



High Pressure Equipment

Technical Information

Selecting the right product to plumb your pressure system or conduct your research project is a critical decision. In this section, High Pressure Equipment Company provides a variety of technical information to assist you in this selection process. We have included a number of English to Metric conversion charts, flow coefficient formulas and valve ratings, reactor pressure ratings, and recommended torque values for our air operated valves and tubing connections.

As you work with this data, it is important to consider that it is general in nature and may vary depending on the actual parameters of your application. If you have any questions concerning this information or would like assistance in selecting an HiP product, our engineering staff is available and ready to help.



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Conversion Tables

Pressure

	Pa	kPa	psi	kg/cm ²	bar	atm	MPa
Pa	1	0.001	1.450×10^{-4}	1.020×10^{-5}	1×10^{-5}	9.869×10^{-6}	1×10^{-6}
kPa	1000	1	0.145	0.01	0.01	0.01	0.001
psi	6.895×10^3	6.895	1	0.07	0.069	0.068	0.007
kg/cm ²	9.807×10^4	98.07	14.22	1	0.981	0.968	0.098
bar	1×10^5	100	14.50	1.02	1	0.987	0.1
atm	101.3×10^5	101.3	14.7	1.033	1.013	1	0.101
MPa	1×10^6	1000	145	10.2	10	9.869	1

Flow

	mL/min	in ³ /min	ft ³ /hr	liter/min	gal/min
mL/min	1	0.061	0.002	0.001	6.242×10^{-4}
in ³ /min	16.39	1	0.035	0.016	0.004
ft ³ /hr	472	28.8	1	0.472	0.125
liter/min	1000	61.02	2.119	1	0.264
gal/min	3785	231	8.021	3.785	1

Weight/Mass

	gram	oz	lb	kg
gram	1	0.035	0.002	0.001
oz	28.35	1	0.063	0.028
lb	453.6	16	1	0.454
kg	1000	35.28	2.205	1

Volume

	mL	in ³	liter	gal	ft ³	m ³
mL	1	0.061	0.001	2.642×10^{-4}	3.531×10^{-5}	1×10^{-6}
in ³	16.39	1	0.016	0.004	5.787×10^{-4}	1.639×10^{-5}
liter	1000	61.02	1	0.264	0.035	0.001
gal	3.785×10^3	231	3.785	1	0.134	0.004
ft ³	2.832×10^4	1.728×10^3	28.32	7.481	1	0.028
m ³	1×10^6	6.102×10^4	1000	264.2	35.32	1

Linear

	micron	millimeter	centimeter	inch	foot	meter
micron	1	0.001	1×10^{-4}	3.937×10^{-5}	3.281×10^{-6}	1×10^{-10}
millimeter	1000	1	0.1	0.03937	0.003	0.001
centimeter	1×10^{-4}	10	1	0.394	0.033	0.01
inch	2.540×10^4	25.4	2.54	1	0.083	0.025
foot	3.048×10^5	304.8	30.48	12	1	0.305
meter	1×10^6	1000	100	39.37	3.281	1

Flow Coefficients

The flow coefficient Cv is a valve sizing designation commonly determined by laboratory test. It corresponds to the flow rate of water through a valve in US gallons per minute at 60°F with a differential pressure drop of one psi.

Flow coefficients of various HiP valves

Valve	Cv	Valve	Cv
15-11AF1	0.03	15-12AF1	0.045
15-11AF2	0.05	15-12AF2	0.075
10-11AF4	0.15	10-12AF4	0.225
10-11AF6	0.15	10-12AF6	0.225
20-11LF4	0.17	20-12LF4	0.255
20-11LF6	0.45	20-12LF6	0.675
20-11LF9	1.12	20-12LF9	1.68
10-11LF12	3.65	10-12LF12	5.475
20-11LF12	2.29	20-12LF12	3.435
10-11LF16	5.91	10-12LF16	8.865
20-11LF16	3.86	20-12LF16	5.79
30-11HF2	0.04	30-12HF2	0.06
30-11HF4	0.09	30-12HF4	0.135
30-11HF6	0.15	30-12HF6	0.225
30-11HF9	0.15	30-12HF9	0.225
30-11HF16	2.29	30-12HF16	3.435
40-11HF9	0.15	40-12HF9	0.225
60-11HF2	0.04	60-12HF2	0.06
60-11HF4	0.04	60-12HF4	0.06
60-11HF6	0.04	60-12HF6	0.06
60-11HF9	0.04	60-12HF9	0.06
100-11XF4	0.04	100-12XF4	0.06
150-11XF6	0.04	150-12XF6	0.06
10-11NFA	0.15	10-12NFA	0.225
10-11NFB	0.15	10-12NFA	0.225
10-11NFC	0.15	10-12NFC	0.225
10-11NFD	1.12	10-12NFD	0.18
15F-11NFA	0.45	15F-12NFA	0.675
15F-11NFB	0.45	15F-12NFB	0.675
15F-11NFC	1.12	15F-12NFC	1.68
15F-11NFD	1.12	15F-12NFD	1.68
10F-11NFF	5.91	10F-12NFF	8.865
10F-11NFH	5.91	10F-12NFH	8.865

With the Cv coefficient known, the following values can be calculated:

- Liquid flow capacity in US gallons per minute

$$Ql = Cv \cdot \sqrt{\frac{\Delta P}{G}}$$

- Pressure drop across valve (liquid flow)

$$\Delta P = G \cdot \frac{Ql^2}{Cv^2}$$

- Gas flow capacity in standard cubic feet per hour (SCFH)

$$Qg = 1360 \cdot Cv \cdot \sqrt{\frac{P \cdot \Delta P}{T \cdot G \cdot Z}}$$

- Pressure drop across valve (gas flow)

$$\Delta P = \frac{T \cdot G \cdot Z}{P} \cdot \left(\frac{Qg}{1360 \cdot Cv} \right)^2$$

Where:

Cv = Valve flow coefficient

G = Specific gravity of fluid

ΔP = Differential pressure drop across valve (psi)

P = System pressure at valve inlet (psia)

Ql = Liquid flow in US gallons per minute (GPM)

Qg = Gas flow in standard cubic feet per hour (SCFH)

T = System temperature (°R)

Z = Gas compressibility factor at operating conditions

Technical Information

Recommended Torque

Tubing Connections

Connection	Recommended Torque
AF1	55 inch pounds
AF2	10 foot pounds initial to compress sleeve onto tube 25 foot pounds to tighten connection
AF4	30 foot pounds initial to compress sleeve onto tube 50 foot pounds to tighten connection
AF6	40 foot pounds initial to compress sleeve onto tube 60 foot pounds to tighten connection
LF4	20 foot pounds
LF6	30 foot pounds
LF9	50 foot pounds
LF12	90 foot pounds
LF16	125 foot pounds
LF24	200 foot pounds
HF2	75 inch pounds
HF4	25 foot pounds
HF6	50 foot pounds
HF9	110 foot pounds
HF16	150 foot pounds
XF4	45 foot pounds
XF6	70 foot pounds

Minimum Packing Gland Torque for Valves

Valve Series	Pressure Rating	Packing Gland Torque
15- ** AF1 15- ** AF2	15,000 psi	15 foot pounds
10- ** AF4 10- ** AF6	10,000 psi	30 foot pounds
10- ** NFA 10- ** NFB 10- ** NFC	10,000 psi	35 foot pounds
10- ** NFD	10,000 psi	50 foot pounds
20- ** LF4 20- ** LF6	20,000 psi 20,000 psi	35 foot pounds
20- ** LF9	20,000 psi	70 foot pounds
30- ** HF2 30- ** HF4 30- ** HF6 30- ** HF9	30,000 psi	30 foot pounds
60- ** HF2 60- ** HF4 60- ** HF6 60- ** HF9	60,000 psi	40 foot pounds
100- ** XF4	100,000 psi	60 foot pounds
150- ** XF6	150,000 psi	90 foot pounds

Minimum Safety Head Hold Down Nut Torque

Pressure psi	Torque foot pounds
10,000	40
15,000	45
20,000	50
25,000	55
30,000	60
35,000	65
40,000	70
45,000	75
50,000	80
55,000	85
60,000	90

Minimum Recommended Bend Radius For High Pressure Tubing

Tube Size O.D. x I.D.	Minimum Bend Radius
0.250 x 0.062 0.250 x 0.083 0.250 x 0.109 0.250 x 0.125	1.25 in
0.375 x 0.062 0.375 x 0.125 0.375 x 0.203 0.375 x 0.250	1.75 in
0.562 x 0.188 0.562 x 0.250 0.562 x 0.312	2.62 in
0.750 x 0.438 0.750 x 0.516	3.50 in
1" x 0.438 1" x 0.562 1" x 0.688	4.62 in

Technical Information

Volumetric Flow Rate

Maximum Recommended Volumetric Flow Rate for Water through a Tube

Orifice Size (inches)	Max Flow (gpm)	Approximate ΔP (psi/ft)
0.016	0.030	525
0.020	0.050	390
0.030	0.112	230
0.031	0.119	220
0.040	0.198	160
0.047	0.274	130
0.052	0.335	115
0.060	0.446	95
0.062	0.476	90
0.078	0.754	70
0.083	0.854	65
0.094	1.09	55
0.109	1.47	45
0.125	1.93	40
0.141	2.46	35
0.156	3.01	30
0.172	3.66	25
0.188	4.38	23
0.203	5.10	21
0.219	5.94	20
0.234	6.78	18
0.250	7.74	17
0.266	8.77	15
0.281	9.78	14
0.294	10.7	13
0.312	12.0	13
0.328	13.3	12
0.344	14.6	11
0.359	15.9	11
0.375	17.4	10
0.391	18.9	<10
0.406	20.4	<10
0.422	22.0	<10
0.438	23.7	<10
0.453	25.4	<10

Orifice Size (inches)	Max Flow (gpm)	Approximate ΔP (psi/ft)
0.469	27.2	<10
0.484	29.0	<10
0.500	30.9	<7
0.516	33.0	<7
0.531	34.9	<7
0.547	37.0	<7
0.562	39.1	<7
0.578	41.4	<7
0.594	43.7	<7
0.609	45.9	<7
0.625	48.4	<7
0.641	50.9	<7
0.656	53.3	<7
0.672	55.9	<5
0.688	58.6	<5
0.703	61.2	<5
0.719	64.0	<5
0.734	66.7	<5
0.750	69.7	<5
0.766	72.7	<5
0.781	75.6	<5
0.797	78.7	<5
0.812	81.7	<5
0.828	84.9	<5
0.844	88.3	<5
0.859	91.4	<5
0.875	94.9	<5
0.891	98.4	<5
0.906	101	<5
0.922	105	<5
0.938	109	<5
0.953	112	<5
0.969	116	<5
0.984	120	<5
1.000	123	<5

Pressure Rating Reduction

316 and 304 SS components at elevated levels.

Temperature °F (°C)	Percent of Room Temperature Rating
Up to 100 (38)	100
200 (93)	100
300 (149)	100
400 (204)	96.5
500 (260)	90
600 (316)	85

Temperature °F (°C)	Percent of Room Temperature Rating
650 (343)	83
700 (371)	81.5
750 (399)	80.5
800 (427)	79.5
850 (453)	78.5

Intermediate values may be linearly interpolated.

Pressure Ratings Equipment in Various Common Materials

Material	Connection	316 CNDS	316 CNDA	NIT50 CNDA	22% Chrome Duplex	25% Chrome Duplex	HC276	IN600
Pressure Rating at Room Temperature (psi)	AF1	15000	10000	15000	15000	15000	15000	10000
	AF2	15000	10000	15000	15000	15000	15000	10000
	AF4	10000	10000	10000	10000	10000	10000	10000
	AF6	10000	10000	10000	10000	10000	10000	10000
	LF12	10000	7500	10000	10000	10000	10000	10000
	LF16	10000	7500	10000	10000	10000	10000	10000
	LF4	20000	10000	14500	17000	20000	12500	9000
	LF6	20000	10000	14500	17000	20000	12500	9000
	LF9	20000	9000	17000	20000	20000	12500	10500
	LF12	20000	9000	17000	20000	20000	12500	10500
	LF16	20000	9000	17000	20000	20000	12500	10500
	LF24*	20000	8000	15000	15000	15000	12500	10500
	HF2	30000	20000	30000	30000	30000	29500	25000
	HF4	30000	20000	30000	30000	30000	29500	25000
	HF6	30000	20000	30000	30000	30000	29500	25000
	HF9	30000	20000	30000	30000	30000	29500	25000
	HF16	30000	14000	25500	30000	30000	19000	16000
	HF9	40000	20000	33000	34500	40000	24500	21000
	HF2	60000	30000	50000	52000	60000	37000	31500
	HF4	60000	30000	50000	52000	60000	37000	31500
HF6	60000	30000	50000	52000	60000	37000	31500	
HF9	60000	30000	50000	52000	60000	37000	31500	
NFA	15000	8000	14500	15000	13000	10500	9000	
NFB	15000	8000	14500	15000	13000	10500	9000	
NFC	15000	8000	14500	15000	13000	10500	9000	
NFD	15000	8000	14500	15000	13000	10500	9000	
NFF	10000	6500	10000	10000	10000	9000	7500	
NFH	10000	6500	10000	10000	10000	9000	7500	

Material	Connection	IN625 Grade 1	IN718	IN825	MO400	Ti2	Ti5	254 Smo
Pressure Rating at Room Temperature (psi)	AF1	15000	15000	15000	10000	15000	15000	15000
	AF2	15000	15000	15000	10000	15000	15000	15000
	AF4	10000	10000	10000	10000	10000	10000	10000
	AF6	10000	10000	10000	10000	10000	10000	10000
	LF12	10000	10000	10000	8000	10000	10000	10000
	LF16	10000	10000	10000	8000	10000	10000	10000
	LF4	15500	20000	9000	6500	10500	20000	11500
	LF6	15500	20000	9000	6500	10500	20000	11500
	LF9	18500	20000	10500	7500	12000	20000	13500
	LF12	18500	20000	10500	7500	12000	20000	13500
	LF16	18500	20000	10500	7500	12000	20000	13500
	LF24*	15000	15000	10500	7500	12500	15000	13500
	HF2	30000	30000	25000	17500	28500	30000	30000
	HF4	30000	30000	25000	17500	28500	30000	30000
	HF6	30000	30000	25000	17500	28500	30000	30000
	HF9	30000	30000	30000	17500	28500	30000	30000
	HF16	28000	30000	16000	11500	18500	30000	20500
	HF9	34500	40000	21000	15000	24000	40000	26500
	HF2	52000	60000	31500	22500	36500	60000	40000
	HF4	52000	60000	31500	22500	36500	60000	40000
HF6	52000	60000	31500	22500	36500	60000	40000	
HF9	52000	60000	31500	22500	36500	60000	40000	
NFA	15000	15000	9000	6500	10500	15000	11500	
NFB	15000	15000	9000	6500	10500	15000	11500	
NFC	15000	15000	9000	6500	10500	15000	11500	
NFD	15000	15000	9000	6500	10500	15000	11500	
NFF	10000	10000	7500	5000	8500	10000	9500	
NFH	10000	10000	7500	5000	8500	10000	9500	

*Note: Fittings with LF24 connections are available in 316 CW material. Standard material for valves with LF24 connections is 2205 Duplex Stainless

Pressure Ratings

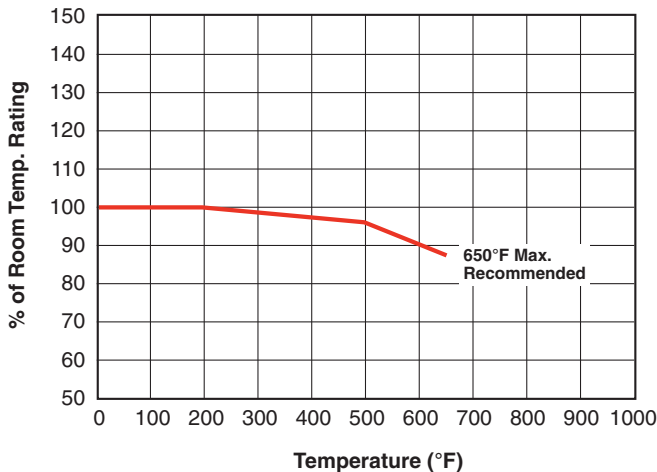
Tubing in Various Materials*

	Part Number	Tubing Size OD x ID (inches)	Material vs Pressure Rating (psi)								
			316 CNDS	316 CNDA	22% Chrome Duplex	25% Chrome Duplex	Hastelloy C276	Inconel 600	Inconel 625 Gr 1	Monel 400	Titanium Gr 2
Low Pressure	15-9A2	1/8 x 0.060	15000	10000	15000	15000	15000	15000	15000	10000	15000
	10-9A4	1/4 x 0.125	10000	7500	10000	10000	10000	9000	10000	6500	9000
	10-9A6	3/8 x 0.250	10000	7500	10000	10000	10000	9000	10000	6500	9000
Medium Pressure	20-9M4	1/4 x 0.109	20000	10000	17500	20000	15000	11500	17500	8000	13000
	20-9M6	3/8 x 0.203	20000	10000	17500	20000	15000	11500	17500	8000	13000
	10-9M9	9/16 x 0.359	15000	7000	13000	15000	10000	8000	15000	6000	9500
	20-9M9	9/16 x 0.312	20000	10000	17500	20000	15000	11500	17500	8000	13000
	10-9M12	3/4 x 0.516	15000	7000	13000	15000	10000	8000	14000	6000	9500
	20-9M12	3/4 x 0.438	20000	10000	17500	20000	15000	11500	17500	8000	13000
	10-9M16	1 x 0.688	15000	7000	13000	15000	10000	8000	14500	6000	9500
	20-9M16	1 x 0.562	20000	10000	17500	20000	15000	11500	17500	8000	13000
High Pressure	60-9H2	1/8 x 0.020	60000	30000	40000	60000	30000	23000	40000	17500	28000
	30-9H2	1/8 x 0.040	30000	20000	30000	30000	25000	17500	30000	13000	21000
	60-9H4	1/4 x 0.083	60000	30000	40000	57000	30000	23000	40000	17500	28000
	60-9H6	3/8 x 0.125	60000	30000	40000	57000	30000	23000	40000	17500	28000
	60-9H9	9/16 x 0.188	60000	30000	40000	57000	30000	23000	40000	17500	28000
	40-9H9	9/16 x 0.250	40000	20000	34000	40000	23000	17500	30000	13000	21000
	30-9H16	1 x 0.437	43000	20000	35000	43000	23000	17500	30000	13000	21000

* Not all tubing sizes available in all materials.

Temperature Rating

Taper Seal Series Valves and Fittings



Pressure Rating Reduction

316 and 304 SS Components at Elevated Temperatures

