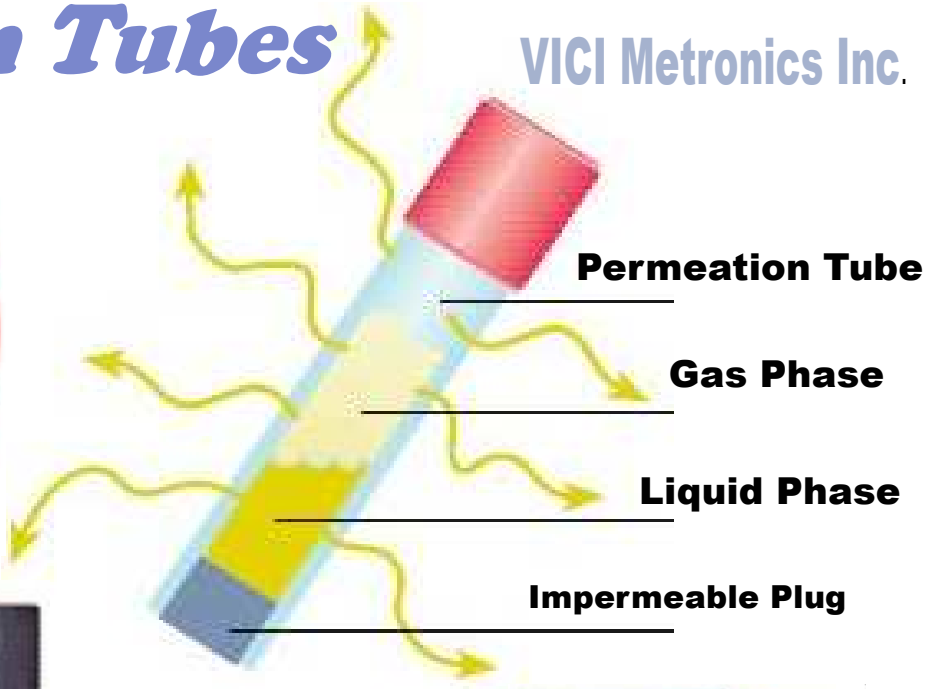
Permeation Tubes

VICI Metronics Inc.



G-Cal Devices

G-Calibrator

Dynacalibrators

Gas Standards

2nd Source TO-14A/TO-15 Gas Calibration Standards

- Standards from TWO manufacturers provide second source on one order.
- 12 month stability in transportable cylinders.
- Drop shipped for fast delivery and maximum shelf life.

A. Spectra (Linde) 104L Cylinders

B. Scotty (Air Liquide) 110L Cylinders (Pi-marked Cylinders for EU Regulations)

For regulators,

RESTEK

DCG Partnership Cylinders:
Size: 7.6 x 24 cm
CGA-170/110 connection.
US DOT Specs: DOT-4B-240ET

Mini-Regulator

Scotty® (Air Liquide) 14
Contents: 14 liters
Pressure: 240 psig (17 bar)
Outlet Fitting: CGA 160
Weight: 1.5 lbs/0.7 kg
Dimensions: 3" diameter x 11" height (7.6 x 28 cm)
DOT Specifications: 4B240

Scotty® (Air Liquide) 48
Contents: 48 liters
Pressure: 300 psig (21 bar)
Outlet Fitting: CGA 165
Weight: 17.5 lbs/0.8 kg
Dimensions: 4" diameter x 16¼" height (10.2 x 41 cm)
DOT Specifications: 3AA

Spectra Gas / Linde

Scott Gas / Air Liquide

DCG-Gases

Environmental Air Monitoring Gas Standards

Our high-quality air monitoring gas calibration standards are provided by Spectra/Linde and Scott/Air Liquide—meeting lab requirements for two separate sources of calibration standards. Mixes are produced gravimetrically using NIST (National Institute of Science and Technology) traceable weights. Each comes with a Certificate of Analysis and unique serial number. All cylinders are disposable and do not require rental or demurrage fees. Recertification of cylinders is available directly with our suppliers. All cylinders are drop-shipped from our suppliers to provide fast delivery and the "freshest" standard possible. 12-month stability on all cylinders unless otherwise specified.

TO-14A Calibration Mix (39 components)

benzene
bromomethane
carbon tetrachloride
chlorobenzene
chloroform
chloromethane
1,2-dibromoethane
m-dichlorobenzene
o-dichlorobenzene
p-dichlorobenzene
dichlorodifluoromethane
1,1-dichloroethane
1,2-dichloroethane
1,1-dichloroethene
cis-1,2-dichloroethene
1,2-dichloropropane
cis-1,3-dichloropropene
trans-1,3-dichloropropene
dichlorotetrafluoroethane
ethyl benzene
ethyl chloride
hexachloro-1,3-butadiene
methylene chloride
styrene
1,1,2,2-tetrachloroethane
tetrachloroethylene
toluene
1,2,4-trichlorobenzene
1,1,1-trichloroethane
1,1,2-trichloroethane
trichloroethene
trichlorofluoromethane
1,1,2-trichlorotrifluoroethane
1,2,4-trimethylbenzene
1,3,5-trimethylbenzene
vinyl chloride
m-xylene
o-xylene
p-xylene

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34400 (ea.)

100ppb in nitrogen, 104 liters @ 1,800psi
cat. # 34421 (ea.)

1ppm in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34400-PI (ea.)

100ppb in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34421-PI (ea.)

TO-14A 41 Component Mix (41 components)

acrylonitrile
benzene
bromomethane
1,3-butadiene
carbon tetrachloride
chlorobenzene
chloroform
chloromethane
1,2-dibromoethane
m-dichlorobenzene
o-dichlorobenzene
p-dichlorobenzene
dichlorodifluoromethane
1,1-dichloroethane
1,2-dichloroethane
1,1-dichloroethene
cis-1,2-dichloroethene
1,2-dichloropropane
cis-1,3-dichloropropene
trans-1,3-dichloropropene
dichlorotetrafluoroethane
ethyl benzene
ethyl chloride
hexachloro-1,3-butadiene
methylene chloride
styrene
1,1,2,2-tetrachloroethane
tetrachloroethylene
toluene
1,2,4-trichlorobenzene
1,1,1-trichloroethane
1,1,2-trichloroethane
trichloroethene
trichlorofluoromethane
1,1,2-trichlorotrifluoroethane
1,2,4-trimethylbenzene
1,3,5-trimethylbenzene
vinyl chloride
m-xylene
o-xylene
p-xylene

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34430 (ea.)

1ppm in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34430-PI (ea.)

100ppb in nitrogen, 104 liters @ 1,800psi
cat. # 34431 (ea.)

100ppb in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34431-PI (ea.)

TO-14A 43 Component Mix (43 components)

acrylonitrile
benzene
bromomethane
1,3-butadiene
carbon tetrachloride
chlorobenzene
chloroform
chloromethane
3-chloropropene
1,2-dibromoethane
m-dichlorobenzene
o-dichlorobenzene
p-dichlorobenzene
dichlorodifluoromethane
1,1-dichloroethane
1,2-dichloroethane
1,1-dichloroethene
cis-1,2-dichloroethene
1,2-dichloropropane
cis-1,3-dichloropropene
trans-1,3-dichloropropene
dichlorotetrafluoroethane
ethyl benzene
ethyl chloride
4-ethyltoluene
hexachloro-1,3-butadiene
methylene chloride
styrene
1,1,2,2-tetrachloroethane
tetrachloroethylene
toluene
1,2,4-trichlorobenzene
1,1,1-trichloroethane
1,1,2-trichloroethane
trichloroethene
trichlorofluoromethane
1,1,2-trichlorotrifluoroethane
1,2,4-trimethylbenzene
1,3,5-trimethylbenzene
vinyl chloride
m-xylene
o-xylene
p-xylene

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34432 (ea.)

1ppm in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34432-PI (ea.)

100ppb in nitrogen, 104 liters @ 1,800psi
cat. # 34433 (ea.)

100ppb in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34433-PI (ea.)

please **note**

Gas standards are subject to hazardous materials shipping fees by most freight carriers. All calibration gas standards are nonreturnable due to DOT hazardous shipping requirements.

2nd Source TO-14A/TO-15 Gas Calibration Standards

- Standards from TWO manufacturers provide second source on one order.
- 12 month stability in transportable cylinders.
- Drop shipped for fast delivery and maximum shelf life.

A. Spectra (Linde) 104L Cylinders

B. Scotty (Air Liquide) 110L Cylinders (Pi-marked Cylinders for EU Regulations)

For regulators, see page 433.

For more available gas standards, visit **www. restek.com/air**

Gas Calibration Standards

TO-14A GC/MS Tuning Mix

4-bromofluorobenzene

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34406 (ea.)

1ppm in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34406-PI (ea.)

100ppb in nitrogen, 104 liters @ 1,800psi
cat. # 34424 (ea.)

100ppb in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34424-PI (ea.)

TO-14A Aromatics Mix (14 components)

benzene
chlorobenzene
m-dichlorobenzene
o-dichlorobenzene
p-dichlorobenzene
ethyl benzene
styrene
toluene
1,2,4-trichlorobenzene
1,2,4-trimethylbenzene
1,3,5-trimethylbenzene
m-xylene
o-xylene
p-xylene

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34404 (ea.)

1ppm in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34404-PI (ea.)

100ppb in nitrogen, 104 liters @ 1,800psi
cat. # 34423 (ea.)

100ppb in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34423-PI (ea.)

TO-14A Chlorinated Hydrocarbon Mix (19 components)

carbon tetrachloride
chloroform
1,1-dichloroethane
1,2-dichloroethane
1,1-dichloroethene
cis-1,2-dichloroethylene
1,2-dichloropropane
cis-1,3-dichloropropene
trans-1,3-dichloropropene
ethyl chloride
hexachloro-1,3-butadiene
methyl chloride
methylene chloride
1,1,2,2-tetrachloroethane
tetrachloroethylene
1,1,1-trichloroethane
1,1,2-trichloroethane
trichloroethene
vinyl chloride

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34402 (ea.)

1ppm in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34402-PI (ea.)

100ppb in nitrogen, 104 liters @ 1,800psi
cat. # 34422 (ea.)

100ppb in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34422-PI (ea.)

TO-14A Internal Standard Mix (3 components)

bromochloromethane
chlorobenzene-d5
1,4-difluorobenzene

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34412 (ea.)

1ppm in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34412-PI (ea.)

100ppb in nitrogen, 104 liters @ 1,800psi
cat. # 34427 (ea.)

100ppb in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34427-PI (ea.)

TO-14A Internal Standard/Tuning Mix (4 components)

bromochloromethane
1-bromo-4-fluorobenzene
(4-bromofluorobenzene)
chlorobenzene-d5
1,4-difluorobenzene

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34408 (ea.) $690

1ppm in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34408-PI (ea.)

100ppb in nitrogen, 104 liters @ 1,800psi
cat. # 34425 (ea.)

100ppb in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34425-PI (ea.)

TO-15 Subset 25 Component Mix (25 components)

acetone
allyl chloride
benzyl chloride*
bromodichloromethane
bromoform
1,3-butadiene
2-butanone (MEK)
carbon disulfide*
cyclohexane
dibromochloromethane
trans-1,2-dichloroethene
1,4-dioxane
ethyl acetate
4-ethyltoluene
heptane
hexane
2-hexanone (MBK)
4-methyl-2-pentanone
methyl *tert*-butyl ether (MTBE)
2-propanol
propylene
tetrahydrofuran
2,2,4-trimethylpentane
vinyl acetate
vinyl bromide

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34434 (ea.)

1ppm in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34434-PI (ea.)

100ppb in nitrogen, 104 liters @ 1,800psi
cat. # 34435 (ea.)

100ppb in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34435-PI (ea.)

*Stability of this compound cannot be guaranteed.

TO-15 65 Component Mix (65 components)

acetone
acrolein
benzene
benzyl chloride*
bromodichloromethane
bromoform
bromomethane
1,3-butadiene
2-butanone (MEK)
carbon disulfide*
carbon tetrachloride
chlorobenzene
chloroethane
chloroform
chloromethane
cyclohexane
dibromochloromethane
1,2-dichlorobenzene
1,3-dichlorobenzene
1,4-dichlorobenzene
1,1-dichloroethane
1,2-dichloroethane
1,1-dichloroethene
cis-1,2-dichloroethene
trans-1,2-dichloroethene
1,2-dichloropropane
cis-1,3-dichloropropene
trans-1,3-dichloropropene
1,4-dioxane
ethanol*
ethyl acetate
ethyl benzene
ethylene dibromide
(1,2-dibromoethane)
4-ethyltoluene
trichlorofluoromethane (Freon 11)
dichlorodifluoromethane (Freon 12)
1,1,2-trichloro-1,2,2-trifluoroethane
(Freon 113)
1,2-dichlorotetrafluoroethane
(Freon 114)
heptane
hexachloro-1,3-butadiene
hexane
2-hexanone (MBK)
4-methyl-2-pentanone (MIBK)
methylene chloride
methyl *tert*-butyl ether (MTBE)
methyl methacrylate
naphthalene
2-propanol
propylene
styrene
1,1,2,2-tetrachloroethane
tetrachloroethene
tetrahydrofuran
toluene
1,2,4-trichlorobenzene
1,1,1-trichloroethane
1,1,2-trichloroethane
trichloroethene
1,2,4-trimethylbenzene
1,3,5-trimethylbenzene
vinyl acetate
vinyl chloride
m-xylene
o-xylene
p-xylene

Now with Naphthalene!

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34436 (ea.)

1ppm in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34436-PI (ea.)

100ppb in nitrogen, 104 liters @ 1,800psi
cat. # 34437 (ea.)

100ppb in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34437-PI (ea.)

*Stability of this compound cannot be guaranteed.

TO-14A/TO-15/TO-17 Performance Test Standard

Restek is pleased to offer the Performance Testing/VOC Audit Sample Program in cooperation with Spectra/Linde. This is an on-going testing program in which laboratories, and/or other users of VOC standards, are able to evaluate their own capabilities, as well as compare their results and accuracy against other laboratories. As a participant in the program, you will receive a disposable cylinder, directly from Spectra/Linde, containing multiple unknown TO-14A/TO-15 components at varying concentrations that are to be identified, quantified, and reported via the Spectra/Linde P-T Audit Program forms. The results will be published and distributed for peer review. To ensure confidentiality, all participating laboratories will be anonymous, and only the individual laboratory will know their own results. To provide statistical analysis, the audit sample will be shipped to all laboratories at the same time, once a year during the fourth quarter.

cylinder **design**

Performance Test Standard

Size: 5A disposable (3.2" x 12")
Volume/Pressure: 150L @ 1,800 psig
CGA 180 outlet fitting
Weight: 2.2 lbs

150 liters @ 1,800psig
cat. # 34560 (ea.) $1040

BTEX Gas Mix (6 components)

benzene, ethylbenzene, toluene, *m*-xylene, *o*-xylene, *p*-xylene

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34414 (ea.)

1ppm in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34414-PI (ea.)

100ppb in nitrogen, 104 liters @ 1,800psi
cat. # 34428 (ea.)

100ppb in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34428-PI (ea.)

BTEX and MTBE Gas Mix (7 components)

benzene, ethylbenzene, methyl *tert*-butyl ether (MTBE), toluene, *m*-xylene, *o*-xylene, *p*-xylene

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34541 (ea.)

1ppm in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34541-PI (ea.)

100ppb in nitrogen, 104 liters @ 1,800psi
cat. # 34542 (ea.)

100ppb in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34542-PI (ea.)

Higher Concentration = MORE STANDARD for your money!

Sulfur 5-Component Mix (5 components)

12-month stability. +/- 10% accuracy.

carbonyl sulfide, dimethyl sulfide, ethyl mercaptan, hydrogen sulfide, methyl mercaptan

1ppm in nitrogen, 110 liters @ 1,800psi
cat. # 34561 (ea.)

1ppm in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34561-PI (ea.)

Massachusetts APH Mix (26 components)

Now with Naphthalene!

benzene, 1,3-butadiene, butylcyclohexane, cyclohexane, *n*-decane, 2,3-dimethylheptane, 2,3-dimethylpentane, *n*-dodecane, ethylbenzene, *n*-heptane, *n*-hexane, isopentane, isopropylbenzene, *p*-isopropyltoluene, methyl *tert*-butyl ether, 1-methyl-3-ethylbenzene, naphthalene, *n*-nonane, *n*-octane, toluene, 1,2,3-trimethylbenzene, 1,3,5-trimethylbenzene, *n*-undecane, *o*-xylene, *m*/*p*-xylene (combined)

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34540 (ea.)

140-450ppb in nitrogen, 90 liters @ 1,500psig (Pi-marked Cylinder)
cat. # 34540-PI (ea.)

Japan Calibration Mix (9 components)

acrylonitrile, benzene, 1,3-butadiene, chloroform, 1,2-dichloroethane, dichloromethane, tetrachloroethylene, trichloroethylene, vinyl chloride

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34418 (ea.)

1ppm in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34418-PI (ea.)

cylinder **design**

Spectra (Linde) 104L Cylinders:

Aluminum construction
Size: 8 x 24 cm
Volume/Pressure: 104 liters of gas @ 1,800 psi
CGA-180 outlet fitting.
Weight: 1.5 lbs/0.7 kg

Scotty (Air Liquide) 110L Cylinders (Pi-marked Cylinders for EU Regulations):

Aluminum construction
Size: 8.3 x 29.5 cm
Volume/Pressure: 110 liters of gas @ 1,800 psi
CGA-180 outlet fitting.
Weight: 2.2 lbs/1 kg
US DOT Specs: 3AL2216

See page 433 for regulators.

did you **know**?

Pi-marked Gas Cylinders for EU Countries

Our Pi-marked gas standards from Scott/Air Liquide meet the requirements of the Transportable Pressure Equipment Directive (TPED) implemented in 2001 that regulates the safe transport of pressurized containers used throughout the European community.

please **note**

Gas standards are subject to hazardous materials shipping fees by most freight carriers. All calibration gas standards are nonreturnable due to DOT hazardous shipping requirements.

Gas Calibration Standards

Ozone Precursor Mixture/PAMS (57 components)

acetylene	isopropylbenzene
benzene	methylcyclohexane
n-butane	methylcyclopentane
1-butene	2-methylheptane
cis-2-butene	3-methylheptane
trans-2-butene	2-methylhexane
cyclohexane	3-methylhexane
cyclopentane	2-methylpentane
n-decane	3-methylpentane
m-diethylbenzene	*n*-nonane
p-diethylbenzene	*n*-octane
2,2-dimethylbutane	*n*-pentane
2,3-dimethylbutane	1-pentene
2,3-dimethylpentane	*cis*-2-pentene
2,4-dimethylpentane	*trans*-2-pentene
n-dodecane	propane
ethane	*n*-propylbenzene
ethylbenzene	propylene
ethylene	styrene
m-ethyltoluene	toluene
o-ethyltoluene	1,2,3-trimethylbenzene
p-ethyltoluene	1,2,4-trimethylbenzene
n-heptane	1,3,5-trimethylbenzene
n-hexane	2,2,4-trimethylpentane
1-hexene	2,3,4-trimethylpentane
isobutane	*n*-undecane
isopentane	*o*-xylene
isoprene	*m*/*p*-xylene (combined)

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34420 (ea.)

1ppm in nitrogen, 30 liters @ 500psi (Pi-marked Cylinder)
cat. # 34420-PI (ea.)

100ppb in nitrogen, 104 liters @ 1,800psi
cat. # 34429 (ea.)

100ppb in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34429-PI (ea.)

Ozone Precursor/PAMS Mix

(57 components at EPA concentrations: ppbC)

acetylene	40	isopropylbenzene	40
benzene	30	methylcyclohexane	30
n-butane	40	methylcyclopentane	25
1-butene	30	2-methylheptane	25
cis-2-butene	35	3-methylheptane	25
trans-2-butene	25	2-methylhexane	25
cyclohexane	40	3-methylhexane	25
cyclopentane	20	2-methylpentane	20
n-decane	30	3-methylpentane	40
m-diethylbenzene	40	*n*-nonane	25
p-diethylbenzene	25	*n*-octane	30
2,2-dimethylbutane	40	*n*-pentane	25
2,3-dimethylbutane	50	1-pentene	25
2,3-dimethylpentane	50	*cis*-2-pentene	35
2,4-dimethylpentane	40	*trans*-2-pentene	25
n-dodecane	40	propane	40
ethane	25	*n*-propylbenzene	30
ethylbenzene	25	propylene	25
ethylene	20	styrene	40
m-ethyltoluene	25	toluene	40
o-ethyltoluene	30	1,2,3-trimethylbenzene	25
p-ethyltoluene	40	1,2,4-trimethylbenzene	40
n-heptane	25	1,3,5-trimethylbenzene	25
n-hexane	30	2,2,4-trimethylpentane	30
1-hexene	60	2,3,4-trimethylpentane	25
isobutane	25	*n*-undecane	30
isopentane	40	*o*-xylene	25
isoprene	40	*m*/*p*-xylene (combined)	40

20-60ppbC in nitrogen, 104 liters @ 1,800psi
cat. # 34445 (ea.)

20-60ppbC in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34445-PI (ea.)

24129

Small Cylinder Stand

- Supports and stabilizes disposable gas cylinders.
- Fits cylinders up to $3^3/_8$" (8 cm) in diameter.
- Adjustable screw secures cylinder in place.

This cylinder stand is designed to support small diameter cylinders, such as 104 L and 110 L disposable cylinders. It is a simple, safe, and economical way to stabilize the position of small cylinders, while keeping them within close proximity. The stand is constructed of heavyweight painted steel and includes an adjustable screw for safely securing cylinders.

Description	qty.	cat.#	price
Small Cylinder Stand	ea.	24129	

Natural Gas and Refinery Gas Standards

- Each available in three varying concentrations.
- Mini-regulator designed specially for these standards.

Natural Gas Standards

Available in three mixes, from lean to rich. Each has an extended list of C6+ components.

	Natural Gas Standard #1 cat.# 34438, ea. % each compound**	Natural Gas Standard #2 cat.# 34439, ea. % each compound**	Natural Gas Standard #3 cat.# 34440, ea. % each compound**
nitrogen	1.000	2.500	5.000
carbon dioxide	0.500	1.000	1.500
methane UHP	94.750	85.250	70.000
ethane UHP	2.000	5.000	9.000
propane	0.750	3.000	6.000
isobutane	0.300	1.000	3.000
n-butane	0.300	1.000	3.000
isopentane	0.150	0.500	1.000
n-pentane	0.150	0.500	1.000
hexanes plus*	0.100	0.250	0.500
Concentration	mole	mole	mole
Volume	13.16L @ 200psig	13.16L @ 200psig	5.5L @ 75psig
Ideal Heating Value (Dry BTU/SCF)	1048 gross	1142 gross	1317 gross

Refinery Gas Standards

Available in three mixes with varying C5 unsaturates or extended C6+ components.

	Refinery Gas Standard #1 cat.# 34441, ea. % each compound**	Refinery Gas Standard #2 cat.# 34442, ea. % each compound**	Refinery Gas Standard #5 cat.# 34443, ea. % each compound**
hydrogen	40.750	12.500	12.500
argon	0.500	1.000	1.000
nitrogen	4.000	37.200	37.200
carbon monoxide	1.000	1.000	1.000
carbon dioxide	3.000	3.000	3.000
methane	8.500	5.000	5.000
ethane	6.000	4.000	4.000
ethylene	2.000	2.000	2.000
acetylene	—	1.000	1.000
propane	7.000	6.000	6.000
propylene	3.000	3.000	3.000
propadiene	0.850	1.000	1.000
cyclopropane	—	0.040	—
isobutane	6.000	5.000	5.000
n-butane	4.000	4.000	4.000
isobutylene	2.000	1.000	1.000
1,3 butadiene	3.000	3.000	3.000
cis-2-butene	2.000	2.000	2.000
trans-2-butene	2.000	3.000	3.000
butene-1	2.000	2.000	2.000
2-methyl-2-butene	—	0.200	0.200
isopentane	1.000	1.000	1.000
n-pentane	1.000	1.000	1.000
cis-2-pentene	—	0.400	0.400
trans-2-pentene	—	0.160	0.200
pentene-1	—	0.400	0.400
n-hexane	0.500	0.100	—
hexanes plus	—	—	0.100
Concentration	mole	mole	mole
Volume	5.2L @ 70psig	4.9L @ 60psig	4.6L @ 60psig

*Contact Restek or your Restek representative for a complete list of hexanes plus.
**Precise concentrations are provided on the data sheet included with each cylinder and may vary slightly from those listed here.

please **note**

Gas standards on this page are not available in Pi-marked cylinders for EU countries.

cylinder **design**

DCG Partnership Cylinders:

Size: 7.6 x 24 cm
CGA-170/110 connection.
US DOT Specs: DOT-4B-240ET

Please note: This cylinder is not approved for use in Canada.

also **available**

See page 433 for regulators.

Scott/Air Liquide Transportable Pure Gases and Mixtures

We offer a wide range of Scott/Air Liquide transportable gases, from pure gases for purging or calibrating to multi-component mixes which are ideal for peak identification work.

The 14-liter container has a CGA 160 connection for more precise integration with analytical systems. The 48-liter cylinder has a CGA 165 connection, and can deliver large volumes of sample. The 110-liter cylinder has a CGA 180 connection.

See regulators pages 433-434 for cylinder information.

Description	Shelf Life	Scotty 14 (14 Liter) cat.#	price	Scotty 48 (48 Liter) cat.#	price	Scotty 110 (110 Liter) cat.#	price
Pure Gases							
Air, zero (THC < 1ppm)	2 yrs.	34448		34449		34449-PI	
Argon, 99.995%	2 yrs.	34457		—	—	34457-PI	
Carbon dioxide, 99.80%	2 yrs.	34451		34452		34452-PI	
Hydrogen, 99.99%	2 yrs.	34453		—	—	34453-PI	
Methane, 99.00%	2 yrs.	34454		—	—	34454-PI	
Oxygen, 99.60%	2 yrs.	34455		—	—	—	—
Two-Component Mixtures							
Benzene in air (1ppm)	1 yr.	—	—	34458		34458-PI	
Benzene in air (100ppm)	1 yr.	—	—	34459		34459-PI	
1,3-Butadiene in nitrogen (10ppm)	2 yrs.	34460		34461		34461-PI	
Carbon dioxide in helium (100ppm)	2 yrs.	34462		—	—	34462-PI	
Carbon dioxide in nitrogen (100ppm)	2 yrs.	34463		34464		34464-PI	
Carbon dioxide in nitrogen (1000ppm)	2 yrs.	34465		34466		34466-PI	
Ethylene in air (8-10ppm)	2 yrs.	34467		34468		34468-PI	
Ethylene in helium (100ppm)	2 yrs.	34489		—	—	34489-PI	
Hydrogen in helium (100ppm)	2 yrs.	34469		—	—	34469-PI	
Hydrogen in nitrogen (1%)	2 yrs.	34471		34472		34472-PI	
Hydrogen in nitrogen (100ppm)	2 yrs.	34473		34474		34474-PI	
Methane in helium (100ppm)	2 yrs.	34476		34477		34477-PI	
Methane in nitrogen (100ppm)	2 yrs.	34478		—	—	34478-PI	
Methane in nitrogen (1%)	2 yrs.	34482		34483		34483-PI	
Nitrogen in helium (100ppm)	2 yrs.	34479		—	—	34479-PI	
Nitrous oxide in nitrogen (1ppm)	2 yrs.	34484		34485		34485-PI	
Oxygen in helium (100ppm)	2 yrs.	34480		—	—	34480-PI	
Oxygen in nitrogen (2%)	2 yrs.	34487		34488		34488-PI	
Oxygen in nitrogen (6%)	2 yrs.	34491		34492		34492-PI	
1,1,1-Trichloroethane in nitrogen (10ppm)	2 yrs.	—		34493		34493-PI	
Trichloroethylene in nitrogen (10ppm)	2 yrs.	34494		34495		34495-PI	
Vinyl chloride in nitrogen (1ppm)	2 yrs.	34496		34497		34497-PI	
Vinyl chloride in nitrogen (10ppm)	2 yrs.	34498		34499		34499-PI	
Vinyl chloride in nitrogen (50ppm)	2 yrs.	34500		—	—	34500-PI	
Vinyl chloride in nitrogen (100ppm)	2 yrs.	34501		—	—	34501-PI	
Vinyl chloride in nitrogen (1000ppm)	2 yrs.	34502		—	—	34502-PI	
Multi-Component Mixtures							
Carbon monoxide, carbon dioxide, hydrogen and oxygen in nitrogen (0.5% each)	2 yrs.	34504		34505		34505-PI	
Carbon monoxide, carbon dioxide, hydrogen and oxygen in nitrogen (1% each)	2 yrs.	34507		34508		34508-PI	
Carbon monoxide, carbon dioxide, methane, ethane, ethylene and acetylene in nitrogen (1% each)	1 yr.	—	—	34511		34511-PI	
Carbon monoxide, carbon dioxide, nitrogen, and oxygen, (5% each) and methane and hydrogen (4% each) in helium	2 yrs.	34512		—	—	34512-PI	
Carbon monoxide (7%), carbon dioxide (15%) and oxygen (5%) in nitrogen	2 yrs.	34514		—	—	34514-PI	
Carbon monoxide (7%), oxygen (4%), carbon dioxide (15%) and methane (4.5%) in nitrogen	2 yrs.	34515		34516		34516-PI	
C1-C6 *n*-Paraffins: methane, ethane, propane, butane, pentane, hexane in nitrogen (15ppm each)	2 yrs.	34518		34519		34519-PI	
C1-C6 *n*-Paraffins: methane, ethane, propane, butane, pentane, hexane in helium (100ppm each)	2 yrs.	34521		34522		34522-PI	
C1-C6 *n*-Paraffins: methane, ethane, propane, butane, pentane, hexane in helium (1000ppm each)	2 yrs.	34524		34525		34525-PI	
C1-C6 *n*-Paraffins: methane, ethane, propane, butane, pentane, hexane in nitrogen (100ppm each)	2 yrs.	34527		34528		34528-PI	
C2-C6 Olefins: ethylene, propylene, 1-butene, 1-pentene, 1-hexene in helium (100ppm each)	2 yrs.	34529		34530		34530-PI	
C2-C6 Olefins: ethylene, propylene, 1-butene, 1-pentene, 1-hexene in nitrogen (100ppm each)	2 yrs.	34531		34532		34532-PI	
Branched Paraffins: 2,2-dimethylbutane, 2,2-dimethylpropane, isobutane, 2-methylbutane, 2-methylpentane, 3-methylpentane in nitrogen (15ppm each)	2 yrs.	34534		—	—	34534-PI	
Methane, ethane, ethylene, acetylene, propane, propylene, *n*-butane, propyne in nitrogen (15ppm each)	1 yr.	—	—	34537		34537-PI	
n-butane, isobutane, *cis*-2-butene, *trans*-2-butene, 1-butene, iso-butylene, 1,3-butadiene, ethyl acetylene in nitrogen (15ppm each)	1 yr.	—	—	34539		34539-PI	

Gas Regulators for Transportable Cylinders

For this cylinder:

DCG Partnership Cylinders:
Size: 7.6 x 24 cm
CGA-170/110 connection.
US DOT Specs: DOT-4B-240ET

Please note: This cylinder is not approved for use in Canada.

Use this regulator:

Mini-Regulator for natural gas and refinery gas standards

- 0–300 psig inlet pressure range.
- 0–15 psig outlet pressure range.
- Supplied with 0–15 psig outlet pressure gauge, brass CGA 170 nut and nipple.

22032

Description	qty.	cat.#	price
Mini-Regulator	ea.	22032	

For these cylinders:

Spectra (Linde) 104L:
Aluminum construction
Size: 8 x 24 cm
Volume/Pressure:
104 liters of gas
@ 1,800 psi
CGA-180 outlet fitting.
Weight: 1.5 lbs/0.7 kg

Scotty® (Air Liquide) 110L
(Pi-marked Cylinders for EU Regulations):
Aluminum construction
Size: 8.3 x 29.5 cm
Volume/Pressure:
110 liters of gas @ 1,800 psi
CGA-180 outlet fitting.
Weight: 2.2 lbs/1 kg
DOT Specifications: 3AL2216

Use these regulators:

Spectra Gas 7621 High-Purity VOC Regulator

- Single-stage, stainless steel.
- Two pressure gauges and CGA-180 fitting.
- 3,000 psig maximum inlet pressure.
- Stainless steel diaphragm and Kel-F® seat.
- 1/8-inch tube compression outlet.
- Low internal volume: 3.03 cc.
- Accurate pressure control even at low flow rates.
- Individually tested for leaks and impurities.

21572

Description	qty.	cat.#	price
0–30psig outlet pressure gauge	ea.	21572	
0–100psig outlet pressure gauge	ea.	21572-R100	

See next page for a syringe adapter kit.

Continued on next page.

For these cylinders:

Scotty® (Air Liquide) 14
Contents: 14 liters
Pressure: 240 psig (17 bar)
Outlet Fitting: CGA 160
Weight: 1.5 lbs/0.7 kg
Dimensions: 3" diameter x 11" height (7.6 x 28 cm)
DOT Specifications: 4B240
Please note: This cylinder is not approved for use in Canada.

Scotty® (Air Liquide) 48
Contents: 48 liters
Pressure: 300 psig (21 bar)
Outlet Fitting: CGA 165
Weight: 1.75 lbs/0.8 kg
Dimensions: 4" diameter x 16 1/4" height (10.2 x 41 cm)
DOT Specifications: 39 NRC

Use these regulators:

Regulators
for use with 14-liter and 48-liter Scott (Air Liquide) Transportable Gases

Specifications:
Maximum Inlet Pressure: 300 psig
Outlet Pressure Range: 2–10 psig
Maximum Delivery Pressure: 25 psig
Operating Temperature Range: 35 °F to 150 °F (2 °C to 65 °C)
Outlet Connection: 1/4" female NPT

Materials of Construction:
Body: Brass
Diaphragm: Viton®
Seat: Acetal
Seal: Viton®


22690

Use the CGA 160 inlet connection with 14-liter Scott/Air Liquide Transportable Gases. Use the CGA 165 inlet connection with 48-liter Scott/Air Liquide Transportable Gases.

Description	qty.	cat.#	price
Regulator, CGA 160 Inlet Connection	ea.	22690	
Regulator, CGA 165 Inlet Connection	ea.	22691	


21118

Syringe Adapter Kit for Single-Stage VOC Regulator
Use to withdraw sample from a high-pressure cylinder after pressure reduction through the high-purity VOC single-stage regulator.

Kit contains one nickel-plated brass 1/4" NPT to female luer fitting, which can be used with an A-2 Luer syringe (cat.# 20162 or 20163, see page 385), and one stainless steel 1/4" NPT x 1/8" compression fitting with septum (can be used with any syringe needle).

Description	qty.	cat.#	price
Syringe Adapter Kit	kit	21118	

also **available**

Single-Stage and Dual-Stage Ultra-High Purity Gas Regulators
See pages 309–311.

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OPERATING INSTRUCTIONS
PORTABLE DYNACALIBRATOR MODEL 120

1) INTRODUCTION

The Dynacalibrator Model 120 is a completely portable instrument designed for generating precision concentrations of selected calibration gases in the field or laboratory. The calibrator is used to verify the accuracy of analytical data generated in air pollution monitoring, industrial hygiene surveys, odor survey programs, tracer studies, and other instruments that measure gas concentrations in the parts-per-million range and lower. The basic calibration gases are derived from VICI Metronics Inc. Dynacal Permeation Devices containing the desired permeant gas.

2) DYNACALIBRATOR BASICS

The Model 120 contains a constant temperature permeation chamber which holds one or more permeation devices or one diffusion vial. The temperature of the chamber, which controls the permeation or diffusion rate of the trace gas, is set and controlled using a digital temperature controller located on the front panel.
Zero air for dilution is produced by an internal pump and activated charcoal scrubber. Front panel access to the valve and flowmeter allows users to accurately set the dilution stream flow rate and, hence, set the concentration of calibration gas at the outlet port of the calibrator. An overflow port and scrubber vents and scrubs the excess calibration gas that is generated.

3) UNPACKING

Every Dynacalibrator is completely calibrated, thoroughly tested and inspected, and carefully packed prior to shipment from the VICI Metronics Inc. plant. Upon receipt of your unit, inspect the packages for visible evidence of damage to the shipment or its containers. Secondly, check the packing list to make sure that the number of cartons received tallies with that on the packing list. If you also ordered tubes, check the packing list to insure that all items on packing list agrees with the items received. Your new Dynacalibrator Model 120 should come with this manual, a power cord, a pair of forceps, a permeation device holder, and a power inverter for operating from an automobile's 12-volt source.

4) MAIN POWER

The Portable Dynacalibrator Model 120 can be operated either using the rechargeable internal lead-acid battery or 110 VAC power source (220 VAC for option C). The battery will power the instrument for up to 24 hours of continuous use (at lower temperatures) and can be fully charged in twelve hours. When using the Dynacalibrator at 100°C, the battery will last about four hours (preheated). To increase battery life at 100°C, it is recommended that you:

1. set a very low flow rate (~ 500cc) when heating the system to its operating temperature. This will minimize the cooling of the permeation chamber by the air flow.
2. preheat the system with the Dynacalibrator plugged into an AC power source.
3. if possible, leave the Dynacalibrator plugged in while doing calibrations.

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The Dynacalibrator can be recharged while in-use by connecting the power cord to a 110 VAC (220 VAC) power source or by using the power inverter while driving to the test site. It is recommended that the unit be charged fully or left charging continuously to keep the battery in good condition. This lead-acid battery does not exhibit the "memory effect" common to nickel-cadmium batteries and requires no further maintenance for optimum performance.

5) FRONT PANEL CONTROLS AND INDICATORS

LEGEND:

- **A** - Span Outlet
- **B** - Rechargeable Scrubber #2
- **C** - Digital Temperature Controller, 30-100°C
- **D** - Permeation Chamber Cap
- **E** - Overflow Vent Bulkhead
- **F** - Output Mode Control Valve
- **G** - Dilution Flowmeter
- **H** - Pump / Heater On Indicator
- **I** - Power Switches
- **J** - Dilution Flow Control Valve
- **K** - 115 VAC Battery Charger / Female Socket (220 VAC for option C)

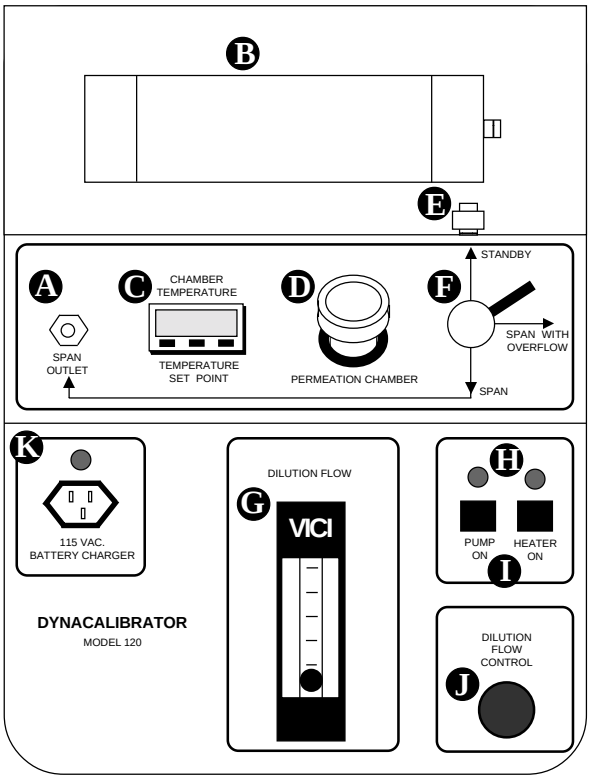


Figure 1. Dynacalibrator Model 120 Front Panel

6) TURN PUMP AND HEATER ON

A. Use rocker switches (I) to activate pump and heater.
B. If 110 VAC (220 VAC) power is accessible, calibrator can be used with power cord connected to AC outlet (K) to save battery.
C. Make sure Pump/Heater On indicator LEDs (H) are lit to show that Dynacalibrator is

OPERATING INSTRUCTIONS
PORTABLE DYNACALIBRATOR MODEL 120

operational.

D. Make sure that there is air flow through the Dilution Flowmeter (G) by turning the Dilution Flow Control knob (J) clockwise. The flowmeter float should rise to indicate dilution flow rate.
E. Temperature controller (C) display will also light up.

7) TEMPERATURE CONTROL

The digital temperature controller was preset and tuned by VICI Metronics Inc. to function at its optimum performance level and need not be configured by the users. All that is required is for the user to input desired temperature (110°C maximum) and allow sufficient time for permeation chamber to equilibrate.

A. To set desired temperature, push the up or down button until the desired temperature displays. Holding the up or down button will make the display change faster.

CAUTION !! **Be sure that the temperature selected is compatible with the permeation tube being used.**

8) INITIAL EQUILIBRATION

A. Set dilution flow at lowest float setting on flowmeter for initial equilibration using dilution flow control valve (G).
B. Switch Mode Control Valve to Standby (F).
   Note: This forces all calibration gas to the overflow scrubber.
C. Set desired temperature on temperature controller (C).
D. Transfer permeation device to permeation chamber (D). If necessary, wipe clean the permeation device and transfer the permeation device with forceps.
E. Let calibrator stabilize for approximately 30 minutes.

9) PLUMBING FLOW DIAGRAM - MODEL 120

Figure 2 shows diagrammatically how Model 120 is plumbed. An internal pump is used to generate an air source which travels through an activated charcoal scrubber to create "zero" air for dilution. A Flow control Knob (J) and a Dilution Flowmeter (G) is used to regulate and indicate dilution air flow rate, respectively. The air then enters an insulated Permeation Chamber (D) containing the permeation devices. The temperature of the Permeation Chamber is controlled by a Digital Temperature Controller (C). The air picks up and mixes with the permeant trace gas and can exit out by three different routes; (1) Span Outlet, (2) Overflow vent, or (3) Span and Overflow. An Output Mode Control Valve (F) is used to select the output route. Calibration gas exiting the Overflow

OPERATING INSTRUCTIONS
PORTABLE DYNACALIBRATOR MODEL 120

Vent (E) is scrubbed via an external Scrubber #2 before being recycled into the environment.

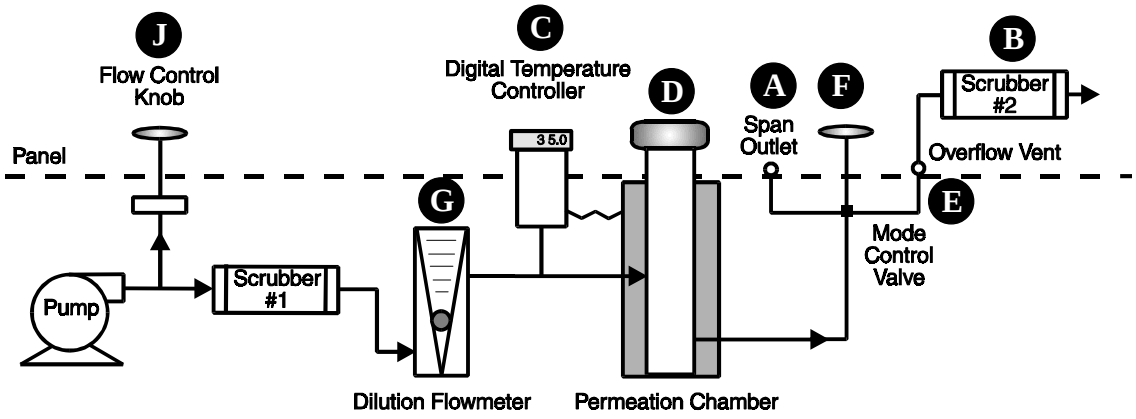
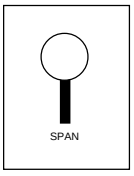


Figure 2. Model 120 Plumbing Diagram

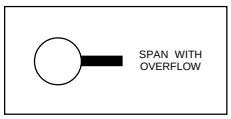
10) CALIBRATION CONNECTION

A. Passive Monitors (no sample pump)
If the sensor to be calibrated does not have a sample pump which will draw the calibration gas from the SPAN OUTLET, then switch the MODE CONTROL VALVE to SPAN. This forces all calibration gas to exit at the "SPAN OUTLET." Connect a sample line from the SPAN OUTLET to the monitor.



CAUTION !! **An exhaust port must be provided down stream of the sensor so that there is no back pressure on the calibrator.**

B. Fixed Sample Flow Monitors
Connect a sample line from the SPAN OUTLET to the monitor. Switch the MODE CONTROL VALVE to SPAN WITH OVERFLOW. Insure that the calibrator flow exceeds the sample flow of the monitor.

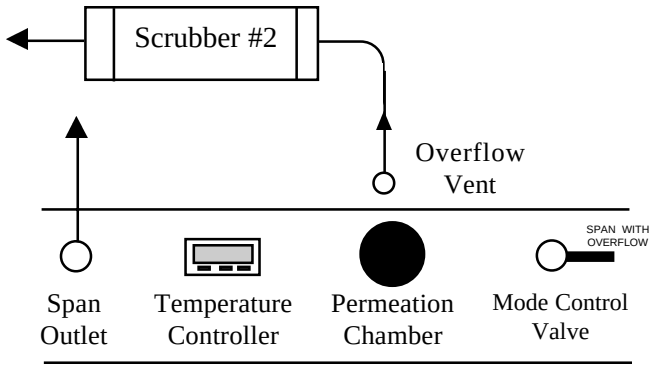


C. For complete diagram and descriptions of the different types of output configurations, refer to section 11 and figure 3 on next page.

OPERATING INSTRUCTIONS
PORTABLE DYNACALIBRATOR MODEL 120

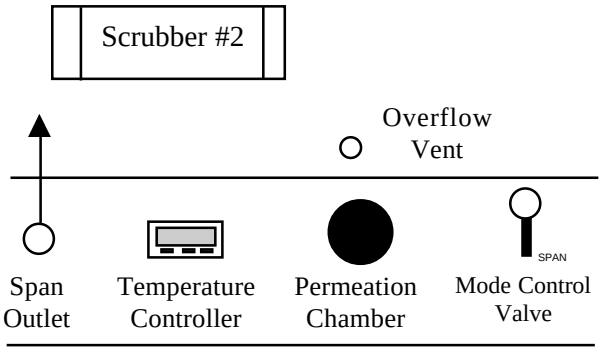
11) MODEL 120 OUTPUT CONFIGURATIONS

Calibration Mode - Monitors with Sample Pumps



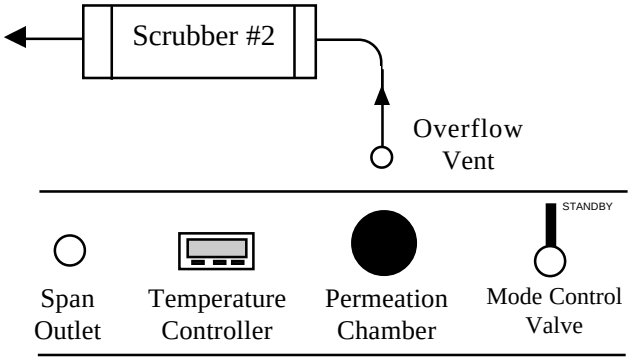
Output of permeation chamber flows into a tee. The flow then exits through the span outlet and overflow vent.

Calibration Mode - Passive Monitors



Total flow Out Span Outlet: Overflow vent is cut off and total flow from permeation chamber exits through Span Outlet.

Standby or Equilibration Mode



Total Flow Out Overflow Vent: Span Outlet is cut off and total flow from permeation chamber is force through Overflow Vent into Scrubber #2.

Figure 3. Model 120 Output Configurations

OPERATING INSTRUCTIONS
PORTABLE DYNACALIBRATOR MODEL 120

12) WIRING SCHEMATIC

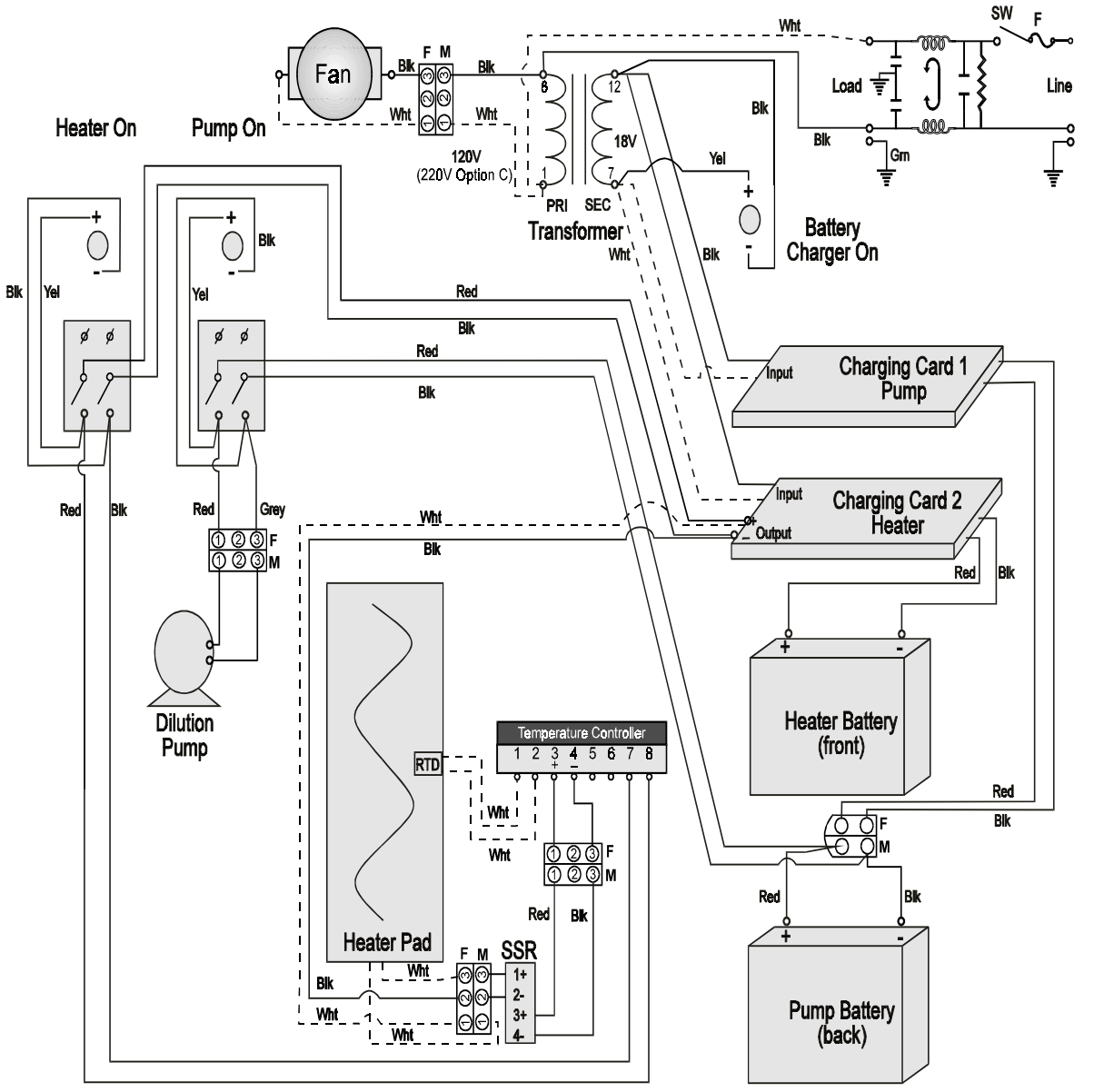


Figure 4. Model 120 Electrical Wiring Schematic (rear view)

OPERATING INSTRUCTIONS
PORTABLE DYNACALIBRATOR MODEL 120

13) CALIBRATION

A. Set temperature on digital temperature controller. Refer to page 3, section 7 for instructions on setting and using the digital temperature controller.

B. For the temperature indicated on the thermometer, find the corresponding flow setting to be used to generate the desired concentrations. Use the Table included with the permeation device or calculate using the following equation:

$$\text{Concentration (PPM)} = \frac{K * P}{F}$$

where: K = 24.45 / (molecular weight of gas)
P = permeation rate (ng/min)
F = dilution flow (ml/min)

If a permeation rate is known at some reference temperature, the rate at a second temperature can be estimated as follows:

$$\log P = \log P_o + .034 (T - T_o)$$

where: P_o = rate at reference temperature To
P = new rate at temperature T
log = log base 10

C. Run each calibration setting until a stable reading is obtained (minimum 5 minutes). For a zero point, remove the permeation tube from the chamber and allow instrument to zero.

14) FLOW CORRECTION FACTOR

When using the portable calibrator in an environment other than standard conditions, the flow must be corrected to standard temperature and pressure using the following formula.

$$\text{Flow} = (0.6262)\, F_C * \sqrt{(P/T)}$$

Flow = indicated flow corrected to standard temperature and pressure. This corrects the flow to standard conditions when the flowmeter is at a different temperature and pressure.
P = ambient pressure- mm Hg
T = Flowmeter temperature -deg Kelvin (273+C)
F_C = Calibrated flow when flowmeter is at standard conditions.

The following Flow Correction Factor table can be used if elevation (in feet) is known. Find the elevation and temperature of your operational environment on this table and multiply this factor to the published calibrated flow. The calibrated flow is found on the flowmeter table provided with your Dynacalibrator.

OPERATING INSTRUCTIONS
PORTABLE DYNACALIBRATOR MODEL 120

14) FLOW CORRECTION FACTOR (cont')

FLOW CORRECTION FACTOR									
	Temperature - Degrees Centigrade								
Elevation - ft	0	5	10	15	20	25	30	35	40
- 1,000	1.064	1.054	1.045	1.036	1.027	1.018	1.010	1.002	0.994
SEA LEVEL	1.045	1.035	1.026	1.017	1.009	1.000	0.992	0.984	0.976
1,000	1.026	1.017	1.008	0.999	0.990	0.982	0.974	0.966	0.958
2,000	1.007	0.998	0.989	0.981	0.972	0.964	0.956	0.948	0.941
3,000	0.989	0.980	0.971	0.963	0.955	0.947	0.939	0.931	0.924
4,000	0.971	0.962	0.954	0.945	0.937	0.929	0.922	0.914	0.907
5,000	0.953	0.944	0.936	0.928	0.920	0.912	0.905	0.897	0.890

15) SAMPLE CALCULATION

Given:

Permeation Rate: 21,000 ng/min Cl_2 at 30^oC
Flow: 1100 cc/min (From Flowmeter Table)
Ambient Temp.: 15^oC
Ambient Pressure: (unknown), elevation = 2000 ft.

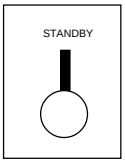
a) Flow corrected to 25^oC, 1 atm (from table above)
F = (0.981)(1100) = 1079 cc/min

b) Concentration (ppm) = $\frac{K * P}{F}$

$$= \frac{(0.346)(21{,}000)}{1079} \quad = 6.73 \text{ PPM}$$

16) STANDBY OPERATION

A. When Dynacalibrator is not in use, switch the Mode Control Valve to the STANDBY position. This will divert all flow and permeant out of the overflow and through scrubber 2. Scrubber 2 will filter the permeant gas so that no concentration of the permeant will escape out into environment.
B. Set pump at minimum flow setting - Control Valve (I)
C. Keep permeation device in chamber to maintain equilibrium until you are ready to use again.



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17) SHUT DOWN

A. Remove permeation device and place in shipping tube with charcoal packets. If the device will not be used for over 1 week and its total useful life is under 1 year, it is recommended that the device be placed in cold storage for longer life.
B. Recharge battery if needed.

18) NOTE ON PERMEATION DEVICES

A calibrated Dynacalibrator flow rate table is included in the back of this manual. Use this flow rate and your device's permeation rate to calculate output concentration. See section 12 on page 6 for formula.

NOTE !! The calibrated flow rate of your Dynacalibrator was corrected to standard temperature and pressure. When using the calibrator in an environment other than standard conditions, the flow must be corrected to standard temperature and pressure. Please refer to section 13 - Flow Correction Factor.

WAFER DEVICES

WAFER DEVICES should be inserted with the wafer side facing up to allow the permeant gas to be released into the carrier flow downstream of the wafer body. If you're using a wafer device with a Dynacalibrator with a Teflon chamber, you may find it hard to remove the device from the chamber. It may be necessary to invert the Dynacalibrator and allow the device to slide out by itself. This will not damage the device nor the Dynacalibrator.

CAUTION !! WAFER DEVICES are heavy and can damage the glass permeation chamber if they are carelessly dropped into the chamber. Use forceps to gently lay the Wafer device into the chamber.

WAFER DEVICE SPACER

The model 115/120 Dynacalibrator is suplied with a teflon spacer* for use with VICI Metronics wafer devices.The spacer fits at the nonpermeating end of the stainless steel wafer device body and raises the device further up from the bottom of the permeation chamber to the region of most accurate temperature zone. When using a wafer device, insert the spacer end first into the permeation chamber.

*(Teflon tube section 1/4" ID x 3.5 cm. length - P/N 035-HE)

OPERATING INSTRUCTIONS
PORTABLE DYNACALIBRATOR MODEL 120

19) WARRANTY

The **Model 120 Dynacalibrator** manufactured by VICI Metronics Inc. is guaranteed to be free of defects in material and workmanship. VICI Metronics Inc. will, for a period of 90 days from the date of shipment of those Dynacalibrators, repair or replace at its option, free of charge, subject to inspection FOB VICI Metronics Inc. factory, any failed component or assembly except for the following:

1. lamps, fuses and glass chamber
2. damage due to improper shipping
3. damage due to improper use
4. damage due to modifications or alterations
5. damage due to improper maintenance

FACTORY REPAIR SERVICE

VICI Metronics Inc. provides complete factory repair and calibration services for the Dynacalibrators. If you need service, contact the VICI Metronics Inc. product manager at (408) 737-0550 or FAX (408) 737-0346 for authorization and repair specifics prior to returning your unit.

Equipment to be repaired or calibrated should be shipped in its original or equivalent packing materials prepaid to:

VICI Metronics Inc.
2991 Corvin Drive
Santa Clara, CA 95051
Attn: Product Department

A complete written description of symptoms, problems or calibration requirement should accompany the equipment. Include the name and phone number of the person to contact for any discussion of needed repairs. On receipt, VICI Metronics Inc. will inspect the equipment and advise you of any unusual repair time or cost factors prior to starting repairs. Repaired equipment will be returned to you with an invoice for any out-of-warranty costs.

OPERATING INSTRUCTIONS
PORTABLE DYNACALIBRATOR MODEL 120

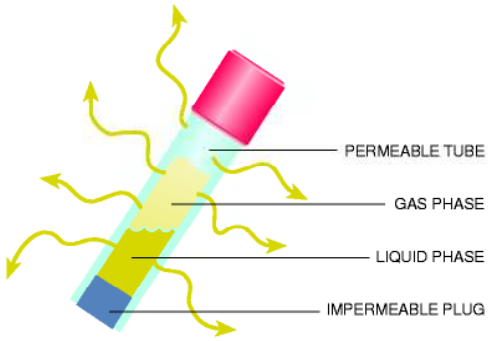
CONTENT

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.

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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US customers call toll-free (877) 737-1887

rev 5/03
PB-023 permtube

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.

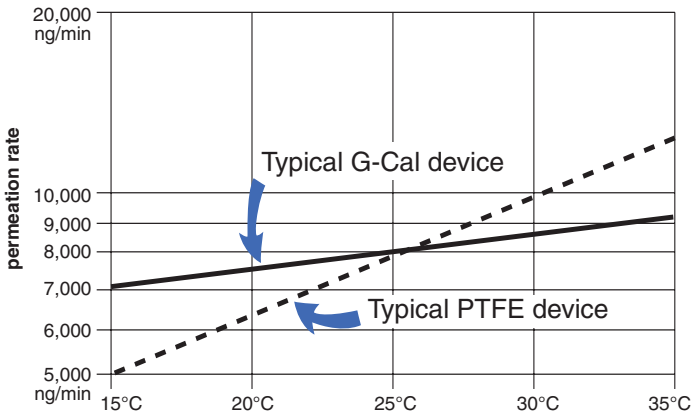
G-Cal devices exhibit the lowest temperature sensitivity among available similar products. The permeation rate of the polymer used in G-Cal devices changes only 1-3% per degree C, eliminating the need for a temperature-controlled chamber.

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 vertified 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

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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metronics@vici.com

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US customers call toll-free (877) 737-1887

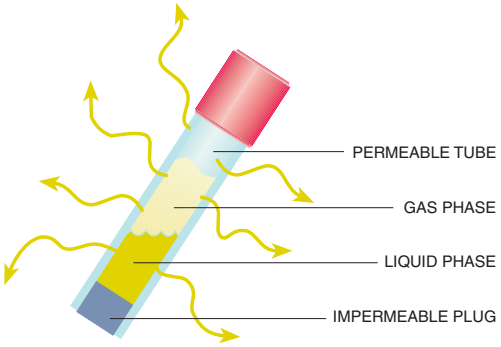
rev 3/11
PB-023 permtube-gcind

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.

Valco Instruments Co. Inc.
VICI AG International

CALIBRATION GAS STANDARDS

Permeation Tubes and Devices from VICI Metronics

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

Valco Instruments Co. Inc.
VICI AG International

CALIBRATION GAS STANDARDS

Overview

A calibration gas standard establishes 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. Permeation rate data is already established for hundreds of different compounds, and rates for new compounds can be easily certified using NIST-traceable standards.

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.

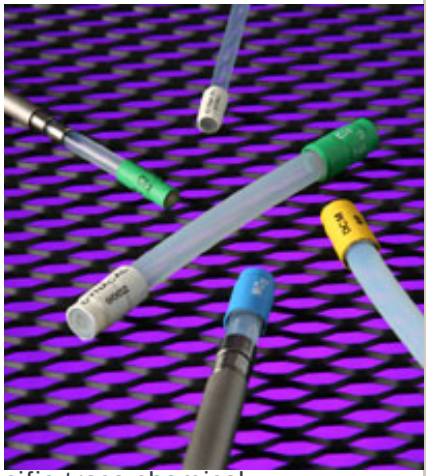
Applications include air pollution monitoring, industrial hygiene surveys, odor surveys, and analyses in chemical, petrochemical, paper, power, and related industries.

- Dynacalibrators®
- G-Calibrators

Valco Instruments Co. Inc.
VICI AG International

CALIBRATION GAS STANDARDS

Dynacal® Permeation Tubes and Devices from VICI Metronics



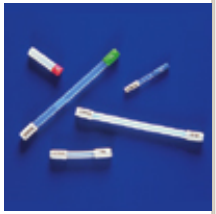
- Ideal for lab environments
- Smaller than G-Cal devices
- More accurate than G-Cal devices
- Require a temperature-controlled environment
- Inexpensive calibration solution

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.

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.

Tubular device

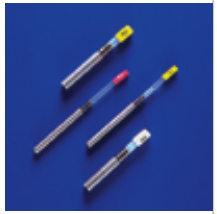
Request a quote



The tubular device, a sealed permeable cylinder containing the desired permeant reference material, is the most widely used of the various permeation devices. 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.

Extended life tubular device

Request a quote



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 has a 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

Request a quote

Wafer devices have only a small permeable window, or wafer, so permeation rates are typically lower than rates for tubular devices. 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.

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)

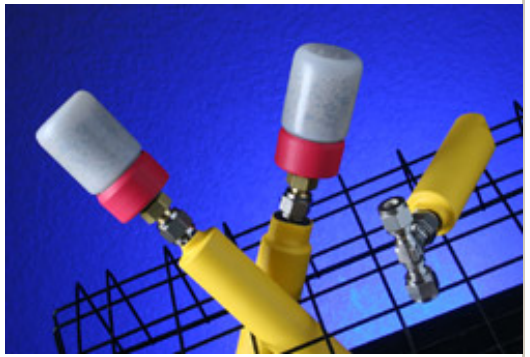
TECHNICAL NOTES

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

Valco Instruments Co. Inc.
VICI AG International

CALIBRATION GAS STANDARDS

G-Cal Permeation Devices from VICI Metronics



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

Request a quote

Patented G-Cal permeation tubes offer a proven and repeatable means of generating a 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. 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. 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 vertified 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.

MORE INFORMATION

- Permeation devices vs. bottled trace level standards
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Valco Instruments Co. Inc.
VICI AG International

CALIBRATION GAS STANDARDS

Calibration Gas Generators from VICI Metronics

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

Valco Instruments Co. Inc.
VICI AG International

CALIBRATION GAS STANDARDS

Permeation Devices vs. Bottled Trace Level Standards

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.

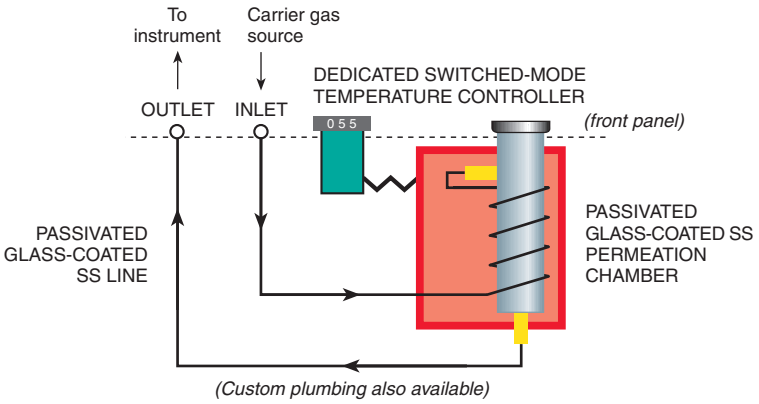
Calibration Gas Generator

- 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.

Analytical Components & Systems

VICI Metronics Inc.

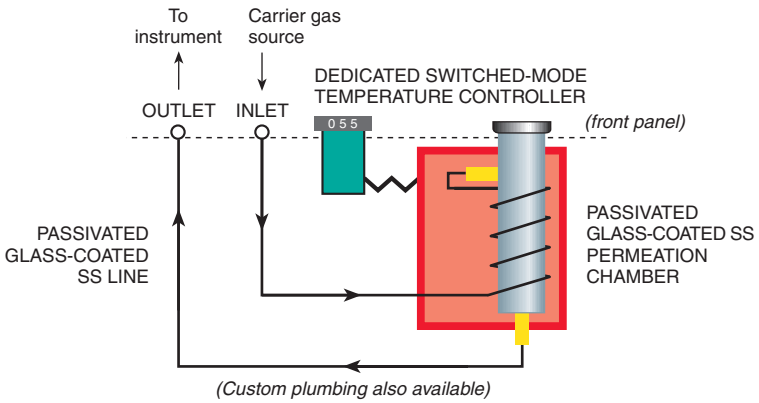
Dynacalibrator® Model 150 Calibration Gas Generator

- 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.

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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US customers call toll-free (877) 737-1887

Rev. 4/09

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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8/10

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

Toxic Gas Monitors/Alarms

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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rev 10/06
PB-022 gcal_monitors

Analytical Components & Systems

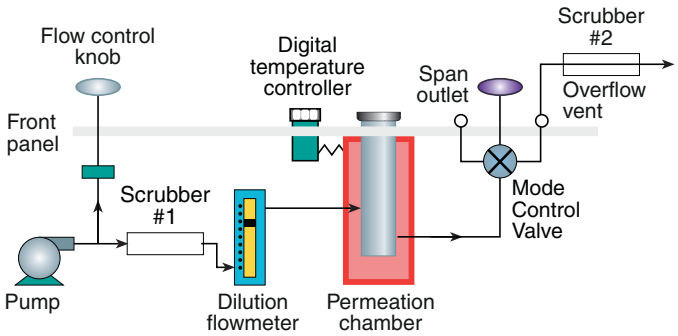
Dynacalibrator® Portable Calibration Gas Generator

- 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.

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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rev 7/04
portcal

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

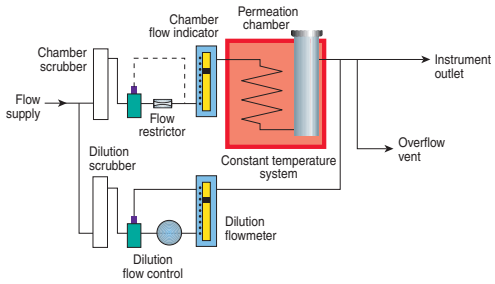
VICI Metronics Dynacalibrators enable calibrations traceable to NIST standards for almost any gas analyzer, in the lab or in the field. The design takes full advantage of all the conveniences inherent in our Dynacal® permeation devices to generate and deliver precise concentrations ranging from ppb to 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

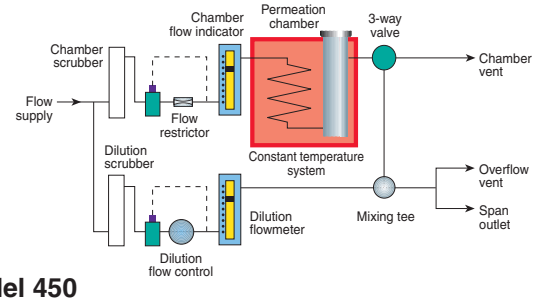
Model 230

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



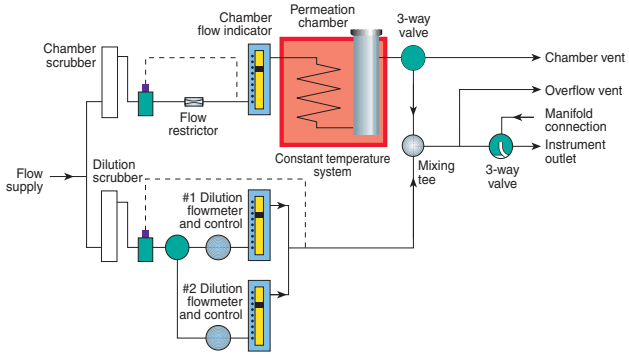
Model 340

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.



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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rev 4/06
PB-026 dynacal

VICI Analytical Components & Systems

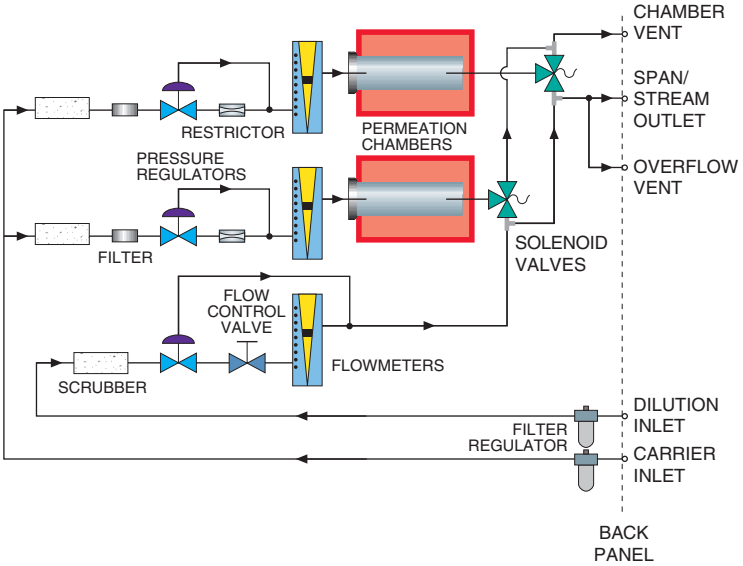
Dynacalibrator® Model 500 Calibration Gas Generator

- 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.



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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.

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

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

Top

B

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	

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	

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

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

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

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	

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	

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

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	

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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	

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	

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	

Top

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

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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	

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	

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S

Chemical	Dynacal designator	G-Cal designator
Selexol	2212	

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

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	

Trioxane	3520
Tungsten hexafluoride	0046

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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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CALIBRATION GAS STANDARDS

Quotation Form for Permeation Devices

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

Select *Your country

*E-mail address

*Phone number

Fax number

Additional relevant information

Submit Reset

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

ORDERING AND INFORMATION

Contact us for more information about any of these products.

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.

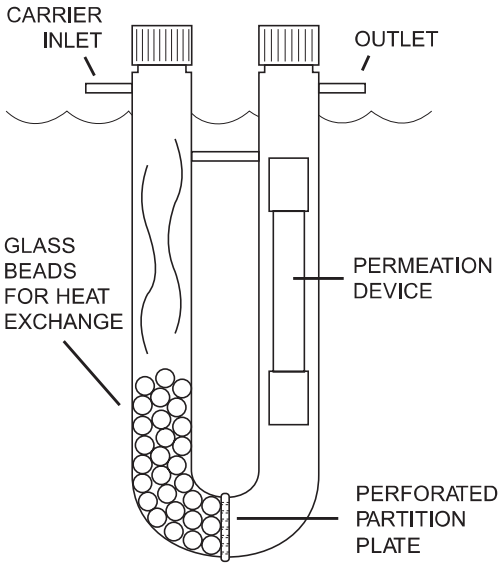

Figure 1: Simple U-tube holder

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.

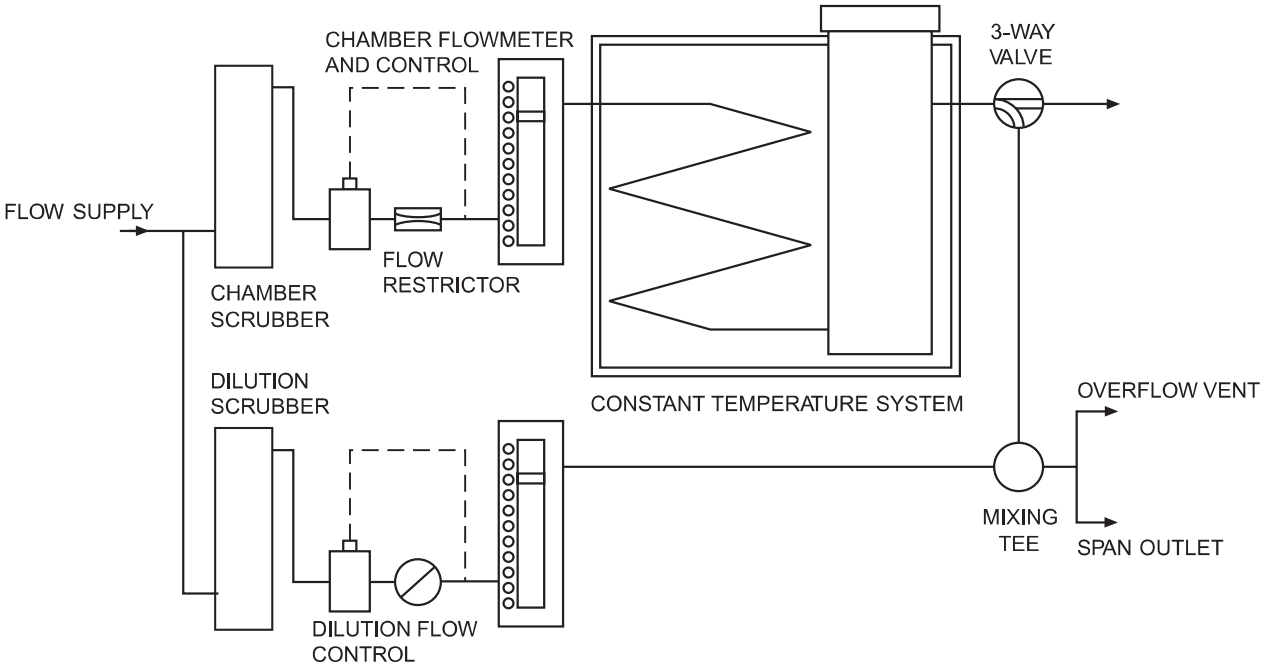

Figure 2: Schematic of Basic System

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

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:

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

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.

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 expressed 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 molecular 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:

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

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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