

MATERIAL COMPATIBILITY

CHART

KEY	I = Insufficient data available to determine the compatibility with the intended gas.	U = Unsatisfactory for use with the intended gas.
	S = Satisfactory for use with the intended gas (dry anhydrous) at normal operating temperature of 70°F	C = Compatibility depends on condition of use

NOTE: This chart is intended as a guide only. Actual applications may include variables which can effect the compatibility of certain materials with particular gases. Contact your gas supplier for additional compatibility information regarding the gases being used.
 * The user should be thoroughly familiar with the specific properties of the gas material compatability depends on condition of use.

Gas	Primary Hazards					Metals					Plastics				Elastomers		
	Asphyxiant	Toxic	Flammable	Corrosive	Oxidizer	Aluminum	Brass	Copper	Monel	Stainless Steel	Kel-F/PTFE	Teflon	Tefzel	Kynar	Viton	Buna-N	Neoprene
Acetylene	•		•			S	S	U	S	S	S	S	S	S	S	S	S
Air					•	S	S	S	S	S	S	S	S	S	S	S	S
Ammonia		•	•	•		S	U	U	S	S	S	S	S	S	S	S	S
Argon	•					S	S	S	S	S	S	S	S	S	S	S	S
*Arsine		•	•			I	S	S	S	S	S	S	S	S	S	S	S
Boron Trichloride		•		•		U	C	C	S	S	S	S	S	I	I	I	I
Boron Trifluoride		•		•		I	C	C	S	S	S	S	S	I	I	I	I
Boron-11 Trifluoride		•		•		I	C	C	S	S	S	S	S	I	I	I	I
*Bromine Trifluoride		•		•	•	C	C	C	S	S	C	C	S	U	U	U	U
1,3-Butadiene		•	•			S	S	S	S	S	S	S	S	S	S	S	S
n-Butane	•		•			S	S	S	S	S	S	S	S	S	S	S	S
1-Butene			•			S	S	S	S	S	S	S	S	S	S	S	S
cis-2-Butene			•			S	S	S	S	S	S	S	S	S	S	S	S
trans-2-Butene			•			S	S	S	S	S	S	S	S	S	S	S	S
Carbon Dioxide	•					S	S	S	S	S	S	S	S	S	S	C	C
Carbon Monoxide		•	•			S	S	S	S	S	S	S	S	S	S	S	S
Chlorine		•		•		U	U	U	S	S	S	S	S	S	S	U	U
*Chlorine Trifluoride		•	•	•	•	S	I	I	S	C	C	C	S	U	U	U	U
Deuterium	•		•			S	S	S	S	S	S	S	S	S	S	S	S
Dichlorosilane		•	•	•		U	I	I	S	S	S	S	S	S	I	I	I
Di-, Mono-, and Trimethylamines		•	•	•		U	U	U	S	S	S	S	S	S	U	U	I
Disilane			•			S	S	S	S	S	S	S	S	S	S	S	S
Ethane	•		•			S	S	S	S	S	S	S	S	S	S	S	S
Ethyl Chloride			•			S	S	S	S	S	S	S	S	S	S	S	S
Ethylene	•		•			S	S	S	S	S	S	S	S	S	S	S	S
*Fluorine		•		•	•	C	C	C	S	C	C	C	C	U	U	U	U
Halobarbon-14						S	S	S	S	S	S	S	S	S	S	S	S
Halocargon-23	•					S	S	S	S	S	S	S	S	S	S	S	S
Halocarbon-116	•					S	S	S	S	S	S	S	S	S	S	S	S
Helium	•					S	S	S	S	S	S	S	S	S	S	S	S
Hydrogen	•		•			S	S	S	S	S	S	S	S	S	S	S	S
Hydrogen Bromide		•		•		U	U	U	S	S	S	S	S	S	S	U	U
Hydrogen Chloride		•		•		U	U	U	S	S	S	S	S	S	S	U	U
*Hydrogen Fluoride		•		•		U	U	U	S	S	S	S	S	S	U	U	U
*Hydrogen Sulfide		•	•	•		S	S	I	S	S	S	S	S	S	U	S	S
Isobutane	•		•			S	S	S	S	S	S	S	S	S	S	S	S
Isobutylene	•		•			S	S	S	S	S	S	S	S	S	S	S	S
Krypton	•					S	S	S	S	S	S	S	S	S	S	S	S
Methane	•		•			S	S	S	S	S	S	S	S	S	S	S	S
Methyl Chloride		•	•			U	S	S	S	S	S	S	S	S	S	U	U
Methyl Fluoride		•	•			S	S	S	S	S	S	S	S	S	I	I	I
Neon	•					S	S	S	S	S	S	S	S	S	S	S	S
Nitric Oxide		•		•	•	S	U	U	U	S	S	S	S	S	S	I	I
Nitrogen	•					S	S	S	S	S	S	S	S	S	S	S	S
Nitrogen Dioxide		•		•	•	S	U	U	U	S	S	S	I	I	U	U	U
Nitrogen Trifluoride		•			•	I	S	S	S	S	S	S	S	S	S	I	I
Nitrous Oxide					•	S	S	S	S	S	S	S	S	S	S	S	S
Octafluorocyclobutane	•					S	S	S	S	S	S	S	S	S	S	S	S
Octafluoropropane	•					S	S	S	S	S	S	S	S	I	I	S	S
*Oxygen					•	U	S	S	S	C	S	S	S	S	C	U	U
*Phosphine		•	•			S	I	I	S	S	S	S	S	I	I	I	I
Propane	•		•			S	S	S	S	S	S	S	S	S	S	S	S
Propylene	•		•			S	S	S	S	S	S	S	S	S	S	S	U
*Silane			•			S	S	S	S	S	S	S	S	S	S	S	S
Silicone Tetrachloride		•		•		U	U	U	S	S	S	S	S	S	U	U	U
Silicone Tetrafluoride		•		•		U	U	U	S	S	S	S	S	S	U	U	U
Sulfur Dioxide		•		•		S	U	S	S	S	S	S	S	S	S	U	U
Sulfur Hexafluoride	•					S	S	S	S	S	S	S	S	S	S	S	S
Sulfur Tetrafluoride		•		•		U	U	U	S	S	S	S	S	S	U	U	U
Tungsten Hexafluoride		•		•		U	U	U	S	S	S	S	S	S	U	U	U
Xenon	•					S	S	S	S	S	S	S	S	S	S	S	S

REGULATOR

CGA CONNECTIONS

GAS	CGA Inlet Connection	GAS	CGA Inlet Connection	GAS	CGA Inlet Connection
Acetylene	510	"Freon 13"		Methyl Bromide	330
Air (Industrial)	590	(Chlorotrifluoromethane)	660	3-Methyl Butene-1	510
Air (Breathing Air)	346	"Freon 13B1"		Methyl Chloride	510
Allene	510	(Bromotrifluoromethane)	660	Methyl Mercaptan	330
Ammonia	705, 240	"Freon 14"		Monoethylamine	705
Argon	580	(Tetrafluoromethane)	580	Monomethylamine	705
Arsine	350	"Freon 22"		Natural Gas	350
Boron Trichloride	660	(Chlorodifluoromethane)	660	Neon	580
Boron Trifluoride	330	"Freon 114"		Nickel Carbonyl	660
Bromine Trifluoride	670	(1, 2 Dichlorotetrafluoroethane)	660	Nitric Oxide	660
Bromine Pentafluoride	670	"Freon 116"		Nitrogen	580
Bromotrifluoroethylene	510	(Hexafluoroethane)	660	Nitrogen Dioxide	660
1-3 Butadine	510	"Freon RC318"		Nitrogen Trioxide	660
Butane	510	(Octafluorocyclobutane)	660	Nitrosyl Chloride	330
Butenes	510	"Genetron 21"		Nitrous Oxide (Formerly 1320)	326
Carbon Dioxide	320	(Dichlorofluoromethane)	660	Oxygen	540
Carbon Monoxide	350	"Genetron 23"		Perfluoro-2-Butene	660
Carbonyl Fluoride	750	(Fluoroform)	660	Perfluoropropane	660
Carbonyl Sulfide	330	"Genetron 115"		Phosgene	660
Chlorine	660	(Monochloropentafluoroethane)	660	Phosphine	350
Chlorine Trifluoride	670	"Genetron 152A"		Phosphorous Pentafluoride	330
Chlorotrifluoroethylene	510	(1, 1-Difluoroethylene)	350	Propane	510
Cyanogen	750	"Genetron 1132A"		Propylene	510
Cyanogen Chloride	750	(1, 1-Difluoroethylene)	350	Silane	350
Cyclopropane	510	Germane	350	Silicon Tetrafluoride	330
Deuterium	350	Helium	580	Sulfur Dioxide	660
Diborane	350	Hexafluoroacetone	330	Sulfur Hexafluoride	590
1,2-Dibromodifluoromethane	668	Hexafluoropropylene	660	Sulfur Tetrafluoride	330
Dimethylamine	705	Hydrogen	350	Sulfuryl Fluoride	660
Dimethyl Ether	510	Hydrogen Bromide	330	Tetrafluoroethylene	350
2-2 Dimethyl Propane	510	Hydrogen Chloride	330	Trimethylamine	705
Ethane	350	Hydrogen Fluoride	670	Vinyl Bomide	510
Ethyl Acetylene	510	Hydrogen Selenide	350	Vinyl Chloride	510
Ethyl Chloride	510	Hydrogen Sulfide	330	Vinyl Fluoride	350
Ethylene	350	Iodine Pentafluoride	670	Vinyl Methyl Ether	510
Ethylene Oxide	510	Isobutane	510	Xenon	580
Fluorine	679	Isobutylene	510		
"Freon 12"		Krypton	580		
(Dichlorodifluoromethane)	660	Methane	350		
		Methyl Acetylene	510		

NOTE: The above are standard CGA connections and are designated by the Compressed Gas Association

SAFETY & TECHNICAL

GAS PROPERTIES

Product	Formula	State	Molecular Weight	THERMOPHYSICAL PROPERTIES						HAZARDOUS PROPERTIES			
				Vapor Pressure at 70° F (psig)	Specific Gravity at 70° F (1atm)	Critical Temp. (°F)	Critical Pressure (psia)	Specific Volume (cf/lb)	Heat Capacity (Btu/lb. Mole °F)	Ignition Temp., (°F)	Flammable Limits in Air (Vol.%)	Threshold Limit Value (ppm)	Physiological Properties
Acetylene	C ₂ H ₂	Dissolved Gas	26.04	635	0.905	97.3	905.3	14.7	10.6	581	2.5-81	SA	
Air		Compressed Gas	28.97	*	1.00	-221.1	546.8	13.3					Oxidant
Ammonia	NH ₃	Liquefied Gas	17.03	114	0.60	270.4	1639	22.6	8.6	1204	15-28	25	Corrosive and Toxic
Argon	Ar	Compressed Gas	39.95	*	1.38	-188.1	710	9.7	4.97			SA	Inert
Arsine	AsH ₃	Liquefied Gas	77.95	205	2.69	211.8	957	5.0			4-64	0.05	Poison
n-Butane	C ₄ H ₁₀	Liquefied Gas	58.12	16	2.08	305.6	550.8	6.4		788	1.8-8.4	800	Narcotic
Carbon Dioxide	CO ₂	Liquefied Gas	44.01	838	1.52	87.8	1071	8.74	8.97			5,000	Inert
Carbon Monoxide	CO	Compressed Gas	28.01	*	0.97	-220.4	507.4	13.8	6.96	1204	12.5-74	50	Toxic
Chlorine	Cl ₂	Liquefied Gas	70.91	85.3	2.47	291.2	1118.7	5.4	8.2			1	Oxidant and Toxic
Deuterium	D ₂	Compressed Gas	4.03	*	0.139	-390.7	241	96.0	6.97	1058	4.9-75	SA	
Diborane	B ₂ H ₆	Compress Gas	27.67	*	0.95	62.1	581			100	0.8-98	0.05	Highly Toxic
Ethane	C ₂ H ₆	Liquefied Gas	30.07	543	1.047	90.1	708	12.8	12.6	986	3-12.4	SA	
Ethyl Chloride	C ₂ H ₅ Cl	Liquefied Gas	64.52			368.96	764.4				3.8-15.4	1000	
Ethylene	C ₂ H ₄	Compressed Gas	28.05	*	0.974	49.8	742	13.8	10.4	1009	3.1-32	SA	
Helium	He	Compressed Gas	4.003	*	0.138	-450.3	33.2	96.7	4.98			SA	Inert
Hydrogen	H ₂	Compressed Gas	2.02	*	0.0696	-399.96	190.8	192	6.89	1085	4-75	SA	
Hydrogen Chloride	HCl	Liquefied Gas	36.46	613	1.27	124.6	1200	10.6	6.9			5	Corrosive and Toxic
Hydrogen Sulfide	H ₂ S	Liquefied Gas	34.08	252	1.189	212.7	1308	11.2	8.2	500	4.3-45	10	Irritant and Toxic
Isobutane	C ₄ H ₁₀	Liquefied Gas	58.12	30.8	2.0	275	592.2	6.5		864	1.8-8.4	SA	Anaesthetic
Krypton	Kr	Compressed Gas	83.8	*	2.898	-82.8	798	4.6	5.0			SA	Inert
Methane	CH ₄	Compressed Gas	16.04	*	0.555	-115.8	673	23.7		1000	5-15	SA	
Methyl Chloride	CH ₃ Cl	Liquefied Gas	50.49	58.7	1.74	289.6	968	7.6	9.97	1170	10.7-17.4	50	Toxic
Neon	Ne	Compressed Gas	20.18	*	0.696	-379.8	384.9	19.2	4.97			SA	Inert
Nitrogen	N ₂	Compressed Gas	28.01	*	0.967	-232.4	492.9	13.8	6.97			SA	Inert
Nitrous Oxide	N ₂ O	Liquefied Gas	44.01	745	1.53	97.6	1054	8.7	9.2			25	Oxidant
Oxygen	O ₂	Compressed Gas	32.0	*	1.105	-181.1	736.9	12.1	7.03				Oxidant
Phosphine	PH ₃	Liquefied Gas	34.0	592.7	1.184	124.3	948	11.4		122	Treat as Pyrophoric	0.3	Poison
Propane	C ₃ H ₈	Liquefied Gas	44.1	109	1.55	206.2	617.4	8.5	17.4	874	2.1-9.5	SA	
Silane	SiH ₄	Compressed Gas	32.12	*	1.11	24.8	702.7	12.0			Pyrophoric	0.5	
Sulfur Dioxide	SO ₂	Liquefied Gas	64.06	34.4	2.26	315	1143	5.9	9.6			2	Irritant and Toxic
Sulfur Hexafluoride	SF ₆	Liquefied Gas	146.05	310	5.11	114	545	2.5				1000	Inert
Xenon	Xe	Compressed Gas	131.3	*	4.56	61.9	852.6	2.9	5.02			SA	Inert

* Above critical temperature @ 21.1 °C.

SA Simple asphyxiant

CONVERSION TABLES

Multiply unit in left column by select applicable factor at right

VOLUME

	cu in	cu ft	cu yd	cu cm	cu meter	liter	US gal
1 cu in	1	-	-	16.387	-	0.02	-
1 cu ft	1,728.0	1	0.0370	28,317	0.0283	28.32	7.481
1 cu yd	46,656	27	1	-	0.7646	764.5	202.0
1 cu cm	0.06	-	-	1	-	0.001	-
1 cu meter	61,024	35.31	1.308	1,000,000	1	1,000	264.2
1 liter	61.024	0.0353	-	1,000	0.001	1	0.2642
1 gallon (US)	231	0.1337	0.00495	3,785.4	0.00379	3.785	1

PRESSURE

	psi	bar	atm	mm Hg	inch Hg	inch water	kPa
1 psi	1	0.0689	0.0680	51.713	2.0359	27.68	6.895
1 bar	14.504	1	0.9869	750.06	29.530	401.48	100
1 atm	14.696	1.01325	1	760	29.921	406.8	101.325
1 mm Hg (torr)	0.0193	0.0013	0.00132	1	0.0394	0.5352	0.133
1 MPa	145.038	10.00	9.8692	7500.62	295.30	4014.63	1000
1 in Hg	0.4912	0.0339	0.0334	25.4	1	13.596	3
1 in water	.0361	0.3587	0.0025	269.02	10.591	1	35.808
1 kPa	0.145	0.01	0.0099	7.519	0	4.015	1

WEIGHT

	grain	oz	lb	ton	gram	kg	metric ton
1 grain	1	0.00229	-	-	0.0648	-	-
1 ounce	437.5	1	0.0625	-	28.35	0.02835	-
1 pound	7,000	16.00	1.00	0.0005	453.60	0.4536	-
1 ton	-	32,000	2,000	1	-	907.2	0.9072
1 gram	15.43	0.04	-	-	1	0.001	-
1 kilogram	-	35.274	2.205	-	1,000	1	0.001
1 metric ton	-	35.274	2.205	1.102	-	1,000	1

FLOW

	scc/min	LPM	SCFM	L/hr	Nm ³ /hr	SCFH
1 scc/min	1	0.001	-	0.06	-	0.00212
1 LPM	1,000	1	0.0353	60	0.06	2.119
1 SCFM	28,317	28	1	1,699	1.699	60
1 L/hr	16.667	0.01667	-	1	0.001	0.0353
1 Nm ³ /hr	16,667	16.667	0.589	1,000	1	35.314
1 SCFH	471.95	0.472	0.0167	28.317	0.0283	1
SCFM	Standard Cubic Feet per Minute		scc/min	Standard Cubic Centimeters per Minute		
SCFH	Standard Cubic Feet per Hour		LPM	Liters per Minute		
			Nm ³ /hr	Normal Cubic Meters per Hour		

DENSITY

	lb/cu in	lb/cu ft	lb/gal	g/cm ³	g/liter
1 lb/cu in	1	1,728	231.00	27.68	27,680
1 lb/cu ft	-	1	0.1337	0.0160	16.019
1 lb/gal	0.00433	7.481	1	0.1198	119.83
1 g/cm ³	0.03613	62.43	8.345	1	1,000
1 g/liter	-	0.06243	0.008345	0.001	1

CONVERSION

LIQUID TO GAS

ARGON

	WEIGHT		GAS		LIQUID	
	Pounds (lbs)	Kilograms (Kg)	Cubic Feet (SCF)	Cubic Meters (Nm3)	Gallons (Gal)	Liters (L)
1 Pound	1	0.4536	9.671	0.2543	0.086	0.3255
1 Kilogram	2.205	1	21.32	0.5605	0.18957	0.7176
1 SCF Gas	0.1034	0.0469	1	0.02832	0.008893	0.03366
1 Nm ³ Gas	3.933	1.784	38.04	1	0.3382	1.2802
1 Gal Liquid	11.63	5.276	112.5	2.957	1	3.785
1 L Liquid	3.072	1.3936	29.71	0.7812	0.2642	1

CARBON DIOXIDE

	WEIGHT		GAS		LIQUID	
	Pounds (lbs)	Kilograms (Kg)	Cubic Feet (SCF)	Cubic Meters (Nm3)	Gallons (Gal)	Liters (L)
1 Pound	1.0	0.4536	8.741	0.2294	0.11806	0.4469
1 Kilogram	2.205	1.0	19.253	0.5058	0.2603	0.9860
1 SCF Gas	0.1144	0.05189	1.0	0.02832	0.013506	0.05113
1 Nm ³ Gas	4.359	1.9772	38.04	1.0	0.5146	1.9480
1 Gal Liquid	8.470	3.842	74.04	1.9431	1.0	3.785
1 L Liquid	2.238	1.0151	19.562	0.5134	0.2642	1.0

NITROGEN

	WEIGHT		GAS		LIQUID	
	Pounds (lbs)	Kilograms (Kg)	Cubic Feet (SCF)	Cubic Meters (Nm3)	Gallons (Gal)	Liters (L)
1 Pound	1.0	0.4536	13.803	0.3627	0.1481	0.5606
1 Kilogram	2.205	1.0	30.42	0.7996	0.3262	1.2349
1 SCF Gas	0.07245	0.03286	1.0	0.02832	0.01074	0.04065
1 Nm ³ Gas	2.757	1.2506	38.04	1.0	0.408	1.5443
1 Gal Liquid	6.745	3.060	93.11	2.447	1.0	3.785
1 L Liquid	1.782	0.8083	24.60	0.6464	0.2642	1.0

OXYGEN

	WEIGHT		GAS		LIQUID	
	Pounds (lbs)	Kilograms (Kg)	Cubic Feet (SCF)	Cubic Meters (Nm3)	Gallons (Gal)	Liters (L)
1 Pound	1.0	0.4536	12.076	0.3174	0.1050	0.3977
1 Kilogram	2.205	1.0	26.62	0.6998	0.2316	0.8767
1 SCF Gas	0.08281	0.03756	1.0	0.02832	0.008691	0.0329
1 Nm ³ Gas	3.151	1.4291	38.04	1.0	0.3310	1.2528
1 Gal Liquid	9.527	4.322	115.1	3.025	1.0	3.785
1 L Liquid	2.517	1.1417	30.38	0.7983	0.2642	1.0

SCF (Standard Cubic Foot) gas measured at 1 atmosphere and 70°F. Nm3 (normal cubic meter) measured at 1 atmosphere and 0°C. Liquid Argon, Oxygen and Nitrogen measured at 1 ATM and Boiling Point of Liquid Carbon Dioxide measured at 21.42 ATM and 1.7°F.

WARRANTY

SMITH SPECIALTY GAS REGULATOR MANUFACTURERS WARRANTY

SMITH EQUIPMENT SPECIALTY GAS REGULATOR MANUFACTURERS WARRANTY

General Purpose, High Purity Analytical, and High Purity Regulators

Smith Equipment warrants the initial user of the products sold that such products are free from defects in material and workmanship under normal use and service for a period of (2) two years from the date of shipment from the factory.

Corrosive Service Regulators

Smith Equipment warrants the initial user of the products sold that such products are free from defects in material and workmanship under normal use and service (see note #1) for a period of three months from the date of installation of the equipment or three months from the date of shipment from the factory, whichever comes first.

Note #1 A Cross-Purge Assembly must be used in conjunction with these models in order to ensure effective purging of hazardous gas traces during cylinder change out.

Within said warranty period, Smith Equipment agrees to replace or repair free of charge at its factory, any product or part that is found to have defects in workmanship or materials.

Smith Equipment will not pay for or warrant repairs made by anyone other than personnel authorized by Smith Equipment to make such repairs. SMITH EQUIPMENT SHALL NOT BE LIABLE FOR CONSEQUENTIAL, SPECIAL, INCIDENTAL, OR INDIRECT DAMAGES, TO THE EXTENT PERMITTED BY LAW. EXCEPT AS OTHERWISE PROVIDED BY LAW, THIS EXPRESS WARRANTY SHALL BE THE EXCLUSIVE WARRANTY AND SHALL BE IN LIEU OF ALL IMPLIED WARRANTIES, INCLUDING IMPLIED WARRANTIES OF FITNESS FOR PARTICULAR PURPOSE AND MERCHANTABILITY. The warranty and remedies provided in this express warranty shall not apply to any product which has been damaged by accident, abuse or misuse, or modified or changed in any way except by personnel authorized by Smith Equipment. THE REMEDIES STATED HEREIN SHALL BE EXCLUSIVE REMEDIES OF THE INITIAL USER UNDER THE EXPRESS WARRANTY CONTAINED HEREIN AND UNDER ANY OTHER WARRANTIES EXPRESS OR IMPLIED REQUIRED BY LAW.