



Calibration gas generation system Permeater

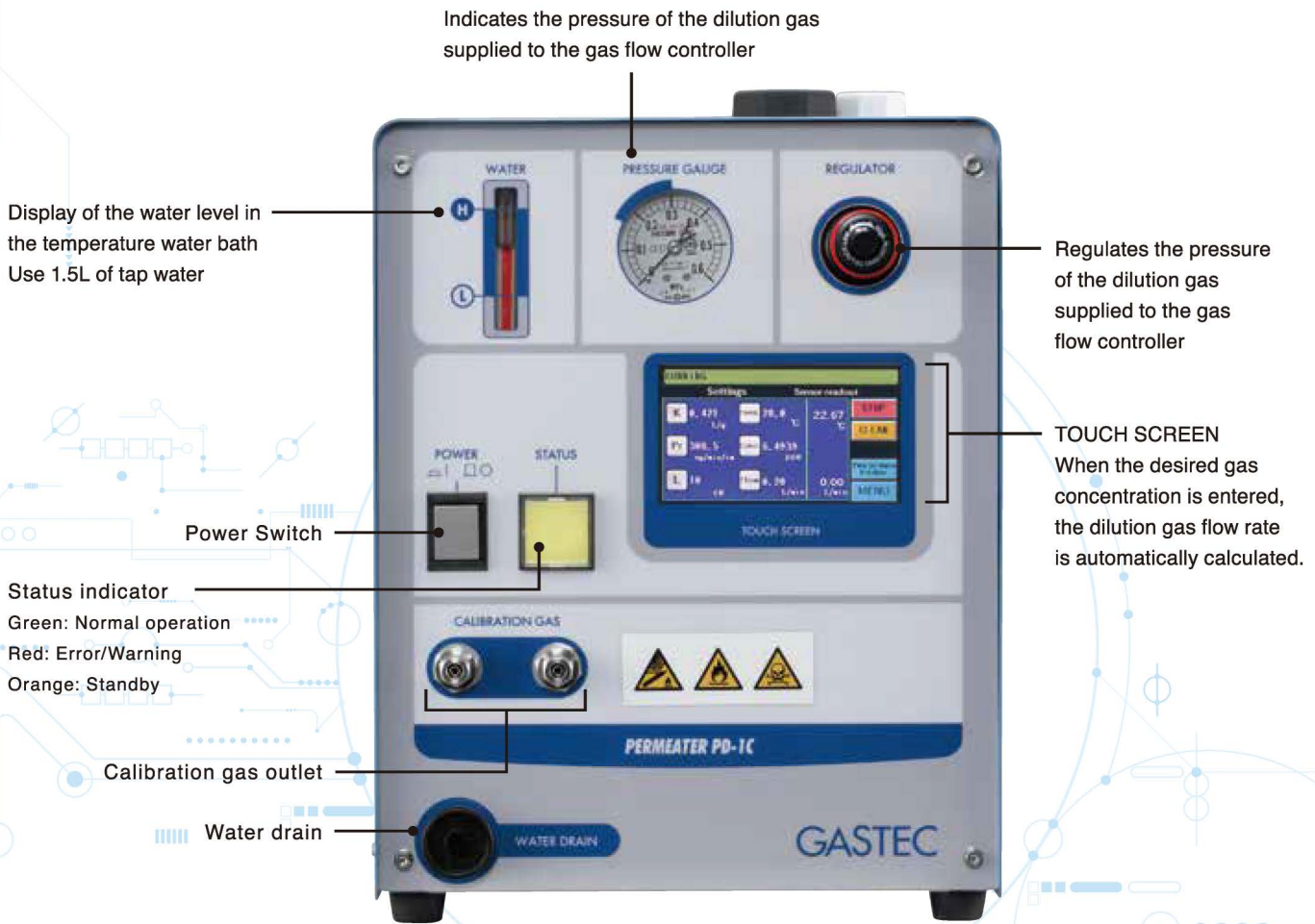
PD-1C



The Permeater is a gas generator for calibration purposes that utilises permeation and diffusion tubes to generate the calibration gas. When the permeation and diffusion tubes are set at a constant temperature, the weight of both the permeating and the evaporating diffusion gas will be respectively set at constant levels. In this manner, calibration gas is continuously generated by setting both tubes at a constant temperature and providing a constant flow of dilution gas such as air or nitrogen.

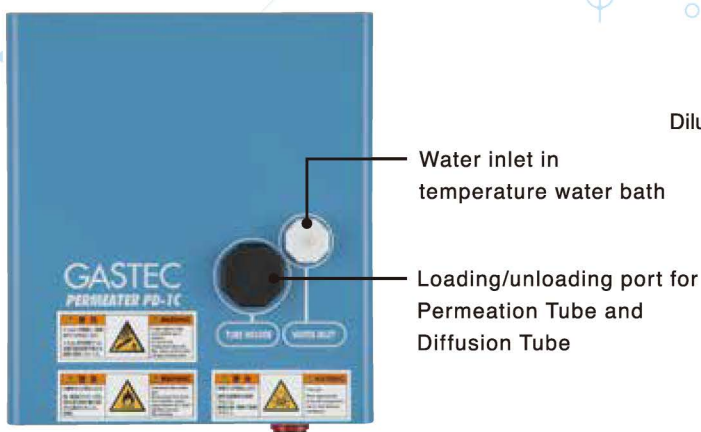
Calibration gas generation system Permeater

- Gas for calibration can be generated continuously for longer periods of time
- Calibration gas can be easily generated in a wide range of concentrations
- Highly reliable as concentration is determined by measuring basic physical quantities such as weight loss and dilution gas quantity
- Many types of low concentration calibration gases can be generated
- Automatic calculation of the dilution gas flow rate when the desired gas concentration to be generated is entered on the touch screen **NEW!**
- Mass flow controller (gas flow controller) controls flow changes **NEW!**



Top view

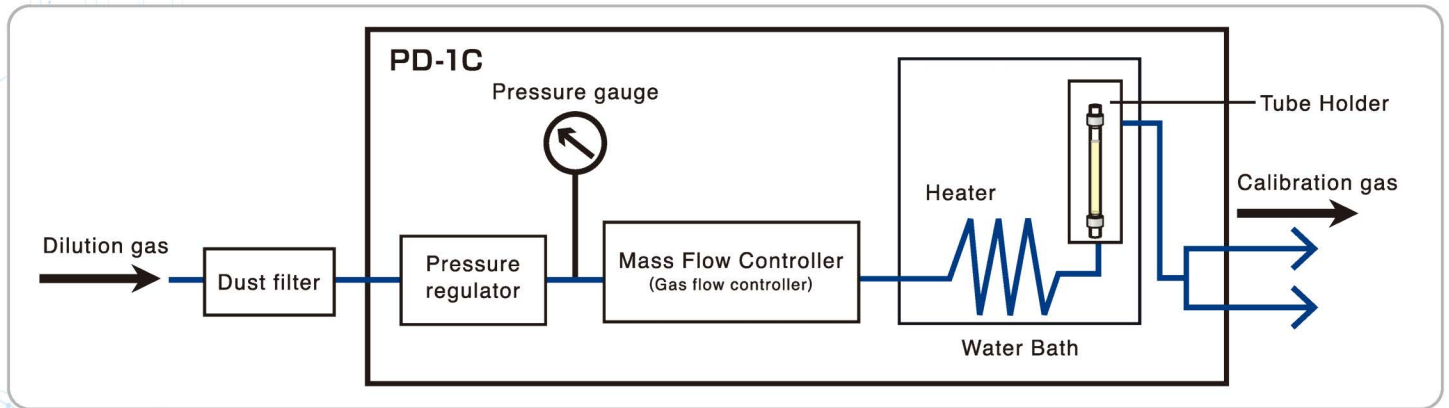
Rear view



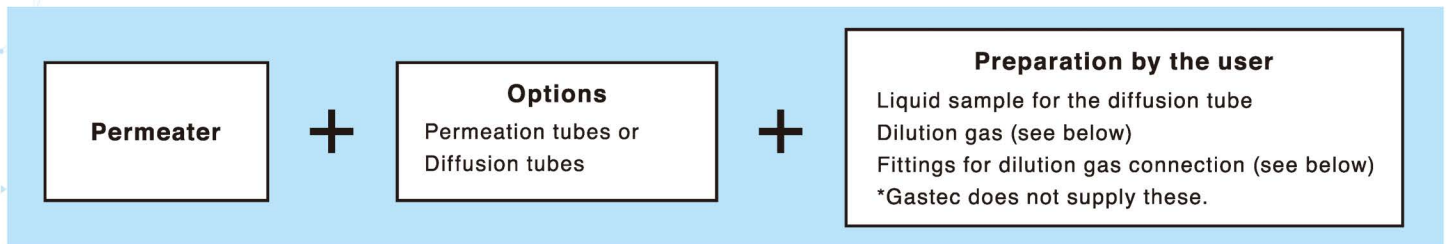
Examples of use

- Calibration gases for environmental measurement and analysis equipment
- Corrosion test
- Exposure test
- Filter evaluation test of air purifiers
- Evaluation tests on sensors and other components
- Odor test
- Deodorisation test

Flow Chart of the System



Preparation for use of permeator



Specifications

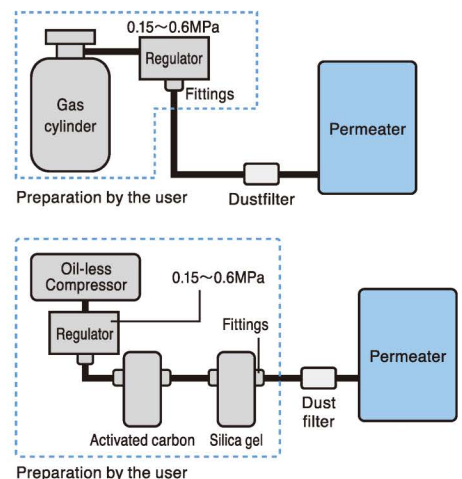
Model No.	PD-1C
Name of Gases to be generated	<ul style="list-style-type: none"> • Permeation Tube Method Stable, high-purity substances with boiling points in the range -60 to +30°C as gas properties. • Diffusion Tube Method Stable, high purity substances with vapour pressures in the range 5-400 mmHg at temperatures between 30 and 50 °C as liquid properties.
Dilution gas	Nitrogen or Air
Dilution gas pressure	0.15 - 0.6MPa
Flow rate setting range	0.2 - 10L/min
Flow rate setting accuracy	0.2 - 0.4L/min: ±13.2% s.p. 0.4 - 1L/min: ±7.0% s.p. 1 - 10L/min: ±3.7% s.p.
Operation temp. range	(Room temperature +5°C) - 50°C *1
Temperature setting accuracy	±0.15°C
Tube Holder Capacity	Permeation tube Standard size: 10pcs. H size *2 : 5pcs. Diffusion Tube for D-10, D-20, D-30: 1pcs. For Multi-type Diffusion Tubes: 4pcs.
Power supply, Max power consumption	100 - 240V AC 50-60Hz 160W
Dimensions	250(W)×340(H)×315(D)mm
Weight	Approx. 14kg (without water)
Standard accessories	Tube for calibration gas(FEP Tube O.D. φ6 x I.D. φ4mm 2m) × 2, Tube for dilution gas (with dust filter) (O.D. φ6 x I.D. φ4mm 2m) × 1, Power Cord × 1 *3, Conversion adapter × 1 *3, Rubber Stopper × 1, Tube hoding cage × 1
Standards	Low Voltage Directive EN61010-1 EMC EN61326-1 (For use in industrial locations)

*1 Room temperature 15-30 °C *2 Permeation tubes with H in Cat. No.

*3 The item(s) may vary by country or region.

For the dilution gas

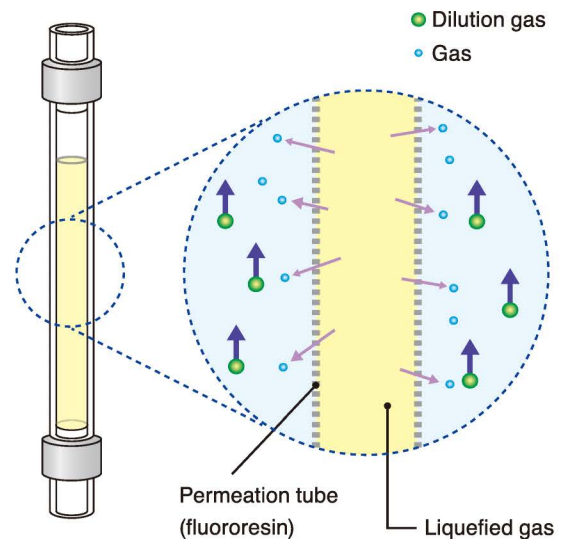
The dilution gas for Permeator is nitrogen or air in a high-pressure gas cylinder, or air compressed with an oil-less compressor, cleaned with activated carbon and silica gel. Use a regulator that can be pressurized from 0.15 to 0.6MPa and supplied to the Permeator.



* Use a cylinder which is capable of withstanding a pressure of 1.2 MPa or higher to fill activated carbon or silica gel.

Generating calibration gas with a permeation tube

A permeation tube is a fluororesin tube that contains high-grade liquefied gas. When the tube is exposed to a certain temperature, liquefied gas penetrates the tube wall by osmosis in time-increments enabling a specific quantity of gas to be retained in the tube. Consequently, a carrier gas flowing at a constant speed (for calibration purposes) can be continuously generated by keeping the tube at a fixed temperature and infusing a constant quantity of dilution gas. This method is highly reliable because the concentration of the calibration gas is determined by calculating the decrease in weight of the permeation tube and the quantity of dilution gas. This dynamic method also enables highly reactive gases such as hydrogen sulphide or ammonia to be generated. As shown in the table below, there are many different kinds of Permeation tubes and they are widely used because they can provide a stable supply of calibration gas.



Calculation of calibration gas concentration with permeation tube

$$C = \frac{K \times Pr \times L}{F}$$

C : Gas concentration for calibration gas (ppm)

Pr : Permeation rate (ng/min/cm)

L : Effective length of tube (cm)

F : Flow of dilution gas (mL/min)

K : Coefficient for converting the gas weight into volume (L/g)

$$K = \frac{22.4}{M} \times \frac{273+t}{273} \times \frac{760}{P}$$

M=Molecular weight
t=Temperature
P=Pressure (mmHg)

Calibration gas examples that can be generated by using a single permeation tube (with 200 to 10000mL/min dilution)

Calibration gas	Catalogue No.	Temperature (°C)	Permeation rate (typical values)	Concentration range (ppm)
Ammonia	P-3	25	117	0.2 - 8.3
		30	174	0.3 - 12.4
		35	250	0.4 - 17.9
Ammonia	P-3-M	25	182	0.3 - 13.0
		30	271	0.4 - 19.4
		35	390	0.6 - 28.0
		40	569	0.8 - 40.8
Bromine	P-10-H	35	106	0.016 - 0.81
		50	330	0.050 - 2.52
1, 3-Butadiene	P-174-H	35	1400	0.7 - 31
Chlorine	P-8-5	25	897	0.15 - 7.7
		30	1300	0.22 - 11.2
Chlorine	P-8-M	35	1906	0.33 - 16.4
		25	1450	0.5 - 25.0
Chlorine	P-8-M	30	2100	0.7 - 36.2
		35	3080	1.1 - 53.1
Dimethyl disulphide	P-73-H	35	11	0.003 - 0.14
		50	35	0.01 - 0.45
Dimethyl sulphide	P-74-H	35	111	0.04 - 2.1
		50	320	0.13 - 6.3
Ethyl mercaptan	P-72-H	35	95	0.04 - 1.87
Formaldehyde	P-91-H-5	50	12	0.0049 - 0.24
Hydrogen sulphide	P-4	25	160	0.1 - 5.7
		30	248	0.2 - 8.8
		35	380	0.3 - 13.6
Methyl chloride	P-132-H	30	3200	1.6 - 77

Calibration gas	Catalogue No.	Temperature (°C)	Permeation rate (typical values)	Concentration range (ppm)
Methyl mercaptan	P-71-5	30	25	0.007 - 0.31
		35	36	0.01 - 0.45
		50	120	0.03 - 1.52
Methyl mercaptan	P-71-H	30	305	0.16 - 7.7
		35	450	0.23 - 11.4
Methylamine	P-182-H	35	650	0.5 - 25.6
Methylene chloride	P-138-H	50	1100	0.3 - 15.8
Propane	P-100	30	45	0.03 - 1.25
		35	70	0.04 - 1.9
Propylene oxide	P-164-H	50	700	0.3 - 15
Styrene	P-124-H	35	19	0.0045 - 0.22
Sulphur dioxide	P-5-5	25	176	0.04 - 1.6
		30	265	0.05 - 2.5
Sulphur dioxide	P-5-5	35	380	0.1 - 3.6
		25	176	0.1 - 3.3
Sulphur dioxide	P-5	30	265	0.1 - 5.0
		35	380	0.2 - 7.2
Sulphur dioxide	P-5-H	30	2788	1.1 - 53.2
		35	4000	1.6 - 76.4
Trimethylamine	P-180-H	35	150	0.06 - 3.1
Vinyl chloride	P-131	30	126	0.05 - 2.4
		35	190	0.08 - 3.7
Vinyl chloride	P-131-H	30	2000	0.8 - 39
		35	3000	1.2 - 58
Vinylidene chloride	P-130-H	35	650	0.16 - 8.2

- Calculate the concentration range based on the Pr shown for each permeation tube.
- If 10 (5 for permeation tubes with H in Cat. No.) permeation tubes are used 10 (5 for permeation tubes with H in Cat. No.) times the concentration shown in Table can be prepared.
- As Permeation tubes have individual differences in permeation rates, the above concentration ranges may differ slightly from the actual range that can be controlled.

Generating calibration gas with a diffusion tube

● Dilution gas
● Gas

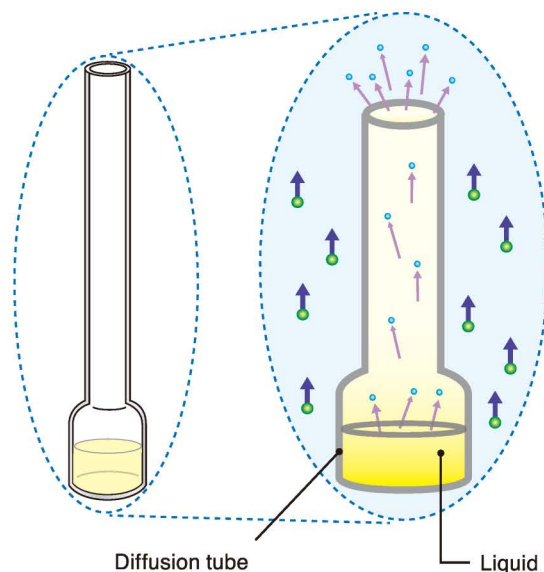
The diffusion tube method is used for the preparation of substances that are generally liquid*1 at room temperature, such as organic solvents.

A diffusion tube with a certain inner diameter is filled with a liquid preparation gas using a syringe, which is maintained at a constant temperature so that the evaporation and diffusion of the liquid in the tube is constant and a constant flow of dilution gas can be fed into it to continuously generate desired low concentration of the calibration gas.

The diffusion tube is a glass container consisting of a diffusion tube with a fixed inner diameter and a liquid reservoir. The diffusion velocity is proportional to the cross-sectional area of the diffusion tube and inversely proportional to its length.

*1 Although not a common application, gases of substances that are solid at normal temperatures can be generated using gas diffusion tubes. Please contact your GASTEC representative for information regarding specific substances.

*2 This method cannot be applied to substances with extremely high or low vapour pressure or substances with decomposability, corrosiveness, hygroscopicity or polymerizability due to their diffusion rate not being constant.



■ Calculation of calibration gas concentration with diffusion tube

$$C = \frac{K \times Dr \times 10^3}{F}$$

C : Gas concentration for calibration gas (ppm)

Dr: Diffusion rate ($\mu\text{g}/\text{min}$)

F : Flow of dilution gas (mL/min)

K : Coefficient for converting the gas weight into volume (L/g)

$$K = \frac{22.4}{M} \times \frac{273+t}{273} \times \frac{760}{P}$$

M=Molecular weight
t=Temperature
P=Pressure (mmHg)



Diffusion tube 3100

Suitable for continuous generation of single component gases for calibration over sustained periods of time.



Diffusion tube for multiple components 3200

Solvents such as thinner contain multiple components. A multiple component type diffusion tube enables the simultaneous generation of 4 types of gases for calibration. Employing this tube enhances analytical testing.

About liquid samples

Use substances with a purity of approx. 95% or higher. Liquid samples must be prepared by the user.

Calibration gas examples that can be generated by using No.3100 diffusion tube (with 200 to 8000mL/min dilution at 30°C(86 °F))

Calibration gas	Diffusion tube type	Diffusion rate (µg/min)30°C	K value (25°C 1atm)	Concentration range(ppm)30°C
Acetic acid	D-30	37.8	0.407	2 - 77
	D-20	12.5		0.6 - 25
	D-10	5.8		0.3 - 12
Acetone	D-30	490	0.421	26 - 1030
	D-20	170		9 - 358
	D-10	75		4 - 158
Amyl acetate	D-30	19	0.188	0.45 - 18
	D-20	6.5		0.15 - 6
	D-10	2.7		0.06 - 2.5
Benzene	D-30	215	0.313	8.4 - 336
	D-20	75		2.9 - 117
	D-10	31		1.2 - 46.5
1-Butanol	D-30	15	0.33	0.62 - 25
	D-20	5.3		0.22 - 8.8
	D-10	2.4		0.1 - 4
2-Butanol	D-30	38	0.33	1.6 - 63
	D-20	13		0.54 - 21.5
	D-10	5.3		0.22 - 8.8
Butyl acetate	D-30	24	0.21	0.6 - 25
	D-20	8.8		0.23 - 9.2
	D-10	4.1		0.11 - 4.4
Carbon disulphide	D-30	1180	0.321	47 - 1890
	D-20	405		16 - 650
	D-10	170		6.8 - 270
Carbon tetrachloride	D-30	445	0.159	9 - 350
	D-20	155		3 - 120
	D-10	65		1.3 - 52
Chlorobenzene	D-30	32	0.217	0.9 - 35
	D-20	11		0.3 - 12
	D-10	4.6		0.125 - 5
Chloroform	D-30	675	0.205	17 - 690
	D-20	230		6 - 240
	D-10	100		2.5 - 100
Cyclohexanol	D-30	3.4	0.244	0.1 - 4
	D-20	1.2		0.04 - 1.5
	D-10	0.47		0.014 - 0.6
Cyclohexanone	D-30	9.8	0.249	0.3 - 12
	D-20	3.3		0.1 - 4
	D-10	1.4		0.044 - 1.7
o-Dichlorobenzene	D-30	4.8	0.166	0.1 - 4
	D-20	1.6		0.033 - 1.33
	D-10	0.7		0.015 - 0.6
cis-1,2-Dichloroethylene	D-30	598	0.252	18.8 - 753
	D-20	203		6.4 - 256
	D-10	79		2.5 - 99.5
trans-1,2-Dichloroethylene	D-30	1241	0.252	39.1 - 1564
	D-20	422		13.3 - 532
	D-10	165		5.2 - 208

Calibration gas	Diffusion tube type	Diffusion rate (µg/min)30°C	K value (25°C 1atm)	Concentration range(ppm)30°C
N,N-Dimethylformamide	D-30	8.5	0.335	0.36 - 14.2
	D-20	2.9		0.12 - 4.8
	D-10	1.3		0.05 - 2.1
1,4-Dioxane	D-30	89	0.277	3 - 120
	D-20	31		1.1 - 43
	D-10	13		0.45 - 18
Ethanol	D-30	104	0.531	7 - 277
	D-20	35.7		2 - 95
	D-10	15.5		1 - 41
Ethyl acetate	D-30	225	0.278	7.8 - 310
	D-20	78		2.7 - 108
	D-10	33		1.2 - 46
Ethylene dichloride	D-30	220	0.247	7 - 270
	D-20	75		2.3 - 93
	D-10	31		1 - 40
Ethyl ether	D-30	2210	0.33	91 - 3650
	D-20	770		32 - 1270
	D-10	340		14 - 560
n-Hexane	D-30	315	0.284	11.2 - 447
	D-20	110		3.9 - 156
	D-10	46		1.6 - 65
Isoamyl acetate	D-30	18	0.188	0.42 - 17
	D-20	6		0.14 - 5.6
	D-10	2.4		0.06 - 2.3
Isoamyl alcohol	D-30	8.6	0.277	0.3 - 12
	D-20	2.9		0.1 - 4
	D-10	1.2		0.04 - 1.7
Isobutyl acetate	D-30	48	0.21	1.3 - 50
	D-20	17		0.45 - 18
	D-10	6.8		0.18 - 7
Isobutyl alcohol	D-30	24	0.33	1 - 40
	D-20	8.5		0.35 - 14
	D-10	3.6		0.15 - 6
Isopropyl acetate	D-30	145	0.239	4.3 - 170
	D-20	50		1.5 - 60
	D-10	21		0.63 - 25
Isopropyl alcohol	D-30	85	0.407	4.3 - 170
	D-20	29		1.5 - 60
	D-10	13		0.66 - 27
Methanol	D-30	210	0.763	20 - 800
	D-20	72		6.9 - 275
	D-10	31		3 - 120
Methyl acetate	D-30	535	0.33	22 - 880
	D-20	185		7.6 - 305
	D-10	79		3.3 - 130
Methyl n-butyl ketone	D-30	31	0.244	0.95 - 37.8
	D-20	11		0.34 - 13.4
	D-10	4.3		0.13 - 5.3

Calibration gas	Diffusion tube type	Diffusion rate (µg/min)30°C	K value (25°C 1atm)	Concentration range(ppm)30°C
Methylcyclohexanol	D-30	2.4	0.214	0.06 - 2.6
	D-20	0.83		0.022 - 0.9
	D-10	0.33		0.009 - 0.35
Methylcyclohexanone	D-30	6.9	0.218	0.19 - 7.5
	D-20	2.4		0.065 - 2.6
	D-10	1		0.027 - 1.1
Methylene chloride	D-30	1600	0.288	58 - 2300
	D-20	545		20 - 790
	D-10	230		8.3 - 330
Methyl ethyl ketone	D-30	185	0.339	7.8 - 314
	D-20	64		2.7 - 109
	D-10	27		1.14 - 46
Methyl isobutyl ketone	D-30	44	0.244	1.3 - 54
	D-20	16		0.49 - 19.5
	D-10	7.4		0.23 - 9
n-Pentane	D-30	1688	0.339	72 - 2860
	D-20	589		25 - 998
	D-10	253		11 - 428
Propyl acetate	D-30	91	0.239	2.7 - 110
	D-20	31		0.93 - 37
	D-10	13		0.4 - 16
Styrene	D-30	15	0.235	0.44 - 17.6
	D-20	5.3		0.16 - 6
	D-10	2.3		0.07 - 2.7
1,1,2,2-Tetrachloroethane	D-30	18	0.146	0.33 - 13
	D-20	6.2		0.11 - 4.5
	D-10	2.6		0.05 - 1.9
Tetrachloroethylene	D-30	66	0.147	1.2 - 49
	D-20	23		0.4 - 17
	D-10	10		0.2 - 7.4
Tetrahydrofuran	D-30	345	0.339	15 - 585
	D-20	120		5 - 200
	D-10	53		2.3 - 90
Toluene	D-30	65	0.265	2.2 - 86
	D-20	23		0.76 - 30
	D-10	9.6		0.4 - 14
1,1,1-Trichloroethane	D-30	380	0.183	8.7 - 350
	D-20	130		3 - 120
	D-10	56		1.3 - 51
Trichloroethylene	D-30	245	0.186	5.7 - 228
	D-20	85		2 - 79
	D-10	36		0.84 - 34
Xylene	D-30	21	0.23	0.6 - 24
	D-20	7.3		0.2 - 8
	D-10	3.3		0.1 - 4

- The Dr values in the table are our measured or estimated values. For higher accuracy, we recommend actual measurement under actual conditions of use.
- If the diffusion tube is held at 50 °C, concentrations approximately three times higher than those shown in the table can be prepared. For further information, please contact us.

Calibration gas examples that can be generated by using No.3200 diffusion tube (with 200 to 8000mL/min dilution at 30 to 50°C(86 to 122°F))

Calibration gas	Calibration range(ppm)
Acetic acid	0.1 - 260
Acetone	1.5 - 4,600
Acrylonitrile	1.1 - 910
Amyl acetate	0.1 - 20
Aniline	0.1 - 9.1
Benzene	0.5 - 1,100
Benzotrithloride	0.02 - 0.7
1-Butanol	0.1 - 100
sec-Butanol	0.1 - 260
tert-Butanol	0.2 - 610
Butyl acetate	0.1 - 62
Carbon disulphide	2.7 - 4,600
Carbon tetrachloride	0.5 - 1,100
Chlorobenzene	0.1 - 110
Chloroform	1.0 - 2,600
Cyclohexane	0.8 - 550
Cyclohexanol	0.1 - 5.9
Cyclohexanone	0.1 - 25

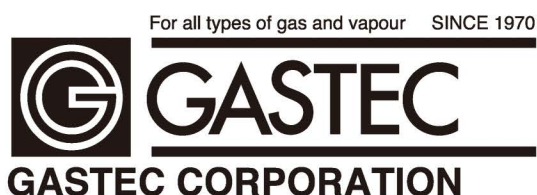
Calibration gas	Calibration range(ppm)
o-Dichlorobenzene	0.1 - 8.5
1,1-Dichloroethane	1.3 - 3,700
1,2-Dichloroethylene	4.1 - 1,700
Diethylamine	1.5 - 4,600
N,N-Dimethylformamide	0.1 - 61
1,4-Dioxane	0.2 - 430
Ethanol	0.4 - 1,000
Ethyl acetate	0.5 - 1,100
Ethyl benzene	0.1 - 96
Ethyl bromide	4.1 - 3,400
Ethylene dichloride	0.4 - 900
Ethyl ether	5.3 - 4,300
Formic acid	0.3 - 770
n-Heptane	0.3 - 220
1-Heptanol	0.1 - 4.5
n-Hexane	0.6 - 1,400
1-Hexanol	0.1 - 11
Isoamyl acetate	0.1 - 32

Calibration gas	Calibration range(ppm)
Isoamyl alcohol	0.1 - 26
Isobutyl acetate	0.1 - 93
Isobutyl alcohol	0.1 - 170
Isopropyl acetate	0.5 - 330
Isopropyl ether	0.6 - 1,500
Methanol	1.1 - 3,200
Methyl acetate	1.3 - 3,800
Methyl n-butyl ketone	0.1 - 70
1-Methylcyclohexanol	0.1 - 9.6
3-Methylcyclohexanone	0.1 - 14
Methylene chloride	2.9 - 3,700
Methyl ethyl ketone	0.4 - 1,000
Methyl isobutyl ketone	0.2 - 113
n-Octane	0.1 - 110
n-Pentane	4.2 - 3,500
1-Pentanol	0.1 - 34
1-Propanol	0.1 - 330
2-Propanol	0.2 - 720

Calibration gas	Calibration range(ppm)
Propionic acid	0.1 - 56
Propyl acetate	0.2 - 190
Propyl bromide (1-Bromopropane)	0.7 - 1,600
Styrene	0.1 - 37
1,1,2,2-Tetrachloroethane	0.1 - 50
Tetrachloroethylene	0.1 - 97
Tetrahydrofuran	1.7 - 1,100
Toluene	0.1 - 290
1,1,1-Trichloroethane	0.5 - 1,200
1,1,2-Trichloroethane	0.1 - 230
Trichloroethylene	0.5 - 410
Triethylamine	0.2 - 570
m-Xylene	0.1 - 77
o-Xylene	0.1 - 67
p-Xylene	0.1 - 79

- The Dr values in the table are our measured or estimated values. For higher accuracy, we recommend actual measurement under actual conditions of use.

Specifications and appearance are subject to change without notice.
Read and understand the instruction manuals completely before operating.
The actual products may differ slightly from the pictures shown.



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