylbutane	0519	
2,2,3-Trimethylpentane	0534	
2,2,4-Trimethylpentane	0535	
2,3,3-Trimethylpentane	0533	
2,3,4-Trimethylpentane	0536	
Trimethyl phosphate	9999	
2,4,6-Trinitrotoluene	7467	

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Trioxane	3520
Tungsten hexafluoride	0046

Top

U

Chemical	Dynacal designator	G-Cal designator
Undecane	0590	

Top

V

Chemical	Dynacal designator	G-Cal designator
Valeric acid	2856	
Vinyl acetate	3120	736
Vinyl bromide	4525	
Vinyl chloride	4300	805

Top

W

Chemical	Dynacal designator	G-Cal designator
Water	0080	

Top

X

Chemical	Dynacal designator	G-Cal designator
m-Xylene	1403	777
o-Xylene	1402	808
p-Xylene	1404	809
m-Xylylene diisocyanate	7484	

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VICI® Valco Instruments Co. Inc.
VICI AG International

CALIBRATION GAS STANDARDS



Quotation Form for Permeation Devices

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Overview
Permeation tubes
- Dynacal®
- G-Cal
Calibration gas generators

* indicates a required field.

Does this device need to be certified? Yes No

Device type: *

Dynacal
G-Cal
Don't know

Upper temperature limit? *

No
Yes

Lower temperature limit? * (NOTE: Must be 5°C above amibient for Dynacal devices)

No
Yes

Calibrator that permeation device will be used in: *

Dynacalibrator
Other

*Chemical(IUPAC name and/or CAS number)

*Min. concentration in: ppm ppb ng/min

Max. concentration

Company name

*Your name

*Your country

*E-mail address

*Phone number

Fax number

MORE INFORMATION

- Permeation devices vs. bottled trace level standards
- Partial list of available compounds
- Technical Note 1001: Generating Calibration Gas Standards with Dynacal® Permeation Devices
- Technical Note 1002: Generating a Part Number for a Dynacal® Permeation Device

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VICI Metronics Inc.

Generating Calibration Gas Standards

with Dynacal® Permeation Devices

Permeation devices provide an excellent method of producing known gas concentrations in the PPM and PPB level for calibration of analytical instrumentation. The basic requirement of any calibration system is to maintain the permeation device at a constant temperature in a known carrier flow. When the permeation rate at that temperature and the dilution flow rate are known, the concentration of the calibration stream can be calculated.

Calibration Systems

Basic U-Tube Holder

A simple calibration system can be assembled utilizing an existing constant temperature water bath and a simple "U" tube holder (**Figure 1**), which can be made or purchased. An external pump is required to provide a carrier flow through the calibration chamber, with the total dilution flow adjusted so that there is an excess of calibration gas furnished to the analyzer inlet. For example, if 200 cc/min meets the required sample flow, the *minimum* dilution flow for generating the calibration stream is 200 cc/min plus 20-50% excess (240 ~ 300 cc/min). Increasing the total dilution flow to 3000 cc/min gives a dynamic range of 1 to 10.

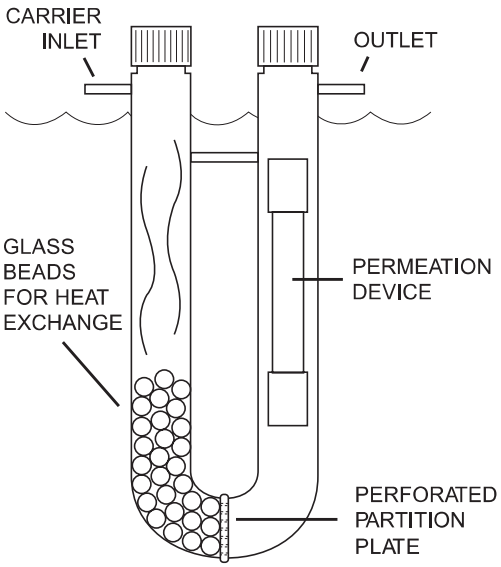


Figure 1: Simple U-tube holder

Calibration Instruments

For easier operation and greater precision, use one of our Dynacalibrators® or assemble an instrument with the following features (**Figure 2**):

1. A constant temperature chamber with 0.05°C temperature control
2. Fixed carrier flow through the chamber
3. Additional dilution air which can be adjusted to give a 10:1 dilution
4. An overflow outlet for excess gas
5. Valve, calibration chamber, and sample line surfaces of glass, stainless, or Teflon.®

Additional System Considerations

Minimization of Pressure Variations

Since some analyzers are sensitive to the variations in pressure which can occur when dilution flows are changed, a "T" connection must be inserted between the calibration system and the analyzer to vent the excess calibration gas. Pressure variations can be further minimized by connecting the analyzer probe line perpendicular to the span gas flow. If problems persist in spite of these precautions, feed the calibration gas into a larger diameter tube or gas mixing bulb, with the analyzer probe inserted into the larger tube or bulb.

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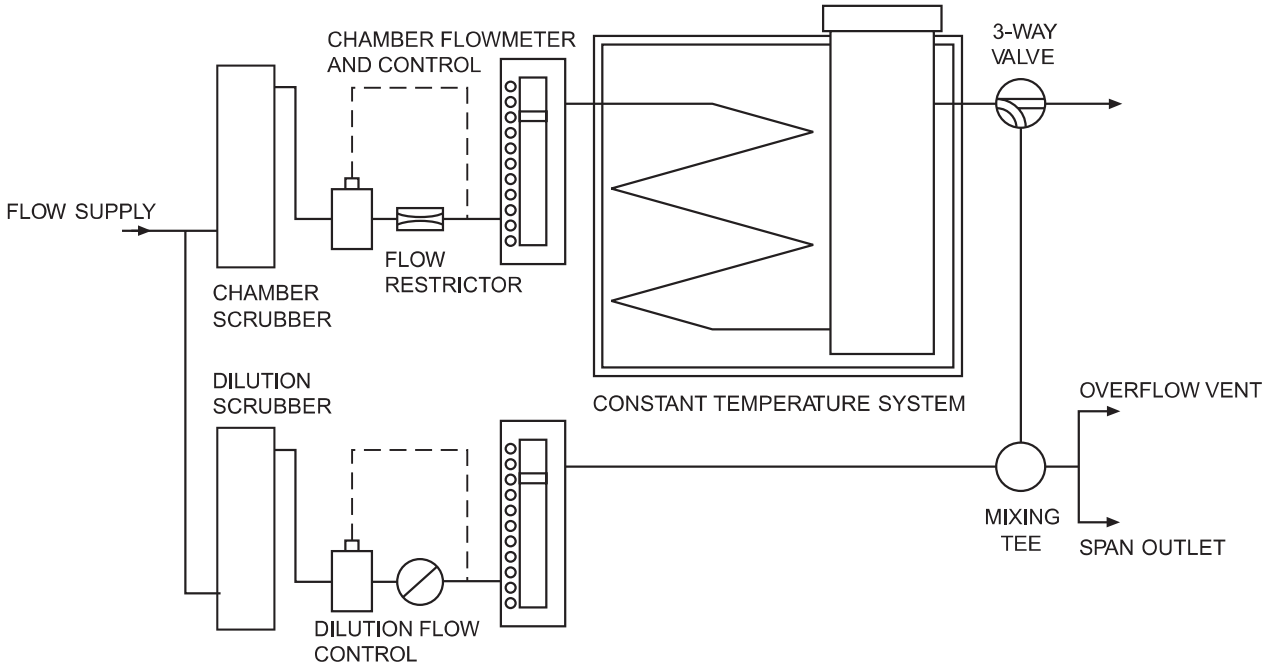


Figure 2: Schematic of Basic System

Special Carrier Flow Requirements

If the chemical fill of the permeation device is subject to deterioration upon exposure to substances in the carrier flow, special scrubbers or carrier gases should be used. For example, NO_2 and CL_2 permeation devices require a dry carrier stream – any moisture in the system will build up on the tube surface and form corrosive deposits on the stainless steel crimp band under the label. Hydrogen sulfide devices should be operated in a flow of nitrogen for best long-term stability. Otherwise, oxygen from the air will back-diffuse into the tube, reacting with the H_2S and depositing sulfur in the tube wall. The observed effect is a gradual rate increase leading to premature failure.

Permeation Device Characteristics and Limitations

Equilibration

Prior to their use, permeation devices should be conditioned at the calibration temperature and carrier flow to bring the rate to its equilibrium value. Most devices require 30 minutes to 3 hours to reach equilibrium. Heavy wall tubes, low vapor pressure compounds, and halogenated compounds typically take longer. The best procedure is to set up the calibration system the day before it is needed, allowing the system to equilibrate overnight. Conduct repeated tests over a period of time to insure that equilibrium has been achieved.

Lifetime

The formulas at right are based on the assumption that the devices have a 75% liquid fill and that the chemical fill is stable under the conditions used. “Rate” is the permeation rate in ng/min per cm, ρ is the liquid specific gravity at the control temperature (for an approximate calculation, assume $\rho = 1$), and L is the active length in cm.

Device type	Lifetime in months
High emission tubular	[5600/rate] x ρ
Standard emission tubular	[1400/rate] x ρ
Low emission tubular	[3125/rate] x ρ
Extended life tubular	[23000/(rate x L)] x ρ
Wafer	[11000/rate] x ρ

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Temperature Limitations
The temperature is usually limited by the control instrument, but the permeation devices have limits as well. Temperatures which create vapor pressures in excess of the following cannot be used:

Device type	Pressure limit
High emission tubular (1/4" OD x .030" wall)	70 psi
Standard emission tubular (1/8" OD x .030" wall)	200 psi
Low emission tubular (3/8" OD x .090" wall)	300 psi
Wafer (.030" thickness)	450 psi
Wafer (.050" thickness)	700 psi

Caution:

The limits in the table above are guidelines only – use them with caution. The strength of Teflon decreases as the temperature increases, so greater safety factors should be used.

Rate Change with Temperature
To estimate the permeation rate at a different temperature when you know the rate at a given temperature, use this rule of thumb: each 1°C increase in temperature increases the rate by 10%. For a precise calculation, use this equation:

$$\text{Log } P_1 = \log P_0 + \alpha\,(T_1 - T_0)$$

where P_0 = Rate at temp T_0 (°C), P_1 = New rate at temp T_1 (°C), and α = the temperature coefficient (0.030 for high emission tubes, 0.034 for standard emission tubes).

CAUTION:

Do not use temperatures which would produce a pressure greater than the limits listed in the table above.

Size Limitations
Once again, the limitation is usually with the device holder. Few systems can accomodate tubes longer than 20 cm, or more than 3 tubes. Check the overall length and inside diameter of the permeation device holder. If a desired rate requires a tube too long to fit it, the options are: higher temperature, multiple tubes, lower dilution flow, or diffusion tubes.

Device type	Active length	Total length	Max. diameter
Standard emission	0.5 to 20 cm	add 3.5 cm	0.64 cm
High emission	0.5 to 20 cm	add 3.5 cm	0.98 cm
Low emission	1.0 or 2.0 cm	3.7 cm	0.98 cm
Low emission #2	1 to 15 cm	add 3.5 cm	0.98 cm
XLT	0.2 to 10 cm	add 9.5 cm	0.64 cm
XLT #2, #3	0.2 to 10 cm	add 7.3 cm	0.98 cm
Wafer	.030 - .090" thick	4.6 cm	1.60 cm

Critical Temperature Limitations
The device must maintain a two phase equilibrium at above room temperature. This eliminates the use of chemicals with a critical temperature below room temperature, such as CO, NO, and methane.

Output Limitations
It is difficult to achieve high PPM concentrations at flows over 1 L/min.

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Frequently-Asked Questions

"Does the permeation rate go down as the amount of liquid decreases?"
No. As long as there is any liquid remaining in the device, there will be a two-phase equilibrium with a constant internal vapor pressure.

"Does the permeation rate change with a change of external pressure?"
No. The permeation rate does not change with altitude or external atmospheric pressure changes. The partial pressure of the chemical at the outer wall or membrane surface is assumed to be zero – a valid assumption when the tube is in a chamber with a purge flow. The permeation rate is a function of the pressure gradient of the chemical fill from the inside to the outside surface. There would have to be a relatively high concentration around the tube before the pressure gradient would change to the extent that a rate change would be detectable.

"Does tube orientation make a difference?"
No. Vapor pressure and solubility of the chemical in the permeable membrane are affected only by temperature. They do not change as a function of liquid/surface contact area.

Calculations

Concentration

Concentrations are ex ressed both in mass per unit volume and parts per unit volume (PPM or PPB). Since the volume of a gas varies with the temperature and pressure, standard conditions must be used in the computation and comparison of pollutant concentrations. Reference conditions are defined as 25°C and 760 mm Hg (1013.2 MB). To compute the concentration of a calibration gas generated by a permeation tube in a dynamic carrier flow, use the following equation:

$$C = \frac{P \times \left(\frac{24.46}{mw}\right)}{F_C}$$

where C = the concentration in PPM by volume, P = the permeation rate in ng/min, mw = the molecu lar weight of the pollutant gas, F_C = the total flow of the calibration mixture in cc/min, corrected to the reference conditions defined above (see next section). The constant 24.46 is the molar volume at the reference conditions.

Correcting the Flow Rate

If necessary, correct the flow rate to the reference conditions with the following equation:

$$F_c = F_m \left(\frac{P}{760}\right) \times \left(\frac{298}{(t + 273)}\right)$$

where F_C = the flow rate at the reference conditions, F_m = the measured flow rate, and t = the temperature in °C. *Note:* the measured conditions are those pertinent to the flow measuring device,not to the chamber where the permeation tube is held.

Many types of flow measuring devices are used to determine flow rate, and the specific type should be considered when applying temperature and pressure corrections. For positive displacement types such as bubble flowmeters and wet or dry test meters, the standard corrections are used. However, for rotameters that use a floating ball, a different flow principle is involved. The height of the ball in the flowmeter is a function of the gas density, viscosity, and momentum. For air, the following equation is used to correct the measured flow to standard conditions:

$$F_c = F_m \sqrt{\frac{P}{760} \times \frac{298}{(t + 273)}} = 0.626\ F_m \sqrt{\frac{P}{T}}$$

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where F_C = the flow rate at the reference conditions of 25°C and 760 mm Hg and F_m = the indicated flow at the observed temperature (t°C) and pressure (P mm Hg).

Sample Problem

What PPM concentration is being generated in this scenario?

An H_2S analyzer is located in an instrument shelter at 5000' elevation. The shelter temperature is 15°C. The permeation tube source is a 4 cm certified tube maintained at 30°C, with a rate of 2050 ng/min. A flow of 200 ml/min is passing into the constant temperature chamber, which is further diluted with a flow of 2000 ml/min dilution air. Both flows are measured with a flow metering device that is in equilibrium at the shelter temperature.

The first step is to correct the flow rate to the reference conditions. If a barometer is not available, the pressure at the particular elevation in the U. S. Standard Atmosphere can be used for a suitable approximation:

$$P = 760\left(1 - \frac{.0065Z}{945}\right)^{5.2568}$$

or, 632 mm Hg at 5000 feet, where Z = altitude in feet and P = pressure in mm Hg. Plugging this value into the equation for correcting the flow gives:

$$F_C = (2000 + 200)\left(\frac{632}{760}\right) \times \frac{298}{(15 + 273)}$$

or, 1893 ml/min at 25°C and 760 mm Hg. Now we can plug the values into the formula for determining concentration:

$$C = \frac{(2050)\left(\frac{24.46}{34}\right)}{1893}$$

or, 0.78 ppm.

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