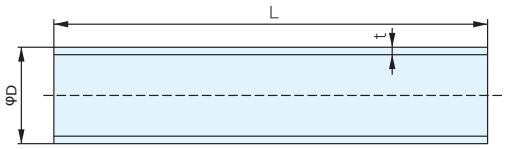
1. Pipes

HT Pipes Code No. 2002

Meaning of symbols
JIS K6776: Product conforms to Japanese Industrial Standards JIS K6776
Ⓜ : Product conforms to the manufacturer's standards



Unit : mm

Nominal Dia.	Outside Dia.D			Thickness t		Approx. Inside Dia. (Reference)	Length L	Tolerance	Reference Weight		Standards
	Basic Dimension	Max./Min. OD Tolerance	Average OD Tolerance	Thickness	Tolerance				kg/m	kg/piece	
13×4m	18.0	±0.2	±0.2	2.5	±0.2	13	4000	+30 −10	0.191	0.76	JIS K 6776
16×4m	22.0	±0.2	±0.2	3.0	±0.3	16	4000		0.281	1.12	
20×4m	26.0	±0.2	±0.2	3.0	±0.3	20	4000		0.340	1.36	
25×4m	32.0	±0.2	±0.2	3.5	±0.3	25	4000		0.492	1.97	
30×4m	38.0	±0.3	±0.2	3.5	±0.3	31	4000		0.596	2.38	
40×4m	48.0	±0.3	±0.2	4.0	±0.3	40	4000		0.868	3.47	
50×4m	60.0	±0.4	±0.2	4.5	±0.4	51	4000		1.232	4.93	
65×4m	76.0	±0.5	±0.3	5.0	±0.5	66	4000		1.651	6.60	Ⓜ
75×4m	89.0	±0.5	±0.3	5.9	±0.4	77	4000		2.380	9.52	
100×4m	114.0	±0.6	±0.4	7.1	±0.5	100	4000		3.743	14.97	
125×4m	140.0	±0.8	±0.5	8.2	±0.6	124	4000		5.025	20.10	
150×4m	165.0	±1.0	±0.5	9.6	±0.6	146	4000		7.280	29.12	
40×1m	48.0	±0.3	±0.2	4.0	±0.3	40	1000	+10 0	0.868	0.87	JIS K 6776
40×2m	48.0	±0.3	±0.2	4.0	±0.3	40	2000		0.868	1.74	
50×1m	60.0	±0.4	±0.2	4.5	±0.4	51	1000		1.232	1.23	
50×2m	60.0	±0.4	±0.2	4.5	±0.4	51	2000		1.232	2.46	
50×3m	60.0	±0.4	±0.2	4.5	±0.4	51	3000		1.232	3.70	
★ 75×3m	89.0	±0.5	±0.3	5.9	±0.4	77	3000		2.380	7.14	Ⓜ

Notes 1. The reference weights are calculated by the basic dimension and a pipe material density of 1.48 g/cm^3, and they are not part of the standards.
2. The ★ " mark indicates a made-to-order product.

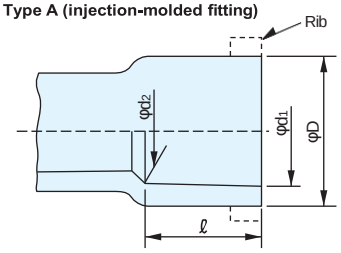
2. Fittings and Accessories

Meaning of symbols
JIS K6777 : Product conforms to Japanese Industrial Standards JIS K6777
Ⓜ : Product conforms to the manufacturer's standards

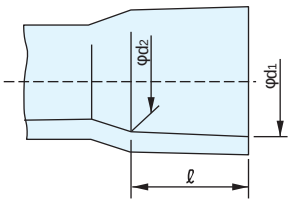
⚠ Be sure to use the Tough dyne HT adhesive for bonding pipes and fittings.

Unit : mm

Type A (injection-molded fitting)



Type B (fabricated fitting)



Nominal Dia.	Type A (injection-molded fitting) Type B (fabricated fitting)							Standards
	Product	d1	Tolerance	d2	Tolerance	ℓ±4	D (min.) Type A	
13	All products	18.30	±0.20	17.55	±0.25	22	26	JIS K 6777
16		22.35		21.55		27	29	
20		26.35		25.50		33	34	
25		32.50	±0.30	31.40	±0.35	38	41	
30		38.50		37.45		42	46	
40		48.50		47.45		47	56	

Nominal Dia.	Type A (injection-molded fitting)							Standards
	Product	d1	Tolerance	d2	Tolerance	ℓ±4	D (min.)	
50	All Type A products	60.50	±0.30	59.45	±0.35	52	69	JIS K 6777
65	Socket	76.60		75.30	±0.30	61	89	Ⓜ
	Elbow/Tee	76.60		–	–	61	91	
75	All Type A products	89.60		–	–	64	106	
100		114.70		–	–	84	134	
125		140.80		–	–	104	166	
150		166.00	±0.40	–	–	132	189	

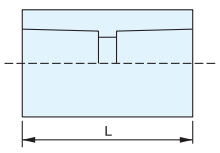
When the socketed end is rib-shaped, the dimension D above indicates the rib diameter.

Nominal Dia.	Type B (fabricated fitting)							Standards
	Product	d1	Tolerance	d2	Tolerance	ℓ±4	D (min.)	
50	Bends	60.50	±0.30	59.45	±0.30	52	–	Ⓜ
				59.10		63	–	
65	All Type A products	76.80		75.12		69	–	
75		89.80		88.13		72	–	
100		115.00	±0.35	112.91	±0.35	92	–	
125		141.20	±0.40	138.71	±0.40	112	–	
150		166.50	±0.50	163.38	±0.50	140	–	

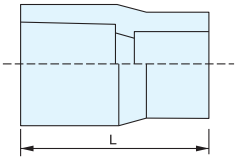
HT Sockets Code No. 2011

Unit : mm

(Abbreviation : HT-S)



(Abbreviation : HT-RS)



Nominal Dia.	L	Standards
13	49	JIS K 6777
16	59	
16×13	53	
20	71	
20×13	61.5	
20×16	66	
25	82	
25×13	73	
25×16	76	
25×20	80.5	
30	87	
30×20	85	
30×25	90	
40	99	
40×20	98	

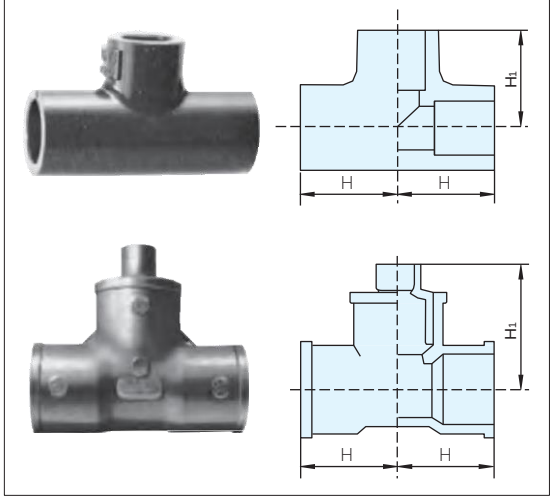
Nominal Dia.	L	Standards
40×25	100	JIS K 6777
40×30	97	
50	109	
50×25	110	
50×30	110	
50×40	110	
65	136	Ⓜ
65×50	215	
75	155	
75×50	245	
75×65	163	
100	200	
100×75	190	
125	240	
150	300	

Note The tolerance for the dimension L of HT sockets is 6 mm and the tolerance for the dimension L of HT reducing sockets is ±5 mm.

HT Tees

Code No. 2013

(Abbreviation : HT-T)



Note HT tee part must not be applied with a bending force or vibration.

Unit : mm

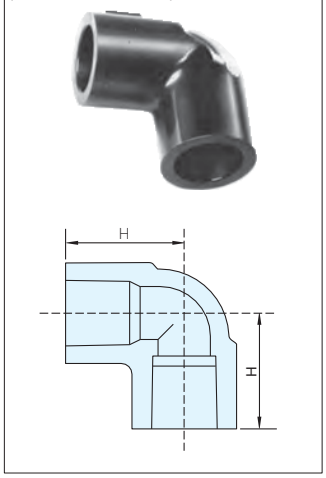
Nominal Dia.	H	H1	Standards
13	34	34	JIS K 6777
16	41	41	
16×13	39	36	
20	53	53	
20×13	45	38	
20×16	47	43	
25	58	58	
25×13	49	41	
25×16	52	46	
25×20	54	52	
30	64	64	
30×13	54	44	
30×16	56	49	
30×20	58	55	
30×25	60	60	
40	75	75	
40×13	62	49	
40×16	63	54	
40×20	65	60	
40×25	68	65	
40×30	72	69	
50	87	87	
50×13	69	55	
50×16	70	60	
50×20	72	70	
50×25	75	75	

Nominal Dia.	H	H1	Standards
50× 30	79	75	JIS K 6777
50× 40	82	80	
65	110	110	
65× 13	100	135	Ⓜ
65× 16	100	137	
65× 20	100	142	
65× 25	100	147	
65× 30	100	150	
65× 40	95	95	
65× 50	102	104	
75	120	120	
75× 20	105	147	
75× 25	93	88	
75× 30	105	155	
75× 40	100	102	
75× 50	105	110	
100	152	152	
100× 20	125	159	
100× 25	125	164	
100× 30	125	167	
100× 40	125	178	
100× 50	125	122	
100× 75	140	132	
125	187	187	
150	230	230	

HT Elbows

Code No. 2012

(Abbreviation : HT-L)



Unit : mm

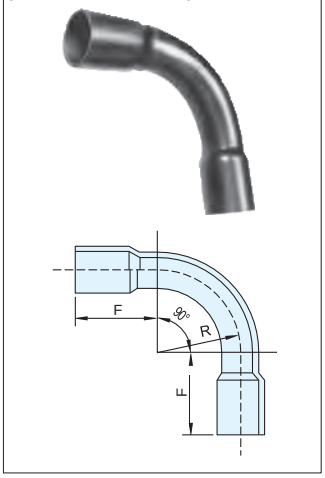
Nominal Dia.	H	Standards
13	34	JIS K 6777
16	41	
20	53	
25	58	
30	64	
40	74	
50	85	
65	110	Ⓜ
75	120	
100	155	
125	188	
150	228	

Notes 1. Use HT 90° Bends for bending sections of buried pipes.
2. HT Elbow sections must not be applied with a bending force or vibration.
3. The tolerance for the dimension H of HT Elbows is ± 4 and t he tolerance for the dimension H of products with nominal diameters of 65 and more is +5/-1.

HT 90° Bends

Code No. 9262

(Abbreviation : HT-90B)



Unit : mm

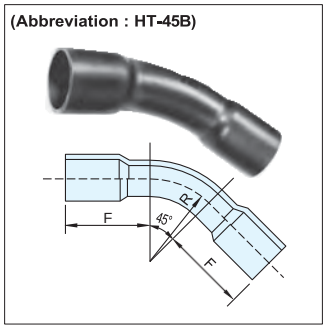
Nominal Dia.	F	R	Standards
★ 13	42	40	Ⓜ
★ 16	47	48	
★ 20	54	55	
★ 25	62	78	
★ 30	70	100	
★ 40	86.5	120	
★ 50	100	160	
★ 65	110	200	
★ 75	120	245	
★100	145	300	
★125	165	400	
★150	195	500	

Note The "★" mark indicates a made-to-order product.

HT 45° Bends

Code No. 9262

(Abbreviation : HT-45B)



Unit : mm

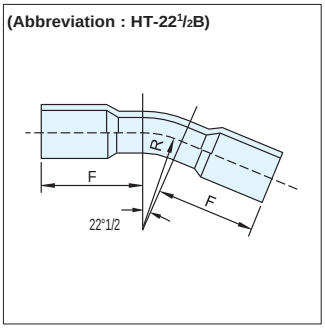
Nominal Dia.	F	R	Standards
★ 13	42	40	Ⓜ
★ 16	47	48	
★ 20	54	55	
★ 25	62	78	
★ 30	70	100	
★ 40	86.5	120	
★ 50	100	160	
★ 65	110	200	
★ 75	120	245	
★100	145	300	
★125	165	400	
★150	195	500	

Note The "★" mark indicates a made-to-order product.

HT 22° 1/2 Bends

Code No. 9262

(Abbreviation : HT-22$^{1}/_{2}$B)



Unit : mm

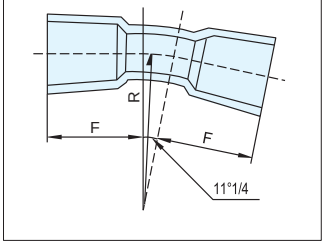
Nominal Dia.	F	R	Standards
★ 13	42	40	Ⓜ
★ 16	47	48	
★ 20	54	55	
★ 25	62	78	
★ 30	70	100	
★ 40	86.5	120	
★ 50	100	160	
★ 65	110	200	
★ 75	120	245	
★100	145	300	
★125	165	400	
★150	195	500	

Note The "★" mark indicates a made-to-order product.

HT 11° 1/4 Bends

Code No. 9262

(Abbreviation : HT-11$^{1}/_{4}$B)



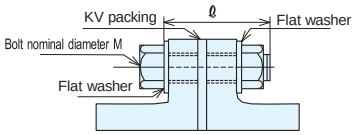
Unit : mm

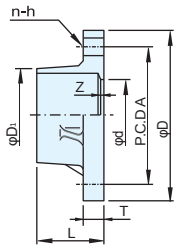
Nominal Dia.	F	R	Standards
★ 50	100	160	Ⓜ
★ 65	110	200	
★ 75	120	245	
★100	145	300	
★125	165	400	
★150	195	500	

Note The "★" mark indicates a made-to-order product.

HT-TS Flanges　Code No. 2342　JIS 10K Flange Type

■ Reference: Length of bolts used to connect TS flanges





Notes
1. **Use KV Packings (gaskets).**
2. **Install flat washers on both bolt side and nut side.**
3. **Be sure to tighten all bolts evenly to the same torque.**
4. **See the table at the right for the bolt tightening torque.**
5. **When installing a butterfly valve, check the product dimensions to make sure that the valve can open fully. When installing, align the centers of the parts.**

Unit : mm

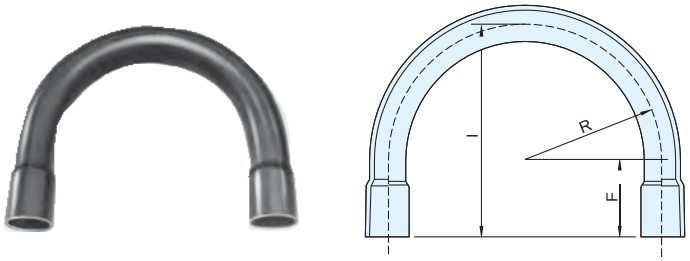
Nominal Dia.	D	A	d	D_1	L	T	Z	n–h	Dimension below Bolt Head ℓ	Standards
15 (16)	95	70	16	31	36	14	6	4–15	M12–50	Ⓜ
20	100	75	20	35	42	14	7	4–15	M12–50	
25	125	90	25	43	46	14	6	4–19	M16–55	
32 (30)	135	100	31	49	51	16	7	4–19	M16–60	
40	140	105	40	61	62	16	7	4–19	M16–60	
50	155	120	51	73	72	20	9	4–19	M16–70	
65	175	140	67	88	69	22	8	4–19	M16–70	
80 (75)	185	150	77	103	72	22	8	8–19	M16–70	
100	210	175	100	132	94	24	10	8–19	M16–75	

Nominal Dia.	Bolt Tightening Torque (Guideline Values) N · m(kgf · m)
13 ~ 30	15(1.5)
40	25(2.5)
50	30(3.1)
75(80)	40(4.1)
100	45(4.6)

Notes　1. The flange conforms to JIS B2220 (steel pipe flanges) 10K.
2. The TS sockets conform to JIS K6777, JIS K6743 and AS 21.

HT 180° Bends　Code No. 9262

(Abbreviation : HT-180B)



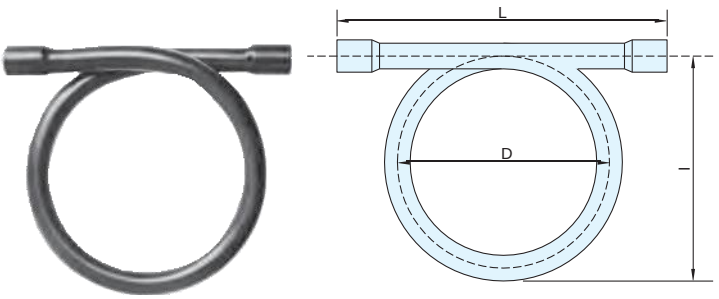
Unit : mm

Nominal Dia.	F	I	R	Standards
★13	40	110	70	Ⓜ
★16	45	125	80	
★20	50	140	90	
★25	60	165	105	
★30	65	185	120	
★40	85	225	140	
★50	100	265	165	

Note　The "★" mark indicates a made-to-order product.

HT Loop Bends　Code No. 9262

(Abbreviation : HT-RB)



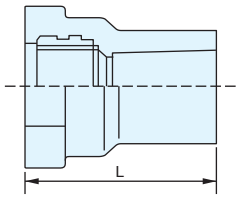
Unit : mm

Nominal Dia.	L (min.)	I (Reference)	D	Standards
★13	212	167	158	Ⓜ
★16	256	198	187	
★20	305	230	217	
★25	358	264	248	
★30	406	299	280	
★40	537	340	316	
★50	638	408	378	

Note　The "★" mark indicates a made-to-order product.

HT Hydrant Sockets with Metal Insert　Code No. 3028

(Abbreviation : HT-MWS)



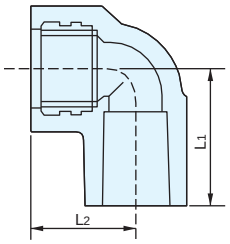
Unit : mm

Nominal Dia.	L	Thread Designation	Standards
13	47	Rp1/2	JIS K 6777
16×13	52	Rp1/2	
20	61	Rp3/4	
20×13	56	Rp1/2	Ⓜ
25	69	Rp1	JIS K 6777

Notes
1. The threads are parallel female threads conform to JIS B0203 (taper pipe threads).
2. The material of the thread insert is free-cutting brass conforms to JIS H5120 CAC406, JIS H5121 CAC406C or JIS H3250.
3. Use seal tape on threads for firm sealing. A solvent-free sealing agent must be used when seal tape and sealing agent are used together. If a solvent-containing sealing agent is used, cracks may occur in the hydrant joint.
4. Excessive tightening of the tapered male threads may cause the RP female thread section to expand and break.
5. Do not connect the product to a steel pipe with tapered male threads that are fabricated at construction sites.

HT Hydrant Elbows with Metal Insert　Code No. 3033

(Abbreviation : HT-MWL)



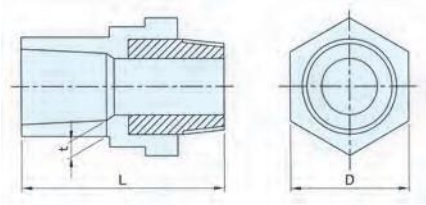
Unit : mm

Nominal Dia.	L1	L2	Thread Designation	Standards
13	35	29	Rp1/2	JIS K 6777
16×13	42	33	Rp1/2	
20	51	36	Rp3/4	
20×13	48	37	Rp1/2	Ⓜ
25	60	40	Rp1	JIS K 6777

Notes
1. The threads are parallel female threads conform to JIS B0203 (taper pipe threads).
2. The material of the thread insert is free-cutting brass conforms to JIS H5120 CAC406, JIS H5121 CAC406C or JIS H3250.
3. Use seal tape on threads for firm sealing. A solvent-free sealing agent must be used when seal tape and sealing agent are used together. If a solvent-containing sealing agent is used, cracks may occur in the hydrant joint.
4. Excessive tightening of the tapered male threads may cause the RP female thread section to expand and break.
5. Do not connect the product to a steel pipe with tapered male threads that are fabricated at construction sites.

HT Valve Sockets with Metal Insert　Code No. 3031

(Abbreviation : HT-MVS)



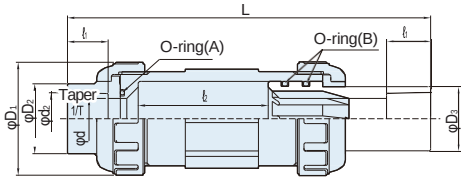
Unit : mm

Nominal Dia.	L	D (min.)	t (min.)	Thread Designation	Standards
13×1/2	64	34	3.5	R1/2	JIS K 6777
16×1/2	70	34	3.5	R1/2	
20×3/4	85	40	4.0	R3/4	
25×1	99	45	4.0	R1	
30×1 1/4	109	62	4.5	R1 1/4	
40×1 1/2	114	68	4.5	R1 1/2	
50×2	132	84	5.0	R2	

Notes
1. The threads are parallel male threads conform to JIS B0203 (taper pipe threads).
2. The material of the thread insert is free-cutting brass conforms to JIS H5120 CAC406, JIS H5121 CAC406C or JIS H3250.

Thermal-Resistant Expansion Joints　Code No. 1063

(Abbreviation : HT-EXP.J)



Unit : mm

Nominal Dia.	L Max.	L Min.	d	d1	ℓ1
20	243	163	20	26	24
25	250	170	25	32	27

Nominal Dia.	1/T	D1	D2	D3	ℓ2 Amount of Expansion and Contraction	Standards
20	1/34	60	35	35	80	Ⓜ
25	1/34	70	43	39	80	

1. Vinyl-Base Adhesives

Usage range of nominal diameters covered by supplied brush

Can size	Guideline range of nominal diameter
100 g	13~50
500 g	13~50
1kg	65~150

⚠ The adhesive must not be mixed with other adhesive. If the adhesive is mixed with other adhesive or a solvent, the adhesive strength decreases significantly.

Tough dyne HI — Code No. 1039

Product conforms to Japan Water Works Association's standards JWWA S101

100 g can (with brush) 500 g can (with brush) 1 kg can (with brush)

Use Bonding of HI products (can be used on general pipes and fittings)
Property Low viscosity (A), quick drying (viscosity: 500 MPa·s)
Color Colorless

Tough dyne HI (White) — Code No. 1039

Product conforms to Japan Water Works Association's standards JWWA S101

500 g can (with brush) 1 kg can (with brush)

Use Bonding of HI products (can be used on general pipes and fittings)
Property Low viscosity (A), quick drying (viscosity: 500 MPa·s)
Color White

Tough dyne Red — Code No. 1039

Product conforms to Japan Water Works Association's standards JWWA S101

500 g can (with brush) 1 kg can (with brush)

Use Bonding of general pipes and fittings
Property High viscosity (B), quick drying (viscosity: 1,700 MPa·s)
Color Colorless

⚠ Caution
- **This adhesive cannot be used to bond HI products.**

Tough dyne Blue — Code No. 1039

Product conforms to Japan Water Works Association's standards JWWA S101

100 g can (with brush) 500 g can (with brush) 1 kg can (with brush)

Use Bonding of general pipes and fittings
Property Low viscosity (A), quick drying (viscosity: 150 MPa·s)
Color Colorless

⚠ Caution
- **This adhesive dries quickly; therefore, it is not suitable for bonding pipes with nominal diameter of 200 and more.**
- **This adhesive cannot be used to bond HI products.**

Tough dyne HT — Code No. 2039

Product conforms to the manufacturer's standards

100 g can (with brush) 250 g can (with brush) 500 g can (with brush)

Use Bonding of HT products
Property Low viscosity, quick drying (viscosity: 500 MPa·s)
Color Colorless

⚠ Caution
- **This adhesive cannot be used to bond general pipes/fittings or HI products.**

(Note) Expiration date is indicated only on the Tough dyne HT can. Please check the expiration date before using.

Color Tough dyne Blue — Code No. 1039

Product conforms to the manufacturer's standards

500 g can (with brush) 1 kg can (with brush)

Use Bonding of DV fittings
Property Low viscosity, quick drying (viscosity: 500 MPa·s)
Color Blue

⚠ Caution
- **Use Tough dyne Yellow for drain pipes with nominal diameter of 200 and more.**
- **This adhesive must not be used to bond pipes and fittings for water supply such as for drinking water.**
- **Be sure to wipe off the adhesive adhered on the base material. The dye contained in the adhesive penetrates the sheet over time. As a result, the blue dye appears on the surface.**

Tough dyne Yellow — Code No. 1039

Product conforms to the manufacturer's standards

1 kg can (with brush) 3 kg can

Use Bonding of general pipes and fittings (nominal diameter of 200 and more)
Property High viscosity, slow drying (viscosity: 1,000 MPa·s)
Color Colorless

⚠ Caution
- **This adhesive must not be used to bond pipes and fittings for water supply such as for drinking water.**
- **When applying to pipes with large diameters, pour a necessary amount of adhesive into a different metal container and use a large brush.**

2. Selection of Vinyl-Base Adhesive to Use

◎Recommended ○Usable × Cannot be used

Pipeline Classification	Pressurized Pipeline						Nonpressurized Pipeline		
Application Classification	Water Supply/Hot Water Supply			General Pressurized Pipe			Drain and Vent		
Pipe Product Classification	HI Product	General Pipe	HT Product	HI Product	General Pipe		HT Product	General Pipe	
Nominal Diameter Classification	150 and less			150 and less	150 and less	200 and more (Note 1)	150 and less	150 and less	200 and more (Note 1)
Tough dyne HI	◎	○	×	◎	○	×	×	○	×
Tough dyne HI (White)	◎	○	×	◎	○	×	×	○	×
Tough dyne Red	×	○ (Note 4)	×	×	○ (Note 4)	◎	×	○ (Note 4)	◎
Tough dyne Blue	×	◎	×	×	◎	× (Note 2)	×	◎	× (Note 2)
Tough dyne HT	×	×	◎	×	×	×	◎ (Note 3)	×	×
Color Tough dyne Blue	×	×	×	×	◎	×	×	◎	× (Note 2)
Tough dyne Yellow	×	×	×	×	×	◎ (Note 2)	×	×	◎

Note 1. When applying the adhesive to pipes with nominal diameter of 200 and more, pour a necessary amount of adhesive into a different metal container and use a large brush.
Note 2. Tough dyne Blue and Color Tough dyne Blue dry quickly; therefore, they are not suitable for bonding pipes with nominal diameter of 200 and more.
Note 3. When bonding HT-DV products to general pipes, such as for the connection of the drain pipe from a dishwasher, use Tough dyne HT.
Note 4. Tough dyne Red is recommended for nominal diameters of 65 and more.
Note 5. Tough dyne Yellow must not be used to bond pipes and fittings for water supply such as for drinking water.
Note 6. Use Tough dyne HI for HI pipes and fittings with nominal diameter of 200 and more.

3. Lubricants for Rubber Ring Joints

V Soap

Code No. 7000 Product conforms to the manufacturer's standards

1 kg resin container (with brush)

2 kg resin container

Use Connecting pipes to fittings with rubber ring
Property Liquid
Main component Potassium soap

V Spray

Code No. 7000 Product conforms to the manufacturer's standards

340ml

Use Connecting pipes to fittings with rubber ring
Property Spray
Main component Silicone oil

4. Amount of Adhesive and Lubricant to Apply

1. The amount of adhesive/lubricant indicated in the tables are guideline figures. When ordering, add 20% to 30% more to compensate for the loss that can occur at the construction site.
2. The indicated amount is the amount applied on the socket and pipe at one location.

Amount of vinyl-base adhesive to apply (reference)

For TS socket g/location

Nominal Dia.	13	16	20	25	28	30	35	40	50	65	75	100	125	150	200	250	300	350	400	450	500	600
Tough dyne HI/ HI (White)	0.6	0.8	1.1	1.6	—	2.1	—	3.3	4.8	6.6	8.1	13	20	30	55	—	—	—	—	—	—	—
Tough dyne Red	0.9	1.2	1.7	2.4	2.6	3.2	3.5	5.0	7.1	9.9	12	20	30	45	80	130	180	—	—	—	—	—
Tough dyne Blue	0.6	0.8	1.1	1.6	1.7	2.1	2.3	3.3	4.8	6.6	8.1	13	20	30	—	—	—	—	—	—	—	—
Tough dyne HT	0.6	0.8	1.1	1.6	—	2.1	—	3.3	4.8	6.6	8.1	13	20	30	—	—	—	—	—	—	—	—
Tough dyne Yellow	—	—	—	—	—	—	—	—	—	—	—	—	—	—	70	105	150	205	265	330	410	595

Note The indicated amount is for a surface area of $1m^2$. The amount in the table were calculated based on 300 g for Tough dyne Red, 200 g for Tough dyne HI and Tough dyne HI (White) , and 250 g for Tough dyne Yellow.

For DV socket g/location

Nominal Dia.	20	25	40	50	65	75	100	125	150	200	250	300	350	400	450	500	600	700
Tough dyne Blue	—	—	4	5	7	10	15	20	30	—	—	—	—	—	—	—	—	—
Color Tough dyne Blue	—	—	4	5	7	10	15	20	30	—	—	—	—	—	—	—	—	—
Tough dyne HT	0.8	1.1	4	5	—	10	—	—	—	—	—	—	—	—	—	—	—	—
Tough dyne Yellow	—	—	—	—	—	—	—	—	—	55	90	125	175	220	275	350	525	700

Amount of lubricant for rubber ring joint to apply (reference)

g/location

Nominal Dia.	40	50	75	100	125	150	200	250	300	350	400	450	500	600
Amount of V Soap used	5	5	7	10	15	20	25	35	50	65	90	115	140	190

Number of application locations per can

Nominal Dia.	150	200	250
Number of joint location per V Spray can	35	23	15

IPerformance and Quality

1. Operating Temperature and Pressure

(1) Operating temperature ranges and operating pressure for HI-VP, VP, VU and major fittings

Pipe	Major fitting	Use	Operating temperature range (see notes)		Operating pressure range (see notes)
HI-VP pipe for water supply VP pipe for water supply	HI-TS fitting TS fitting	Water pipe	Ordinary temperature (5 - 35ºC)		0.75 MPa (hydrostatic pressure)
VP pipe for general purposes	TS fitting	Pressure pipe	Ordinary temperature (5 - 35ºC)		1.0 MPa (hydrostatic + water hammer pressure)
	DV fitting	Non-pressure pipe	W/o external pressure	5 - 60 ºC	–
			W/ external pressure	5 - 45 ºC	
VU pipe for general purposes	VU fitting	Non-pressure pipe	W/o external pressure	5 - 60 ºC	–
			W/ external pressure	5 - 45 ºC	

Notes: 1. The operating temperature range and pressure may vary with the fitting type or joint technique.
2. Since PVC-U pipes expand and contract due to temperature differences, exposed PVC-U pipes require a means to absorb thermal expansion and contraction.

(2) Maximum operating pressures for HT pipes at various temperature

Use	Nominal Dia	Max. operating pressure various temperatures (hydrostatic + water hammer pressure)				
Pipes for hot water and hot-spring water supply (pressure pipe)	13-50	Operating temperature (ºC)	50-40	41-60	61-70	71-90 (see Notes)
		Max. operating pressure	1.0 MPa	0.6 MPa	0.4 MPa	0.2 MPa
	65-150	Operating temperature (ºC)	50-40	41-60	61-70	71-85 (see Notes)
		Max. operating pressure	1.0 MPa	0.6 MPa	0.25 MPa	0.15 MPa

Notes: 1. The continuous operating temperature range for pressure pipes is 5 to 85ºC for nominal diameters of 13 to 50 and 5 to 80ºC for nominal diameters of 65 to 150.
2. Since the thermal expansion coefficient of HT pipes due to temperature differences is four to six times those of copper and steel pipes, a means to absorb thermal expansion and contraction are important for HT pipes.

2. Performance Specification for VP and HI-VP Pipes for Water Supply

(excerpt from JIS K 6742: 2007)

Performance attribute		Performance	Applicable pipe
Tensile yield strength		Min. 45 MPa for the tensile strength at yield at 23ºC.	VP
		Min. 40 MPa for the tensile strength at yield at 23ºC.	HI -VP
Pressure resistance (hydrostatic pressure 4.0 MPa x 1 min at ordinary temperature)[1]		There shall be no leaks and other defects.	VP, HI-VP
Flatness		There shall be no cracks.	VP, HI-VP
Impact resistance		There shall be no anomalies.	HI-VP
Vicat softening temperature		MIn. 76ºC	VP, HI-VP
Opacity		Visible light transmittance shall be 0.2% or less.	VP
Leachability	Turbidity	Max. 0.5 degree	VP, HI-VP
	Chromaticity	Max. 1 degree	
	Organic matter (TOC)	Max. 1 mg/L	
	Lead	Max. 0.008 mg/L	
	Zinc	Max. 0.5 mg/L	
	Reduction in residual chlorine	Max. 0.7 mg/L	
	Odor	There shall be no anomalies.	
	Taste	There shall be no anomalies.	

Note: 1. 4.0 MPa is the pressure for the hydrostatic pressure test to check product quality. The maximum operating pressure of VP and HI-VP Pipes for water supply is 0.75 MPa and the maximum operating pressure (water hammer + hydrostatic pressure) is 1.0 MPa.

3. Performance Specification for VP Pipes for General Purposes

(excerpt from JIS K 6741: 2007)

Performance attribute	Performance	Applicable pipe
Tensile yield strength	Min. 45 MPa for the tensile strength at yield at 23ºC.	VP,VM, VU
Pressure resistance (VP: hydrostatic pressure 2.5 MPa x 1 min at ordinary temperature)[1]	There shall be no leaks or other defects.	VP,VM, VU
Joint pressure resistance[1,2]	There shall be no leaks or other defects.	VP,VM, VU
Flatness	There shall be no cracks.	VP,VM, VU
Vicat softening temperature	Min. 76ºC	VP,VM, VU

Notes: 1. 2.5 MPa is the pressure for the hydrostatic pressure test to check product quality. The maximum operating pressure (water hammer + hydrostatic pressure) of VP pipes for general purposes is 1.0 MPa.
2. The joint pressure resistance applies to pipes with rubber ring and bonding-type ends for pressure applications. For these pipes, this joint pressure resistance test may be substituted for a pressure test.

4. Performance Specification for HT-VP Pipes for Hot Water Supply

(excerpt from JIS K 6776: 2007)

Performance attribute		Performance		Applicable pipe
Tensile yield strength		Min. 50 MPa for the tensile strength at yield at 23ºC.		HT
Pressure resistance (hydrostatic pressure 4.0 MPa x 1 min at ordinary temperature)[1]		There shall be no leaks other defects.		HT
Hot internal pressure creep performance		There shall be no leaks other defects.		HT
Flatness		There shall be no cracks.		HT
Vicat softening temp erasure		Min. 95ºC		HT
Leachability[2]	Turbidity	Max. 0.5 degree		HT
	Chromaticity	Max. 1 degree		
	Organic matter (TOC)	Max. 1 mg/L		
	Lead	Max. 0.008 mg/L		
	Zinc	Max. 0.5 mg/L		
	Odor	There shall be no anomalies.		
	Taste	There shall be no anomalies.		
	Reduction in residual chlorine	Leachate at 90±2ºC[3]	Max. 1mg/L	
		Leachate at ordinary temperature[4]	Max. 0.7mg/L	

Notes: 1. 4.0 MPa is the pressure for the hydrostatic pressure test to check product quality. The operating temperature and the maximum operating pressure of HT Pipes for hot water supply are as per item1.
2. Unless otherwise specified, a leachate at 90±2ºC shall be used in the leaching test.
3. “Leachate at 90±2ºC” means a leaching test using a leachate at 90±2ºC.
4. “Leachate at ordinary temperature” means a leaching test using a leachate at ordinary temperature.

5. General Properties of VP, HI-VP and HT-VP Products

	Attribute	Units	VP	HI	Test method	HT	Test method
Physical properties	Color	—	Gray	Grayish blue	—	Brown	—
	Specific gravity	—	1.43	1.40	JIS K 7112 Sink-float method 20ºC	1.48	ASTM D 792 20ºC
	Hardness	Rockwell R	115	115	ASTM D 785 20ºC	140	JIS K 7202 20ºC
	Water absorption	One week at ordinary temperature mg/cm^2	Max. 0.15	Max. 0.15		Max. 0.15	
Mechanical properties	Tensile strength	MPa (kgf/cm^2)	49-54(500-550)	49-54(500-530)	JIS K 6742 23ºC, eta.	49-54 (500-550)	JIS K 6776 20ºC
	Longitudinal elastic modulus	MPa (kgf/cm^2)	2942 (3X10^4)	2942 (3X10^4)	JIS K 7113 20ºC	2942 (3X10^4)	ASTM D 747 20ºC
	Elongation at fracture	%	50-150	50-150	JIS K 6741 20ºC	40-80	JIB K 6741 20ºC
	Bending strength	MPa (kgf/cm^2)	78.5-98.1 (800-1000)	78.5-98.1 (800-1000)	JIS K 7203 20ºC 65%RH	89 (900)	ASTM D 970 20ºC
	Bending elastic modulus	MPa (kgf/cm^2)	2746(2.8X10^4)	2746(2.8X10^4)	JIS K 7203 20ºC 65%RH	—	—
	Compression strength	MPa (kgf/cm^2)	69(700)	64(650)	JIS K 7208 20ºC 85%RH	69 (700)	ASTM D 695 20ºC
	Poisson's ratio	—	0.35-0.40	0.35-0.40		0.38	—
	Charpy impact strength	kJ/m^2 (kgf•cm/cm^2)	6.9-9.8(7-10)	Min. 17.7		7.84X10^{-2} (8.0)	ASTM D 256
Thermal properties	Vicat softening temperature	ºC	Min. 76	Min. 76	JIS K 6742	Min. 95	JIS K 6776
	Linear expansion coefficient	1/ºC	6-8X10^{-5}	6-8X10^{-5}		6-8X10^{-5}	
	Specific heat	J/(kg•K) (cal/g•ºC)	1.05X10^3 (0.25)	1.05X10^3 (0.25)		1.05X10^3(0.25)	
	Thermal conductivity	W/(m^2•K) (kcal/m•h•ºC)	0.15 (0.13)	0.15 (0.13)	DIN 8061	0.15 (0.13)	DIN 8061
	Combustibility	—	Self-extinguishability	Self-extinguishability		Self-extinguishability	—
Electrical properties	Voltage resistance	kV/mm	Min. 40	Min. 40		Min. 40	—
	Volume resistivity	Ωcm	5.3X10^{15}	5.3X10^{15}	30ºC 65%RH	5.3X10^{15}	ASTM D 257
	Dielectricity 60 Hz	—	3.2	3.2	30ºC 55%RH	3.2	ASTM D 150
	Dielectricity 10^3 Hz	—	3.1	3.1		—	—
	Dielectricity 10^6 Hz	—	3.0	3.0		—	—
	Power factor 60 Hz	10^2	1.18	1.18	30ºC 55%RH	—	—
	Power factor 10^3 Hz	10^2	1.91	1.91		—	—
	Power factor 10^6 Hz	10^2	1.72	1.72		—	—

Note: The above values indicate typical values.

6. Chemical Resistance of VP and HI-VP Products

The chemical resistance in the table is only for reference. Please consult us when using VP and HI-VP products for chemicals.

	Chemical name	Temperature (ºC) 20	40	60		Chemical name	Temperature (ºC) 20	40	60		Chemical name	Temperature (ºC) 20	40	60
Acids	Hydrochloric acid 35%	◎	◎	△	Alkali	Aqueous ammonia 30%	◎	○	△	Organic chemicals	Ethyl acetate	×	×	×
	Sulfuric acid 60%	◎	◎	△		Lime milk	◎	◎	◎		Ethylene chloride	×	×	×
	Sulfuric acid 98%	×	×	×	Salts	Most metal chlorides, nitrates, sulfates	◎	◎	○		Formalin	◎	○	○
	Nitric acid 70%	○	△	×		Potassium bichromate 10%	◎	○	△		Carbon bisulfide	×	×	×
	Nitric acid 95%	×	×	×		Potassium perchlorate 1%	○	△	×		Acetaldehyde	×	×	×
	Mixed acid H_2SO_4 + HNO_3 50-10%:20-40%	◎	○	○		Potassium permanganate 15%	◎	○	△		Gasoline	△		
	50%:50%	△	×	×		Sodium hypochlorite	△*	△*	×		Petroleum	×	×	×
	Mixed acid: CrO_3 : H_2SO_4 25%:25%	×	×	×	Organic chemicals	Methylene chloride	×	×	×		Aromatic hydrocarbon	×	×	×
						Triol (toluene)	×	×	×		Glycerin	◎	◎	◎
						Trichloroethylene	×	×	×		Oil, fat	◎	◎	◎
	Hydrogen fluoride 10%	◎	◎	△		Acetone	×	×	×		Cresol solution 5%	×	×	×
	Phosphoric acid	◎	◎	△		Ketones	×	×	×		Lacquer, thinner	×	×	×
	Acetic acid 95%>	○	△	△		Methyl alcohol	◎	△	×	Gas	Dry chlorine gas 100%	△	×	×
	Acetic acid =>95%	△	×	×		Ethyl ether	×	×	×		Wet chlorine gas 5%	△	×	×
	Aminoformic acid 50%	◎	○	×		Ethyl alcohol	◎	○	△		Ammonia, many other gaseous wastes	◎	○	○
	Oxalic acid	◎	◎	◎		Butyl alcohol	◎	○	△	Other	Seawater, brine	◎	◎	◎
	Lactic acid	○	△	△		Aniline	×	×	×		Ant repellent	×	×	×
	Hydrogen peroxide 30%	◎	○	△		Benzene	×	×	×		Wood preservative (creosote)	×	×	×
Alkali	Caustic soda 40%>=	◎	◎	○		Carbon tetrachloride	×	×	×					
	Caustic potash 40%>=	◎	◎	○		Chloroform	×	×	×					

Notes: ◎: not eroded at all ○: not apparently eroded △: slightly eroded ×: unusable
For chemical marked with *, VP and HI-VP products may not be used depending on the service conditions. Please consult us.

7. Chemical Resistance of HT-VP Products

The chemical resistance in the table is only for reference. Please consult us when using HT-VP products for chemicals.

	Chemical name	Temperature (ºC) 20	40	60	80		Chemical name	Temperature (ºC) 20	40	60	80		Chemical name	Temperature (ºC) 20	40	60	80
Acids	35% hydrochloric acid	◎	◎	◎	○	Alkalis	50% caustic soda	○	○	△	×	Organic chemicals	Oil, fat	◎	◎	◎	○
	Nitric acid 70%=>	○	×	×	×		60% caustic potash	◎	○	○	○		Ethyl ether	X	—	—	—
	Sulfuric acid 90%=>	◎	◎	○	△		Saturated ammonia water	◎	◎	◎	○		Hexane	◎	—	—	—
	Hypochlorous acid	△	×	×	×	Gas	Chlorine, sulfurous acid	○	—	—	—		Creosote	×	×	×	×
	50% chromium acid	△	×	×	×		Ammonia	◎	◎	○	△		Benzol	×	×	×	×
	Acetic acid 95%=>	○	△	×	×	Salts	Most metal chlorides	◎	◎	◎	○		Formalin	◎	◎	○	—
	Chloroacetic acid	◎	○	○	×		Potassium perchlorate	◎	◎	◎	○		Benzin	×	—	—	—
	Oxalic acid	◎	◎	◎	◎	Organic	Ethanol	◎	○	○	△		Ketones	×	—	—	—
	Lactic acid	◎	◎	○	○		Butanol	◎	◎	◎	○		Plating solutions	◎	◎	○	○
	Fatty acid	○	○	○	△		Carbon tetrachloride	×	×	×	×	Other	Petroleum	×	×	×	×
	Maleic acid	◎	◎	◎	◎		Glycerin	◎	◎	◎	◎						

Note: ◎: not eroded at all ○: not apparently eroded △: slightly eroded (usable with restrictions on length of period and pressure) ×: unusable

II Installation Design

1. Installation Design for HT Pipes for Hot Water Supply

1.1 Main check points

(1) Operating temperature ranges and operating pressure (hydrostatic + water hammer pressure)

Nominal diameters of 50 and less (JIS K 6776)

Operating temperature (°C)	5~40	41~60	61~70	71~90(Note)
Maximum operating pressure (MPa)	1.0	0.6	0.4	0.2

Note : Continuous normal operating maximum temperature is 85°C.

Nominal diameters of 65 and more (manufacturer's standards)

Operating temperature (°C)	5~40	41~60	61~70	71~85(Note)
Maximum operating pressure (MPa)	1.0	0.4	0.25	0.15

Note : Continuous operating maximum temperature is 80°C.

(2) Applications which HT pipes cannot be used

- Do not use HT pipes for instant water heaters since the water temperature can be as high as 100°C when the water flow rate decreases.
- Do not use HT pipes for solar water heaters or heat exchangers since the water temperature can be as high as 100°C.
- If the water heater is other than the types above and it directly receives water pressure, it is necessary to take a measure such as installing a pressure reducing valve.

(3) About expansion and contraction protection

- Use expansion joints or form a pipe loop.
- Use fixed supports at pipe sections near tees and elbows because the expansion and contraction force in the hot water supply pipe acts on the fittings.

* For details, refer to "1.5 Pipe Expansion and Contraction Protection" and "1.6 Pipe Supports."

(4) About buried pipes

- When burying pipes in concrete, use casing pipes or bury the pipes to a depth of less than 1 m, and do not bury fittings.
- When burying pipes under dirt floor or outdoors, do not use elbows at bending parts. Bends are only recommended at bending parts.
- Do not bury pipes that branch to multiple faucets, such as pipes to a bathroom.

(5) About freeze-up prevention and thermal insulation

For pipes that may freeze, take a freeze-up prevention measure such as installation of water drain port or thermal insulation material.

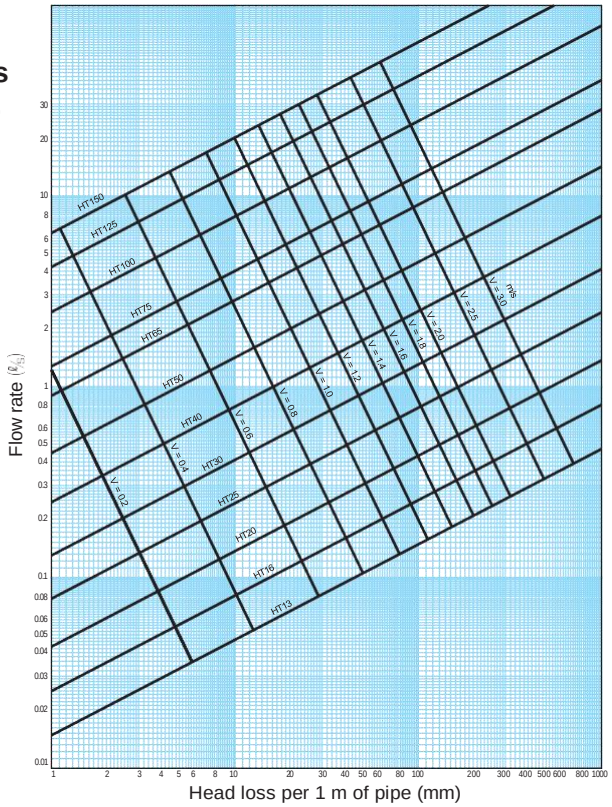
1.2 Head Loss in Pipeline

(1) Friction head loss in straight pipe sections

Use the following Darcy-Weisbach Equation to calculate the friction head loss in a straight pipe section.

$$h = \lambda \frac{\ell}{d} \cdot \frac{V^2}{2g}$$

h : Friction head loss in straight pipe section (m)
λ : Friction loss coefficient (0.02)
ℓ : Pipeline length (m)
d : Pipe inside diameter (m) V : Pipe flow velocity (m/sec)
g : Gravitational acceleration (9.8 m/sec²)



(2) Head loss in fitting (reference)

The head loss in a fitting can be determined by calculation according to the shape of the fitting. For the calculation, a fitting is usually converted to a straight-pipe-equivalent length and added as an extension pipe to the straight pipe section to determine head loss.

Straight-pipe-equivalent lengths for the calculation of head loss in fittings

Unit : m

Fitting \ Nominal Dia.	13	16	20	25	30	40	50	65	75	100
Elbow	0.2	0.3	0.4	0.5	0.5	0.7	0.9	1.2	1.4	1.8
90° Bend	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.5	0.6
45° Bend	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4
Same-diameter tee ⊥→	0.2	0.3	0.4	0.5	0.5	0.7	0.9	1.2	1.4	1.8
Same-diameter tee ↑⊥	0.7	0.8	1.0	1.3	1.5	2.0	2.5	3.3	3.8	5.0
Reducer (1: 0.5)	—	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5
Gate valve (fully open)	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.4	0.5	0.7
Stop valve (fully open)	5.5	5.5	7.6	9.1	12.1	13.6	18.2	21.2	26.0	36.0

1.3 Temperature Drop and Thermal Insulation

HT pipes offer excellent thermal insulation performance, so no insulation measure is necessary for short-distance hot water supply pipes. However, to reduce the electricity/gas expenses, use commercially available easy-to-install heat insulation covers on heating/cooling equipment pipes.
Use the following formula to calculate the temperature drop in HT pipes used for hot water supply.

$$t_o = t_a + (t_i - t_a)\, e^{-\left(\frac{2\pi L}{R \cdot Cp \cdot Q}\right)}$$

t_o : Water temperature at pipe outlet (°C)
t_a : Outdoor air temperature (°C)
t_i : Water temperature at pipe inlet (°C)
e : Base of natural logarithm (2.71828)
L : Pipe length (m)
R : Heat transfer resistance (h·m·°C/Kcal)
Cp : Specific heat of water (1 Kcal/kg·°C)
Q : Water flow rate (kg/h)

Use the following formula to calculate heat transfer resistance R. Note that heat transfer resistance R varies depending on whether thermal insulation is installed or not.

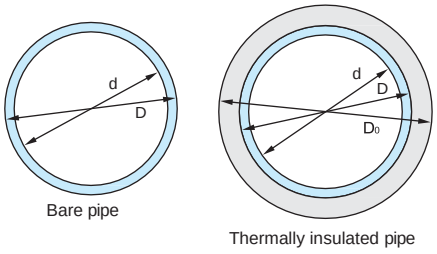
(1) For exposed bare pipes

$$R = \frac{2}{h_a \cdot D} + \frac{1}{\lambda} \ell_n \frac{D}{d} + \frac{2}{h_w \cdot d}$$

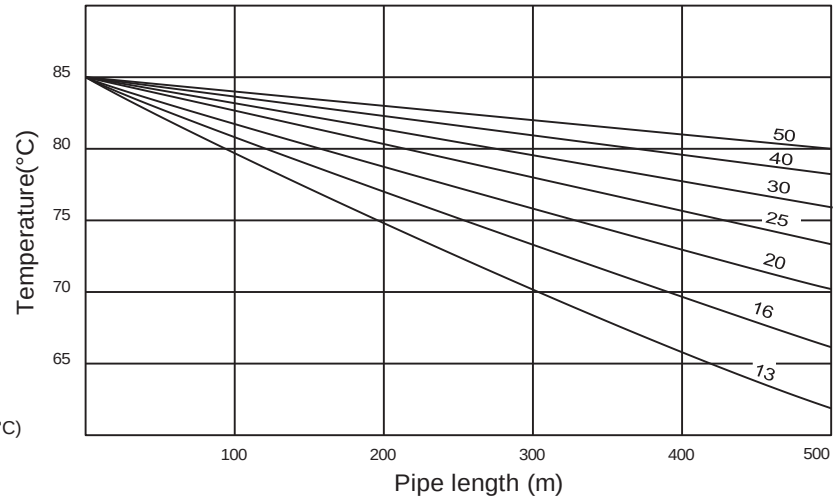
(2) For exposed thermally insulated pipes

$$R = \frac{2}{h_a \cdot D_o} + \frac{1}{\lambda_o} \ell_n \frac{D_o}{D} + \frac{1}{\lambda} \ell_n \frac{D}{d} + \frac{2}{h_w \cdot d}$$

h_a : Coefficient of heat transfer to outside air (10 Kcal/h·m^2·°C)
h_w : Heat transfer coefficient of water in pipe (Min. 3,000 Kcal/h·m^2·°C)
d : HT pipe inside diameter of (m)
D : HT pipe outside diameter (m)
D_o : Outside diameter of thermally insulated pipe (m)
λ : Thermal conductivity of HT pipe (0.12 Kcal/h·m·°C)
λ_o : Thermal conductivity of thermal insulation material (Kcal/h·m·°C)



Example of temperature drop in exposed bare pipe



Conditions: Pipe inlet temperature at 85°C, outside air temperature at 0°C, pipe flow velocity at 1.5 m/s

Thermal transfer coefficient of thermal insulation materials

Unit : cm

Thermal Insulation Material	Thermal Conductivity (Kcal/h·m·°C)
Magnesium carbonate	0.040~0.048
Diatomaceous earth	0.053~0.097
Rock wool	0.046~0.056
Cow fur felt	0.046~0.047
Hemp felt	0.046~0.050
Carbonized cork	0.043~0.046
Glass fiber	0.039~0.057
Polyurethane foam	0.027~0.047

1.4 Thermal Expansion and Contraction and Thermal Stress

(1) Thermal expansion and contraction

The linear expansion coefficiency α of a HT pipe is usually 7 x 10^{-5}/°C, which is 4 to 6 times higher than that of a steel pipe or copper pipe. The amount of expansion and contraction resulting from a change in the temperature inside the pipe can be obtained with the following formula. According to the formula, the amount of expansion and contraction per 1 m of pipe resulting from a temperature change of 10°C is 0.7 mm.

$$\Delta \ell = \alpha \cdot \ell \cdot \Delta t$$

△ℓ : Amount of expansion and contraction (cm) α : Linear expansion coefficient (7 x 10^{-5}/°C) ℓ : Pipe length (cm)
△t : Temperature difference (°C)

(2) Thermal stress

When the HT pipe movement in the axial direction is restricted and the temperature increases, compressive stress generates. When the temperature decreases, tensile stress generates. The thermal stress values can be obtained with the following formula. By multiplying a thermal stress value by the cross-sectional area of the pipe, the amount of expansion and contraction force that is generated due to the heat and acts on the pipe body can be obtained.

$$\sigma = \alpha \cdot E \cdot \Delta t$$

σ : Thermal stress (kN/cm^2)
E : Elastic modulus of pipe (kN/cm^2)

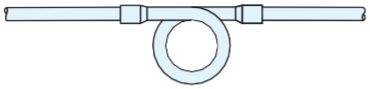
1.5 Pipe Expansion and Contraction Protection

Since HT pipes have a higher linear expansion coefficient than metal pipes, it is important to protect HT pipes against thermal expansion and contraction when designing pipe installation.
By either using expansion fittings or using a special piping method, thermal expansion and contraction can be absorbed for the protection of pipes, fittings and equipments.

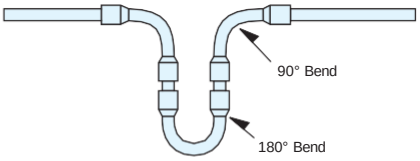
(1) Types of expansion and contraction protection

Expansion fittings

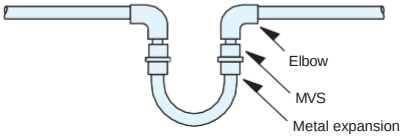
Loop Bend (nominal diameter: 13 to 50 mm)



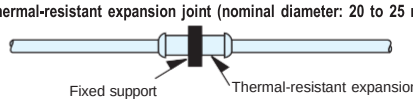
U-shape expansion pipe loop (nominal diameter: 13 to 50 mm)



Metal expansion pipe loop (nominal diameter: 13 to 25 mm)



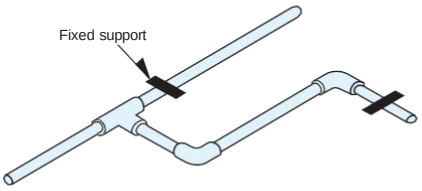
Thermal-resistant expansion joint (nominal diameter: 20 to 25 mm)



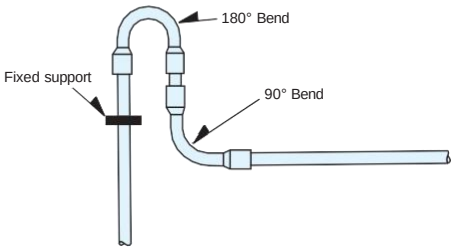
Do not use this expansion joint in a concealed location.
It is difficult to conduct maintenance of the joint installed in a concealed location.

Piping method

Pipe loop formed with elbows (for branching)



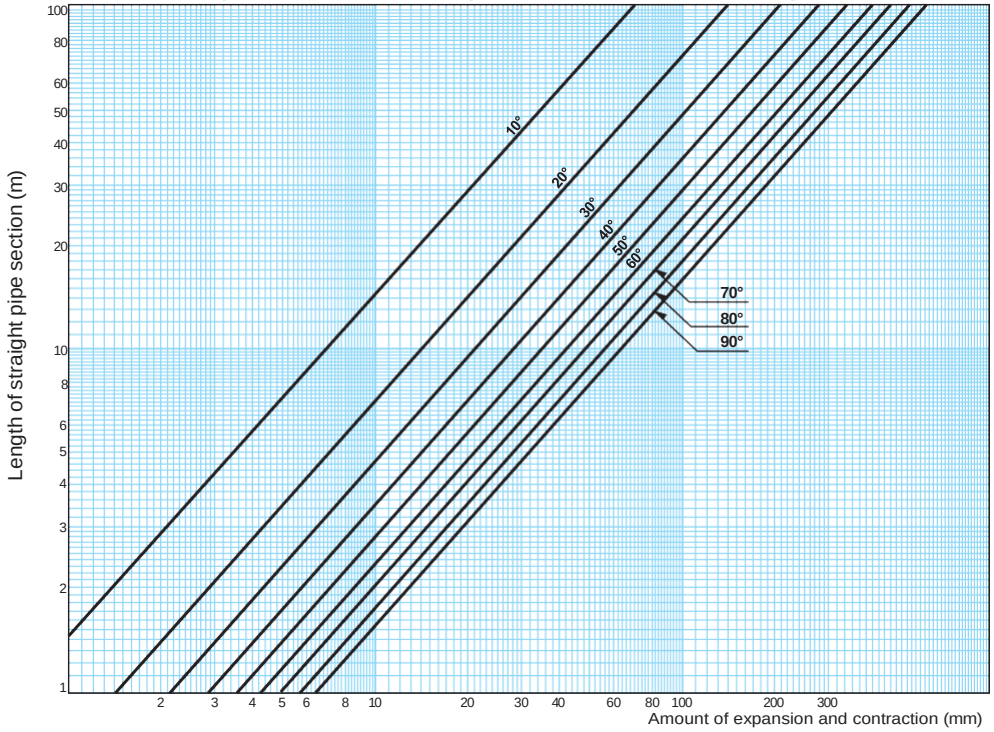
Pipe loop formed with Bend (nominal diameter: 13 to 50 mm)



(2) Selection of expansion and contraction protection method

The amount of expansion and contraction absorbed varies depending on the type of expansion and contraction protection method, such as installation of expansion fittings or use of a special piping method. Select the most suitable expansion and contraction protection method to use based on the difference between the temperature at the time of pipe installation and the temperature during hot water supply or between the temperature at the time of pipe installation and the temperature during the cold season as well as the length of the straight pipe section and by referring to the diagram below.

Selection of expansion and contraction protection method based on temperature difference



Thermal-resistant expansion joint, 1 piece			2 pieces	3 pieces
90° Bend, 1 piece	Loop Bend, 1 piece	2 pieces	3 pieces	4 pieces
	U-shape expansion fitting, 1 piece	2 pieces		3 pieces
180° Bend, 1 piece				

Note Secure one side of the 90° Bend at a location 50 cm away using a fixed support.
180° Bend is combined with a 90° Bend.

Supporting length per expansion fitting

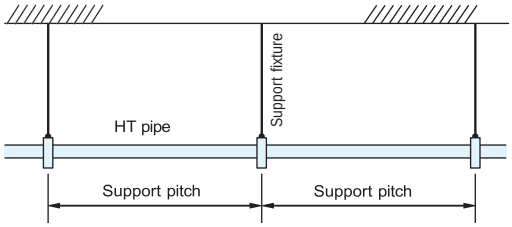
Unit : m

Expansion fitting \ Temperature difference (°C)	80	60	40
Thermal-resistant expansion joint	12.0	16.0	25.0
90° Bend	1.7	2.3	3.5
180° Bend	3.6	5.0	7.2
Loop Bend	5.0	6.8	10.0
U-shape expansion pipe loop	7.0	9.5	14.0

1.6 Pipe Supports

(1) Maximum support pitch

The elastic modulus of HT pipe decreases as the temperature increases. To ensure the pipeline reliability, make the support pitch less than the value shown in the table.

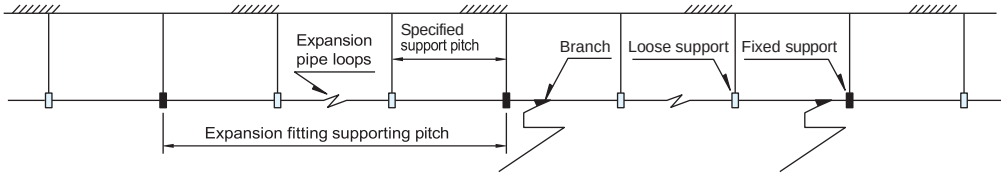


Unit : cm

Nominal Dia.(mm)	Maximum operating temperature 85℃
13	55
16	60
20	65
25	70
30	75
40	85
50	95
65	95
75	110
100	120

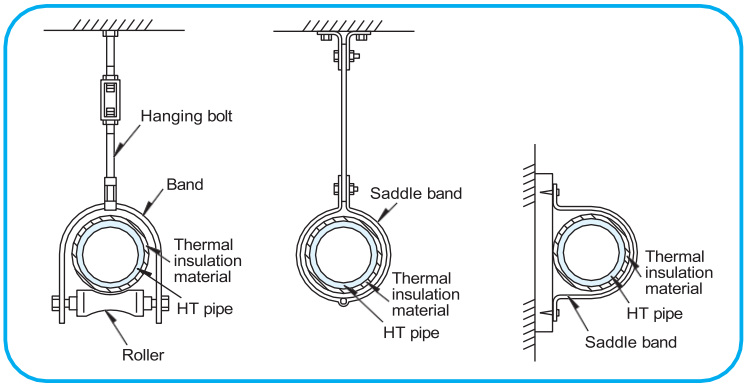
(2) Support method

Either loose supports, which allow the movement of the pipe in the axial direction, or fixed supports, which constrict the pipe movement, are used to support HT pipes. Although loose supports are used in general, always use fixed supports at interval locations equal to the supporting pitch required for each expansion fitting determined based on the temperature difference, at locations near branching sections, and at elbows.



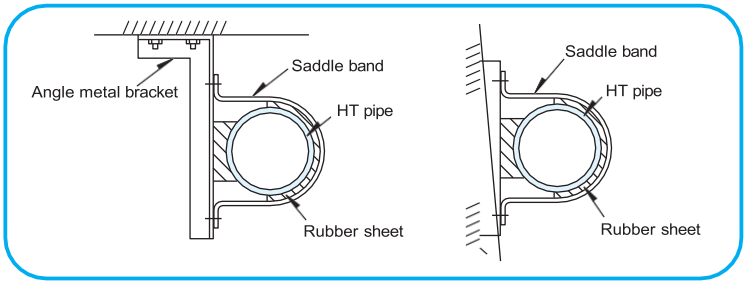
Examples of loose support

When using loose supports, provide Min. 10 cm space between the joint and supporting fixture in order to prevent the joint from contacting the support fixture when the pipe expands.



Examples of Fixed support

When installing a pipe to a fixed support, use a saddle band with wider than the pipe outside diameter. If a U-bolt is used, local stress will be generated and cause pipe deformation.
Also, place a rubber sheet between the pipe and saddle band and secure the pipe directly in place, and then cover the pipe with a thermal insulation material if necessary.



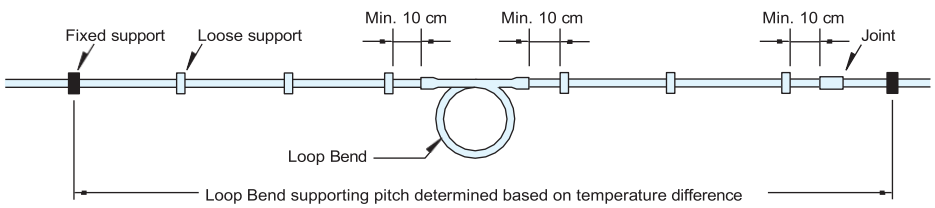
⚠ The rubber sheets used must not contain any plasticizer.

1.7 Standard Piping Diagrams

(1) Examples of expansion and contraction protection

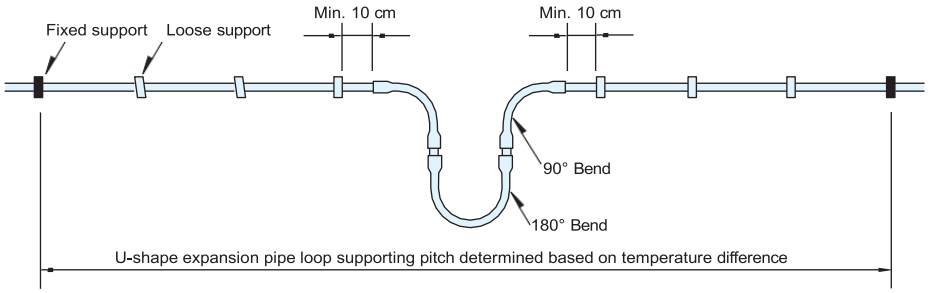
* Depending on the conditions of construction site, the most suitable method may not be indicated. Consult our company for details.

A Loop Bend



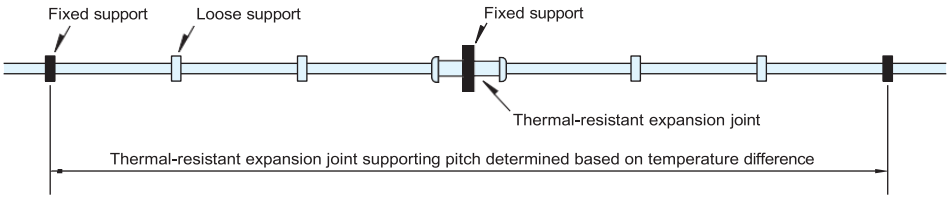
- The pitch of loose supports must be less than the maximum support pitch determined based on the operating temperature.
- Position the loop bend section horizontal or downward. If the loop bend is installed upward, air will be trapped inside the pipe.
- This method cannot be used for riser pipes.

B U-shape expansion pipe loop



- Position the U-shape expansion pipe loop section horizontal or downward.
- This method can be used for riser pipes.

C Thermal-resistant expansion joint

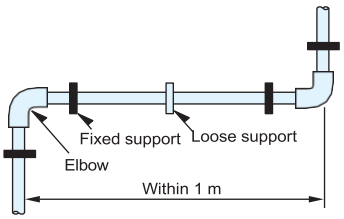


- Do not use thermal-resistant expansion joints in concealed locations such as above ceiling or under floor because it will be difficult to maintain the joints installed in concealed places.
- Be sure to secure the thermal-resitant expansion joints firmly in place.
- The pipe butt gap in the thermal-resistant expansion joint must be as follows: $\frac{\theta_1-\theta_2}{\theta} \times 50+10$ (mm); where θ is the maximum temperature difference in the pipe, θ1 is the temperature of hot water, and θ2 is the temperature of the pipe at the time of installation.

(2) Examples of pipe installation at bending section

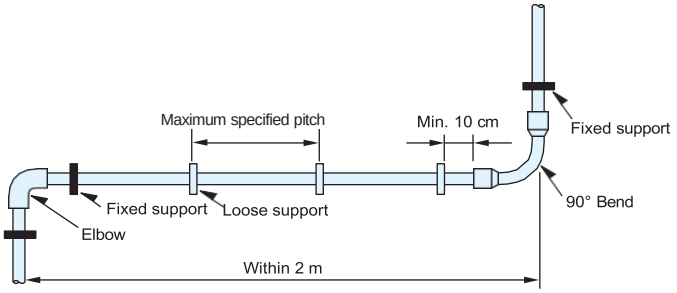
A Elbow

- Be sure to use fixed supports at locations near the elbows.
- When using two elbows at the bending section, the distance between the elbows must not exceed 1 m.
- When connecting a joint or securing the pipe in place, do not apply any twisting, bending or pulling force. If excessive force is applied to the pipe, especially under low temperatures, damage can occur to the pipe or joint.



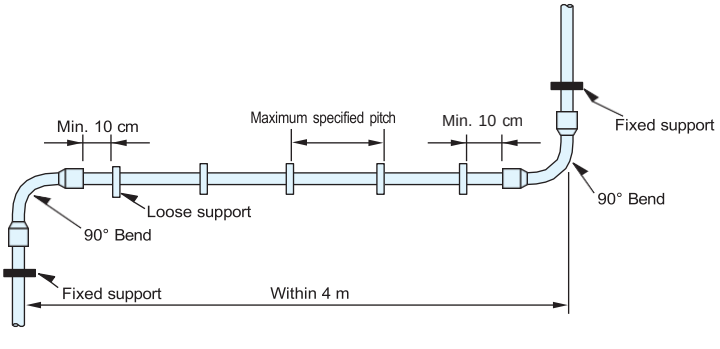
B Elbow + Bend

- Secure the pipe at locations near both sides of the elbow and at a location near one side of the 90° Bend as shown in the diagram.
- The distanace between the elbow and 90° Bend must be less than 2 m.



C Bend

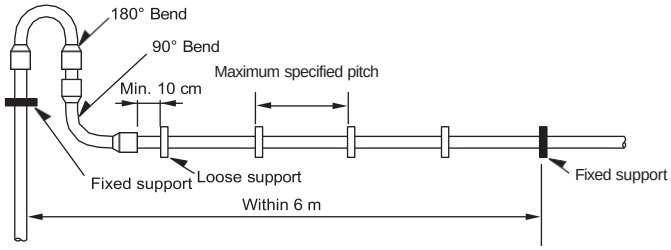
- Use a fixed support on a location near one side of the 90° Bend as shown in the diagram.
- The distance between the Bends must be less than 4 m.
- If the distance between the Bends exceeds 4 m for unavoidable reasons, form a loop bend, U-shape expansion pipe loop, etc.



D 180° Bend

- Use a fixed support at a location near one side of the 180° Bend as shown in the diagram.
- When providing expansion and contraction protection by combining a 180° Bend and a 90° Bend, the distance between the fixed supports must not exceed 6 m.

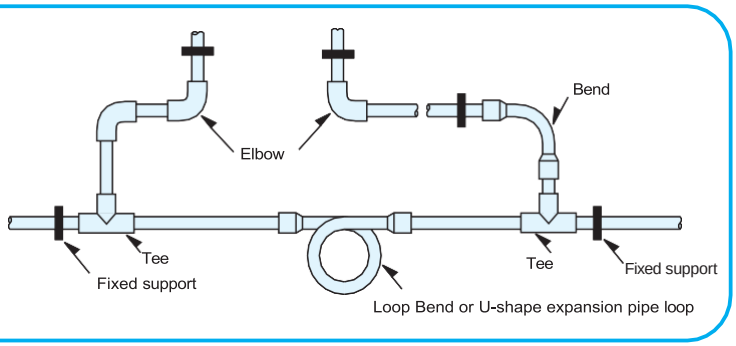
* Regarding the maximum support pitch, refer to "(1) Maximum support pitch" above.



(3) Examples of pipe branching

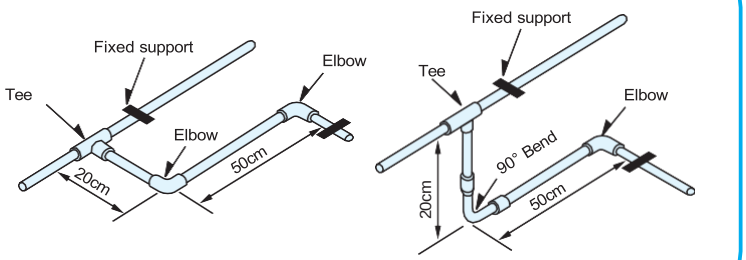
A Method of braching pipe from main pipe

- Use a fixed support at a location near the branching section.
- If a fixed support cannot be used, connect the branching pipe at a location near a fixed support and route it to the water supply point.



B Branching pipe installation

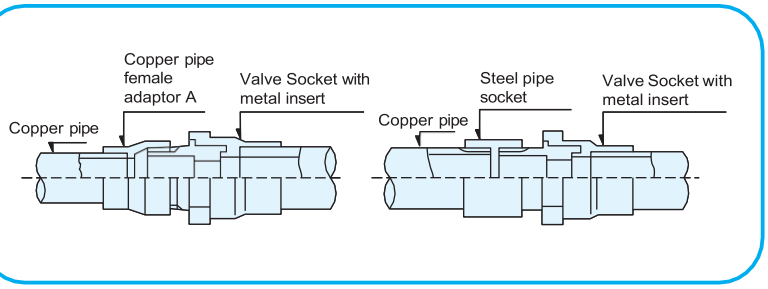
- When two elbows are used, install the pipes on the same plane in order to prevent excessive force from being applied to the pipes or joints.
- A continuously bending section is subject to vibration caused by water hammer. Install a fixed support within 1 m from the branching point.
- When a swing pipe is provided by using fittings at two or more locations, use 90° Bends instead of elbows.
- A continuously bending section is subject to vibration caused by water hammer. Install a fixed support within 1 m from the branching point.



(4) Accessories and connection examples

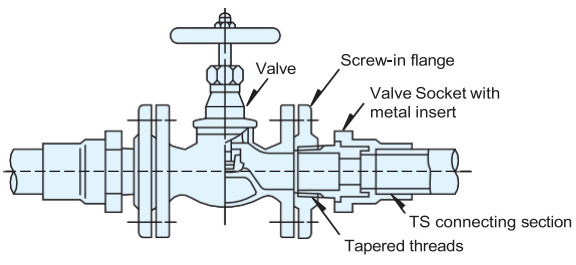
A Connection to copper/steel pipe

- Use a valve socket with metal insert (HT-MVS), and use a copper pipe female adaptor when connecting to a copper pipe and use a steel pipe socket when connecting to a steel pipe.
  Do not connect a steel pipe with tapered threads to a hydrant socket with metal insert (MWS) or hydrant elbow with metal insert (MWL).



B Connection to valve

- Use a valve socket with metal insert when connecting to a screw-in valve.
- To connect to a flanged valve, use a screw-in flange and connect in the same way as with a screw-in valve



2. Bonding HT-TS Products

1 Cutting the pipe


Determine the cutting length of the pipe, considering the insertion length of the fitting. When drawing a cut line, wrap a wide piece of paper around the pipe to ensure that the cut surface will be at right angles to the longitudinal axis of the pipe. Draw the line all around the pipe with a felt-tip pen.
Use a saw with fine teeth. Cut the pipe shallowly all around the circumference rotating the pipe.

2 Chamfering

Chamfer the pipe to remove burrs and shavings produced by the cutting work on the inner and outer edges, using a chamfering tool or a rasp.
Always chamfer the cut surface. Otherwise, when the pipe is inserted, the adhesive on the surface of the fitting will be removed by the cut edge, leading to potential pipe clogging.

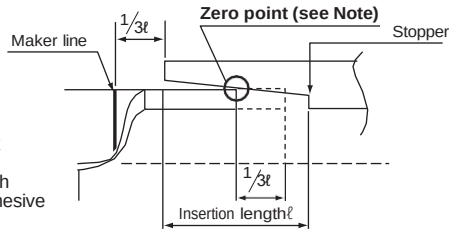
3 Drawing a marker line

Measure the joint length of the fitting. Draw a marker line around the inserting end of the treated pipe.

Note: The insertion length of the fitting varies with the product types. Always measure the length of the fitting and draw a marker line.

For nominal diameters 50 and more, the position of the marker line should be obtained by adding one-third of the insertion length ℓ to the zero point length.

- Zero point and bonding length



Note: The zero point indicates the insertion length before the adhesive is applied.

4 Cleaning

Clean the inner surface of the fitting and the outer surface of the inserting end of the pipe with a dry cloth. Dirty surface may cause leakage or the disconnection of the pipe and fitting.
Wipe off any oil with a small amount of acetone or alcohol. Be careful not to touch the bonding surfaces with oily or wet gloves.

5 Applying the adhesive

Always use Tough dyne HT. Do not use other adhesives.
Apply the adhesive evenly and thinly around the inner surface of the fitting first and then the outer surface of the inserting end of the pipe. Do not apply the adhesive excessively to the inner surface of the fitting.
Excessive adhesive will be pushed into the pipe when the pipe is inserted, which leads to potential cracking (solvent cracking).

- **Amount of adhesive to apply (reference)**

g/surface

Nominal Dia.	13	16	20	25	30	40	50	65	75	100	125	150
Amount	0.6	0.8	1.1	1.6	2.1	3.3	4.8	6.6	8.1	13	20	30

Notes: 1. The above values are for use on each of the inserting surface of the pipes and the surface of the socket.
2. Prepare 20 to 30% more required amount of adhesive, taking into account the expected loss in actual use.

6 Bonding the pipe to the fitting


Push the pipe into the fitting tightly. Check the positions and orientations of the pipe and the fitting, and align their axes so that there is no twisting. Insert the pipe straight into the fitting up to the marker line without a pause. Hold the fitting and the pipe together for the time shown in the table below.
After bonding the pipe to the fitting, immediately remove any adhesive coming out of the joint surface .

- **Typical holding time**

Nominal Dia.	Time
50 and less	At least 30 sec.
65 -150	At least 60 sec.

Due to the tolerance of the fitting, the pipe may not be inserted in to the marker line. If this is the case, stop inserting the pipe there. Do not hammer the pipe into the fitting. The fitting will be subject to large load and may crack.

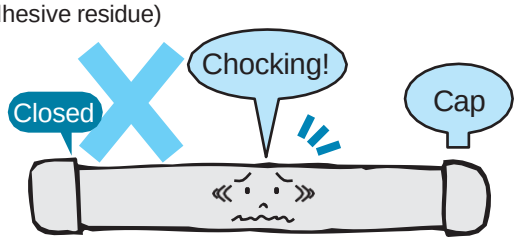
7 Treatment after bonding

During the bonding work, open both ends of the pipe to remove the solvent vapor of the adhesive from the pipe by natural ventilation or using a blower. Do not move the bonded pipe and fitting for 15 to 30 minutes. If a bending or tension force is applied to the joint immediately after bonding, the bonded surfaces will be separated.
After the bonding work, fix the pipe and provide protection against expansion. Check any parts that came into contact with chemicals, such as creosote, to prevent accidents after start of use.

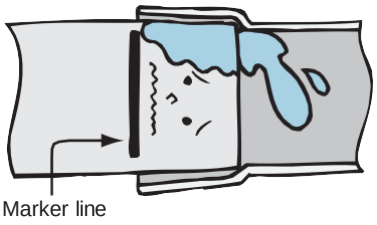
IV Preventing Solvent Cracking

Solvent cracking is a phenomenon which hairline cracks occurs when a solvent is added to objects.
The hairline cracks would grow larger after starting the service and increase the possibility of leakage. For PVC-U or PVC-C pipes, the possibility of leakage increases particularly when the following factors occur.
When all these factors are combined, the possibility increases furtherer.

- **Pipe clogging after bonding**
  (adhesive residue)

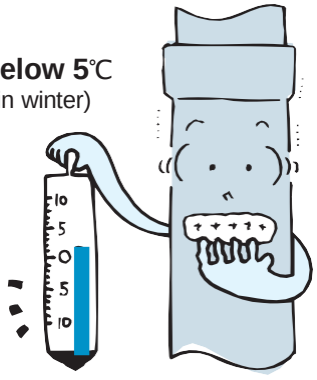


- **Presence of solvent**
  Adhesive coming out of the inner surface of the pipe due to excessive adhesive applied or the presence of chemicals that have adverse effects (such as preservatives) on the surface



- **Unreasonable stress being applied**
  (Thermal stress, pipe flattening, pipe bending)

- **Low temperature below 5℃**
  (Particularly piping work in winter)

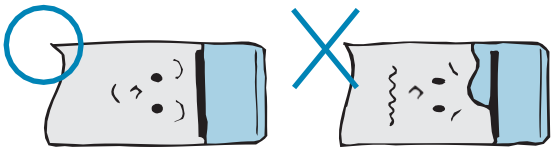


Preventing solvent cracking

During bonding work

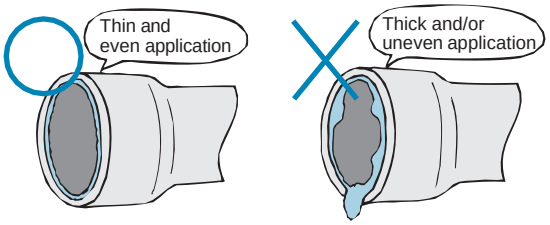
Position to apply the adhesive on the outer surface of the pipe

⚠ Do not apply the adhesive beyond the marker line.



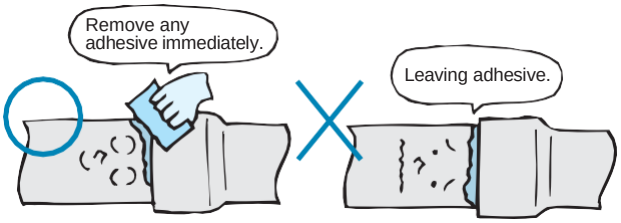
Adhesive coming out to the pipe inner surface

⚠ **Apply the adhesive thinly and evenly to the inner surface of the TS fittings.**



Removing excessive adhesive

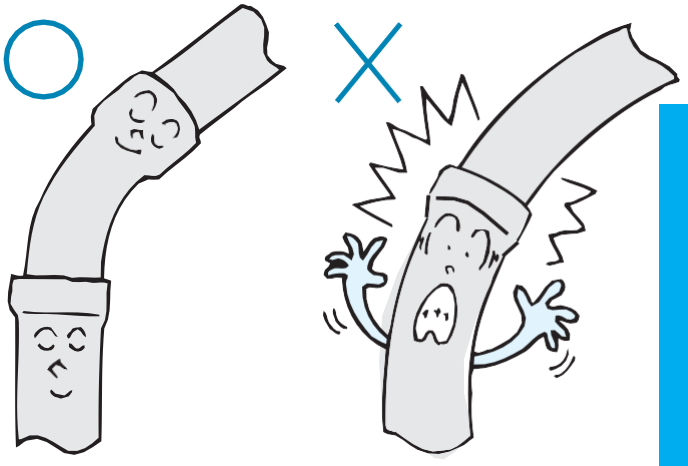
⚠ After inserting the pipe into the fitting, remove adhesive coming out of the joint surface with a cloth.



During piping work

Use bends

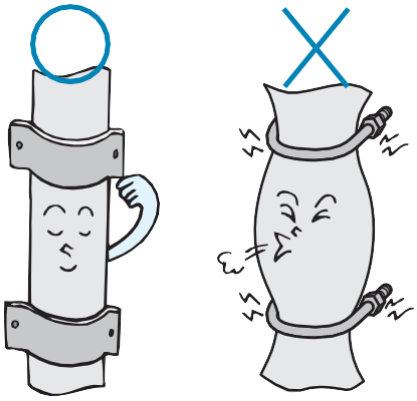
⚠ Use bends at pipe corners. Do not bend the pipe.



Reference

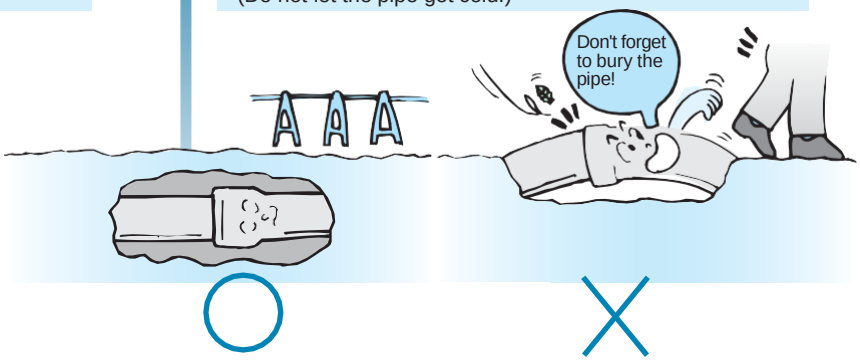
Pipe supports

⚠ When supporting the pipe with saddle bands, use wide fastener bands. Do not use U-bolts. Be careful not to tighten the bands excessively.



Backfilling

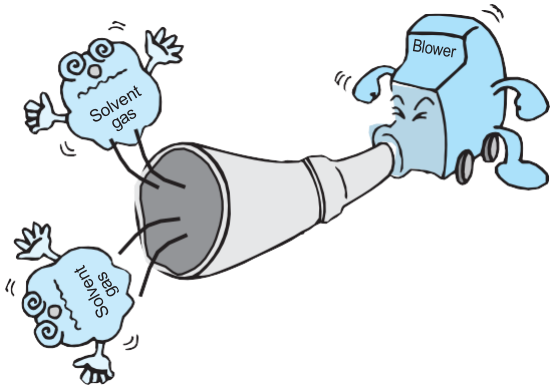
⚠ Backfill the pipe as quickly as possible to prevent thermal stress due to temperature differences or external impact. (Do not let the pipe get cold.)



Removing the solvent gas after bonding work

Ventilation

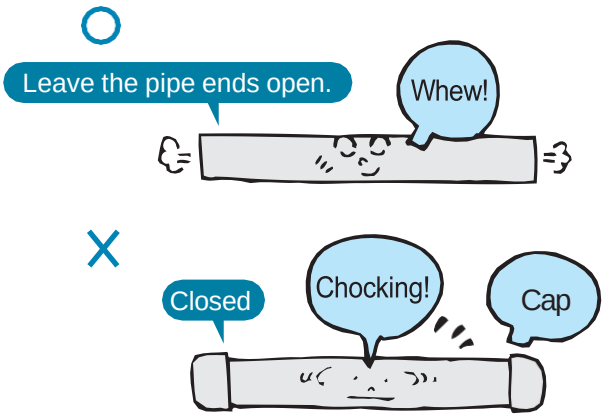
⚠ After bonding work, remove the solvent gas using a blower (low pressure type) or other means.



Washing with water avoiding water pressure in the pipe

⚠ Pour water into the pipe 30 minutes after the bonding work for nominal diameter 50 and less and one hour after the bonding work for nominal diameters 65 and more. Do not make any water pressure in the pipe.

Opening the pipe ends

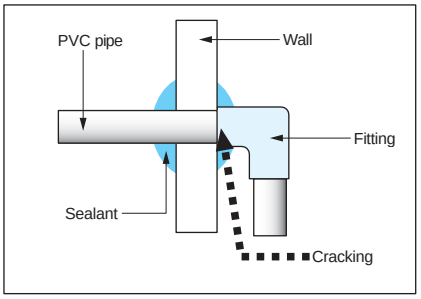


⚠ Do not close the pipe ends. Leave them open to remove the adhesive vapor.

Other important information

There is a recently developed technique which installs a PVC-U or PVC-C pipe through an interior wall and then the gap between the pipe and the wall is filled with a sealant. Some sealants contain a plasticizer, such as DOP and phthalate ester, or a solvent such as xylene and toluene, which may cause solvent cracking to PVC pipes. Usually, these plasticizers and solvents are contained in polyurethane sealants but not in silicon sealants.

However, plasticizers and solvent may be added to silicon sealants to improve their performance in the future. It is advisable to contact the sealant manufacturer for details.



V User Instructions

This section is about do's and don'ts in order to make the most of the performance of Okubo Plumbing Co., Ltd PVC-U or PVC-C pipes and fittings. Please read carefully and use the instructions in the safety manual where appropriately.

● Please observe the following instructions.
Classes of actions are represented by the following graphic symbols.

indicates that the action needs to be taken carefully.	indicates that the action is prohibited.	indicates that the action must be taken.

1. Instructions for the treatment of left-over material and scraps

No on-site burning

Do not burn PVC pipes and fittings on site. Toxic chlorine gas will be released into the air, by burning.

Laws and regulations

Left-over and scrapped PVC pipes and fittings should be treated according to local laws and regulations. Do not crush leftovers and scraps with a hammer. Crushed pieces may fly away.

2. Carrying instructions

Wear gloves

Wear rubber-coated gloves with a firm grip to prevent injury.

Careless handling is dangerous

Large PVC pipes are heavy. Also, PVC pipes which are bundled together can be heavier than expected. Handle them with care to prevent injury. Careless handling is dangerous.

Do not step on pipes

Do not step on pipes. The surface of PVC pipes is slippery, which may lead to an accident.

Use a cushion

Place cushions between pipes and the truck bed and on the parts of a pipe that are secured with a rope to prevent scratches and deformation.

Careful handling

When loading and unloading the PVC pipes from truck, do not throw or drag PVC pipes into the truck. Handle with care to prevent scratches and damage to the pipes and injury.

Prevent collasping during transport

Take measures to stop ropes from becoming loose or coming off to prevent pipes from falling off the truck.

Carefully lift and lower pipes

If a truck with a hoist is used, balance the load when lifting to prevent injury.

3. Storage instructions

When storing pipes horizontally indoors

When storing PVC-U or PVC-C pipes, pile them in a crisscross pattern or in a staggered pattern to prevent them from warping or deforming. Put stoppers at the pipe ends to prevent the pile from collapsing.

When storing pipes outdoors

When storing pipes outdoors, put a simple roof over the storage area or an opaque sheet on the pipes to block direct sunlight. When a sheet is used, provide a good air flow.

Storing pipes vertically

When there is no choice but to store pipes vertically, take measures to prevent them from falling over, such as securing them with ropes.

Storing fittings

Fittings should be stored indoors with the pipes. When there is no choice but to store them outdoors, put a sheet over them to protect from sunlight. Always put a cover on fittings with a rubber ring to protect from direct sunlight which will degrade the performance quality of rubber rings.

4. Installation instructions

Pipes and fittings should be installed using the standard installation techniques recommended by Okubo Plumbing Co., Ltd, in order to ensure work safety and the performance of pipe lines. If installation conditions do not allow this, please contact us.

Using the proper tools

Select tools with the proper specifications for tasks such as cutting, drilling and joining. Read and ensure that you fully understand the instruction manuals of the tools before using.

Ventilation after bonding work

After bonding work, ventilate the bonded pipe well. Do not close the bonded pipe. Otherwise, solvent cracking or a bad odor may result. Solvent cracking is a phenomenon which hairline cracks occur in a PVC-U or PVC-C pipe due to residual solvent vapor in the adhesive. Residue of bad odor in drinking-water pipes affects the smell and taste of the water. It should be noted that, particularly in the winter, solvents do not easily evaporate and tend to remain in the pipe.

Caution against the use of organic chemicals

PVC-U or PVC-C pipes and fittings can be eroded by organic chemicals, and should not be allowed to come into contact with creosote (wood preservative), termite and other pesticides or paint. If soil contaminated by these chemicals is expected along the pipe line route, take measures to protect against contamination by avoiding contaminated areas when installing the pipe line.

Treatment for thermal expansion and contraction

For pipes bonded to fittings, expansion fittings should be used to prevent pipes from becoming disconnected from their fittings or damaged due to thermal expansion and contraction.

Do not bend pipes

Do not bend pipes. Otherwise, the strain will remain, causing potential pipe rupture. If curved pipes are required, always use bends.

About thrust protection

For buried pipes subject to hydrostatic pressure, thrust protection should be provided to prevent the pipes from becoming disconnected from their fittings at corners and branches. The standard installation technique recommended by the Japan PVC Pipe and Fittings Association and Okubo Plumbing Co., Ltd should be used.

Do not heat pipes on site

Do not heat pipes on site. Pipes may become scorched or burnt, resulting in reduced strength.

About protective insulation cover

Avoid installing pipes near steam and hot-water pipes in order to prevent deformation and damage due to high temperatures. If this is not possible, put a protective insulation cover around the pipe.

Public space used for pipes

When pipes are buried under public roads, follow the burying standards or instructions provided by the road administrator. For siphon pipes across a river and pipes buried under railways, follow the instructions provided by the respective administrators.

Squeeze-off tools

Squeeze-off tools for polyethylene pipes should not be used to repair small water pipes. The ductility of PVC-U or PVC-C pipes is smaller than that of polyethylene pipes. If water sealing work is carried out with squeeze-off tools, whitening due to plastic deformation may occur to the pipe which lead to damage in the future.

Freeze protection

In cold regions, pipes should be buried 20 cm deeper than the maximum freeze depth. Thermal insulation should be wrapped around the exposed part of a vertical water pipe to protect against freezing.

Cutting small pipes

Do not use a pipe cutter to cue small pipes. The cutter may cause chippings or deformation to the cut section of the pipe.

Joining a hydrant

Since a hydrant has parallel pipe threads, water cannot be sealed by inserting the threads into the female threads of a water fitting with sealing tape. When joining a hydrant to a water fitting, place a gasket between the hydrant flange (the face with the gasket on) and the water fitting.

Do not thread PVC pipes and fittings

Do not thread PVC-U or PVC-C pipes and fittings directly. These pipes have a large notch effect, and their strength decreases if cracks or notches are made.

Use of lubricant specifically designed for joining fittings with a rubber ring

A lubricant specifically designed for rubber rings should be used to joint fittings with a rubber ring to a pipe. Do not use adhesive or oil. It may damage the rubber ring.

Insertion force joining pipes to TS fittings

When joining a pipe to a TS fitting, unreasonable stress may be applied to the fitting depending on the dimensional combination of the pipe and the fitting if the pipe is inserted up to the stopper in the fitting. In terms of the relation between the bonding length and the pressure resistance, it has been confirmed that a practically sufficient hydrostatic resistance can be achieved by inserting the pipe up to one-third of the insertion length of the fitting from the insertion length position without any adhesive applied (zero point position).
In order to prevent the bonded pipe from becoming disconnected from the fitting due to the elasticity of the pipe, the insertion force should be applied for over 30 seconds for nominal diameters 50 and less and for over 60 seconds for nominal diameters 65 and more.

Joining steel pipes to fittings with a tapered female thread

Do not insert the tapered male threads of a metal pipe into a hydrant fitting. The joint may be damaged. Normally, a metal socket should be joined to the tapered male thread of the metal pipe. Then, a valve socket should be joined to the metal socket. When strength is required for the inserted section, a valve socket with a metal male thread should be joined to the metal socket.

5. Instructions for handling PVC adhesive

Do not use adhesives for other applications

PVC and plastic adhesives were developed to bond PVC pipes to PVC fittings, and should not be used for other applications.

Use of appropriate adhesives

There are three types of adhesive: one for HI products, one for HT products and one for other products. The adhesives are designed to provide appropriate joint strength to pipes and fittings. Therefore, it is necessary to use the adhesive appropriate for the type of pipe.

If adhesive enters the eye

If adhesive enters the eye, do not rub the eye. Seek medical attention immediately

Storage according to laws and regulations

Adhesives are hazardous substances under the Fire Defense Law. Follow applicable laws, regulations and municipal ordinances when storing adhesives.

Ventilation and fire prevention

When using an adhesive, ventilation should be provided to prevent intoxication. Also fire sources should be kept away from organic solvents.

Use of gloves

Wear gloves to protect against skin irritation and sores. Do not touch the adhesive directly. If the adhesive touches the skin, wash it off with soap and water immediately.

Washing hands and gargling

After using the adhesive, wash your hands and gargle well.

Store in a cool and dark place away from fire sources

Adhesives contain organic solvents. After using the adhesive close the lid of the can securely and store it in a cool and dark place indoors. Be sure to keep away from fire sources.

Do not use old and expired adhesives

Do not use an old and expired adhesive that has jelled or that has no pungent solvent odor. Do not thin the adhesive with thinner. This will decrease the adhesion, leading to the pipe disconnection from the fitting and causing leakage.