Collar Circumferential Membrane Stress Due to Pressure

$$S_1' = \frac{PD_c^2 L_t E_c k}{2\left(ntE_b L_t \left(D_b + nt\right) + t_c k E_c L_c D_c\right)}$$

Bellows Circumferential Membrane Stress Due to Pressure

$$S_2 = \frac{PD_m K_r q}{2A_c}$$

Bellows Meridional Membrane Stress Due to Pressure

$$S_3 = \frac{Pw}{2nt_p}$$

Bellows Meridional Bending Stress ORK Due to Pressure

$$S_4 = \frac{P}{2n}\left(\frac{w}{t_p}\right)^2 C_p$$

Note: The above stresses should be evaluated for pressure capacity as f

$$S_1 \,\&\, S_2 \le C_{wb} W_b S_{ab} \qquad S_1' \le C_{wc} W_c S_{ac}$$

$$S_3 + S_4 \le C_m S_{ab} \quad \text{(Below the Creep Range)}$$

$$S_3 + \left(S_4 / 1.25\right) \le S_{ab} \quad \text{(In the Creep Range)}$$

Bellows Meridional Membrane Stress Due to Deflection

$$S_5 = \frac{E_b t_p^{\,2} e}{2w^3 C_f}$$

Bellows Meridional Bending Stress Due to Deflection

$$S_6 = \frac{5E_b t_p e}{3w^2 C_d}$$

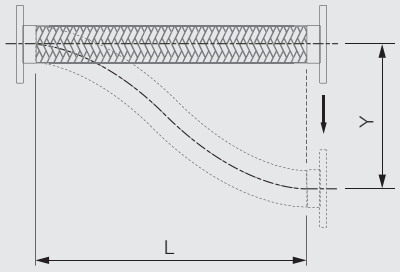
Note: Modulus of elasticity, E_b, in Equations (4-32) and (4-33) is at roo

Motion

1.Offset motion (lateral displacement)

The offset motion includes parallel displacement where a hose moves parallel keeping constant the distance between the joints at both ends and backward displacement where a hose moves parallel reducing the distance between the joints at both ends.
The parallel displacement is applied in cases of absorption of vibration with small displacement and in cases where the face-to-face dimension is restrained.
The backward displacement is applied in cases of absorption of ground subsidence with large displacement, in cases where the face-to-face dimension is not restrained and to L-shaped piping on which two flexible hoses are connected with an elbow.

Parallel displacement



[Explanation of symbols]
L : Hose length
Y : Amount of lateral displacement

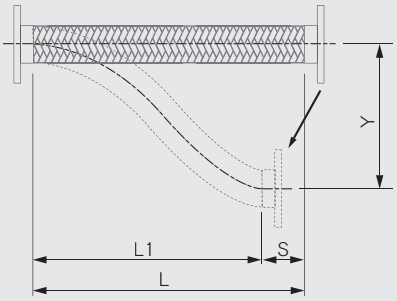
Type A

Nominal diameter (A)	Allowable displacement : Y (mm)		
	L=300	L=500	L=1000
8	36	61	122
10			
15			
20			
25			
32			
40			
50			
65	33		
80	24		
100	22		
125	16	44	
150	14	40	

Type SF

Nominal diameter (A)	Allowable displacement : Y (mm)		
	L=300	L=500	L=1000
8	36	61	122
10			
15			
20			
25			
32			
40			
50			
65			
80	37		
100	29		
125	24		
150	23		

Backward displacement



[Explanation of symbols]
L : Hose length
Y : Amount of lateral displacement
L1 : Length of hose after moving backward
S : Distance of backward motion
S≦L x 5%

Type A

Nominal diameter (A)	Allowable displacement : Y (mm)		
	L=300	L=500	L=1000
8	80	134	269
10			
15			
20			
25			
32	78		
40	63		
50	55		
65	48	133	
80	34	96	
100	33	91	
125	23	65	257
150	21	59	234

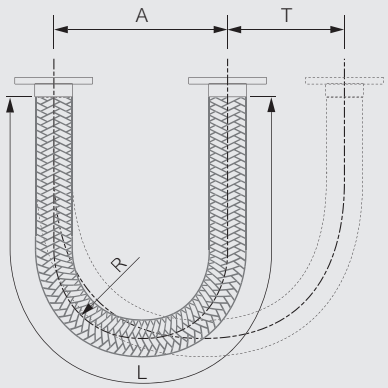
Type SF

Nominal diameter (A)	Allowable displacement : Y (mm)		
	L=300	L=500	L=1000
8	80	134	269
10			
15			
20			
25			
32			
40			
50			
65	60		
80	57		
100	45	125	
125	36	99	
150	34	94	

2.Radial motion (motion in bending radius)

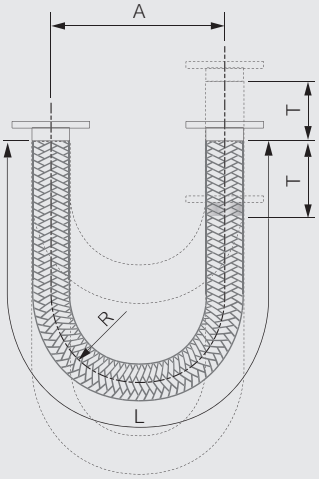
The radial motion is horizontal or vertical movement of one end of a hose installed in the shape of U with the other end secured.

Horizontal movement



[Explanation of symbols]
A : Distance of installation (2R)
T : Amount of displacement
L : Hose length
R : Bending radius

Vertical movement



[Explanation of symbols]
A : Distance of installation (2R)
T : Amount of displacement
L : Hose length
R : Bending radius

3.Axial motion (axial displacement)

The axial motion indicates the expansion or contraction in the axial direction. For flexible hoses, only an insignificant axial motion is allowed. Expansion joints (pages 55 to 72) are suitable for such displacement.

4.Permanent bending

The permanent bending and constant bending are used for correcting misalignment between pipes and for bends. Once a hose is bent, the hose will be kept in the state semipermanently.

5.Random motion

The random motion is free motion in which a hose moves freely like a watering hose and it is unclear at which points and to what degree it will be bent.

Flexible hoses

Instructions common to flexible hoses and bellows

○These products are made from thin plates. Even insignificant impact may damage the products. For transportation, pack them with sufficient packaging materials, and handle them carefully during transportation.
○Store the products in a clean and dry room. Avoid contact with high moisture, saline matter and highlyacid atmosphere.
○Use them in the ranges specified in drawings, delivery specifications and catalogs.If any product is used out of the design specifications, it may be damaged.
○Avoid using fluids which do not have corrosion resistance for each material.
○Do not expose the products directly to sparks from a welder or a grinder.When using a welder or a grinder near the products, appropriately protect them.
○If they are moved after installation or used as measures against vibration, fatigue cracks may develop in them in a short period.

Flexible hoses

○When installing any flexible hose, do not apply torsion to it.
To prevent damage owing to torsion during installation, it is recommended to use a joint, such as a loose flange, union joint or SNM joint, which can prevent torsion at one end of the tube.

○Do not install any flexible hose in such a way that the tube is twisted when it is bent.
Install the tube in such a way that it is constantly on a certain plane to prevent damage to the tube caused by torsion when it is bent.

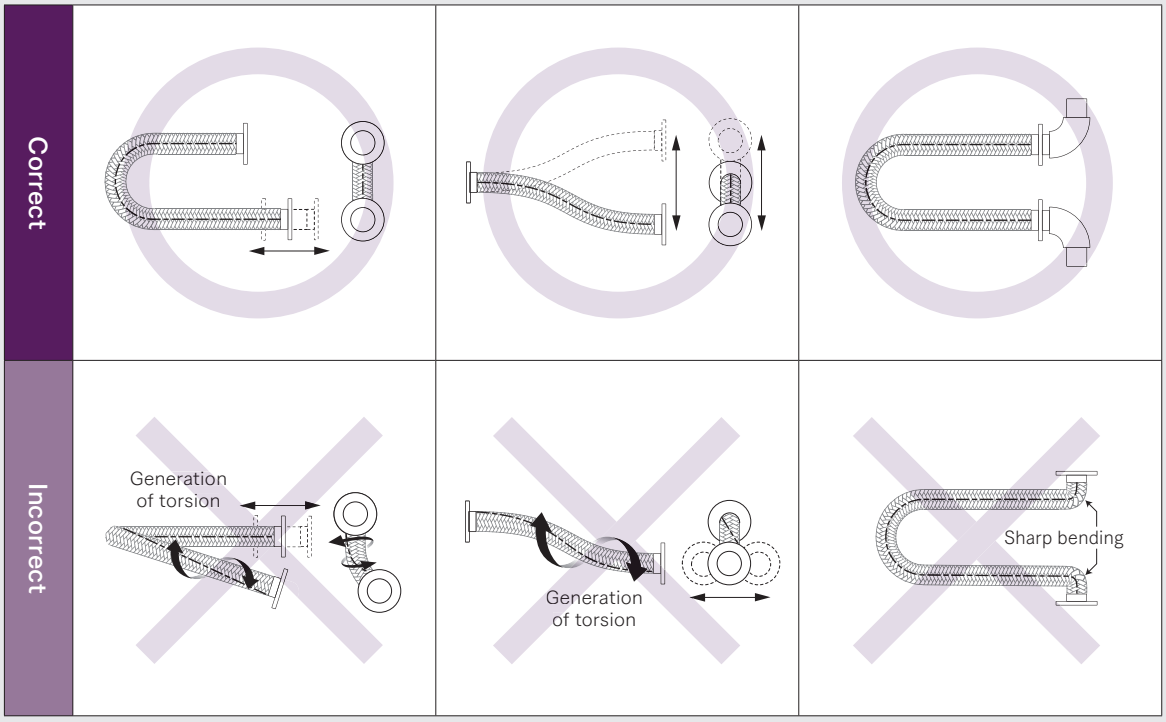
○Avoid bending any flexible hose at a sharp angle.
If a tube is installed improperly, the tube may be repeatedly bent at a sharp angle. If a tube is used at a radius lower than the allowable minimum bending radius, it will be fatigued early and damaged in a short period.

○Do not expand or contract any flexible hose.
Do not install a tube in an expanded or contracted condition exceeding the specified range.

○Reworking
Avoid reworking any joint if possible. When reworking a joint, take care not to damage the hose or joint, and protect the hose to prevent entry of dust into the tube.

○Welding
When welding a hose to a mating pipe joint, take utmost care that the hose is not thermally influenced. Otherwise, it may be distorted, or the material characteristics may be degraded, thereby resulting in early breakage.

○Examples of correct use and incorrect use



Bellows

Bellows

○When carrying

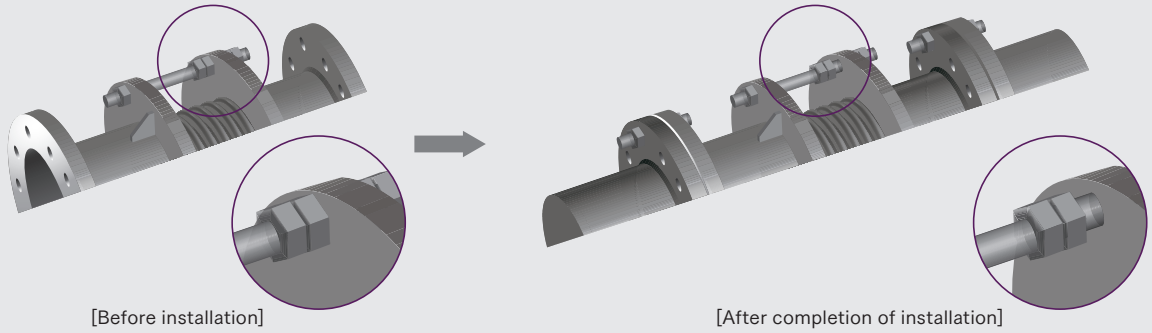
When lifting up and down bellows, fit a patch to the pipe zone, wind a wire rope around it, and lift the bellows. Do not wind a rope around the bellows, bellows protective cover, set bolt or guide rod.

○Set bolt

Bellows are provided with a set bolt for transportation and size adjustment. After the completion of installation of the bellows, remove the set bolt without fail before performing the pressure resistance test.

○Guide rods/tie rods

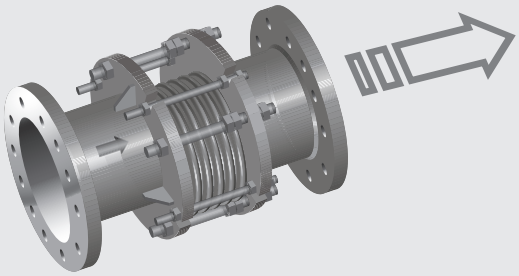
Guide rods/tie rods have been installed according to the design specifications. Do not loosen or tighten the nuts. The nuts to be adjusted after the completion of installation shall be adjusted as specified on the drawing.



[Before installation] [After completion of installation]

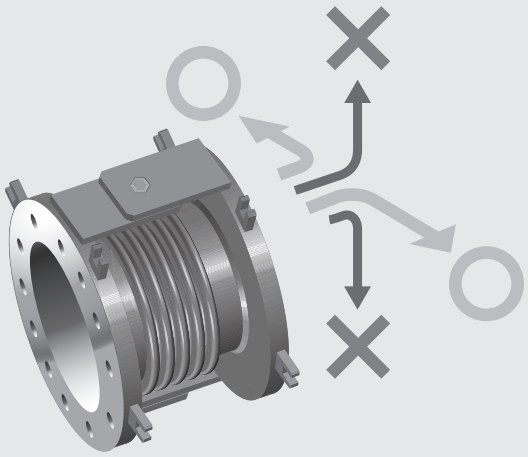
○Flowing direction

Bellows are marked with an arrow if the flowing direction through the bellows has been determined. Install such bellows in the indicated direction.



○Hinge type expansion joint (p.72)

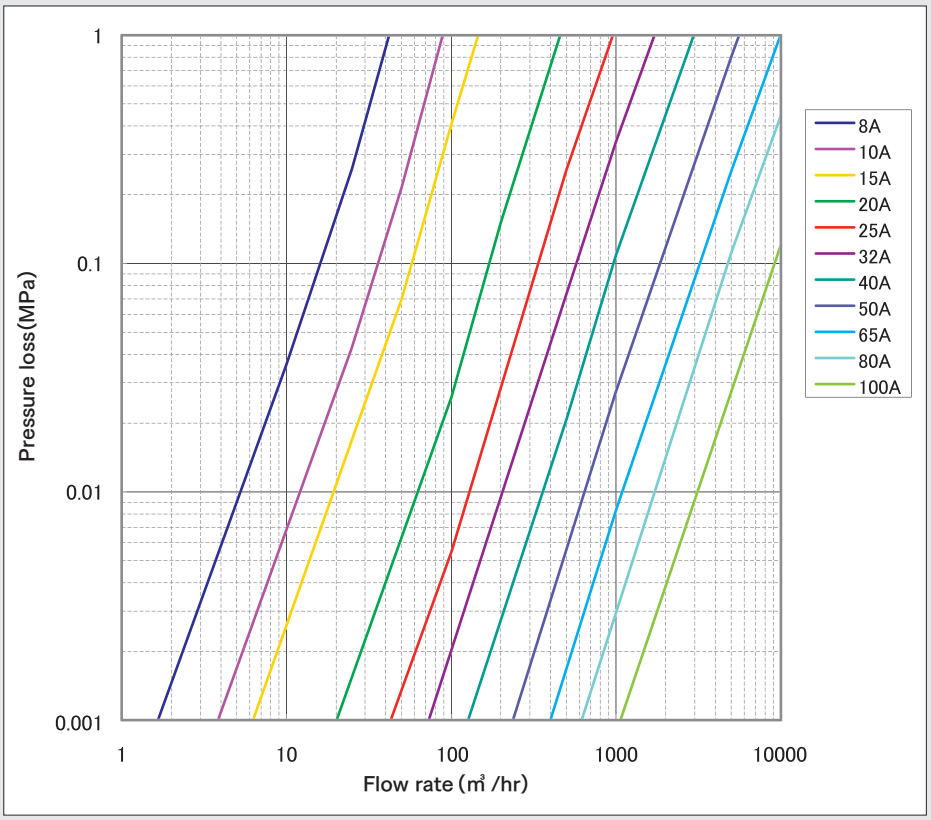
The hinge type joints can absorb only angular displacement in a plane. When installing them, check carefully the hinge plate direction.



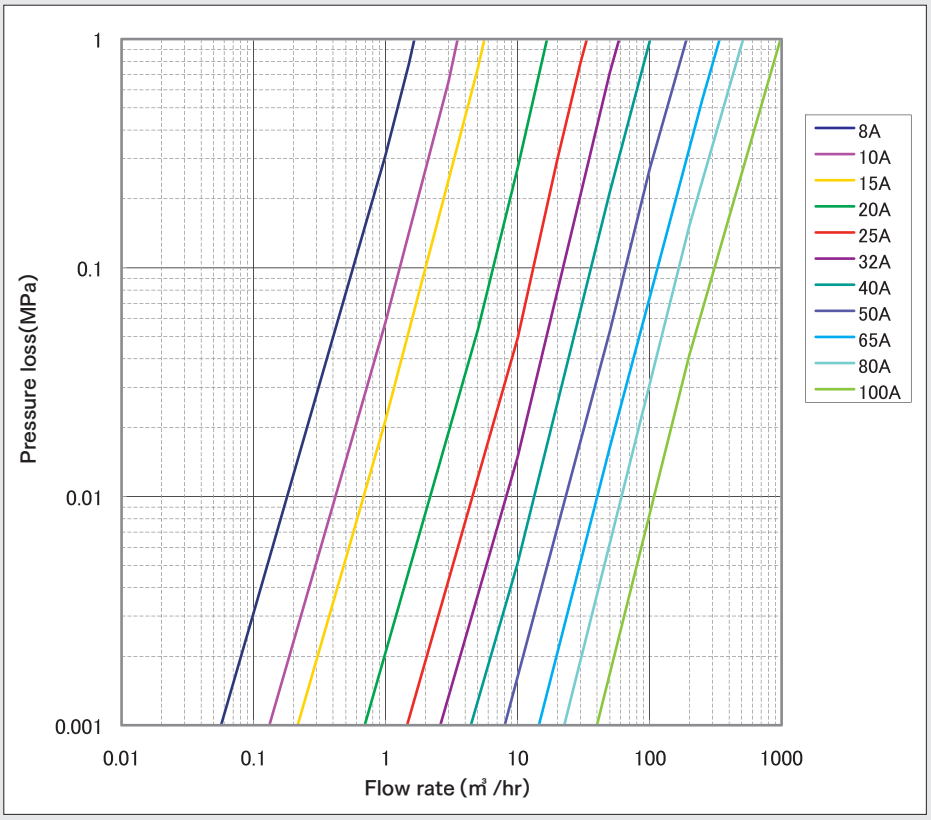
Pressure loss (type A)

■Pressure loss in 1 m of type A flexible hose
■The following charts show calculated values, and there are some errors between these values and the values of actual products.

Air (20℃)



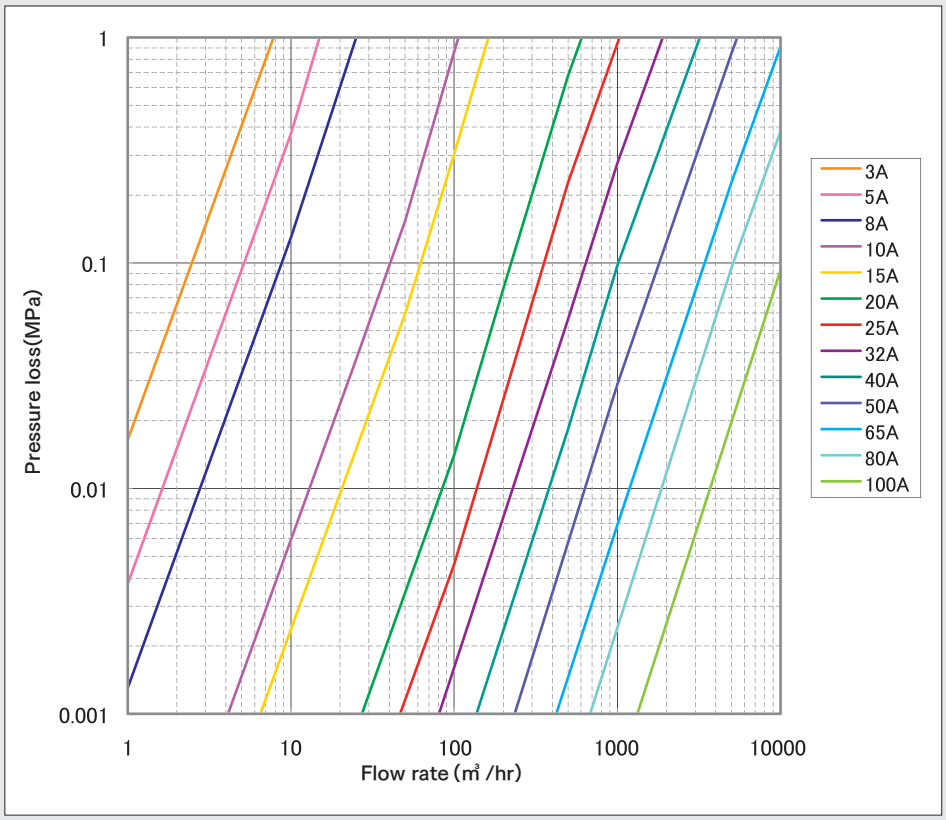
Water (20℃)



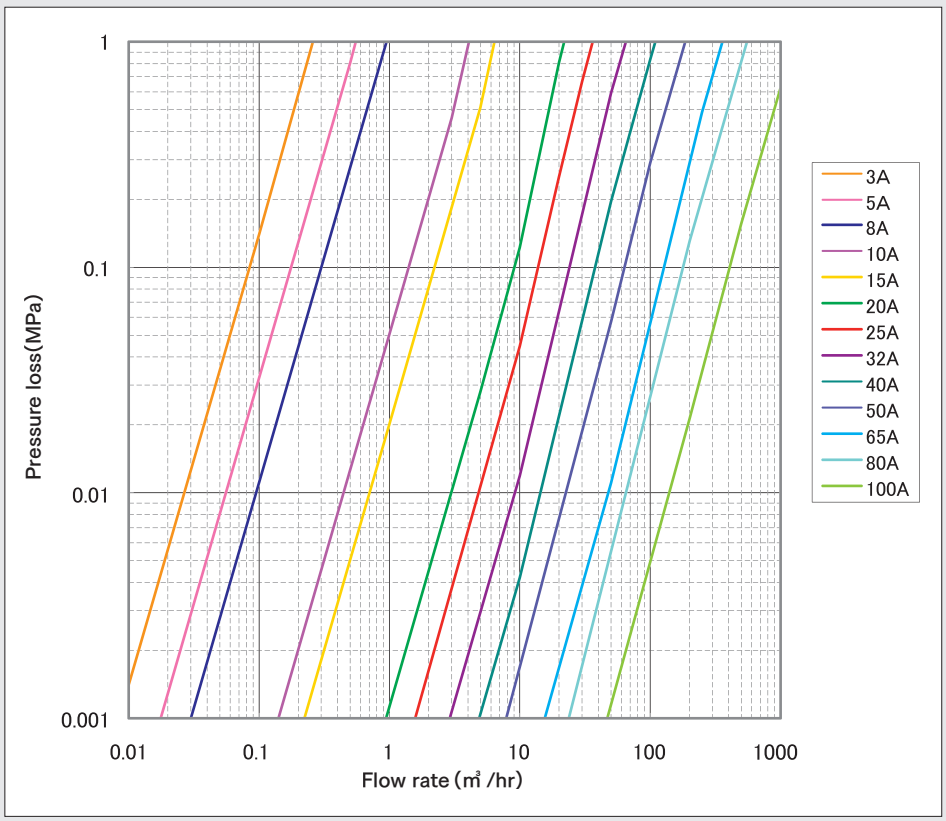
Pressure loss (type SF)

■Pressure loss in 1 m of type SF flexible hose
■The following charts show calculated values, and there are some errors between these values and the values of actual products.

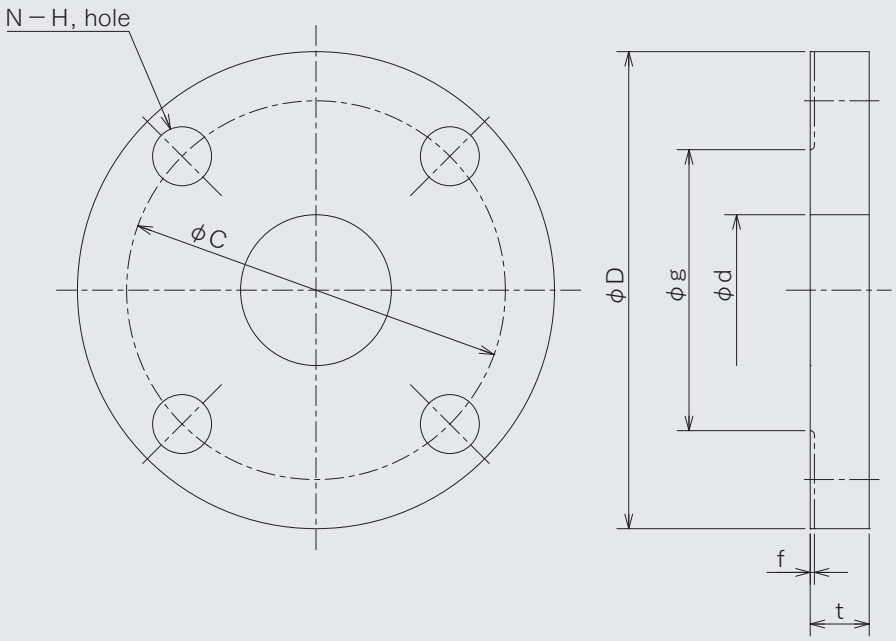
Air (20℃)



Water (20℃)

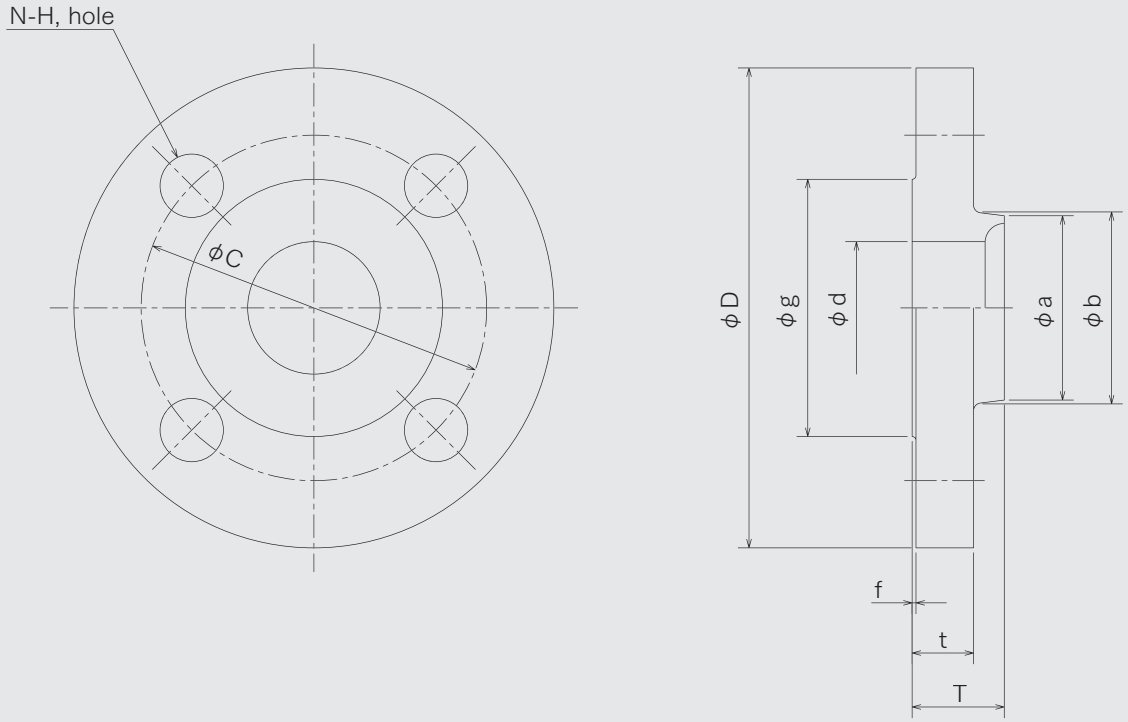


Dimensions of flanges having nominal pressure of 10K(JIS B 2220 SOP)



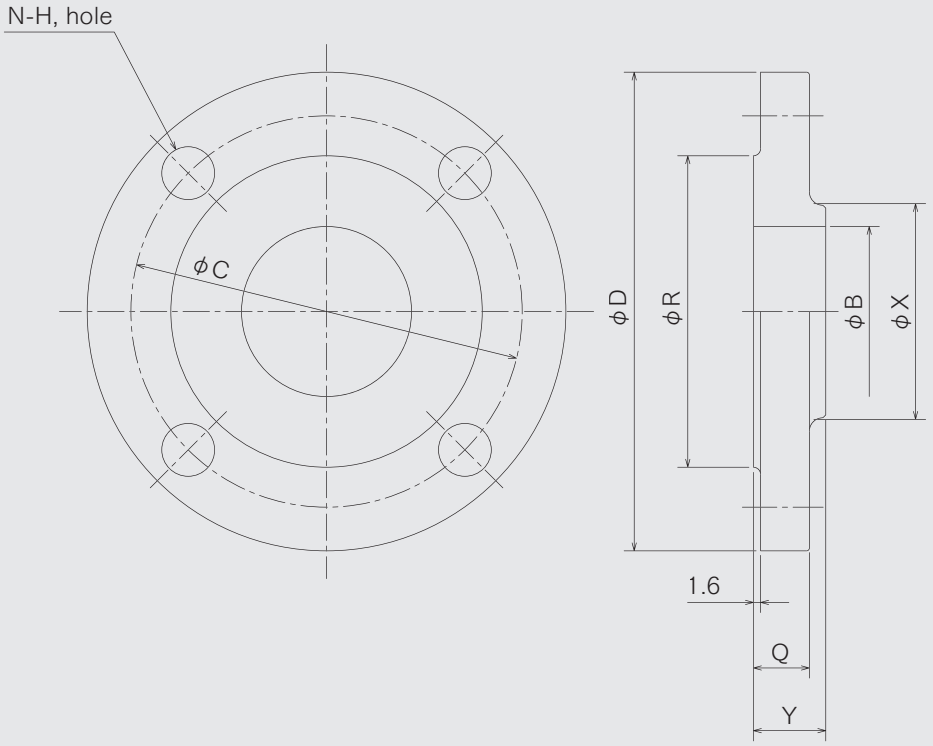
Nominal diameter A	Nominal diameter B	Flange outside diameter D	Flange thickness t	Inner diameter d	Raised face diameter g	Raised face height f	Pitch circle diameter C	Bolt hole H	Number of bolts N	Bolt
10	3/8	90	12	17.8	48	1	65	15	4	M12
15	1/2	95	12	22.2	51	1	70	15	4	M12
20	3/4	100	14	27.7	56	1	75	15	4	M12
25	1	125	14	34.5	67	1	90	19	4	M16
32	1･1/4	135	16	43.2	76	2	100	19	4	M16
40	1･1/2	140	16	49.1	81	2	105	19	4	M16
50	2	155	16	61.1	96	2	120	19	4	M16
65	2･1/2	175	18	77.1	116	2	140	19	4	M16
80	3	185	18	90.0	126	2	150	19	8	M16
(90)	(3･1/2)	195	18	102.6	136	2	160	19	8	M16
100	4	210	18	115.4	151	2	175	19	8	M16
125	5	250	20	141.2	182	2	210	23	8	M20
150	6	280	22	166.6	212	2	240	23	8	M20
(175)	(7)	305	22	192.1	237	2	265	23	12	M20
200	8	330	22	218.0	262	2	290	23	12	M20
(225)	(9)	350	22	243.7	282	2	310	23	12	M20
250	10	400	24	269.5	324	2	355	25	12	M22
300	12	445	24	321.0	368	3	400	25	16	M22
350	14	490	26	358.1	413	3	445	25	16	M22
400	16	560	28	409	475	3	510	27	16	M24
450	18	620	30	460	530	3	565	27	20	M24
500	20	675	30	511	585	3	620	27	20	M24
550	22	745	32	562	640	3	680	33	20	M30
600	24	795	32	613	690	3	730	33	24	M30

Dimensions of flanges having nominal pressure of 20K (JIS B 2220 SOH Type A)



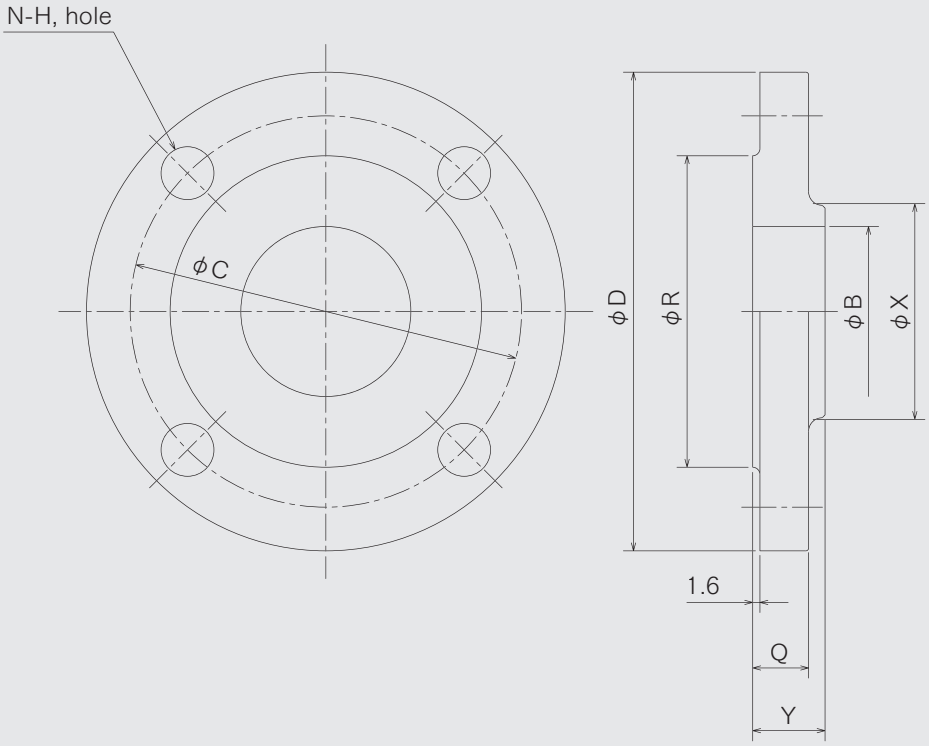
Nominal diameter		Flange outside diameter	Flange thickness	Inner diameter	Overall length of flange	Raised face diameter	Raised face height	Hub minor diameter	Hub major diameter	Pitch circle diameter	Number of bolts	Bolt hole	Bolt
A	B	D	t	d	T	g	f	a	b	C	N	H	
10	3/8	90	14	17.8	20	46	1	30	32	65	4	15	M12
15	1/2	95	14	22.2	20	51	1	34	36	70	4	15	M12
20	3/4	100	16	27.7	22	56	1	40	42	75	4	15	M12
25	1	125	16	34.5	24	67	1	48	50	90	4	19	M16
32	1･1/4	135	18	43.2	26	76	2	56	60	100	4	19	M16
40	1･1/2	140	18	49.1	26	81	2	62	66	105	4	19	M16
50	2	155	18	61.1	26	96	2	76	80	120	8	19	M16
65	2･1/2	175	20	77.1	30	116	2	100	104	140	8	19	M16
80	3	200	22	90.0	34	132	2	113	117	160	8	23	M20
90	(3･1/2)	210	24	102.6	36	145	2	126	130	170	8	23	M20
100	4	225	24	115.4	36	160	2	138	142	185	8	23	M20
125	5	270	26	141.2	40	195	2	166	172	225	8	25	M22
150	6	305	28	166.6	42	230	2	196	202	260	12	25	M22
200	8	350	30	218.0	46	275	2	244	252	305	12	25	M22
250	10	430	34	269.5	52	345	2	304	312	380	12	27	M24
300	12	480	36	321.0	56	395	3	354	364	430	16	27	M24
350	14	540	40	358.1	62	440	3	398	408	480	16	33	M30x3
400	16	605	46	409	70	495	3	446	456	540	16	33	M30x3
450	18	675	48	460	78	560	3	504	514	605	20	33	M30x3
500	20	730	50	511	84	615	3	558	568	660	20	33	M30x3
550	22	795	52	562	90	670	3	612	622	720	20	39	M36x3
600	24	845	54	613	96	720	3	666	676	770	24	39	M36x3

Dimensions of class 150Lb flanges (JPI-7S-15-1999, slip-on type)



Nominal diameter A	Nominal diameter B	Flange outside diameter D	Flange inside diameter B	Diameter of hub root X	Raised face diameter R	Thickness Q	Overall length Y	Pitch circle diameter C	Number of bolt holes N	Bolt hole H
15	1/2	89	22.2	30.0	35.1	11.2	16	60.5	4	16
20	3/4	99	27.7	38.0	42.9	12.7	16	69.8	4	16
25	1	108	34.5	49.5	50.8	14.3	18	79.2	4	16
(32)	(1・1/4)	117	43.2	58.5	63.5	15.8	21	88.9	4	16
40	1・1/2	127	49.1	65.0	73.2	17.6	22	98.6	4	16
50	2	152	61.1	77.5	91.9	19.1	25	120.6	4	19
65	2・1/2	178	77.1	90.5	104.6	22.4	28	139.7	4	19
80	3	190	90.0	108	127.0	23.9	30	152.4	4	19
(90)	(3・1/2)	216	102.6	122	139.7	23.9	32	177.8	8	19
100	4	229	115.4	135	157.2	23.9	33	190.5	8	19
(125)	(5)	254	141.2	164	185.7	23.9	37	215.9	8	22
150	6	279	166.6	192	215.9	25.4	40	241.3	8	22
200	8	343	218.0	246	269.7	28.5	44	298.4	8	22
250	10	406	269.5	305	323.8	30.3	49	362.0	12	26
300	12	483	321.0	365	381.0	31.8	56	431.8	12	26
350	14	535	358.1	400	412.8	35.1	57	476.2	12	29
400	16	595	409.0	457	469.9	36.6	64	539.8	16	29
450	18	635	460.0	505	533.4	39.7	68	577.8	16	32
500	20	700	511.0	559	584.2	43.0	73	635.0	20	32
600	24	815	613.0	663	692.2	47.8	83	749.3	20	35

Dimensions of class 300Lb flanges (JPI-7S-15-1999, slip-on type)



Nominal diameter A	Nominal diameter B	Flange outside diameter D	Flange inside diameter B	Diameter of hub root X	Raised face diameter R	Thickness Q	Overall length Y	Pitch circle diameter C	Number of bolt holes N	Bolt hole H
15	1/2	95	22.2	38.0	35.1	14.3	22	66.5	4	16
20	3/4	117	27.7	48.0	42.9	15.8	25	82.6	4	19
25	1	124	34.5	54.0	50.8	17.6	27	88.9	4	19
(32)	(1･1/4)	133	43.2	63.5	63.5	19.1	27	98.6	4	19
40	1･1/2	155	49.1	70.0	73.2	20.6	30	114.3	4	22
50	2	165	61.1	84.0	91.9	22.4	33	127.0	8	19
65	2･1/2	190	77.1	100	104.6	25.4	38	149.4	8	22
80	3	210	90.0	117	127.0	28.5	43	168.1	8	22
(90)	(3･1/2)	229	102.6	133	139.7	30.3	44	184.2	8	22
100	4	254	115.4	146	157.2	31.8	48	200.2	8	22
(125)	(5)	279	141.2	178	185.7	35.1	51	235.0	8	22
150	6	318	166.6	206	215.9	36.6	52	269.7	12	22
200	8	381	218.0	260	269.7	41.2	62	330.2	12	26
250	10	444	269.5	321	323.8	47.8	67	387.4	16	29
300	12	520	321.0	375	381.0	50.8	73	450.8	16	32
350	14	585	358.1	425	412.8	53.9	76	514.4	20	32
400	16	650	409.0	483	469.9	57.2	83	571.5	20	35
450	18	710	460.0	533	533.4	60.5	89	628.6	24	35
500	20	775	511.0	587	584.2	63.5	95	685.8	24	35
600	24	915	613.0	702	692.2	69.9	106	812.8	24	42

Dimensions of standard pipes

Pipe weight table

Nominal diameter		Outer diameter (mm)	JIS G 3459 Stainless steel pipes (SUS TP) Nominal thickness													
			Sch 5S		Sch 10S		Sch 20S		Sch 40		Sch 80		Sch 120		Sch 160	
A	B		Thickness	Weight	Thickness	Weight	Thickness	Weight	Thickness	Weight	Thickness	Weight	Thickness	Weight	Thickness	Weight
6	1/8	10.5	1.0	0.237	1.2	0.278	1.5	0.336	1.7	0.373	2.4	0.484	–	–	–	–
8	1/4	13.8	1.2	0.377	1.65	0.499	2.0	0.588	2.2	0.636	3.0	0.807	–	–	–	–
10	3/8	17.3	1.2	0.481	1.65	0.643	2.0	0.762	2.3	0.859	3.2	1.12	–	–	–	–
15	1/2	21.7	1.65	0.824	2.1	1.03	2.5	1.20	2.8	1.32	3.7	1.66	–	–	4.7	1.99
20	3/4	27.2	1.65	1.05	2.1	1.31	2.5	1.54	2.9	1.76	3.9	2.26	–	–	5.5	2.97
25	1	34.0	1.65	1.33	2.8	2.18	3.0	2.32	3.4	2.59	4.5	3.31	–	–	6.4	4.40
32	1･1/4	42.7	1.65	1.69	2.8	2.78	3.0	2.97	3.6	3.51	4.9	4.61	–	–	6.4	5.79
40	1･1/2	48.6	1.65	1.93	2.8	3.19	3.0	3.41	3.7	4.14	5.1	5.53	–	–	7.1	7.34
50	2	60.5	1.65	2.42	2.8	4.02	3.5	4.97	3.9	5.50	5.5	7.54	–	–	8.7	11.2
65	2･1/2	76.3	2.1	3.88	3.0	5.48	3.5	6.35	5.2	9.21	7.0	12.1	–	–	9.5	15.8
80	3	89.1	2.1	4.55	3.0	6.43	4.0	8.48	5.5	11.5	7.6	15.4	–	–	11.1	21.6
90	3･1/2	101.6	2.1	5.20	3.0	7.37	4.0	9.72	5.7	13.6	8.1	18.9	–	–	12.7	28.1
100	4	114.3	2.1	5.87	3.0	8.32	4.0	11.0	6.0	16.2	8.6	22.6	11.1	28.5	13.5	33.9
125	5	139.8	2.8	9.56	3.4	11.6	5.0	16.8	6.6	21.9	9.5	30.8	12.7	40.2	15.9	49.1
150	6	165.2	2.8	11.3	3.4	13.7	5.0	20.0	7.1	28.0	11.0	42.3	14.3	53.8	18.2	66.6
200	8	216.3	2.8	14.9	4.0	21.2	6.5	34.0	8.2	42.5	12.7	64.4	18.2	89.8	23.0	111
250	10	267.4	3.4	22.4	4.0	26.2	6.5	42.2	9.3	59.8	15.1	94.9	21.4	131	28.6	170
300	12	318.5	4.0	31.3	4.5	35.2	6.5	50.5	10.3	79.1	17.4	131	25.4	185	33.3	237
350	14	355.6	–	–	–	–	–	–	11.1	95.3	19.0	159	27.8	227	35.7	284
400	16	406.4	–	–	–	–	–	–	12.7	125	21.4	205	30.9	289	40.5	369
450	18	457.2	–	–	–	–	–	–	14.3	158	23.8	257	34.9	367	45.2	464
500	20	508.0	–	–	–	–	–	–	15.1	185	26.2	314	38.1	446	50.0	570
550	22	558.8	–	–	–	–	–	–	15.9	215	28.6	378	41.3	532	54.0	679
600	24	609.6	–	–	–	–	–	–	17.5	258	31.0	447	46.0	646	59.5	815
650	26	660.4	–	–	–	–	–	–	18.9	302	34.0	531	49.1	748	64.2	953

Nominal diameter		Outer diameter (mm)	JIS G 3454 Carbon steel pipes for pressure service (STPG) Nominal thickness												JIS G 3452 Carbon steel pipes for ordinary piping (SGP)	
			Sch 10		Sch 20		Sch 30		Sch 40		Sch 60		Sch 80			
A	B		Thickness	Weight	Thickness	Weight	Thickness	Weight	Thickness	Weight	Thickness	Weight	Thickness	Weight	Thickness	Weight
6	1/8	10.5	–	–	–	–	–	–	1.7	0.369	2.2	0.450	2.4	0.479	2.0	0.419
8	1/4	13.8	–	–	–	–	–	–	2.2	0.629	2.4	0.675	3.0	0.799	2.3	0.652
10	3/8	17.3	–	–	–	–	–	–	2.3	0.851	2.8	1.00	3.2	1.11	2.3	0.851
15	1/2	21.7	–	–	–	–	–	–	2.8	1.31	3.2	1.46	3.7	1.64	2.8	1.31
20	3/4	27.2	–	–	–	–	–	–	2.9	1.74	3.4	2.00	3.9	2.24	2.8	1.68
25	1	34.0	–	–	–	–	–	–	3.4	2.57	3.9	2.89	4.5	3.27	3.2	2.43
32	1･1/4	42.7	–	–	–	–	–	–	3.6	3.47	4.5	4.24	4.9	4.57	3.5	3.38
40	1･1/2	48.6	–	–	–	–	–	–	3.7	4.10	4.5	4.89	5.1	5.47	3.5	3.89
50	2	60.5	–	–	3.2	4.52	–	–	3.9	5.44	4.9	6.72	5.5	7.46	3.8	5.31
65	2･1/2	76.3	–	–	4.5	7.97	–	–	5.2	9.12	6.0	10.4	7.0	12.0	4.2	7.47
80	3	89.1	–	–	4.5	9.39	–	–	5.5	11.3	6.6	13.4	7.6	15.3	4.2	8.79
90	3･1/2	101.6	–	–	4.5	10.8	–	–	5.7	13.5	7.0	16.3	8.1	18.7	4.2	10.1
100	4	114.3	–	–	4.9	13.2	–	–	6.0	16.0	7.1	18.8	8.6	22.4	4.5	12.2
125	5	139.8	–	–	5.1	16.9	–	–	6.6	21.7	8.1	26.3	9.5	30.5	4.5	15.0
150	6	165.2	–	–	5.5	21.7	–	–	7.1	27.7	9.3	35.8	11.0	41.8	5.0	19.8
200	8	216.3	–	–	6.4	33.1	7.0	36.1	8.2	42.1	10.3	52.3	12.7	63.8	5.8	30.1
250	10	267.4	–	–	6.4	41.2	7.8	49.9	9.3	59.2	12.7	79.8	15.1	93.9	6.6	42.4
300	12	318.5	–	–	6.4	49.3	8.4	64.2	10.3	78.3	14.3	107	17.4	129	6.9	53.0
350	14	355.6	6.4	55.1	7.9	67.7	9.5	81.1	11.1	94.3	15.1	127	19.0	158	7.9	67.7
400	16	406.4	6.4	63.1	7.9	77.6	9.5	93.0	12.7	123	16.7	160	21.4	203	7.9	77.6
450	18	457.2	6.4	71.1	7.9	87.5	11.1	122	14.3	156	19.0	205	23.8	254	7.9	87.5
500	20	508.0	6.4	79.2	9.5	117	12.7	155	15.1	184	20.6	248	26.2	311	7.9	97.4
550	22	558.8	6.4	87.2	9.5	129	12.7	171	15.9	213	–	–	–	–	–	–
600	24	609.6	6.4	95.2	9.5	141	14.3	210	–	–	–	–	–	–	–	–
650	26	660.4	7.9	127	12.7	203	–	–	–	–	–	–	–	–	–	–

※The unit of dimensions is mm, and the unit of weight is kg/m.
※The data on 175A and 225A SGP are omitted.
※The weight values of pipes made of SUS 304 are shown as the weight of stainless steel pipes.

Pipe heat deformation

Temperature (℃)	Steel pipe (mm)	Stainless steel pipe (mm)
−40	−0.645	−0.948
−30	−0.545	−0.792
−20	−0.435	−0.635
−10	−0.330	−0.478
0	−0.230	−0.326
10	−0.117	−0.175
20	−0.015	−0.016
30	0.103	0.152
40	0.218	0.321
50	0.328	0.488
60	0.442	0.654
70	0.553	0.824
80	0.670	0.994
90	0.784	1.162
100	0.917	1.332
110	1.044	1.504
120	1.153	1.674
130	1.270	1.847
140	1.403	2.021
150	1.527	2.193
160	1.660	2.367
170	1.790	2.545
180	1.922	2.725
190	2.059	2.905
200	2.192	3.086
210	2.328	3.268
220	2.470	3.449
230	2.606	3.634
240	2.743	3.816
250	2.880	3.996
260	3.017	4.175
270	3.160	4.355
280	3.309	4.535
290	3.454	4.723
300	3.602	4.909
310	3.750	5.097

Temperature (℃)	Steel pipe (mm)	Stainless steel pipe (mm)
320	3.895	5.282
330	4.057	5.470
340	4.210	5.660
350	4.367	5.851
360	4.520	6.040
370	4.672	6.230
380	4.836	6.423
390	4.995	6.617
400	5.149	6.813
410	5.310	7.004
420	5.471	7.198
430	5.633	7.394
440	5.796	7.549
450	5.972	7.800
460	6.140	7.998
470	6.304	8.192
480	6.473	8.394
490	6.636	8.595
500	6.798	8.796
510	6.959	9.000
520	7.121	9.204
530	7.284	9.406
540	7.445	9.605
550	7.617	9.814
560	7.788	10.015
570	7.962	10.217
580	8.135	10.428
590	8.310	10.637
600	8.475	10.838
610	8.635	11.042
620	8.790	11.237
630	9.946	11.452
640	9.104	11.655
650	9.268	11.859
660	9.437	12.059
670	9.603	12.264

※Heat deformation per m at each temperature based on deformation at 70° F (21.1° C) (extracted from EJMA)

Corrosion table

■This table is designed as a guide to selection of materials of flexible hoses and bellows.
■The corrosion resistance varies depending on the fluid conditions, such as temperature and concentration. The performance shown in the table may not be assured.

○: Applicable
×: Inapplicable
–: Unknown

Fluid	Concentration (%)	Temperature (℃)	SUS 304	SUS 316L	HASTELLOY
Acetylene	100	40	○	○	○
		200	○	○	–
Acetone	100	40	○	○	○
		100	○	–	○
	10	40	○	○	○
		100	○	–	○
Sulfurous acid	100	40	×	×	×
		100	×	×	×
	90	65	○	○	–
	10	10	×	×	×
Sodium sulfite	50	10	–	○	–
		100	×	○	–
	30	40	×	○	○
		100	×	○	○
Ammonia (Anhydrous)	100	40	○	○	○
		200	○	○	○
Sulfur	100	40	×	○	○
		150	×	×	○
	90	10	×	○	–
		150	–	×	×
Isopropyl alcohol (isopropanol)	100	40	○	○	○
		100	○	○	○
	90	40	○	○	–
Ethanol (Ethyl alcohol)	100	40	○	○	○
		100	○	○	○
	10	40	○	○	○
		100	○	○	○
Ethane	100	40	○	○	–
		200	○	○	–
Ethylene glycol	100	40	○	○	–
		100	○	○	–
Aluminum chloride	100	10	×	–	○
		100	–	–	×
	10	10	×	×	○
		100	–	–	○
Hydrogen chloride (Anhydrous)	100	40	○	○	○
		200	○	○	○
Ferrous chloride	70	40	–	–	×
	10	10	×	×	×
		100	–	–	×
Ferric chloride	70	25	×	×	×
	10	25	×	×	○
		100	–	×	×
Phosphoryl chloride (Phosphorus oxychloride)	100	10	○	○	×
		150	×	×	×
	90	10	×	×	×
		150	–	–	×
Magnesium chloride	100	40	–	–	○
		100	–	–	○
	10	40	×	×	○
		100	×	×	○
Methyl chloride	100	25	○	○	–
		100	○	○	–
	90	25	×	–	–
Methylene chloride	100	25	○	×	○
		100	×	×	○
	90	25	○	○	–
		100	–	○	–

Fluid	Concentration (%)	Temperature (℃)	SUS 304	SUS 316L	HASTELLOY
Hydrochloric acid (aerated)	40	10	×	×	–
	10	10	×	×	–
Chlorine	100	10	○	○	○
		100	○	○	○
	90	10	×	×	○
		100	–	–	×
Sea Water	100	25	×	×	○
Hydrogen peroxide	100	10	×	×	–
	10	10	○	○	○
		100	×	×	–
Gasoline	150	100	○	○	○
Gallium	150	100	○	–	×
Ethylene glycol	100	10	○	○	–
		100	○	○	–
Glycerol	100	10	○	○	○
		200	○	○	○
	10	10	○	○	○
		100	○	○	○
Chlorosilanes	100	10	×	×	×
		100	×	×	×
Crude oil	100	40	○	○	○
Acetic acid (Aerated)	100	10	○	○	○
		100	×	×	○
	10	10	○	○	○
		100	○	○	○
Ethyl acetate	100	10	○	○	○
		150	○	○	○
	90	10	○	○	○
		150	–	○	○
Butyl acetate	100	25	○	○	○
		100	○	○	○
	10	25	–	○	○
		100	–	○	○
Arsenic trichloride	100	10	×	×	×
	10	10	×	×	×
Boron trichloride	100	25	×	×	×
		75	×	×	×
Sodium hypochlorite	90	10	×	–	–
	10	10	×	×	○
		40	×	×	×
Silicon tetrachloride	100	10	○	○	○
	90	10	×	×	–
Carbon tetrachloride	100	10	○	○	○
		100	○	○	○
		125	–	–	×
	90	10	×	–	–
Cyclohexanol	100	10	○	○	○
		100	○	○	○
Cyclohxanone	100	10	×	×	×
		100	×	×	×
Cyclohexane	100	10	×	×	×
		100	×	×	×
Cyclohexene	100	10	×	×	×
		100	×	×	×
Oxalic acid	100	10	×	×	×
		100	×	×	×

■This table is designed as a guide to selection of materials of flexible hoses and bellows.
■The corrosion resistance varies depending on the fluid conditions, such as temperature and concentration. The performance shown in the table may not be assured.

○: Applicable
×: Inapplicable
–: Unknown

Fluid	Concentration (%)	Temperature (℃)	SUS 304	SUS 316L	HASTELLOY
Bromine-dry	100	10	×	–	○
		100	×	×	×
	90	10	–	–	×
Bromine-wet	100	10	×	×	○
		125	–	–	×
	90	10	–	–	×
Nitric acid	100	10	×	×	○
	30	10	○	○	–
		125	×	×	–
Potassium hydroxide	100	10	○	○	–
	50	10	×	×	×
		100	×	×	×
Sodium hydroxide	70	40	○	○	–
		100	×	×	×
	40	10	×	○	○
		100	×	×	–
Barium hydroxide	50	40	×	○	×
		100	×	○	×
	10	40	×	○	×
		100	×	○	×
Sodium carbonate	100	40	○	○	○
		100	○	○	○
	10	40	○	○	○
		100	○	○	○
Triethylene glycol	100	40	○	○	○
		100	○	○	○
Toluene	100	25	○	○	○
		100	○	○	○
Naphtha	100	40	○	○	○
		100	○	○	○
Carbon dioxide	100	40	○	○	○
		100	○	○	○
	10	40	○	○	○
		100	○	○	○
Urea	50	40	×	×	–
		100	×	×	–
	10	10	○	○	–
		40	×	×	–
Butane	100	40	○	○	○
		100	○	○	○
Hydrogen fluoride	100	40	×	○	○
		150	–	×	×
Hydrofluoric acid	100	10	–	○	○
		40	×	–	×
	40	10	×	–	○
		100	×	–	×
Flourine gas	100	40	○	○	○
		200	○	○	○
Propane	100	40	○	○	○
		100	○	○	○
Benzene	100	40	○	–	×
		100	○	–	×
	10	40	○	○	×
		100	○	○	×
Pentane	100	40	×	×	○
		100	×	×	○

Fluid	Concentration (%)	Temperature (℃)	SUS 304	SUS 316L	HASTELLOY
Boric acid	100	40	–	–	×
	10	40	○	○	○
		150	○	○	○
Maleic anhydride	100	25	○	○	–
		200	○	○	–
Acetic anhydride	100	40	×	○	○
		100	×	○	○
	10	40	–	–	○
		100	–	–	○
Methanol	100	25	○	○	○
		100	○	○	○
	10	25	×	○	○
		100	×	○	○
Methane	100	40	○	○	○
		100	○	○	○
Methl ethyl ketone	100	25	○	○	○
		100	○	○	×
	10	25	×	×	×
		100	×	×	×
Iodine	100	40	○	○	○
		150	–	×	○
Hydrogen sulfide	100	40	○	○	×
		100	×	×	×
Sulfuric acid	100	10	○	○	–
		40	×	×	–
	50	10	×	×	○
		40	×	–	×
Zinc sulfate	40	40	×	○	×
		100	×	○	×
	10	10	○	○	○
		100	×	○	○
Aluminum sulfate	100	10	○	○	×
		100	×	×	×
	90	10	○	○	○
		100	×	×	○
Ammonium sulfate	40	10	×	×	×
		100	–	×	×
	10	10	×	×	×
		100	–	×	×
Calcium sulfite	10	40	○	○	○
		100	○	○	○
Potassium sulfate	100	10	○	○	○
	10	40	○	○	×
		100	○	○	×
Sodium sulfate	100	40	○	○	○
		100	○	○	–
	30	40	○	○	×
		100	○	○	×
Barium sulfate	100	10	×	×	×
		100	×	×	–
	10	10	×	×	–
		100	×	×	–
Magnesium sulfate	100	25	×	×	○
		100	×	×	×
	40	25	○	○	○
		100	○	○	○

Unit conversion table

Pressure

Pa	kPa	MPa	bar	atm	kgf/cm^2	mmH$_2$O (mmAq)	mmHg (Torr)	psi
1	1×10^{-3}	1×10^{-6}	1×10^{-5}	9.86923×10^{-6}	1.01972×10^{-5}	1.01972×10^{-1}	7.50062×10^{-3}	1.45×10^{-4}
1×10^{3}	1	1×10^{-3}	1×10^{-2}	9.86923×10^{-3}	1.01972×10^{-2}	1.01972×10^{2}	7.50062	1.45×10^{-1}
1×10^{6}	1×10^{3}	1	10	9.86923	1.01972×10	1.01972×10^{5}	7.50062×10^{3}	1.45×10^{2}
1×10^{5}	1×10^{2}	1×10^{-1}	1	9.86923×10^{-1}	1.01972	1.01972×10^{4}	7.50062×10^{2}	1.45×10
1.01325×10^{5}	1.01325×10^{2}	1.01325×10^{-1}	1.01325	1	1.03323	1.03323×10^{4}	7.60000×10^{2}	1.47×10
9.80665×10^{4}	9.80665×10	9.80665×10^{-2}	9.80665×10^{-1}	9.67841×10^{-1}	1	1×10^{4}	7.35559×10^{2}	1.422×10
9.80665	9.80665×10^{-3}	9.80665×10^{-6}	9.80665×10^{-5}	9.67841×10^{-5}	1×10^{-4}	1	7.35559×10^{-2}	1.422×10^{-3}
1.33322×10^{2}	1.33322×10^{-1}	1.33322×10^{-4}	1.33322×10^{-3}	1.31579×10^{-3}	1.35951×10^{-3}	1.35951×10	1	1.933×10^{-2}
6.895×10^{3}	6.895	6.895×10^{-3}	6.895×10^{-2}	6.800×10^{-2}	7.031×10^{-2}	7.031×10^{2}	5.171×10	1

Stress

MPa (N/mm^2)	kgf/mm^2
1	1.01972×10^{-1}
9.80665	1

Force

N	kgf	lbf
1	1.01972×10^{-1}	2.2481×10^{-1}
9.80665	1	2.20462
4.4482	4.5359×10^{-1}	1

Length

m	in	ft
1	3.937×10	3.281
2.540×10^{-2}	1	8.333×10^{-2}
3.048×10^{-1}	12	1

Weight

kg	lb	ton
1	2.205	1×10^{-3}
4.536×10^{-1}	1	4.536×10^{-4}
1000	2205	1

Flow rate

Pa・m^3/sec	Torr・ℓ/sec	atm・cm^3/sec	sccm
1	7.50062	9.86923	5.92154×10^{2}
1.33322×10^{-1}	1	1.31579	7.89474×10
1.01325×10^{-1}	7.60000×10^{-1}	1	60
1.68875×10^{-3}	1.26667×10^{-2}	1.66667×10^{-2}	1

Temperature

K	℃	℉
0	-273.15	-459.67
273.15	0	32
255.37	-17.78	0

Nominal diameter

A	B
8	1/4
10	3/8
15	1/2
20	3/4
25	1
32	1・1/4
40	1・1/2
50	2
65	2・1/2
80	3
90	3・1/2
100	4
125	5
150	6
200	8
250	10
300	12
350	14
400	16
450	18
500	20
550	22
600	24
650	26
700	28
750	30
800	32
850	34
900	36
950	38
1000	40
1050	42
1100	44
1150	46
1200	48
1250	50
1300	52
1350	54
1400	56
1450	58
1500	60