



## **CPVC**

*Advanced Industrial Piping System*

*Product Information*



# Company History



- 1980 Hershey Valve Co. Ltd. was found in Chingshui, Taichung, Taiwan.
- 1982 Moved to Kwanlien industrial District, Wuchi, Taichung, Taiwan.
- 1982 Overseas marketing department was set up to promote export business.
- 1984 Export business expanded to the USA, Canada, Australia, Europe and other advanced countries.
- 1988 USA and Canada became the major export markets.
- 1990 Japan became the most important export country in Asia.
- 1993 Korean market was developed.
- 1995 Responding to the market demands, Taiwan domestic sales department was set up to develop Taiwanese markets.
- 1996 Taiwan factory was awarded SGS ISO 9002 certification.
- 1996 Valve products were approved by NSF International.
- 1997 Shanghai factory was awarded SGS ISO 9002 certification.
- 1997 Began manufacturing SCH40/80 UPVC, SCH40/80 CORZAN® CPVC and SDR 13.5 BlazeMaster® CPVC piping systems in Taiwan Wuchi No. 2 factory.
- 1998 USA Lubrizol (BF Goodrich) authorized Hershey Valves as the exclusive licensee of FlowGuard® CPVC piping system.
- 1998 SCH40 FlowGuard® CPVC hot and cold water distribution system and SCH40 clear PVC piping system came on line.
- 1999 BlazeMaster® CPVC fire sprinkler system was certificated by LPCB (UK).
- 1999 Hershey Valve Taiwan was awarded LPCB ISO 9002.
- 1999 BlazeMaster® CPVC fire sprinkler system was approved by National Fire Administration Ministry of Interior in Taiwan.
- 2001 Hershey Taichang factory was established in China.
- 2003 BlazeMaster® CPVC material obtained WRAS approval.
- 2004 CORZAN® 4910 CPVC sheet obtained FM approval.
- 2005 Hershey BlazeMaster® fire sprinkler fittings were listed by UL (Underwriters Laboratories Inc.).
- 2006 Hershey Taiwan factories were consolidated and moved to Taichung Chungkang Export Processing Zone and it serves as Hershey Group Global Headquarters.
- 2010 Hershey Taiwan factory was awarded LPCB ISO9001: 2008  
Hershey Taichung factory was awarded ISO9001:2008

# *Design , Installation and Product Specification CPVC Industrial Piping System*

## Table of Contents

### System Description

- 03 Product Features
- 03 Product Advantages
- 05 Application Areas
- 05 Basic Physical Properties
- 06 Fire Performance Characteristics
- 07 Weatherability
- 07 Biological resistance
- 08 Abrasion Resistance
- 09 General Specification
- 09 Application Limits
- 10 Applicable Standards

### Engineering Information

- 11 Pressure rating
- 14 Fluid Handling Characteristics
- 20 Thermal Expansion and Thermal Stresses
- 23 Support Spacing
- 25 Thermal Conductivity

### General Installation Guides

- 26 Installation Guides
- 27 Joining CPVC Pipe and Fittings – Solvent Cementing
- 31 Flanging of CPVC pipe
- 33 Back-Welding of Pipe Joints
- 34 Underground Installation Guidelines

### Product Dimension and Drawing

- 36 Pipe
- 37 SCH 80 Fittings
- 46 Fabricated Fittings

# CPVC Advanced Industrial Piping System

## Product Features

- Full series of system components and fabrication products.

Hershey CPVC advanced industrial piping Systems are made of high performance CPVC material. Products are available from 1/2" to 24" that satisfying for your demand.

- Advanced piping system with more than 40 years of experience approval.  
Meet with the requirements of chemical resistance and mechanical properties for industrial applications.
- Engineering technique and design consultation service.  
Support the planning requirements of industrial and special applications.

## Product Advantages

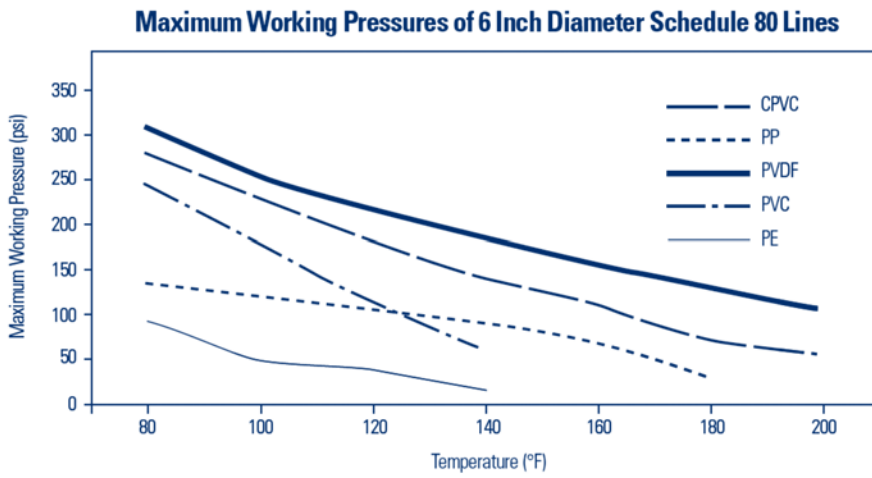
### Excellent Chemical Resistance

Hershey CPVC advanced industrial piping systems are chemically inert to most mineral acids, bases and salts, as well as aliphatic hydrocarbons. In addition, these systems are not subject to galvanic corrosion. If any questions about the chemical resistance, please refer to our chemical resistance data or consult with us for your special anticorrosion requirement.



### Superior Mechanical properties

Comparing with other engineering thermoplastics such as PVDF, PP, PVC, and ABS, Hershey CPVC industrial system has the maximum working pressure and support spacing . It provides the user with the superior operating range and design space, and its expected life for pressuring service is up to 50 years or more.



### Outstanding Balance propertie

No matter the chemical resistance requirement, system design pressure loading, or the equipment operation and maintenance cost, Hershey CPVC advanced industrial piping system also can meet with the most particular needs. Obviously it is the best choice of industrial thermoplastic piping system.

## Application Areas

With more than 40 years of system proven experience, CPVC piping system has been well applied for different application areas such as metal treatment, pulp and paper, chemical processing, waste water treatment, electronic manufacturer, semiconductor manufacturer, copper foil manufacturer, power plant, food and beverage industry, bio-tech, pure and ultra-pure water applications, it will be more widely utilized in the future.

## Basic Physical Properties

PROPERTY	UNIT	Material Type	Standard
		VFC001	
Tensile strength (73°F/23°C) At yield (5mm/min)	Kg/cm <sup>2</sup> Psi	526 7500	ASTM D 638
Tensile modulus (73°F/23°C) (5mm/min)	Mpa psi	2786 404000	ASTM D 638
Elongation (5mm/min)	%	50	ASTM D 638
Specific gravity	---	1.50	ASTM D792
Zod Impact strength (Notched) @73°F	ft-ibs/in	1.9	ASTM D256
Heat deflection under load 264 psi, 1/8" bar annealed	°C	102	ASTM D648
Vicat softening, method(50N)	°C	103.0	ASTM D1525
FLAMMABILITY UL94		V-0	ASTM D635
Cell classification		23447	ASTM D1784

## Fire Performance Characteristics

When thermoplastic piping materials are selected, consideration is often given to the fire performance characteristics of the material. Evaluating fire performance involves consideration of many factors, such as resistance to ignition, heat of combustion, limiting oxygen index, flame spread and smoke generation characteristics.

Without the benefit of flame retardants and smoke inhibitors, Hershey CPVC inherently exhibits outstanding fire performance characteristics in terms of limited flame propagation and low smoke generation. When coupled with its excellent balance of mechanical strength, low thermal conductivity, improved hydraulics and outstanding corrosion resistance, Hershey CPVC provides excellent value in terms of safety and performance in wide range of industrial process and ducting application.

### Ignition Resistance

Hershey CPVC has a flash ignition temperature of 900°F which is the lowest temperature at which sufficient combustible gas is evolved to be ignited by a small external flame. Many other ordinary combustibles, such as wood, ignite at 500°F or less.

Flash Ignition Temperature Comparison

Material	°C	°F
CPVC	482	900
PVC, rigid	399	750
Polyethylene	343	650
White Pine	204	400
paper	232	450

### Burning Resistance

Hershey CPVC will not sustain burning. It must be forced to burn due to its very high Limiting Oxygen Index (LOI) of 60. LOI is the percentage of oxygen needed in an atmosphere to support combustion. Since Earth's atmosphere is only 21% oxygen, Hershey CPVC will not burn unless a flame is constantly applied and stops burning when the ignition source is removed. Other materials will support combustion due to their low LOI.

Limiting Oxygen Index Comparison

Material	CPVC	PVC, rigid	PVDF	ABS	Polypropylene	Polyethylene
LOI	60	45	44	18	17	17



## Heat of Combustion

Hershey CPVC has a significantly lower heat of combustion at 7,700 BTU/lb compared to Douglas fir at 9,040 BTU/lb and polypropylene at nearly 20,000 BTU/lb. Materials with a high heat combustion generate more heat, and burning process becomes self-sustaining.

## Weatherability

Weatherability is defined as a material's ability to maintain its basic physical properties after prolonged exposure to sunlight, wind and rain/humidity.

Hershey CPVC has been blended with a titanium dioxide (TiO<sub>2</sub>) and carbon black. TiO<sub>2</sub> coupled with carbon black is widely recognized as an excellent ultraviolet blocking agent and helps to protect the polymer backbone from the effects of ultraviolet radiation. Therefore, Hershey CPVC piping system will be able to meet the requirements of most outdoor installations.

If the specific installation requires additional protection from UV exposure, Hershey CPVC piping system can be painted with common acrylic latex paint. Priming of the piping is not necessary prior to painting.

## Biological resistance

Hershey CPVC industrial piping systems are resistant to attack from fungi. Fungus growth on plastics is supported when plasticizers or other additives are present for the fungus to feed on. Hershey CPVC contains no additives which would provide a nutrient source for fungi.

Bacteria are encountered in nearly all situations where water is present. The smooth interior surface of Hershey CPVC industrial piping provides fewer footholds for bacteria to take hold and multiply. Hershey CPVC industrial piping systems are resistant to the action of all forms of bacteria, many of which are known to cause corrosion in metal piping systems, such as iron-oxidizing bacteria, sulfate-reducing bacteria, and acid-producing bacteria.

Hershey CPVC is also resistant to most commonly used biocidal chemicals.



## Abrasion Resistance

A piping system's resistance to abrasion is a function of many factors:

- ◎ Particle size and shape
- ◎ Particle concentration
- ◎ Velocities
- ◎ Design of the piping system
- ◎ Hardness of particles
- ◎ Densities of fluid and particle
- ◎ Properties of piping materials

While all piping systems will exhibit some degree of wear over time, the actual erosion will depend on the specific combination of these factors. Excluding the piping material itself, the system conditions which will minimize abrasion include:

- Lower velocities (<5 ft/sec)
- Large, round particles
- Uniform particle distribution
- Minimum changes in direction

When these ideal slurry conditions do not exist, the selection of the piping material becomes important. Hershey CPVC industrial piping systems will usually outperform metal when transporting abrasive media and have been used successfully in many abrasive industrial applications.

No single test method exists which can consistently predict the abrasion resistance of a material to the broad range of potentially abrasive conditions. As a result, the best guide in selecting materials for abrasive service is past experience. In lieu of such case histories, attention should be directed towards approaching the ideal system conditions mentioned above, particularly minimizing changes in direction. At the same time, changes in direction can be designed to minimize abrasion potential. Large radius elbows and capped tee bends are usually specified to reduce particle impingement on the pipe wall.

One widely referenced test method is the Taber test, in which the weight loss of a material is measured after being exposed to an abrasive wheel for 1000 cycles. While the Taber test cannot predict actual performance of a material to a given application, it does provide a relative measure to compare materials.

### TABER ABRASION TESTER (Abrasion Ring CS-10, Load 1 kg)

Material	Weight loss(mg/1000 cycles)	Material	Weight loss(mg/1000 cycles)
Nylon 6-10	5	CTFE	13
UHMW PE	5	PS	40-50
PVDF	5-10	Steel (304 SS)	50
PVC (rigid)	12-20	ABS	60-80
PP	15-20	PTFE	500-1000
CPVC	20		

Source: Industrial and High Purity Piping System Engineering Handbook, George Fischer + GF +,2002.

# General Specification

## Product Features

Hershey CPVC industrial pipe and fittings are extruded/molded from CPVC compounds. The compounds shall meet cell class 23447 as defined by ASTM D1784 and have a design stress of 2000psi @73°F and a maximum service temperature of 200°F.

**Pipe :** Pipe meets the requirements of ASTM F441 in Schedule 40 and 80 dimensions. Available in size range 1/2" – 24".

**Fittings :** Smaller diameter fittings from 1/2" – 14" are injection molded which meet the requirements of ASTM F437 (Schedule 80 threaded) , ASTM F439 (Schedule 80 socket) or ASTM F438 (Schedule 40 socket). Larger diameter fittings from 14" to 24" are fabricated which shall meet Hershey's standard or customer's requirements. Please refer to product dimension and drawing in this catalog for further details.

**Primer/Solvent Cement :** All socket type joints shall be made up employing primers and solvent cements that meet or exceed the requirements of ASTM F656 and F493 respectively. The standard practice for safe handling of primer and cement shall be in accordance with ASTM F402. Only CPVC primer and solvent cement shall be used when making CPVC solvent cement joints.

## Basic Use

Hershey CPVC pipe and fittings are intended for use in both pressure and drain applications in general chemical manufacturing plants, pulp and paper plants, waste water treatment plants, metal treating/electroplating plants, water purification plants, semiconductor/electronic manufacturers and food processing plants where excellent resistance to corrosion from a wide range of chemicals, acids and bases at temperature up to 200°F is required.

## System Design

System design shall be in accordance with standard industry practice for thermoplastic industrial piping systems and shall take into consideration such factors as pressure and flow requirements, friction loss, operating temperatures, supports spacing, anchoring, bracing and trust blocking, temperature correction factors, joining methods, chemical environment, collapse and loading, and thermal expansion and contraction.

# Application Limits

- Air or compressed gas shall never be used for pressure testing rigid thermoplastic piping systems.
- Temperature correction factors shall be applied when operating temperatures exceed 73°F.
- Only schedule 80 pipe may be threaded up to and including 4" size, and which will operate at 130°F or less. The threads should be in accordance with ANSI B1.20.1 Taper Pipe Thread.
- Degreasing type solvents shall never be used to clean threads.
- Only Teflon tape is safe for making CPVC threaded connections.
- Flanged system shall not exceed 150psi working pressure.

- Threaded joints shall have 50% of the pressure rating of schedule 80 pipe.
- Hershey CPVC is not recommended for use with most polar organic solvents such as chlorinated or aromatic hydrocarbons, esters, or ketones. Prior testing is recommended when required service includes surfactants, oil or grease. Consult Hershey Valve for specific chemical resistance information.

## ***Applicable Standards***

- ASTM D1784 Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
- ASTM F402 Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
- ASTM F437 Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, schedule 80
- ASTM F438 Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride)(CPVC) Plastic Pipe Fittings, Schedule 40
- ASTM F439 Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
- ASTM F441 Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedule 40 and 80
- ASTM F493 Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) plastic Pipe and Fittings
- ASTM F656 Specification for primers for use in solvent cement joints of poly (Vinyl Chloride) (PVC) plastic pipe and fittings

# Engineering Information

## Dimension and Pressure Rating

### Engineering Data

In the engineering of thermoplastic piping systems, it is necessary to have not only a working knowledge of piping design but also an awareness of a number of the unique properties of the thermoplastics.

In addition to chemical resistance, important factors to be considered in designing piping systems employing thermoplastics:

- 1. Pressure ratings
- 2. Water hammer
- 3. Temperature-Pressure relationships
- 4. Thermal expansion and thermal stresses
- 5. Friction-loss characteristics

These factors are considered in detail in this manual.

### Pressure rating

#### Determining pressure-stress pipe relationships

ISO Equation : Circumferential stress is the largest stress present in any pressurized piping system. It is the factor that determines the pressure that a section of pipe dimensions is described by ISO (for International Standardization Organization) Equation. In Various forms this equation is:

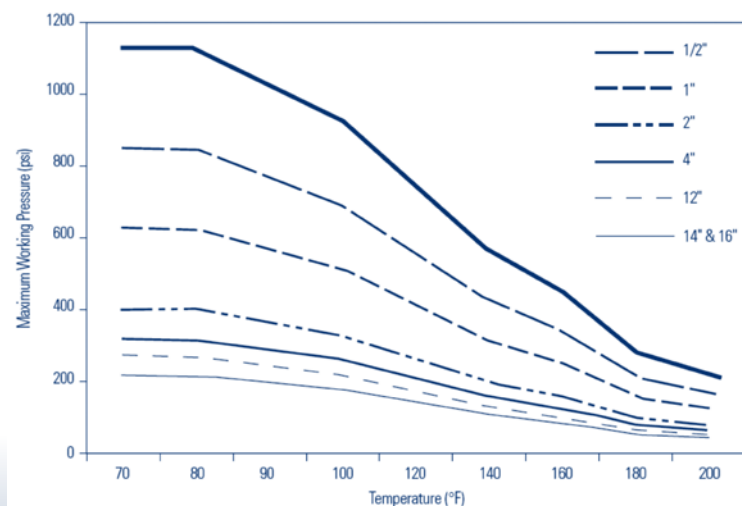
$$P = \frac{2S}{R - 1} = \frac{2St}{Do - t} \quad \frac{2S}{P} = \frac{Do}{t} - 1$$

$$\frac{2S}{P} = R - 1 \quad S = \frac{P(R - 1)}{2}$$

Where  
 P = Internal Pressure, psi  
 S = Circumferential Stress, psi  
 t = Wall Thickness, in  
 Do = Outside Pipe Diameter, in  
 R = Do/t

Long-term strength : To determine the long-term strength of thermoplastic pipe, lengths of pipe are capped at both ends and subjected to various internal pressure, to produce circumferential stresses that will produce failure in from 10 to 10,000 hours. The test is run according to ASTM D1598 – Standard test for time hydrostatic pressure.

**Maximum Working Pressure vs. Temperature for Schedule 80 CPVC Industrial Piping System**



## Pressure Rating for Pipe

Size	OD (inch)	Sch 80		SCH 40	
		Max Working Pressure	Max Working Pressure	Max Working Pressure	Max Working Pressure
		kg/cm <sup>2</sup>	psi	kg/cm <sup>2</sup>	psi
1/2"	0.840	59.76	850	42.18	600
3/4"	1.050	48.51	690	33.75	480
1"	1.315	44.29	630	31.64	450
1-1/4"	1.660	36.56	520	26.01	370
1-1/2"	1.900	33.04	470	23.2	330
2"	2.375	28.12	400	19.69	280
2-1/2"	2.875	29.53	420	21.09	300
3"	3.500	26.01	370	18.28	260
4"	4.500	22.5	320	15.47	220
5"	5.563	20.39	290	13.36	190
6"	6.625	19.69	280	12.66	180
8"	8.625	17.58	250	11.25	160
10"	10.750	16.17	230	9.84	140
12"	12.750	16.17	230	9.14	130
14"	14.000	15.47	220	9.14	130
16"	16.000	15.47	220	9.14	130
18"	18.000	15.47	220	9.14	130
20"	20.000	15.47	220	8.44	120
24"	24.000	14.76	210	8.44	120

Note :

1. Pressure rating applies for water at 73°F. For temperature greater than 73°F see derating factors. For fluids other than water the full pressure rating may not apply, see chemical resistance table.
2. All dimension of Schedule 40 pipe should never be threaded, Schedule 80 pipe if diameter 6" and greater also should not be threaded. Schedule 80 pipe operating above 130°F should not be threaded. Use flanged joints, or unions where occasional disassembly is necessary.

### Temperature Derating factors for Pipe

Operation Temperature		Derating Factor
°F	°C	
73-80	22.5-26.7	1.00
90	32.2	0.91
100	37.8	0.82
120	48.9	0.65
140	60	0.50
160	71.1	0.40
180	82.2	0.25
200	93.3	0.20

### Temperature Correction Factors-Valve

Operation Temperature	Factor
°F	CPVC
73-80	1.00
90	0.95
100	0.90
120	0.80
140	0.70
160	0.61
180	0.53
200	0.45

## Pressure Rating for Valves

Hershey CPVC valves will typically be rated to 150psi at 73°F. If the temperature increases, valves pressure rating must be derated as Temperature Pressure Tables for individual valves.

## Pressure Rating for Flanged systems

Flanged system of any size should not exceed 150psi working pressure. If the temperature increases, flange pressure rating must be derated as below table.

Max. operating temperature (°F)	73-100	110	120	130	140	150	160	170	180	190	200	210
Max. operating pressure (psi)	150	140	130	120	110	100	90	80	70	60	50	NR

NR: Not recommended

## Pressure Rating for Threaded Systems

Threaded systems are derated to 50% of the pressure rating for the piping at the system operating temperature.

# Fluid Handling Characteristics

## Linear Fluid Flow Velocity

The linear velocity of flowing fluid in a pipe is calculated from

$$V = \frac{0.4085 \text{ g}}{d^2}$$

Where

V = linear fluid flow velocity, in feet per second

g = flow rate in gallon per minute

d = inside diameter of pipe, in

The values in the following tables are based on this formula. These values are accurate for all fluids. Linear fluid flow velocity in a system should generally be limited 5ft/sec, particularly for pipe sizes 6" and greater. Following this guideline will minimize risk of hydraulic shock damage due to water hammer surge pressures.

## Friction Loss in Pipe

A great advantage that Hershey CPVC industrial pipe enjoys over its metallic competitors is a smooth inner surface which is resistant to scaling and fouling. This means that friction pressure losses in the fluid flow are minimized from the beginning and do not significantly increase as the system ages, as can be the case with metal pipes subject to scaling.

The Hazen-Williams formula is the generally accepted method of calculating friction head losses in piping systems. The values in the following fluid flow tables are based on this formula and a surface roughness constant of C =150 for CPVC pipe. Surface roughness constants for other piping materials are given below:

$$f = 0.002083 L \left[ \frac{100}{C} \right]^{1.852} \frac{g^{1.852}}{d^{4.8655}}$$

where

f = friction head in feet of water per feet of pipe

c = Hazen-Williams roughness constant

g = flow rate in gallon per minute

d = inside diameter of pipe, in

L = pipe length , ft

$$\Delta P = \frac{4.55}{C^{1.852}} \times \frac{g^{1.852}}{d^{4.8655}} \times L$$

where

ΔP = Pressure drop, psi

c = Hazan-Williams coefficients

g = volume flow, gal/min

d = inside diameter of pipe, in

L = Pipe length, ft

Material	Constant(c)
PVC/CPVC, new~40 years old	150
Steel/cast iron and copper, new	130-140
Steel, old	125
Cast iron and copper, 4-12 years old	120
Galvanized steel and cast iron, 13-20 years old	110
Cast iron, worn/pitted	60-80

## Friction Loss in Fittings

Friction losses through fittings are calculated from the equivalent length of straight pipe which would produce the same friction loss in the fluid. The equivalent lengths of pipe for common fittings are given below.

### Equivalent length of pipe ( Feet )

Nominal Size (in)	90° Standard Elbow	45° Standard Elbow	Standard Tee Run Flow	Standard Tee Branch Flow
1/2	1.5	0.8	1.0	4.0
3/4	2.0	1.1	1.4	5.0
1	2.6	1.4	1.7	6.0
1 ¼	3.8	1.8	2.3	7.0
1½	4.0	2.1	2.7	8.1
2	5.7	2.7	4.3	12.0
2½	6.9	3.3	5.1	14.7
3	7.9	4.1	6.2	16.3
4	11.4	5.3	8.3	22.0
6	16.7	8.0	12.5	32.2
8	21.0	10.6	16.5	39.7
10	25.1	13.4	19.1	50.1
12	29.8	15.9	22.4	63.0

\*The data provided in this table is for reference only.



## Pressure Drop in Valves and Strainers

Pressure drop in valves and strainers is calculated using flow coefficient values. The equation for calculating pressure drop in this manner is:

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

Where  $\Delta P$  = water pressure drop, psi

G = maximum flow rate, gal/min

Cv = the valve flow coefficient

$\rho$  = specific gravity of fluids

Typical flow coefficients for different valves and strainers can be given below. Pressure drops for fluids other than water may be calculated by multiplying the value calculated from the above equation by the specific gravity of the fluid.

Valves	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
MIP Ball	8	15	29	75	90	140	330	480	600
Double Union Ball	8	15	29	75	90	140	330	480	600
Single Union Ball	8	15	29	75	90	140	-	-	-
Swing Check	15	22	76	120	120	125	255	285	490
Butterfly	-	-	-	-	70	120	260	310	480
Diaphragm	6	6.5	11	14	32.5	54	110	150	250
<b>Strainers (Clean)</b>	<b>1/2"</b>	<b>3/4"</b>	<b>1"</b>	<b>1-1/4"</b>	<b>1-1/2"</b>	<b>2"</b>	<b>2-1/2"</b>	<b>3"</b>	<b>4"</b>
Y Type	3.8	6.6	8.4	20	25	35	60	60	95
T Type	6	9.5	29	-	40	55	-	125	155

## Water Hammer Surge pressure

Whenever the flow rate of fluid in a pipe is changed, there is a surge in pressure known as water hammer. The longer the line and the faster the fluid is moving, the greater the hydraulic shock will be. Water hammer may be caused by opening or closing a valve, starting or stopping a pump, or the movement of entrapped air through the pipe. The maximum water hammer surge pressure may be calculated from:

Step1. Calculate wave velocity :

From Uni-Bell Handbook of PVC Pipe, Design and construction, 2001, Chapter V, the wave velocity is given by the follow equation:

### HANDBOOK OF PVC PIPE

#### EQUATION 5.13

$$a = \frac{4660}{\sqrt{1 + \frac{kD_i}{Et}}}$$

Where:

**a** = wave velocity, ft/s

**k** = fluid bulk modulus, (300,000 psi for water)

**Di** = pipe ID, in

**E** = modulus of elasticity of the pipe, (400,000 psi for PVC water pipe, 423,000 psi for CPVC @ 73 °F)

**t** = wall thickness, in

Substituting dimension ratio (**DR**) for  $\frac{D_i}{t}$  :

$$\text{(note that } DR = \frac{D_o}{t} = \frac{D_i + 2t}{t} = \frac{D_i}{t} + 2)$$

### EQUATION 5.14

$$a = \frac{4660}{\sqrt{1 + \frac{k}{E} (DR - 2)}}$$

The maximum pressure surge may be calculated,

### EQUATION 5.15

$$P = \frac{a(\Delta V)}{2.31g}$$

Where:

$\Delta V$  = maximum velocity change, ft/s

$g$  = acceleration due to gravity, 32.2 ft/s<sup>2</sup>

$P$  = pressure surge, psi

**Example** – A flow of 2 ft/s is suddenly stopped in a 6 in pressure class 150 (DR 18) PVC pipe. Calculate the expected maximum surge pressure.

Step2. Calculate maximum pressure surge :

$$P = \frac{a(\Delta V)}{2.31g}$$

where

$P$  = surge pressure, psi

$a$  = wave velocity, ft/sec

$\Delta V$  = maximum velocity change, ft/sec

$g$  = acceleration due to gravity, 32.2 ft/sec<sup>2</sup>

The values in the following tables are based on this formula at 73°F and the assumption that water flowing at a given rate of gallons per minute is suddenly completely stopped. At 180°F, the surge pressure is approximately 15% less. The value for fluids other than water may be approximated by multiplying by the square root of the fluid's specific gravity.

## THE WATER HAMMER SURGE PRESSURE PLUS THE SYSTEM OPERATING PRESSURE SHOULD NOT EXCEED 1.5 TIMES THE RECOMMENDED WORKING PRESSURE RATING OF THE SYSTEM.

In order to minimize hydraulic shock due to water hammer, linear fluid flow velocity should generally be limited to 5 ft/s, particularly for pipe sizes of 6" or larger. Velocity at system start-up should be limited to 1 ft/s during filling until it is certain that all air has been flushed from the system and the pressure has been brought up to operating conditions.

Air should not be allowed to accumulate in the system while it is operating. Pumps should not be allowed to draw in air.

Where necessary, extra protective equipment may be used to prevent water hammer damage. Such equipment might include pressure relief valves, shock absorbers, surge arrestors, and vacuum air relief valves.

**Carrying Capacity and Friction Loss for Schedule 80 CPVC Pipe**  
 Independent Variables: Volumetric Flow Rate and Average Pipe ID  
 Dependent Variables: Linear Velocity, Friction Head Loss, and Pressure Drop

volumetric flow (gpm/ltm)	1/2 inch				3/4 inch				1 inch				1 1/4 inch				1 1/2 inch				2 inch				2 1/2 inch				3 inch						
	linear velocity (ft/s)	friction head loss (ft water/100 ft)	friction pressure (psi/100 ft)	Maximum Surge Pressure (PSI)	linear velocity (ft/s)	friction head loss (ft water/100 ft)	friction pressure (psi/100 ft)	Maximum Surge Pressure (PSI)	linear velocity (ft/s)	friction head loss (ft water/100 ft)	friction pressure (psi/100 ft)	Maximum Surge Pressure (PSI)	linear velocity (ft/s)	friction head loss (ft water/100 ft)	friction pressure (psi/100 ft)	Maximum Surge Pressure (PSI)	linear velocity (ft/s)	friction head loss (ft water/100 ft)	friction pressure (psi/100 ft)	Maximum Surge Pressure (PSI)	linear velocity (ft/s)	friction head loss (ft water/100 ft)	friction pressure (psi/100 ft)	Maximum Surge Pressure (PSI)	linear velocity (ft/s)	friction head loss (ft water/100 ft)	friction pressure (psi/100 ft)	Maximum Surge Pressure (PSI)	linear velocity (ft/s)	friction head loss (ft water/100 ft)	friction pressure (psi/100 ft)	Maximum Surge Pressure (PSI)			
1	1.47	2.20	0.05	48.16	0.78	0.47	0.20	23.17	0.93	0.49	0.21	26.67	0.52	0.12	0.05	13.47	0.38	0.05	0.02	9.30															
2	2.93	7.94	0.20	96.31	1.56	1.71	0.74	46.34	1.40	0.98	0.45	53.34	0.78	0.25	0.11	27.21	0.56	0.11	0.05	13.95															
3	4.40	16.82	0.45	144.47	2.34	3.62	1.56	69.51	2.10	1.47	0.74	80.00	1.17	0.41	0.20	40.41	0.84	0.19	0.08	18.59															
4	5.86	28.65	0.81	216.70	3.51	6.17	2.66	102.69	3.18	2.30	1.16	116.68	1.79	0.64	0.38	53.68	1.24	0.29	0.13	23.54															
5	7.33	43.31	1.27	325.05	5.25	9.26	4.03	158.86	4.55	3.44	1.63	171.00	2.59	0.94	0.58	71.17	1.79	0.41	0.20	27.89															
6	8.79	60.71	1.81	228.84	7.50	13.07	5.64	233.38	6.47	4.98	2.16	245.54	3.81	1.19	0.51	92.41	2.29	0.54	0.23	32.54															
7	10.26	80.76	2.46	348.88	10.26	18.78	7.51	331.06	9.36	7.01	2.71	353.38	5.48	1.51	0.66	126.68	2.89	0.78	0.41	37.19															
8																																			
9																																			
10																																			
15																																			
20	0.57	0.04	0.02	11.78	7.79	33.65	14.53	231.71	4.67	9.70	4.19	133.55	2.59	2.31	1.00	67.35	1.88	1.05	0.45	46.69	1.12	0.30	0.13	25.71	0.78	0.12	0.05	18.40	0.50	0.04	0.02	11.06	10		
25	0.71	0.06	0.03	14.73	10.35	43.50	19.95	317.57	6.31	13.29	5.87	200.03	3.58	3.18	1.41	101.03	2.61	1.41	0.56	64.99	1.67	0.65	0.27	38.56	1.17	0.26	0.11	27.60	0.75	0.09	0.04	16.59	15		
30	0.85	0.08	0.04	17.67	13.80	58.81	28.12	456.19	8.58	18.21	8.14	276.72	5.05	4.36	2.02	139.46	3.58	1.98	0.77	91.49	2.33	1.07	0.46	51.42	1.56	0.45	0.19	36.79	1.00	0.15	0.07	22.12	20		
35	1.00	0.11	0.05	20.62	18.27	79.66	39.17	639.84	11.68	25.21	22.85	333.38	6.47	12.59	5.44	188.38	4.69	2.48	1.16	126.68	3.44	1.63	0.70	64.27	1.95	0.68	0.29	45.99	1.25	0.23	0.10	27.65	25		
40	1.14	0.14	0.06	23.56	23.79	106.07	54.03	889.71	16.02	34.17	32.03	400.06	7.77	17.64	7.62	202.06	5.63	3.04	1.34	139.46	4.47	2.28	0.98	77.13	2.34	0.95	0.41	55.19	1.49	0.32	0.14	33.18	30		
45	1.28	0.17	0.08	26.51	29.45	138.04	75.00	1200.00																											
50	1.42	0.21	0.09	29.45	33.33	178.81	102.69	1650.00																											
60	1.71	0.30	0.13	35.35	41.24	228.84	132.91	2250.00																											
70	1.99	0.39	0.17	41.24	51.66	299.54	174.84	3093.75																											
80	2.28	0.51	0.22	47.13	63.93	390.86	233.38	4200.00																											
90	2.56	0.63	0.27	53.02	79.66	500.00	300.00	5625.00																											
100	2.85	0.76	0.33	58.91	98.42	650.00	381.25	7500.00																											
125	3.56	1.16	0.50	73.64	157	1166.67	600.00	15000.00																											
150	4.27	1.62	0.70	88.36	188	1472.22	750.00	19125.00																											
200	5.70	2.76	1.19	117.82	251	2152.78	1026.93	27000.00																											
250	7.12	4.17	1.80	147.27	313	2854.55	1329.10	36000.00																											
300	8.55	5.85	2.53	176.73	376	3690.00	1748.44	47250.00																											
350	9.97	7.78	3.36	206.18	439	4672.50	2288.84	61500.00																											
400	11.40	9.96	4.30	235.64	501	5711.11	2995.45	78750.00																											
450	12.82	12.99	5.35	265.09	564	6916.67	3900.00	101250.00																											
500	14.25	15.06	6.50	294.55	627	8290.00	5000.00	131250.00																											
600	17.10	21.11	9.12	353.46	752	11666.67	7500.00	180000.00																											
700																																			
800																																			
900																																			
1000	1.61	0.04	0.02	27.39	15.67	11.14	4.81	301.12	11.28	28.3	1.22	161.26	5.67	0.94	0.41	99.82	4.00	0.40	0.12	17.69	1.72	0.74	1.17	19.501	9.28	1.21	0.34	12.63	0.53	0.05	0.02	11.06	15		
1250	1.61	0.04	0.02	27.39	15.67	11.14	4.81	301.12	11.28	28.3	1.22	161.26	5.67	0.94	0.41	99.82	4.00	0.40	0.12	17.69	1.72	0.74	1.17	19.501	9.28	1.21	0.34	12.63	0.53	0.05	0.02	11.06	15		
1500	1.93	0.06	0.03	32.87	18.78	13.82	5.94	370.78	13.82	34.9	1.51	202.06	6.91	1.13	0.51	119.78	4.80	0.57	0.24	22.52	2.13	1.18	1.18	207.04	9.10	1.41	0.61	15.646	0.717	0.79	0.34	12.63	20		
2000	2.58	0.11	0.05	43.83	25.80	18.78	8.14	487.50	18.78	47.22	2.02	276.72	9.36	1.51	0.66	158.38	6.53	0.83	0.36	29.95	2.89	1.63	1.63	281.25	12.15	2.02	0.83	20.06	1.04	1.04	0.40	40.88	25		
2500	3.22	0.16	0.07	54.78	33.33	25.00	10.91	630.00	25.00	62.50	2.71	363.33	12.50	2.02	0.83	210.00	8.50	1.04	0.46	40.88	3.81	2.13	2.13	375.00	16.18	2.71	1.04	26.52	1.35	1.35	0.53	53.00	30		
3000	3.87	0.22	0.10	65.74	42.86	33.33	14.72	833.33	33.33	83.33	3.62	483.33	16.67	2.71	1.04	281.25	11.25	1.35	0.53	53.00	5.00	2.89	2.89	500.00	21.43	3.62	1.35	33.33	1.81	1.81	0.71	68.13	35		
3500	4.51	0.30	0.13	76.69	53.00	42.86	20.00	1100.00	42.86	110.00	4.83	630.00	22.50	3.62	1.35	375.00	15.00	1.81	0.71	68.13	6.53	3.81	3.81	666.67	28.13	4.83	1.81	42.86	2.46	2.46	0.91	98.38	40		
4000	5.15	0.38	0.16	87.65	63.93	51.66	27.00	1400.00	51.66	141.67	6.39	833.33	30.00	4.83	1.81	500.00	19.29	2.46	0.91	98.38	8.50	5.00	5.00	833.33	36.36	6.39	2.46	54.78	3.33	3.33	1.21	126.68	45		
4500	5.80	0.47	0.20	98.61	75.00	61.73	36.00	1800.00	61.73	180.00	8.50	1100.00	40.00	6.39	2.46	666.67	25.00	3.22	1.10	135.00	11.25	6.53	6.53	1100.00	45.00	8.50	3.22	70.71	4.50	4.50	1.61	166.67	50		
5000	6.44	0.57	0.25	109.56	87.65	72.92	46.46	2400.00	72.92	240.00	11.25	1500.00	53.00	8.50	3.22	900.00	32.26	4.28	1.47	181.82	15.00	8.50	8.50	1500.00	60.00	11.25	4.28	90.91	6.00	6.00	2.17	225.00	55		
6000	7.73	0.80	0.35	131.48	102.69	85.71	54.78	3240.00	85.71	324.00	15.00	2000.00	70.71	11.25	4.28	1200.00	40.00	5.80	2.00	245.00	20.00	11.25	11.25	2000.00	80.00	15.00	5.80	120.00	8.00	8.00	2.89	300.00	60		
7000	9.02	1.07	0.46	153.39	122.89	100.00	69.51	4285.71	100.00	428.57																									

Carrying Capacity and Friction Loss for Schedule 40 CPVC Pipe  
Independent Variables: Volumetric Flow Rate and Average Pipe ID  
Dependent Variables: Linear Velocity, Friction Head Loss, and Pressure Drop

volumetric flow (gpm)	1/2 inch				3/4 inch				1 inch				1 1/4 inch				2 inch				3 inch							
	linear velocity (ft/s)	friction head loss (ft water/100 ft)	friction pressure (psi/100 ft)	Maximum Surge Pressure (PSI)	linear velocity (ft/s)	friction head loss (ft water/100 ft)	friction pressure (psi/100 ft)	Maximum Surge Pressure (PSI)	linear velocity (ft/s)	friction head loss (ft water/100 ft)	friction pressure (psi/100 ft)	Maximum Surge Pressure (PSI)	linear velocity (ft/s)	friction head loss (ft water/100 ft)	friction pressure (psi/100 ft)	Maximum Surge Pressure (PSI)	linear velocity (ft/s)	friction head loss (ft water/100 ft)	friction pressure (psi/100 ft)	Maximum Surge Pressure (PSI)	linear velocity (ft/s)	friction head loss (ft water/100 ft)	friction pressure (psi/100 ft)	Maximum Surge Pressure (PSI)	linear velocity (ft/s)	friction head loss (ft water/100 ft)	friction pressure (psi/100 ft)	Maximum Surge Pressure (PSI)
1	1.11	0.43	0.27	15.63	0.44	0.08	0.03	9.67	0.32	0.04	0.02	6.73	0.28	0.03	0.01	5.00	0.22	0.03	0.01	3.60	0.18	0.02	0.01	2.80	0.15	0.02	0.01	2.20
2	2.21	0.73	0.43	31.25	0.77	0.30	0.13	18.58	0.44	0.08	0.03	13.43	0.32	0.04	0.02	9.67	0.32	0.04	0.02	6.73	0.28	0.03	0.01	5.00	0.22	0.03	0.01	3.60
3	3.32	1.09	0.64	46.88	1.15	0.48	0.20	27.87	0.66	0.17	0.07	20.51	0.48	0.08	0.03	13.43	0.32	0.04	0.02	9.67	0.32	0.04	0.02	6.73	0.28	0.03	0.01	5.00
4	4.42	1.44	0.83	62.50	1.53	0.69	0.29	37.15	0.88	0.28	0.11	29.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73	0.28	0.03	0.01	5.00
5	5.52	1.80	1.10	78.13	1.91	1.04	0.43	46.44	1.10	0.43	0.18	38.33	0.81	0.20	0.09	24.52	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
6	6.63	2.16	1.46	93.75	2.30	1.32	0.60	55.73	1.32	0.60	0.26	48.00	0.97	0.28	0.16	31.25	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
7	7.74	2.52	1.81	109.38	2.68	1.65	0.80	65.02	1.54	0.80	0.34	57.00	1.13	0.38	0.24	41.25	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
8	8.84	2.88	2.16	125.00	3.06	2.00	1.00	74.31	1.76	1.00	0.44	66.00	1.29	0.48	0.31	44.52	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
9	9.94	3.24	2.52	140.63	3.45	2.34	1.20	83.60	1.98	1.20	0.55	75.00	1.45	0.60	0.38	47.83	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
10	11.04	3.60	2.88	156.25	3.83	2.68	1.40	92.89	2.20	1.40	0.67	84.00	1.61	0.73	0.45	51.13	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
15	16.56	5.40	4.26	212.50	5.24	3.79	2.10	129.52	2.87	2.10	1.00	113.00	2.16	1.04	0.67	66.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
20	22.08	7.20	5.76	268.75	6.63	5.04	2.80	166.15	3.39	2.80	1.32	144.00	2.52	1.36	0.88	81.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
25	27.60	9.00	7.65	325.00	8.06	6.39	3.50	202.78	4.00	3.50	1.64	174.00	3.06	1.74	1.10	96.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
30	33.12	10.80	10.08	381.25	9.49	7.74	4.20	239.41	4.69	4.20	1.96	201.00	3.52	2.08	1.32	108.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
35	38.64	12.60	12.96	437.50	10.92	9.09	4.90	276.04	5.38	4.90	2.28	228.00	4.08	2.40	1.54	120.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
40	44.16	14.40	15.12	493.75	12.35	10.38	5.60	312.67	6.06	5.60	2.60	255.00	4.56	2.72	1.76	132.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
45	49.68	16.20	16.92	550.00	13.78	11.76	6.30	349.30	6.76	6.30	2.92	282.00	5.04	2.94	1.98	144.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
50	55.20	18.00	18.72	606.25	15.21	13.15	7.00	385.93	7.45	7.00	3.24	309.00	5.52	3.16	2.20	156.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
55	60.72	19.80	20.52	662.50	16.64	14.54	7.70	422.56	8.14	7.70	3.56	336.00	6.00	3.38	2.42	168.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
60	66.24	21.60	22.32	718.75	18.07	15.93	8.40	459.19	8.83	8.40	3.88	363.00	6.48	3.60	2.64	180.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
65	71.76	23.40	24.12	775.00	19.50	17.32	9.10	495.82	9.52	9.10	4.20	390.00	6.96	3.82	2.86	192.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
70	77.28	25.20	25.92	831.25	20.93	18.71	9.80	532.45	10.21	9.80	4.52	417.00	7.44	3.96	3.08	204.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
75	82.80	27.00	27.72	887.50	22.36	20.10	10.50	569.08	10.90	10.50	4.84	444.00	7.92	4.10	3.30	216.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
80	88.32	28.80	29.52	943.75	23.79	21.49	11.20	605.71	11.59	11.20	5.16	471.00	8.40	4.26	3.52	228.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
85	93.84	30.60	31.32	1000.00	25.22	22.88	11.90	642.34	12.28	11.90	5.48	498.00	8.88	4.42	3.74	240.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
90	99.36	32.40	33.12	1056.25	26.65	24.27	12.60	678.97	12.97	12.60	5.80	525.00	9.36	4.58	3.96	252.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
95	104.88	34.20	34.92	1112.50	28.08	25.66	13.30	715.60	13.66	13.30	6.12	552.00	9.84	4.74	4.18	264.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
100	110.40	36.00	36.72	1168.75	29.51	27.05	14.00	752.23	14.35	14.00	6.44	579.00	10.32	4.90	4.40	276.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
105	115.92	37.80	38.52	1225.00	30.94	28.44	14.70	788.86	15.04	14.70	6.76	606.00	10.80	5.06	4.62	288.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
110	121.44	39.60	40.32	1281.25	32.37	29.83	15.40	825.49	15.73	15.40	7.08	633.00	11.28	5.22	4.84	300.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
115	126.96	41.40	42.12	1337.50	33.80	31.22	16.10	862.12	16.42	16.10	7.40	660.00	11.76	5.38	5.06	312.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
120	132.48	43.20	43.92	1393.75	35.23	32.61	16.80	898.75	17.11	16.80	7.72	687.00	12.24	5.54	5.28	324.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
125	138.00	45.00	45.72	1450.00	36.66	34.00	17.50	935.38	17.80	17.50	8.04	714.00	12.72	5.70	5.50	336.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
130	143.52	46.80	47.52	1506.25	38.09	35.39	18.20	972.01	18.49	18.20	8.36	741.00	13.20	5.86	5.72	348.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
135	149.04	48.60	49.32	1562.50	39.52	36.78	18.90	1008.64	19.18	18.90	8.68	768.00	13.68	6.02	5.94	360.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
140	154.56	50.40	51.12	1618.75	40.95	38.17	19.60	1045.27	19.87	19.60	9.00	795.00	14.16	6.18	6.16	372.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
145	160.08	52.20	52.92	1675.00	42.38	39.56	20.30	1081.90	20.56	20.30	9.32	822.00	14.64	6.34	6.38	384.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
150	165.60	54.00	54.72	1731.25	43.81	40.95	21.00	1118.53	21.25	21.00	9.64	849.00	15.12	6.50	6.60	396.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
155	171.12	55.80	56.52	1787.50	45.24	42.34	21.70	1155.16	21.94	21.70	9.96	876.00	15.60	6.66	6.82	408.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
160	176.64	57.60	58.32	1843.75	46.67	43.73	22.40	1191.79	22.63	22.40	10.28	903.00	16.08	6.82	7.04	420.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
165	182.16	59.40	60.12	1899.99	48.10	45.12	23.10	1228.42	23.32	23.10	10.60	930.00	16.56	6.98	7.26	432.00	0.64	0.13	0.06	18.58	0.48	0.08	0.03	13.43	0.32	0.04	0.02	6.73
170	187.68	61.20	61.92	1956.25	49.53	46.51	23.80	1265.05	24.01	23.80	10.92	957.00	17.04	7.14	7.48	444.00	0.64											

# Thermal Expansion and Thermal Stresses

## General

It is important to consider thermal expansion when designing a system with Hershey CPVC industrial pipe. Most thermoplastics have a coefficient of thermal expansion which is significantly higher than those of metals. The thermal expansion of a piping system subject to a temperature change can therefore be significant, and may need compensation in the system design. The expansion or contraction of thermoplastic pipe may be calculated from the following formula:

Thermal Expansion Formula

$$\Delta L = L_p C \Delta T$$

Where:  $\Delta L$  = Change in length due to change in temperature (in.)

$L_p$  = Length of pipe (in.)

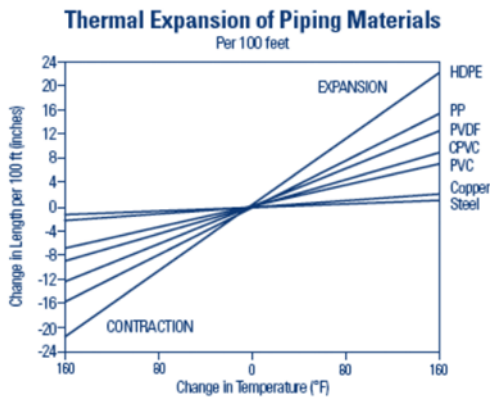
$C$  = Coefficient of thermal expansion (in./in./°F)

3.0 x 10<sup>-5</sup> in./in./°F for PVC

3.4 x 10<sup>-5</sup> in./in./°F for CPVC

$\Delta T$  = Change in temperature (°F)

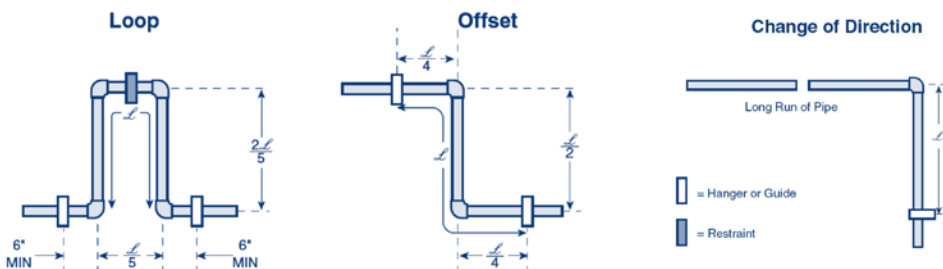
The thermal expansion and contraction of CPVC and other piping materials is displayed below.



## Expansion Loops and Offsets

As a rule of thumb, if the total temperature change is greater than 30°F (17°C), compensation for thermal expansion should be included in the system design for pipe run greater than 100 ft ( 30m ). The recommended method of accommodating thermal expansion is to include expansion loops, offsets, or changes in direction where necessary in the system design.

An expansion loop schematic is presented here.



### Expansion Loop Formula

$$L = \sqrt{\frac{3ED(\Delta L)}{2S}}$$

Where: L = Loop length (in.)

E = Modulus of elasticity at maximum temperature (psi)

S = Working Stress at maximum temperature (psi)

D = Outside diameter of pipe (in.)

$\Delta L$  = Change in length due to change in temperature (in.)

### Modulus of Elasticity & Stress VS. Temperature

Temperature		Modulus, E		Stress, S	
°F	°C	psi	MPa	psi	MPa
73	23	423,000	2,917	2,000	14
90	32	403,000	2,779	1,800	12
110	43	371,000	2,558	1,500	10
120	49	355,000	2,448	1,300	9
140	60	323,000	2,227	1,000	7
160	71	291,000	2,006	750	5
180	82	269,000	1,855	500	3

Expansion loops and offsets should be constructed with straight pipe and 90° elbows which are solvent cemented together. If threaded pipe is used in the rest of the system, it is still recommended that expansion loops and offsets be constructed with solvent cement in order to better handle the bending stresses incurred during expansion. The expansion loop or offset should be located approximately at the midpoint of the pipe run and should not have any supports or anchors installed in it. Valves or strainers should not be installed within an expansion loop or offset.

### Thermal Stresses

If thermal expansion is not accommodated, it is absorbed in the pipe as an internal compression. This creates a compressive stress in the pipe. The stress induced in a pipe which is restrained from expanding is calculated with the following formula:

$$S = EC\Delta T$$

where S = stress induced in the pipe

E = Modulus of elasticity at maximum temperature

C = coefficient of thermal expansion

$\Delta T$  = total temperature change of the system

Because the coefficient of thermal expansion of steel is five times lower than that of CPVC, dimensional changes due to thermal expansion will be five times less. However, as can be seen by the equation above, the stresses induced in the piping system due to restrained thermal expansion are dependent on the material's modulus as well as its coefficient of thermal expansion. Because the modulus of steel is approximately 80 times higher than that of CPVC, the stresses resulting from restrained expansion over a given temperature change will be approximately 16 times higher for steel than for CPVC.

For instance, restrained expansion over a 50°F temperature change will produce approximately 600 psi of stress in a CPVC system, but 9800 psi of stress in a steel system. CPVC's relatively more flexible nature will usually allow it to absorb its lower stresses in a bucking or snaking of the line if necessary. Because steel piping is too rigid to buckle, its higher stresses are often transferred to surrounding structures, resulting in damaged supports, anchors, or even abutting walls.

## **Horizontal Piping Hangers and Supports**

CPVC pipe should be supported per the hanger support spacing found in the following Tables on next pages. Piping should not be anchored tightly to supports, but rather secured with smooth straps or hangers that allow for movement caused by expansion and contraction. Hangers should not have rough or sharp edges which come in contact with the pipe.

## **Vertical Piping Hangers and Supports**

Vertical runs of CPVC pipe should be supported by pipe clamps or by hangers located on the horizontal connection close to the riser. Hangers and straps that do not distort, cut or abrade the piping should be utilized. Maintain vertical piping in straight alignment with supports at each level plus a mid-story guide for pipe sizes 2" and smaller or as specified by the design engineer to allow for expansion/contraction.

# Typical Recommended Maximum Support Spacing

Temperature (°F)	SCH80 CPVC industrial pipe Maximum Support Spacing						SCH40 CPVC industrial pipe Maximum Support Spacing					
	80	100	120	140	160	180	80	100	120	140	160	180
1/2"	5.5	5	4.5	4	3	2.5	5	4.5	4.5	4	2.5	2.5
3/4"	5.5	5.5	5	4.5	3	2.5	5	5	4.5	4	2.5	2.5
1"	6	6	5.5	5	3.5	3	5.5	5.5	5	4.5	3	2.5
1-1/4"	6.5	6	6	5.5	3.5	3	5.5	5.5	5.5	5	3	3
1-1/2"	7	6.5	6	6	3.5	3.5	6	6	5.5	5	3.5	3
2"	7	7	6.5	6	4	3.5	6.5	6.5	5.5	5	3.5	3
2-1/2"	8	7.5	7.5	6.5	4.5	4	7	7	6.5	6	4	3.5
3"	8	8	7.5	7	4.5	4	7	7	7	6	4	3.5
4"	9	9	8.5	7.5	5	4.5	7.5	7.5	7	6.5	4.5	4
6"	10	9.5	9	8	5.5	5	8.5	8	7.5	7	5	4.5
8"	11	10.5	10	9	6	5.5	8.5	8	7.5	7	5	5
10"	11.5	11	10.5	9.5	6.5	6	9.5	8	8	7.5	5.5	5.5
12"	12.5	12.5	11	10.5	7.5	6.5	10.5	10	9	8	6	6
14"	15	13.5	12.5	11	9.5	8	11	10	9	8	6.5	6.25
16"	16	15	13.5	12	10	8.5	12	11	9.5	8.5	7	7
18"	17	16	14.5	13	11	9	13	12	10	9	7.5	7.5
20"	18	17	15.5	14	12	10	14	13	11	9.5	8	8
24"	20	19	17	15	13	11	15	14	12	10.5	9	9

(Unit : Feet)

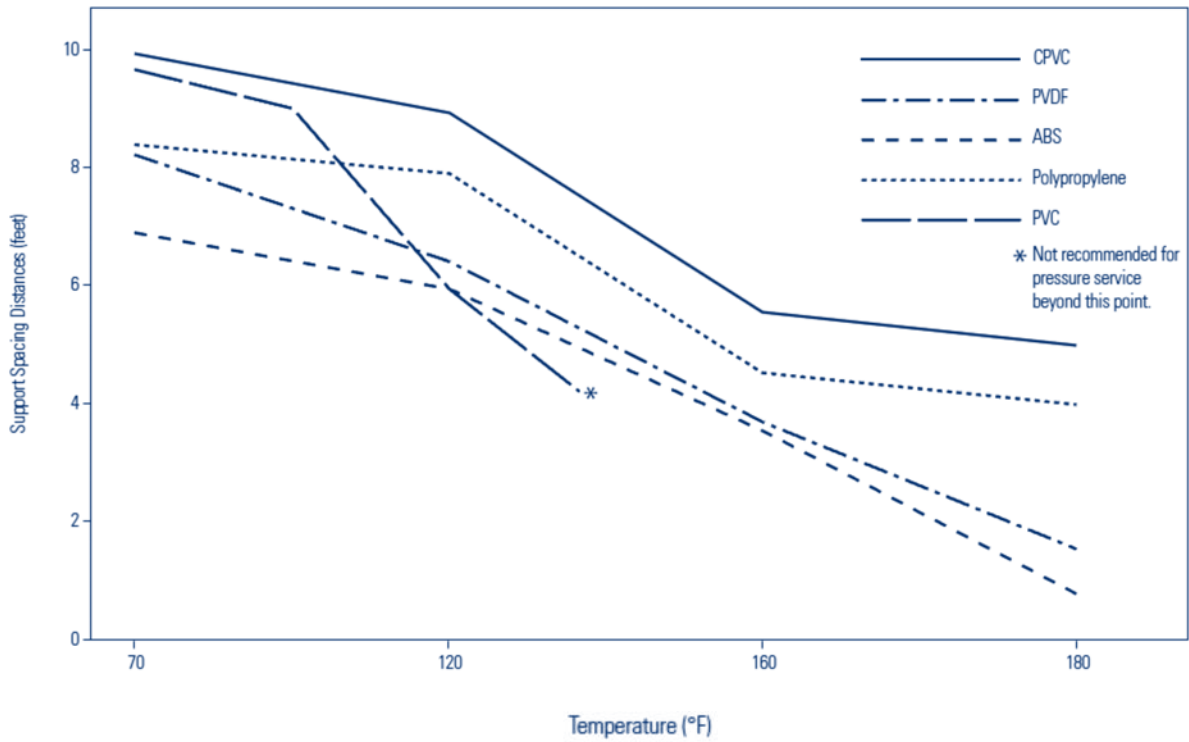
\* Chart based on spacing for continuous spans and for uninsulated line conveying fluids of specific gravity up to 1.00. For specific gravities greater than 1.0, the support spacing from the table provided should be multiplied by the following correction factors:

Specific Gravity	1.0	1.1	1.2	1.4	1.6	2.0	2.5
Correction Factor	1.00	0.98	0.96	0.93	0.90	0.85	0.80

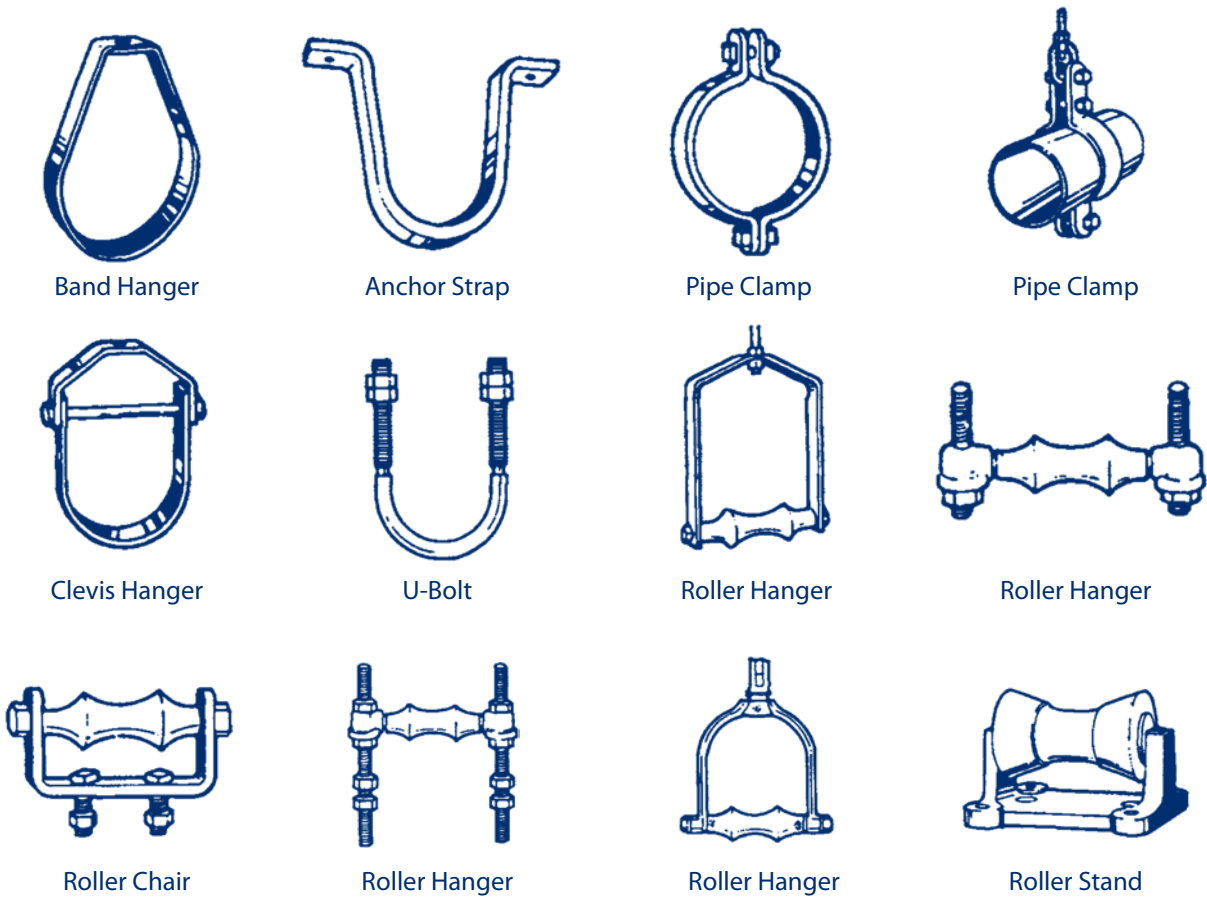
\* The pipe should not be anchored tightly by the support, but secured in a manner to allow for movement caused by thermal expansion and contraction. It is recommended that you use clamps or straps that allow pipe to remain away from the framing, thus reducing the noise generated when pipe is allowed to rub against wood.



Support Spacing for 6 Inch Diameter, Schedule 80 Thermoplastic Systems



Pipe Hangers, Clamps, & Supports



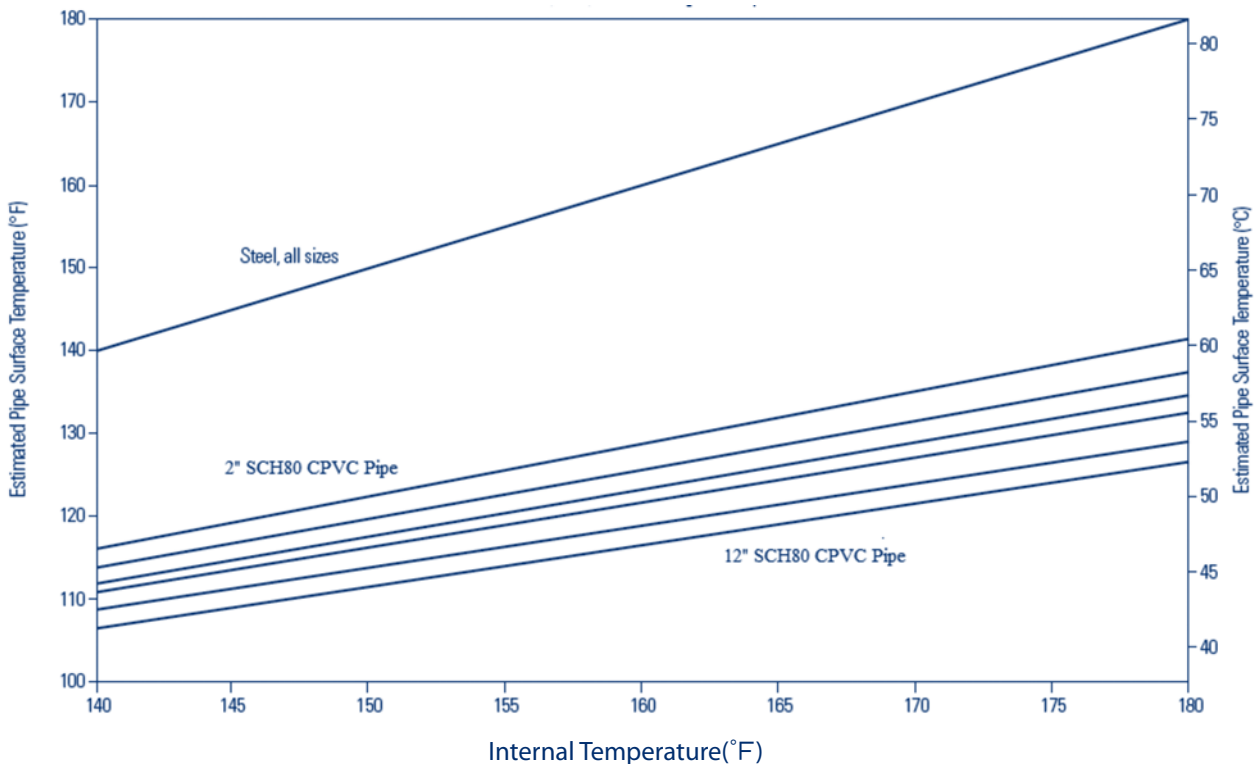
# Thermal Conductivity

Hershey CPVC industrial piping has a very low thermal conductivity value, approximately 1/300th that of steel. A prudent practice to ensure worker safety is to insulate pipes which have exterior surface temperatures greater than 140°F. Because metal pipes have such a high thermal conductivity, the exterior surface temperature is approximately equal to the temperature of the fluid being conveyed. Therefore, pipes carrying fluids at temperatures of 140°F or more should be insulated if there is the possibility of worker contact. This generates more cost in the initial installation of a system and makes periodic inspections of the pipe more difficult. Because CPVC has a much lower thermal conductivity, the surface temperature of CPVC pipe is significantly lower than the internal fluid temperature. Insulation is therefore often not needed on Hershey CPVC industrial pipe. The figure below shows the approximate pipe surface temperature as a function of internal fluid temperature for a piping system and with 73°F air circulating at 0.75 feet per second. CPVC pipe sizes of 2, 4, 6, 8, 10, and 12" Schedule 80 are represented. This figure is intended to demonstrate the significant difference between steel and CPVC pipe, but should not be used for system design. The actual surface temperature of pipe in a working system is dependent on many factors, including ambient temperature, air circulation velocity and direction, etc.

CPVC's low thermal conductivity also means that energy in the process stream is conserved. The rate of heat transfer through CPVC piping is typically 50-60% that of steel piping

## Estimated Pipe Surface Temperature vs. Internal Fluid Temperature

With 73°F (23°C) Air Circulating at 0.75 fps



# General Installation Guidelines

## Installation Guides

Proper install of Hershey CPVC industrial piping systems is critical to the performance of the system. A few sample guidelines should be followed to ensure long service life and safe operation.

### Handling

Proper care should be exercised when transporting or installing Hershey CPVC piping to prevent damage. Hershey CPVC piping should be stored and shipped only with other non-metallic piping. It should not be dropped or dragged during handling, especially during extremely cold weather. The same treatment should apply to the handling of Hershey CPVC fittings.

Prior to actual installation, the pipe and fittings should be thoroughly inspected for cracks, gouges, or other signs of damage. Particular attention should be given to the inside surface of the part. While the outside surface may not exhibit damage, improper handling can result in damage that appears only on the inside surface of the part.

### Cutting

Lengths of pipe can be easily and successfully cut by following a few simple guidelines. Best results are obtained by using fine-toothed saw blades (16 to 18 teeth per inch) with little or no offset (0.025" max.). Circular power saws (6,000 rpm) or band saws (3,600 ft./min.) are recommended using ordinary hand pressure. Miter boxes or other guide devices are strongly recommended for manual operation to ensure square cuts. Burrs, chips, and dust should be removed following cutting to prevent contamination of the piping system and facilitate joining.

### Joining Methods

Hershey CPVC piping can be installed using a number of joining techniques. Solvent welding, flanging, and threading are the more common methods and are covered in greater detail in this section. Back welding of joints using hot gas welders is also covered in some detail. Less common joining methods are also possible with Hershey CPVC piping and fittings. Contact Hershey Sales rep for assistance with less common joining methods.

### Hanging/Laying of Pipe

Hershey CPVC piping can be installed above ground or buried underground. Methods to minimize stress on the piping as a result of installation are covered in detail below.

### System Stress

Any metal or non-metal piping system is subject to stress-induced corrosion. As a result, special attention should be given to minimizing stress throughout the system. The total stress on a piping system includes not only the known pressure stress, but also stresses from sources such as expansion or installation. Expansion stresses can be minimized with expansion joints or loops. Installation stresses are minimized with careful installation techniques. Pipe and fittings should be properly prepared when joints are made up. Hangers and supports should be properly spaced to prevent sagging and should not cut into the pipe or clamp it tightly, preventing movement. System components should not be forced into place.

## Thermal Expansion

CPVC piping has the lowest coefficient of thermal expansion of any thermoplastic piping. However, thermal expansion will be greater than that of metal piping. Typically, expansion loops or offsets in the piping are designed to account for any thermal expansion. These design methods are covered in the previous section. Expansion joints can also be installed. Information on expansion joints can be obtained by contacting Hershey Valve sales rep.

## Testing the Piping System

After the piping system is installed and any solvent cement is fully cured, the system should be pressure tested and checked for leaks using water. **Testing using compressed air or inert gas is not recommended.** All entrapped air should be allowed to vent as the system is filled with water. Water filling should occur at a velocity not more than 1ft/sec. After filling, the system should be pressured to 125% of the maximum design pressure of the lowest rated part of the system. Pressure should be held for no more than one hour while the system is checked for leaks.

# Joining CPVC Pipe and Fittings – Solvent Cementing

## Cutting

Hershey CPVC pipe can be easily cut with a ratchet cutter, wheel-type plastic tubing cutter, power saw, or fine-toothed saw. To ensure the pipe is cut square, a mitre box must be used when cutting with a saw. Cutting the pipe as squarely as possible provides the maximum bonding surface area.

## Chamfering and Deburring

Burrs and filings can prevent proper contact between the pipe and fitting and may put undue stress on the pipe and fitting assembly. Burrs and filings must be removed from the outside and inside of the pipe. A chamfering tool or file is suitable for this purpose. A slight bevel should be placed at the end of the pipe to ease entry of the pipe into the socket and minimize the chances of wiping solvent cement from the fitting. For pipe sizes 2 inches and larger a 10°-15° chamfer of 3/32" is recommended.

## Fitting Preparation

Loose soil and moisture should be wiped from the fitting socket and pipe end with a clean, dry rag. Moisture can slow the curing, and at this stage of assembly excessive water can reduce the joint strength. The dry fit of the pipe and fitting should be checked. The pipe should enter the fitting socket easily 1/4 to 3/4 of the depth. If the pipe bottoms in the fitting with little interference, extra solvent cement should be used to prepare the joint.

## Primer Application

Use primer conforming to ASTM F656. Primer is needed to prepare the bonding area for the addition of the cement and subsequent assembly. It is important that a proper applicator be used. A dauber, swab or paintbrush approximately half the size of the pipe diameter is appropriate. A rag should not be used. Primer is applied to both

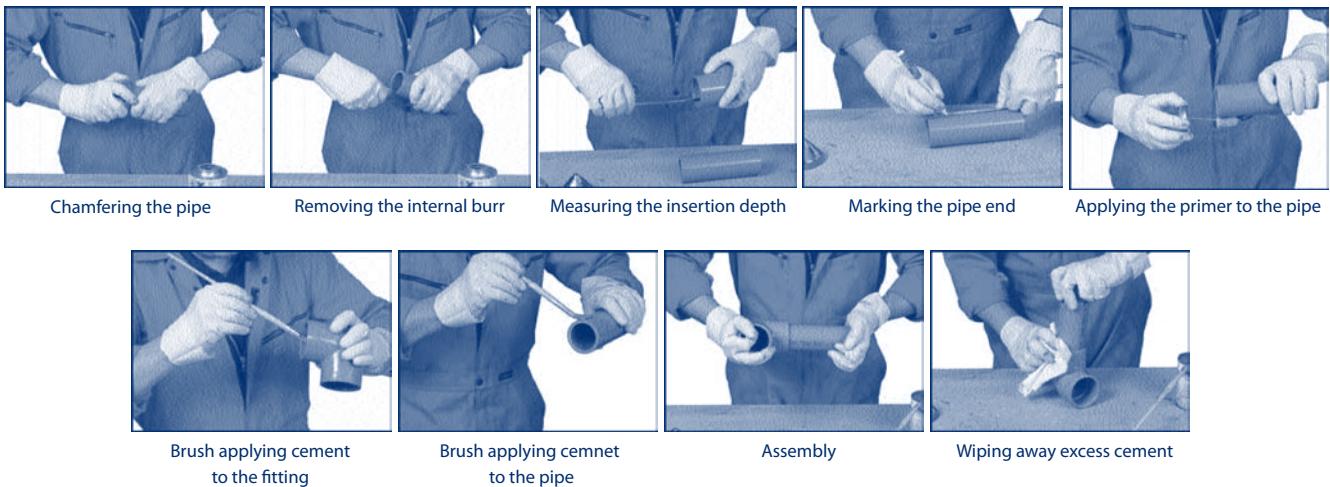
outside of the pipe end and inside of the fitting socket, redipping the applicator as necessary to ensure that the entire surface of both is tacky.

### Solvent Cement Application

Use only solvent cement conforming to ASTM F493. Solvent cement must be applied when the pipe surface is tacky, not wet, from primer. Joining surfaces must be penetrated and softened. Cement should be applied with a natural bristle brush or swab half the size of the pipe diameter. A dauber may be used to apply cement on pipe sizes below 2 inches. A heavy, even coat of cement should be applied to the outside of the pipe end, and a medium coat should be applied to the inside of the fitting socket. Pipe sizes greater than 2 inches should receive a second coat of cement on the pipe end.

### Assembly

After cement application, for smaller pipe under 4" should immediately be inserted into the fitting socket and rotated 1/8 to 1/4 turn until the fitting-stop is reached. The fitting should be properly aligned for installation at this time. The pipe must meet the bottom of the fitting socket. The assembly should be held in place for 10 to 30 seconds to ensure initial bonding and to avoid pushout. A bead of cement should be evident around the pipe and fitting juncture. If this bead is not continuous around the socket shoulder, it may indicate that insufficient cement was applied. In this case, the fitting should be discarded and the joint reassembled. Cement in excess of the bead may be wiped off with a rag.



### Joining of Large Diameter Pipe

For 6 inch or larger diameter pipe, a pipe puller (come-along) is recommended to assemble the joint and hold it in place for the initial set time without applying excess force that may damage the pipe or fitting. This equipment should be set up prior to the start of priming so the assembly can happen quickly while primer and cement are still fluid.

### Set and Cure Times

Solvent cement set and cure times are a function of pipe size, temperature, relative humidity, and tightness of fit. Drying time is faster for drier environments, smaller pipe sizes, high temperatures, and tighter fits. The assembly must be allowed to set, without any stress on the joint, per the time shown in the following tables. Following the initial set period, the assembly can be handled carefully avoiding significant stresses to the joint. Refer to the following table for minimum cure times prior to testing.

Extra care should be exercised when systems are assembled in extreme temperature conditions. Extra set and cure times should be allowed when the temperature is below 40°F (4°C). When the temperature is above 100°F (38°C), the assembler should ensure that both surfaces to be joined are still wet with cement before joining them.

## Recommended Set Times

After a joint is assembled using solvent cement, it should not be disturbed for a period of time to allow for proper “setting” of the newly prepared joint. Recommended set times are as follows:

### Average initial set schedule for PVC / CPUC solvent cement \*\*

#### Solvent Cement Cure Times

Ambient Temperature	To 1 1/4"		1 1/4" to 2"		2 1/2" to 8"		10" to 15"	15"+
	Up to 160 psi	Above 160 psi to 370 psi	Up to 160 psi	Above 160 psi to 315 psi	Up to 160 psi	Above 160 psi to 315 psi	Up to 100 psi	Up to 100 psi
60°F to 100°F	15 min	6 hrs	30 min	12 hrs	1 1/2hrs	24 hrs	48 hrs	72 hrs
40°F to 60°F	20 min	12 hrs	45 min	24 hrs	4 hrs	48 hrs	96 hrs	6 days
0°F to 40°F	30 min	48 hrs	1 hr	96 hrs	72 hrs	8 days	8 days	14 days

Note:

1. Initial set schedule is the necessary time to allow before the joint can be carefully handled. In damp or weather allow 50% more set time.

\*\* These figures are estimates based on laboratory tests using water; extended set times are required for chemical applications. Due to the many variables in the field, these figures should be used as a general guide only.

## Recommended Cure Times

After a joint is assembled using solvent cement, the cement must be allowed to properly "cure" before the piping system is pressurized. Recommended minimum cure times are shown below. These recommendations should only serve as a guide since atmospheric conditions during installation will affect the curing process. High humidity and/or colder weather will require longer cure times: typically add 50% to the recommended cure time if surroundings are humid or damp.

### Average Joint Cure Schedule for PVC / CPVC Solvent Cements\*\*

Relative Humidity 60% or Less	Cure Time Pipe Sizes 1/2" to 1 1/4"		Cure Time PiPe Sizes 1 1/2" to 2"		Cure Time Pipe Sizes 2 1/2" to 8"		Cure Time Pipe Sizes 10" to 15"	Cure Time Pipe Sizes 15"+
	Up to 160 psi	above 160 to 370 psi	up to 160 psi	above 160 to 315 psi	up to 160 psi	above 160 to 315 psi	up to 100 psi	up to 100 psi
Temperature range during assembly and cure periods								
60°-100°F	15 min	6 hrs	30 min	12 hrs	1 1/2 hrs	24 hrs	48 hrs	72 hrs
40°-60°F	20 min	12 hrs	45 min	24 hrs	4 hrs	48 hrs	96 hrs	6 days
0°-40°F	30 min	48 hrs	1 hr	96 hrs	72 hrs	8 days	8 days	14 days

Note-Joint cure schedule is the necessary time to allow before pressurizing system. In damp or humid weather allow 50% more cure time.

\*\*These figures are estimates based on laboratory tests; extended set and cure times are required for chemical applications. Due to the many variables in the field, these figures should be used as a general guide only.

**Average Number of Joints/Qt. of Cement\***

Pipe Diameter	1/2"	3/4"	1"	1 1/2"	2"	3"	4"	6"	8"	10"	12"	15"	18"
Number of Joints	300	200	125	90	60	40	30	10	5	2-3	1-2	3/4	1/2

**\*For Primer: Double the number of joints shown for cement.**

These figures are estimates based on laboratory tests. Due to the many variables in the field, these figures should be used as a general guide only.

## Flanging of CPVC pipe

Flanging can be used to provide temporary disassembly of a piping system or when it is not possible to make up solvent cemented joints at the assembly site.

Flanges are joined to the pipe by solvent cement or threaded joints. Refer to the sections on solvent cementing or threading of CPVC pipe for the proper techniques.

Flanged joints incorporate an elastomeric gasket between the mating faces to provide for a seal. The gasket selected must be full-faced and have a hardness of 55-80 durometer A. Typically, gaskets are 1/8" thick. The gasket material must be resistant to the chemical environment. Many manufacturers of gasketing materials supply this kind of information. If the piping system is for potable water service, the gasket must also be approved for potable water.

The flanges should be carefully aligned and the bolts inserted through matching holes. A flat washer should be used beneath each nut and bolt head. Each bolt should be partially tightened in the alternating sequence indicated in the patterns below. A torque wrench should be used for the final tightening of the bolts. The bolts should be tightened to the torque recommended in the table below in the same alternating sequence used previously.

Flange joints are typically rated to 150 psi at 73°F. For systems operating at higher temperatures, the flange pressure rating should be derated as below table.

Max. operating temperature (°F)	73-100	110	120	130	140	150	160	170	180	190	200	210
Max. operating pressure (psi)	150	140	130	120	110	100	90	80	70	60	50	NR

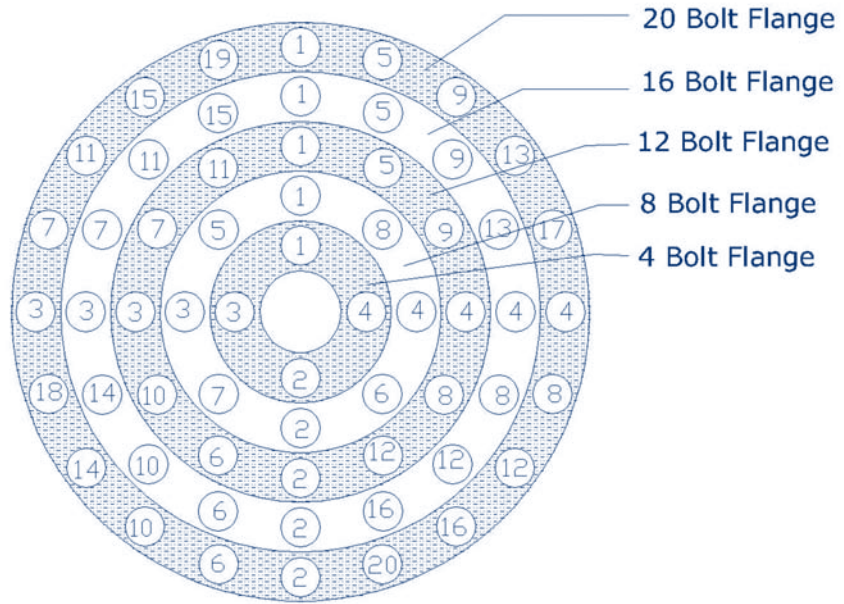
NR : Not recommended

### Recommended Bolt Torque

Normal pipe size	Number of bolt holes	Bolt diameter (in)	Recommended torque (ft-lbs)
1/2" – 1 1/2"	4	1/2	12
2" – 3"	4	5/8	25
4"	8	5/8	25
6" – 8"	8	3/4	40
10"	12	7/8	64
12"	12	1	95
14"	12	1	110
16"	16	1	110
18"	16	1 1/8	110
20"	20	1 1/8	110
24"	20	1 1/4	110



### Flange Bolt Tightening Patterns



## ***Back-Welding of Pipe Joints***

Back-welding may be used to repair minor leaks in solvent cemented or threaded joints. Back-welding is a hot-air welding technique which consists of forcing a welding rod to fuse in the joint fillet while both rod and fillet are softened with hot air.

Before hot-air welding begins, the section of piping where the repair will be made must be emptied. Joints should not be welded with fluid still in the pipe.

All dirt and moisture should be wiped away from the joint to be repaired. Excess dried solvent cement around the joint should be removed with an emery cloth. Residual solvent cement may tend to scorch and burn during welding. If the joint to be welded is a threaded joint, excess threads in the joint area should be removed with a file in order to provide a smooth surface for welding.

The welding temperature should be approximately 550-600°F. Only welding rod made of CPVC should be used for back welding CPVC joints.

The end of the welding rod should be inserted into the junction of the pipe and fitting, and the rod should be held at a 90° angle to the joint. The rod and base material should be preheated with the welding torch 1/4 to 3/4 inch away from both the rod and the base material and fanning back and forth in the immediate welding area. While preheating, the rod can be moved up and down until it is soft enough to stick to the base.

When the materials are softened enough to fuse, the rod should be advanced by the application of a slight pressure. The fanning motion of the torch should be continued throughout the welding process. When the weld is finished, another inch of rod material should be lapped over the bead.

When large diameter pipe is welded, three beads may be required to fill the joint adequately. The first bead should be laid directly into the joint fillet, and the subsequent beads on either side of the first bead.

# Underground Installation Guidelines

## References

These guidelines are based upon the following:

1. ASTM D2774: Standard Recommended Practice for Underground Installation of Thermoplastic Piping
2. Industry Experience

For additional information and data, consult ASTM standards D2774, D2321, or F645.

## Installation Procedures

This procedure will cover the typical steps encountered in underground installations: trench design, trench preparation, piping assembly, laying of pipe, and backfilling.

### Trench Design

- Width** The trench should be of adequate width to allow for convenient installation, but as narrow as possible depending on whether the piping will be assembled inside or outside of the trench.
- Depth** The trench depth should be sufficient to place the pipe deep enough to meet frost, above-ground load, and any trench bedding requirements.
- Frost** Piping at least 12 inches below the frost line.
- Loads** Piping should be deep enough to keep external stress levels below acceptable design stress. Design stress will be determined by pipe size and operating temperature and may be governed by various codes.
- Bedding** 4 to 6 inches underneath piping, if necessary.

### Trench Preparation

The trench bottom should be continuous, relatively smooth and free of rocks. If ledge rock, hardpan, boulders, or rocks that are impractical to remove are encountered, it will be necessary to pad the trench bottom to protect the piping from damage. 4 to 6 inches of tamped earth or sand bedding will be sufficient in such situations.

### Piping Assembly/Placement

Piping may be assembled using conventional solvent cementing techniques either inside or outside of the trench depending on the specific installation requirements. Solvent cement usually requires at least 12 to 24 hours for the cemented joint to cure properly. During this critical curing process, every effort should be made to minimize the stress on any joints. As a result, the piping should not be moved during the curing period, nor should the pipe be backfilled, or otherwise constrained during curing. See the recommendations on joint curing time to determine the exact curing requirements for a specific installation.

If the piping was assembled outside of the trench, the pipe may be placed into the trench after proper curing, but **MUST NOT** be rolled or dropped into place. Long lengths of joined piping should be properly supported as the piping is put into place to prevent excessive stress.

After proper curing and before backfilling, the piping should be brought to within 15°F of the expected operating temperature. Backfilling can proceed while the piping is maintained at this temperature in order to minimize stress.

on the system due to thermal expansion/contraction. If this step is impractical, then stress calculations must be done to determine the loads that will be created due to constrained thermal expansion/contraction.\* These loads must then be compared to the design stress of the particular piping system.

## Backfilling

Backfilling should only proceed after all solvent cement joints have been properly cured and the piping brought close to normal operating temperature, if operation will be more than 15°F different than the current ambient temperature. The piping should be uniformly supported over its entire length on firm, stable material.

Backfill material should be free of rocks and have a particle size no greater than 1/2." Piping should initially be surrounded with backfill to provide between 6" and 8" of cover. The backfill should be compacted using vibratory or water flooding methods. If water flooding is used, additional material should not be added until the water flooded backfill is firm enough to walk on. Backfill containing a significant amount of fine-grained material, such as silt or clay, should be hand or mechanically tamped.

The remainder of the backfill should be placed and spread in approximately uniform layers to completely fill the trench without voids. Particle size for this final fill should not exceed 3." Rolling equipment or heavy tampers should only be used to consolidate the final backfill.

# Product Dimension and Drawing

## SCH 80 and SCH 40 CPVC Pipe

### SCH 80 CPVC Pipe

Size	Standard			
	D	Tolerance	t(min)	Tolerance
1/2"	21.34	±0.10	3.73	+0.51
3/4"	26.67	±0.10	3.91	+0.51
1"	33.40	±0.13	4.55	+0.53
1-1/4"	42.16	±0.13	4.85	+0.58
1-1/2"	48.26	±0.15	5.08	+0.61
2"	60.32	±0.15	5.54	+0.66
2-1/2"	73.02	±0.18	7.01	+0.84
3"	88.90	±0.20	7.62	+0.91
4"	114.30	±0.23	8.56	+1.02
5"	141.30	±0.25	9.52	+1.14
6"	168.28	±0.28	10.97	+1.32
8"	219.08	±0.38	12.70	+1.52
10"	273.05	±0.38	15.06	+1.80
12"	323.85	±0.38	17.45	+2.08
14"	355.60	±0.38	19.05	+2.29
16"	406.40	±0.48	21.41	+2.57
18"	457.20	±0.48	23.80	+2.84
20"	508.00	±0.58	26.20	+3.15
24"	609.60	±0.79	30.94	+3.71

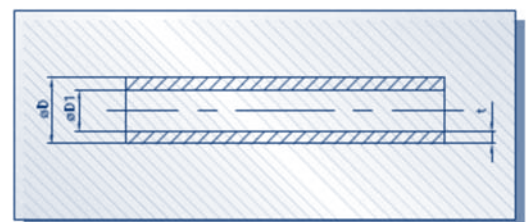
(unit :mm)



### SCH 40 CPVC Pipe

Size	Standard			
	D	Tolerance	t(min)	Tolerance
1/2"	21.34	±0.10	2.77	+0.51
3/4"	26.67	±0.10	2.87	+0.51
1"	33.40	±0.13	3.38	+0.51
1-1/4"	42.16	±0.13	3.56	+0.51
1-1/2"	48.26	±0.15	3.68	+0.51
2"	60.32	±0.15	3.91	+0.51
2-1/2"	73.02	±0.18	5.16	+0.61
3"	88.90	±0.20	5.49	+0.66
4"	114.30	±0.23	6.02	+0.71
5"	141.30	±0.25	6.55	+0.79
6"	168.28	±0.28	7.11	+0.86
8"	219.08	±0.38	8.18	+0.99
10"	273.05	±0.38	9.27	+1.12
12"	323.85	±0.38	10.31	+1.24
14"	355.60	±0.38	11.10	+1.35
16"	406.40	±0.48	12.70	+1.52
18"	457.20	±0.48	14.27	+1.70
20"	508.00	±0.58	15.06	+1.80
24"	609.60	±0.79	17.45	+2.08

(unit :mm)



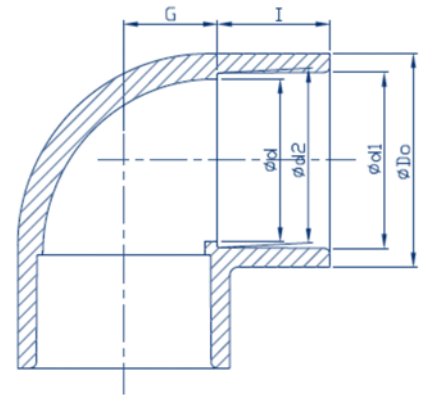
## SCH 80 CPVC Fittings

### SCH 80 CPVC 90° Elbow (Slip×Slip)

Size	Outside Dia	Socket Type			Structure Diameter	
	D0	d1	d2	l	d	G
1/2"	31.5	21.54	21.23	22.22	16.5	12.8
3/4"	37.3	26.87	26.57	25.4	22	15.3
1"	45.9	33.65	33.27	28.58	28	18
1-1/4"	55.2	42.42	42.04	31.75	35	23
1-1/2"	62.4	48.56	48.11	34.93	43	26
2"	74.9	60.63	60.17	38.1	54	32
2-1/2"	90	73.38	72.85	44.45	69	38
3"	107	89.31	88.70	47.63	84	48
4"	133	114.76	114.07	57.15	105	59
5"	163.5	141.81	141.05	66.68	136	80
6"	191	168.83	168.00	76.2	150	89
8"	246	219.84	218.69	101.6	200	115
10"	306.5	273.81	272.67	127.	265	150
12"	364	324.61	323.47	152.4	315	180
14"	396.5	356.49	355.22	*180	346	248

Note : Manufacturer's standard, if mark with \*.

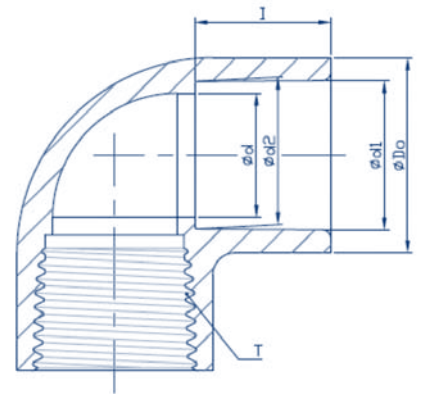
(unit : mm)



### SCH 80 CPVC 90° Elbow (Slip×NPT)

Size	Outside Dia	Socket Type			Structure Diameter	
	D0	d1	d2	l	d	NPT(thd./in)
1/2"	30.5	21.54	21.23	22.22	16	14
3/4"	38	26.87	26.57	25.4	22	14
1"	46	33.65	33.27	28.58	28	11.5
1-1/4"	55	42.42	42.04	31.75	35	11.5
1-1/2"	60	48.56	48.11	34.93	43	11.5
2"	75	60.63	60.17	38.1	54	11.5

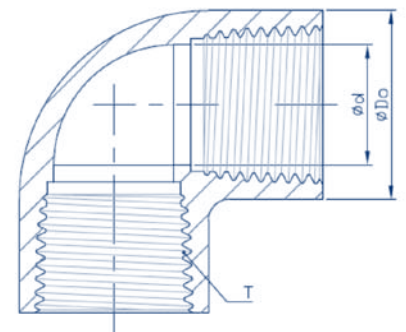
(unit : mm)



### SCH 80 CPVC 90° Elbow (NPT×NPT)

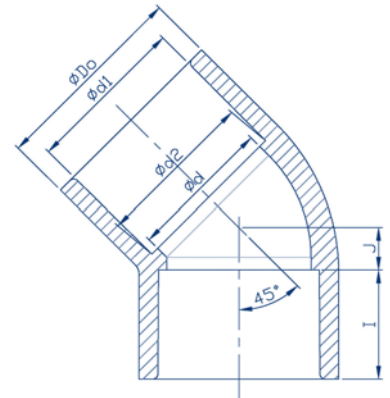
Size	Outside Dia	Structure Diameter	
	D0	d	NPT(thd./in)
1/2"	30.5	16	14
3/4"	38	22	14
1"	46	28	11.5
1-1/4"	55	35	11.5
1-1/2"	60	43	11.5
2"	75	54	11.5

(unit : mm)



### SCH 80 CPVC 45° Elbow (Slip×Slip)

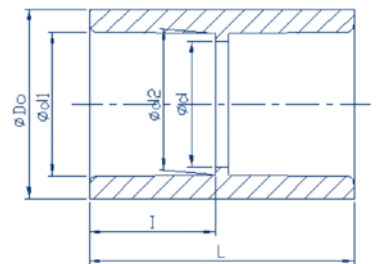
Size	Outside Dia	Socket Type			Structure Diameter	
	D0	d1	d2	l	d	L
1/2"	30.8	21.54	21.23	22.22	16.5	6.5
3/4"	39.1	26.87	26.57	25.4	22	8
1"	45.8	33.65	33.27	28.58	28	8
1-1/4"	55.8	42.42	42.04	31.75	35	10
1-1/2"	62.3	48.56	48.11	34.93	43	12
2"	75.5	60.63	60.17	38.1	54	16
2-1/2"	90	73.38	72.85	44.45	69	18
3"	107	89.31	88.70	47.63	84	20
4"	133	114.76	114.07	57.15	108	26
5"	163.5	141.81	141.05	66.68	136	38.5
6"	191	168.83	168.00	76.2	150	45
8"	246	219.84	218.69	101.6	200	51
10"	307	273.81	272.67	127	265	60
12"	364	324.61	323.47	152.4	315	73
14"	396.5	356.49	355.22	*180	350	90



Note : Manufacturer's standards, if mark with \*. (unit : mm)

### SCH 80 CPVC Coupling (Slip×Slip)

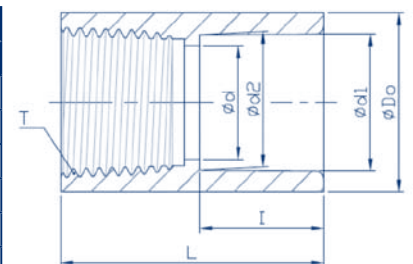
Size	Outside Dia	Socket Type			Structure Diameter	
	D0	d1	d2	l	d	L
1/2"	30.5	21.54	21.23	22.22	16.5	49.3
3/4"	37.6	26.87	26.57	25.4	22	62.7
1"	46.2	33.65	33.27	28.58	28	69.2
1-1/4"	55.2	42.42	42.04	31.75	35	75.3
1-1/2"	60.9	48.56	48.11	34.93	42.5	76.7
2"	73.4	60.63	60.17	38.1	54	84.1
2-1/2"	89	73.38	72.85	44.45	65	100
3"	106	89.31	88.70	47.63	80	108
4"	133	114.76	114.07	57.15	100	126
5"	163	141.81	141.05	66.68	134.5	160
6"	191	168.83	168.00	76.2	158	169
8"	246	219.84	218.69	101.6	200	220
10"	307	273.81	272.67	127	259	283
12"	364	324.61	323.47	152.4	308	336.5
14"	396.5	356.49	355.22	205	346	436.5
16"	454	407.54	405.89	230	396	486.5



Note : Manufacturer's standards, if mark with \*. (unit : mm)

### SCH 80 CPVC Female Adapter (Slip×NPT)

Size	Outside Dia	Socket Type			Structure Diameter		
	D0	d1	d2	l	d	L	NPT(thd./in)
1/2"	30.5	21.54	21.23	22.22	16.5	52	14
3/4"	37	26.87	26.57	25.4	24.22	60	14
1"	47	33.65	33.27	28.58	28	65	11.5
1-1/4"	55.5	42.42	42.04	31.75	35	75	11.5
1-1/2"	63	48.56	48.11	34.93	42.5	79.5	11.5
2"	75	60.63	60.17	38.1	54	88	11.5

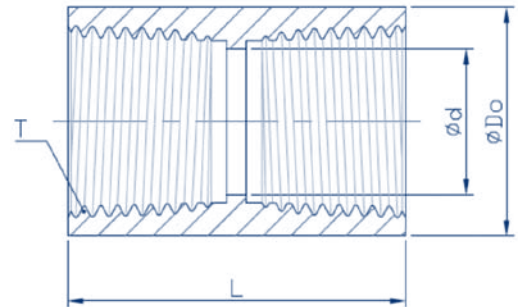


(unit : mm)

### SCH 80 CPVC Coupling (NPT×NPT)

Size	Outside Dia	Structure Diameter		
	D0	d	L	NPT(thd./in)
1/2"	30.5	16.5	52	14
3/4"	37	22	60	14
1"	47	28	65	11.5
1-1/4"	55.5	35	75	11.5
1-1/2"	63	42.5	79.5	11.5
2"	75	54	88	11.5

(unit : mm)

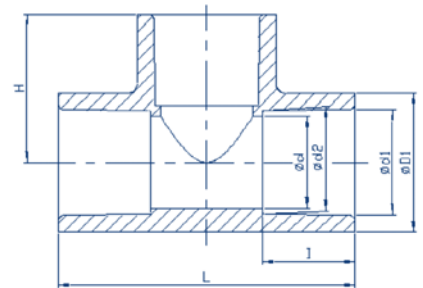


### SCH 80 CPVC Tee (Slip×Slip×Slip)

Size	Outside Dia	Socket Type			Structure Diameter		
	D0	d1	d2	1	d	L	H
1/2"	30.2	21.54	21.23	22.22	16.5	72.3	37.25
3/4"	37.4	26.87	26.57	25.4	24	89.1	42.5
1"	45.7	33.65	33.27	28.58	28	102.6	51.5
1-1/4"	55.8	42.42	42.04	31.75	35	119	57.75
1-1/2"	62.3	48.56	48.11	34.93	41	132	64
2"	75.2	60.63	60.17	38.1	52	151.9	73
2-1/2"	92	73.38	72.85	44.45	69	173	86.5
3"	109	89.31	88.70	47.63	84	197	98.5
4"	135	114.76	114.07	57.15	109	239	119.5
5"	163.5	141.81	141.05	66.68	136	298	149
6"	191	168.83	168.00	76.2	150	336.5	168.25
8"	246	219.84	218.69	101.6	200	439	219.5
10"	317	273.81	272.67	127	265	560	280
12"	364	324.61	323.47	152.4	315	660	330
14"	396.5	356.49	355.22	*180	346	856.5	428.25

Note : Manufacturer's standard, if mark with \*.

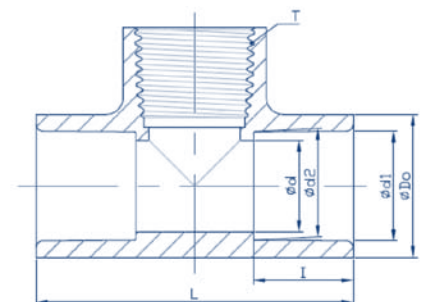
(unit : mm)



### SCH 80 CPVC Tee (Slip×Slip×NPT)

Size	Outside Dia	Socket Type			Structure Diameter		
	D0	d1	d2	l	d	L	NPT(thd./in)
1/2"	32	21.54	21.23	22.22	16.5	74.5	14
3/4"	37	26.87	26.57	25.4	24	85	14
1"	48.5	33.65	33.27	28.58	28	97	11.5
1-1/4"	55.5	42.42	42.04	31.75	35	115.5	11.5
1-1/2"	63.5	48.56	48.11	34.93	41	128	11.5
2"	75	60.63	60.17	38.1	52	146	11.5

(unit : mm)

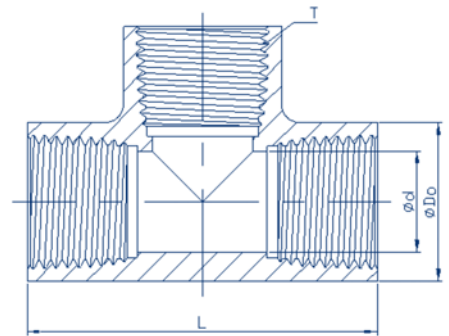




## SCH 80 CPVC Tee (NPT×NPT×NPT)

Size	Outside Dia	Structure Diameter		
	D0	d	L	NPT(thd./in)
1/2"	32	16.5	74.5	14
3/4"	37	24	85	14
1"	48.5	28	97	11.5
1-1/4"	55.5	35	115.5	11.5
1-1/2"	63.5	41	128	11.5
2"	75	52	146	11.5

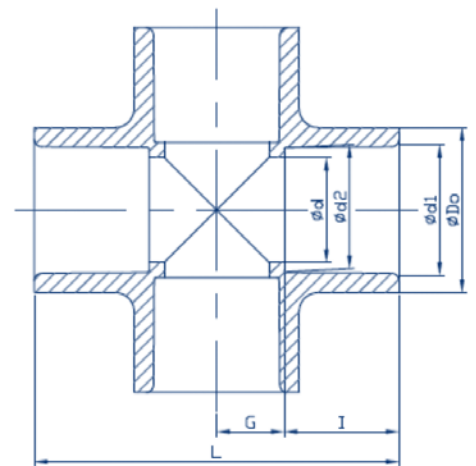
(unit : mm)



## SCH 80 CPVC Cross (Slip×Slip×Slip×Slip)

Size	Outside Dia	Socket Type			Structure Diameter		
	D0	d1	d2	l	d	G	L
1/2"	32	21.54	21.23	22.22	16.5	13	74.5
3/4"	44	26.87	26.57	25.4	22	15.4	86
1"	47	33.65	33.27	28.58	28	17.8	97
1-1/4"	56	42.42	42.04	31.75	35	23	116
1-1/2"	65	48.56	48.11	34.93	43	26.1	128.5
2"	78	60.63	60.17	38.1	54	31.8	146
2-1/2"	89	73.38	72.85	44.45	65	37.8	171
3"	105	89.31	88.70	47.63	80	47.6	196
4"	132	114.76	114.07	57.15	100	58	236.5

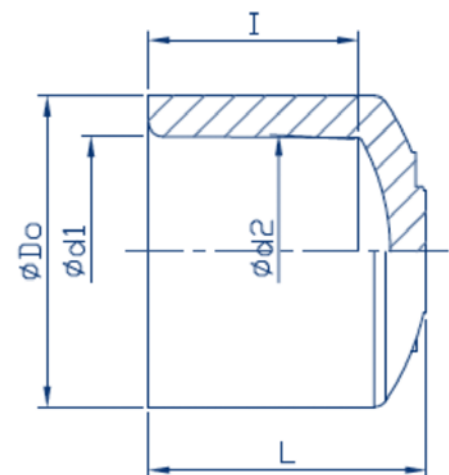
(unit : mm)



## SCH 80 CPVC Cap (Slip)

Size	Outside Dia	Socket Type			Structure Diameter
	D0	d1	d2	l	L
1/2"	30.5	21.54	21.23	22.22	31
3/4"	37	26.87	26.57	25.4	36
1"	45.5	33.65	33.27	28.58	41
1-1/4"	55	42.42	42.04	31.75	46
1-1/2"	61.5	48.56	48.11	34.93	50
2"	75	60.63	60.17	38.1	55.5
2-1/2"	91	73.38	72.85	44.45	65.5
3"	106	89.31	88.70	47.63	69.5
4"	134	114.76	114.07	57.15	78
5"	163.5	141.81	141.05	66.68	108
6"	192	168.83	168.00	76.2	118.5
8"	246	219.84	218.69	101.6	143
10"	307	273.81	272.67	127	194
12"	366	324.61	323.47	152.4	235.5
14"	395	356.49	355.22	180	226
16"	452	407.54	405.89	205	258.5

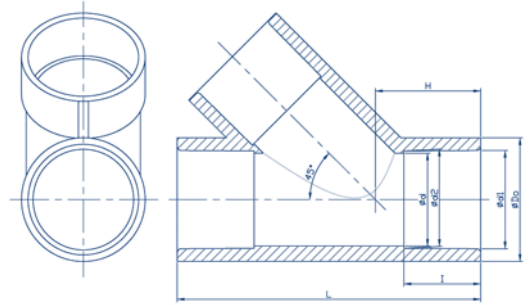
(unit : mm)



### SCH 80 CPVC Y-Tee (45°, Slip×Slip×Slip)

Size	Outside Dia	Socket Type			Structure Diameter		
	D0	d1	d2	l	d	L	H
1/2"	30.5	21.54	21.23	22.22	19	90	34
3/4"	36	26.87	26.57	25.4	24.5	105	40
1"	44	33.65	33.27	28.58	31	117	42
1-1/4"	61	42.42	42.04	31.75	40	150	52
1-1/2"	61	48.56	48.11	34.93	46	150	52
2"	76.5	60.63	60.17	38.1	58.5	181	60
3"	106	89.31	88.70	47.63	74	222	68
4"	132	114.76	114.07	57.15	100	277	83
6"	191	168.83	168	76.2	150	393	114
8"	246	219.84	218.69	101.6	200	570	177

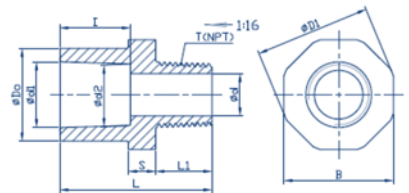
(unit : mm)



### SCH 80 CPVC Male Adapter (Slip×NPT)

Size	Outside Dia	Socket Type			Structure Diameter					
	D0	d1	d2	l	d	L	L1	B	D1	NPT
1/2"	30.5	21.54	21.23	22.22	13	50	19	36	38	14
3/4"	35	26.87	26.57	25.4	17	50	15	41	43	14
1"	44	33.65	33.27	28.58	23	59	21	50	53	11.5
1-1/4"	54	42.42	42.04	31.75	29	61	19	60	63	11.5
1-1/2"	60	48.56	48.11	34.93	37	72	27	65	68	11.5
2"	73	60.63	60.17	38.1	48	77	27	80	83	8
2-1/2"	88	73.38	72.85	44.45	57	97	40	95	100	8
3"	105	89.31	88.70	47.63	72	103	42	115	122	8
4"	132	114.76	114.07	57.15	96	116	45	145	154	8

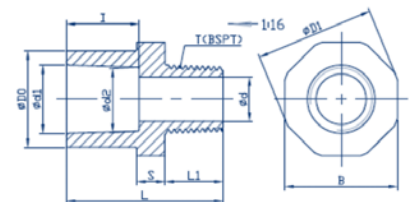
(unit : mm)



### SCH 80 CPVC Male Adapter (Slip×BSPT)

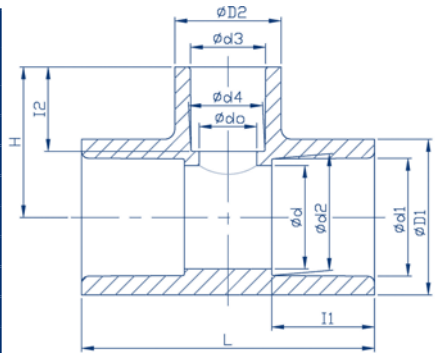
Size	Outside Dia	Socket Type			Structure Diameter					
	D0	d1	d2	l	d	L	L1	B	D1	BSPT
1/2"	30.5	21.54	21.23	22.22	13	50	19	36	38	14
3/4"	35	26.87	26.57	25.4	17	50	15	41	43	14
1"	44	33.65	33.27	28.58	23	55	16.5	50	53	11
1-1/4"	54	42.42	42.04	31.75	29.5	61	19	60	63	11
1-1/2"	60	48.56	48.11	34.93	37	64	19	65	68	11
2"	73	60.63	60.17	38.1	48	70.5	20.5	80	83	11
2-1/2"	88	73.38	72.85	44.45	57	90	32	95	100	11
3"	105	89.31	88.70	47.63	72	94.5	32	115	122	11
4"	132	114.76	114.07	57.15	96	109.5	38	145	154	11

(unit : mm)



## SCH 80 CPVC Reducer Tee (SlipxSlipxSlip)

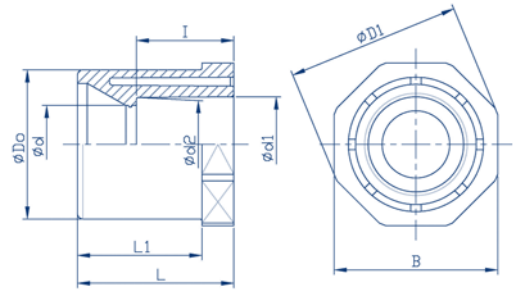
Size	Outside Dia		Socket Type						Structure Diameter			
	D1	D2	d1	d2	I1	d3	d4	I2	L	H	d	d0
3/4"X3/4"X1/2"	37	32	26.87	26.57	25.4	21.54	21.23	22.22	88	38.5	22	16.5
1"X1"X1/2"	44	30	33.65	33.27	28.58	21.54	21.23	22.22	97	41	28	16.5
1"X1"X3/4"	46	32	33.65	33.27	28.58	26.87	26.57	25.4	97	44	28	22
1"X1"X2"	44	73	33.65	33.27	28.58	60.63	60.17	38.1	97	65	28	28
1-1/4"X1-1/4"X1/2"	57	32	42.42	42.04	31.75	21.54	21.23	22.2	116	44.5	35	16.5
1-1/4"X1-1/4"X3/4"	57	37	42.42	42.04	31.75	26.87	26.57	25.4	116	48	35	22
1-1/4"X1-1/4"X1"	57	46	42.42	42.04	31.75	33.65	33.27	28.58	116	52	35	28
1-1/2"X1-1/2"X1/2"	62	32	48.56	48.11	34.93	21.54	21.23	22.22	128.5	48.5	43	16.5
1-1/2"X1-1/2"X3/4"	62	37	48.56	48.11	34.93	26.87	26.57	25.4	128.5	52	43	22
1-1/2"X1-1/2"X1"	62	48	48.56	48.11	34.93	33.65	33.27	28.58	128.5	55.5	43	28
1-1/2"X1-1/2"X1-1/4"	62	56	48.56	48.11	34.93	42.42	42.04	31.75	128.5	60	43	35
2"X2"X1/2"	76	32.5	60.63	60.17	38.1	21.54	21.23	22.22	146	54	54	16.5
2"X2"X3/4"	76	37	60.63	60.17	38.1	26.87	26.57	25.4	146	57.5	54	22
2"X2"X1"	76	46	60.63	60.17	38.1	33.65	33.27	28.58	146	60.5	54	28
2"X2"X1-1/4"	76	56	60.63	60.17	38.1	42.42	42.04	31.75	146	65	54	35
2"X2"X1-1/2"	76	62	60.63	60.17	38.1	48.56	48.11	34.93	146	69	54	43
2-1/2"X2-1/2"X1"	91	46	73.38	72.85	44.45	33.65	33.27	28.58	171	67.5	65	28
2-1/2"X2-1/2"X1-1/4"	91	54	73.38	72.85	44.45	42.42	42.04	31.75	171	72	65	35
2-1/2"X2-1/2"X1-1/2"	91	62	73.38	72.85	44.45	48.56	48.11	34.93	171	75.5	65	43
2-1/2"X2-1/2"X2"	91	75	73.38	72.85	44.45	60.63	60.17	38.1	171	79	65	54
3"X3"X1"	107	46	89.31	88.7	47.63	33.65	33.27	28.58	196	77.5	80	28
3"X3"X1-1/4"	107	56	89.31	88.7	47.63	42.42	42.04	31.75	196	77.5	80	35
3"X3"X1-1/2"	107	62	89.31	88.7	47.63	48.56	48.11	34.93	196	82	80	43
3"X3"X2"	107	75	89.31	88.7	47.63	60.63	60.17	38.1	196	86.5	80	54
3"X3"X2-1/2"	107	91	89.31	88.7	47.63	73.38	72.85	44.45	196	95	80	65
4"X4"X1"	133	46	114.76	114.07	57.15	33.65	33.27	28.58	237.5	89.5	100	28
4"X4"X1-1/4"	133	57	114.76	114.07	57.15	42.42	42.04	31.75	237.5	90.5	100	38
4"X4"X1-1/2"	133	64	114.76	114.07	57.15	48.56	48.11	34.93	237.5	97	100	43
4"X4"X2"	133	75	114.76	114.07	57.15	60.63	60.17	38.1	237.5	96	100	54
4"X4"X2-1/2"	133	91	114.76	114.07	57.15	73.38	72.85	44.45	237.5	104	100	65
4"X4"X3"	133	107	114.76	114.07	57.15	89.31	88.7	46.63	237.5	110	100	80
5"X5"X2"	163	75	141.81	141.04	66.68	60.63	60.17	38.1	237.5	114.5	132	54
6"X6"X1"	191	45	168.83	168	76.2	33.65	33.27	28.58	298	115	150	29
6"X6"X1-1/4"	191	54	168.83	168	76.2	42.42	42.04	31.75	336.5	120	150	38
6"X6"X1-1/2"	191	60.5	168.83	168	76.2	48.56	48.11	34.93	336.5	123	150	44
6"X6"X2"	191	73	168.83	168	76.2	60.63	60.17	38.1	336.5	125	150	54
6"X6"X2-1/2"	191	89	168.83	168	76.2	73.88	72.85	44.45	336.5	130	150	65
6"X6"X3"	191	105	168.83	168	76.2	89.31	88.7	47.63	336.5	135	150	80
6"X6"X4"	191	132	168.83	168	76.2	114.76	114.07	57.15	336.5	145	150	100
8"X8"X2"	246	75	219.84	218.69	101.6	60.63	60.17	38.1	439	151	200	54
8"X8"X3"	246	105	219.84	218.69	101.6	89.31	88.7	47.63	439	160	200	80
8"X8"X4"	246	132	219.84	218.69	101.6	114.76	114.07	57.15	439	170	200	100
8"X8"X6"	246	191	219.84	218.69	101.6	168.83	168	76.2	439	194	200	150
10"X10"X2"	307	74	273.81	272.67	127	60.63	60.17	38.1	560	185	265	54
10"X10"X3"	307	107	273.81	272.67	127	89.31	88.7	47.63	560	194	265	80
10"X10"X4"	307	134	273.81	272.67	127	114.76	114.07	57.15	560	205	265	100
10"X10"X6"	307	193	273.81	272.67	127	168.83	168	76.2	560	225	265	160
10"X10"X8"	307	248	273.81	272.67	127	219.84	218.69	101.6	560	250	265	210
12"X12"X2"	364	74	324.61	323.47	152.4	60.63	60.17	38.1	660	215	315	54
12"X12"X3"	364	108	324.61	323.47	152.4	89.31	88.7	47.63	660	225	315	80
12"X12"X4"	364	136	324.61	323.47	152.4	114.76	114.07	57.15	660	235	315	100
12"X12"X6"	364	195	324.61	323.47	152.4	168.83	168	76.2	660	255	315	160
12"X12"X8"	364	248	324.61	323.47	152.4	219.84	218.69	101.6	660	280	315	210
12"X12"X10"	364	308	324.61	323.47	152.4	273.81	272.67	127	660	298	315	265
14"X14"X4"	396.5	133	356.49	355.22	*205	114.76	114.07	57.15	856.5	290	346	100
14"X14"X6"	396.5	192	356.49	355.22	*205	168.83	168	76.2	856.5	310	346	144
14"X14"X8"	396.5	246	356.49	355.22	*205	219.84	218.69	101.6	856.5	339	346	200
14"X14"X10"	396.5	307	356.49	355.22	*205	273.81	272.67	127	856.5	365	346	259
14"X14"X12"	396.5	364	356.49	355.22	*205	324.61	323.47	152.4	856.5	390	346	308



## SCH 80 CPVC Reducer Bushing (Spig×Slip)

Size	Outside Dia		Socket Type			Structure Diameter				
	D0	d1	d2	l	d	L	L1	D1	B	
1/2"X1/4"	21.34	14.02	13.61	19	11	29	23	31	30	
1/2"X3/8"	21.34	17.45	17.04	22	12	29	23	31	30	
3/4"X1/2"	26.67	21.54	21.23	24	13	33	27	31	30	
1"X3/8"	33.4	17.45	17.04	24	12	38	30	39.5	38	
1"X1/2"	33.4	21.54	21.23	24	12	38	30	39.5	38	
1"X3/4"	33.4	26.87	26.57	26	18	38	30	39.5	38	
1-1/4"X1/2"	42.16	21.54	21.23	24.2	16.5	44	35	52	50	
1-1/4"X3/4"	42.16	26.87	26.57	26	21	44	35	52	50	
1-1/4"X1"	42.16	33.65	33.27	29.5	28	44	35	52	50	
1-1/2"X1/2"	48.26	21.54	21.23	24.2	16.5	47	38	58	55	
1-1/2"X3/4"	48.26	26.87	26.57	26	21	47	38	58	55	
1-1/2"X1"	48.26	33.65	33.27	29.5	28	47	38	58	55	
1-1/2"X1-1/4"	48.26	42.42	42.04	32.5	35	47	38	58	55	
2"X1/2"	60.33	21.54	21.23	24.2	16.5	52	42	68	65	
2"X3/4"	60.33	26.87	26.57	26	21	52	42	68	65	
2"X1"	60.33	33.65	33.27	29.5	28	52	42	68	65	
2"X1-1/4"	60.33	42.42	42.04	32.5	35	52	42	68	65	
2"X1-1/2"	60.33	48.56	48.11	35.5	43	52	42	68	65	
2-1/2"X1-1/4"	73.03	42.42	42.04	32.5	36	60	48.5	85	80	
2-1/2"X1-1/2"	73.03	48.56	48.11	35.5	43	60	48.5	85	80	
2-1/2"X2"	73.03	60.63	60.17	39.1	52	60	48.5	85	80	
3"X1-1/2"	88.9	48.56	48.11	35.5	43	65	51	105	99	
3"X2"	88.9	60.63	60.17	39.1	54	65	51	105	99	
3"X2-1/2"	88.9	73.38	72.85	47.5	65	65	51	105	99	
4"X2"	114.3	60.63	60.17	41.1	54	75	60.5	132	125	
4"X2-1/2"	114.3	73.38	72.85	47.5	65	75	60.5	132	125	
4"X3"	114.3	89.31	88.7	50.6	80	75	60.5	132	125	
5"X4"	141.3	114.76	114.1	60.2	100	82	69.6	150	145	
6"X2"	168.28	60.63	60.17	41.1	51	89	76.5	191	180	
6"X3"	168.28	89.31	88.7	50.6	80	89	76.5	191	180	
6"X4"	168.28	114.76	114.1	60.2	105	89	76.5	191	180	
6"X5"	168.28	141.81	114.1	69.5	125	89	76.5	191	180	
8"X4"	219.1	114.76	114.1	60.5	100	120	104.6	246	235	
8"X6"	219.1	168.83	168	79	150	120	104.6	246	235	
10"X3"	273.05	89.31	88.7	50.6	80	148	130	290	280	
10"X4"	273.05	114.76	114.1	60.2	105	148	130	290	280	
10"X6"	273.05	168.83	168	79.2	150	148	130	290	280	
10"X8"	273.05	219.84	218.69	105	200	148	130	290	280	
12"X4"	323.85	114.76	114.1	60.2	100	175	155	345	330	
12"X6"	323.85	168.83	168	79.2	150	175	155	345	330	
12"X8"	323.85	219.84	218.69	105	200	175	155	345	330	
12"X10"	323.85	273.81	272.67	130	245	175	155	345	330	
14"X10"	355.6	273.81	272.67	130	245	200	180	380	360	
14"X12"	355.6	324.61	323.47	155	300	200	180	380	360	

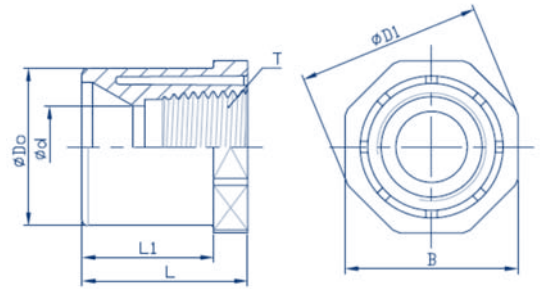
(Unit : mm)



## SCH 80 CPVC Reducer Bushing (Spig×NPT)

Size	Outside Dia		Structure Diameter					NPT(thd./in)
	D0	d	L	L1	D1	B		
1/2"X1/4"	21.34	11	29	23	30	31	18	
1/2"X3/8"	21.34	12	29	23	30	31	18	
3/4"X1/2"	26.67	13	33	27	30	31	14	
1"X3/8"	33.4	12	38	30	38	39.5	18	
1"X1/2"	33.4	12	38	30	38	39.5	14	
1"X3/4"	33.4	18	38	30	38	39.5	14	

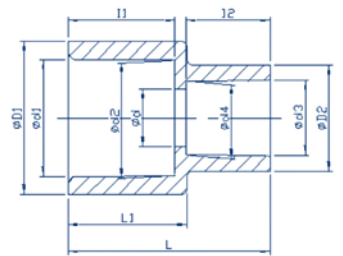
(unit : mm)



## SCH 80 CPVC Reducer Coupling (Slip×Slip)

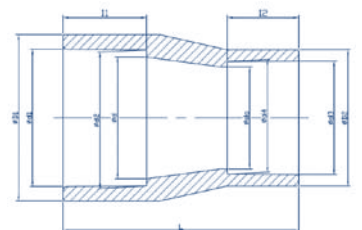
Size	Outside Dia		Socket Type						Structure Diameter		
	D1	D2	d1	d2	l1	d3	d4	l2	d	L	L1
3/4" X 1/2"	37	30.5	26.87	26.57	25.4	21.54	21.23	22.22	16.5	57.5	30
1" X 1/2"	47	30.5	33.65	33.27	28.58	21.54	21.23	22.22	16.5	58	36
1" X 3/4"	47	35	33.65	33.27	28.58	26.87	26.57	25.4	21	61	36
1-1/4" X 1/2"	55.5	30.5	42.42	42.04	31.75	21.54	21.23	22.22	16.5	62.5	42
1-1/4" X 3/4"	55.5	35	42.42	42.04	31.75	26.87	26.57	25.4	21	65	42
1-1/4" X 1"	55.5	44	42.42	42.04	31.75	33.65	33.27	28.58	28	68.5	42
1-1/2" X 1/2"	63	30.5	48.56	48.11	34.93	21.54	21.23	22.22	16.5	65	44
1-1/2" X 3/4"	63	35	48.56	48.11	34.93	26.87	26.57	25.4	21	68	44
1-1/2" X 1"	63	44	48.56	48.11	34.93	33.65	33.27	28.58	28	71	44
1-1/2" X 1-1/4"	63	54	48.56	48.11	34.93	42.42	42.04	31.75	35	75	44
2" X 1/2"	75	30.5	60.63	60.17	38.1	21.54	21.23	22.22	16.5	68	49.5
2" X 3/4"	75	35	60.63	60.17	38.1	26.87	26.57	25.4	21	71	49.5
2" X 1"	75	44	60.63	60.17	38.1	33.65	33.27	28.58	28	74.5	49.5
2" X 1-1/4"	75	54	60.63	60.17	38.1	42.42	42.04	31.75	35	78.5	49.5
2" X 1-1/2"	75	60	60.63	60.17	38.1	48.56	48.11	34.93	42.5	82.5	49.5

(unit : mm)



Size	Outside Dia		Socket Type						Structure Diameter		
	D1	D2	d1	d2	l1	d3	d4	l2	d	d0	L
2-1/2" X 1"	89	44	73.38	72.85	44.45	33.65	33.27	28.58	65	27.5	117.5
2-1/2" X 1-1/2"	89	61	73.38	72.85	44.45	48.56	48.11	34.93	65	42.5	124
2-1/2" X 2"	89	73	73.38	72.85	44.45	60.63	60.17	38.10	65	54.5	127
3" X 1-1/2"	106	61	89.31	88.70	47.63	48.56	48.11	34.93	81	42.5	136
3" X 2"	106	73	89.31	88.70	47.63	60.63	60.17	38.10	81	54.5	140
3" X 2-1/2"	106	89	89.31	88.70	47.63	73.38	72.85	44.45	81	65	147
4" X 2"	133.5	73	114.76	114.10	57.15	60.63	60.17	38.10	-	54.5	158.5
4" X 2-1/2"	133.5	89	114.76	114.10	57.15	73.38	72.85	44.45	-	65	158.5
4" X 3"	133.5	106	114.76	114.10	57.15	89.31	88.70	47.63	-	81	158.5

(unit : mm)



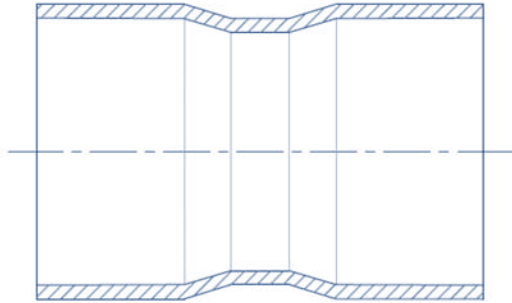


Note :

1. All of Hershey Valve's molded fittings meet ASTM standards in dimension and performance. While their dimensions complying with ASTM standards, Hershey Valve reserves the right to change or modify designs without further notice.
2. Data shown in the tables are typical values which meet ASTM standards. For detail information of ASTM values, please see ASTM F437 (CPVC threaded fittings), ASTM F438 (CPVC sch40 fittings) and ASTM F439 (CPVC sch80 fittings).

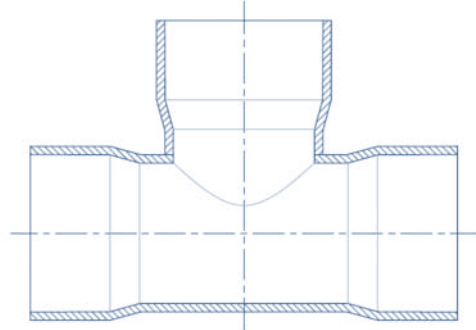
### Fabricated CPVC Fittings

Coupling



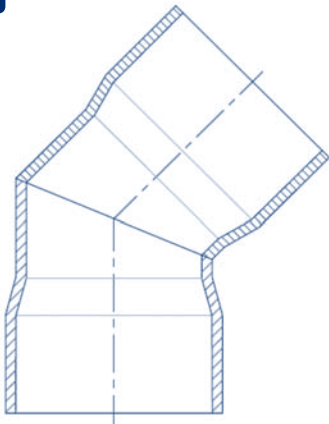
Size : 14"~24"

Tee



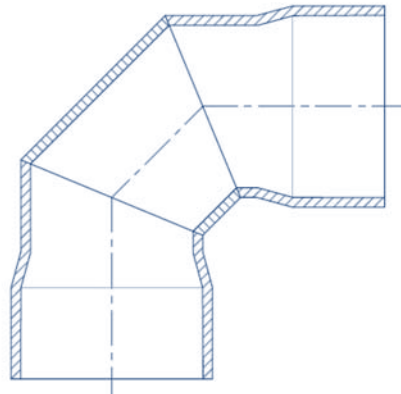
Size : 14"~24"

45°Elbow



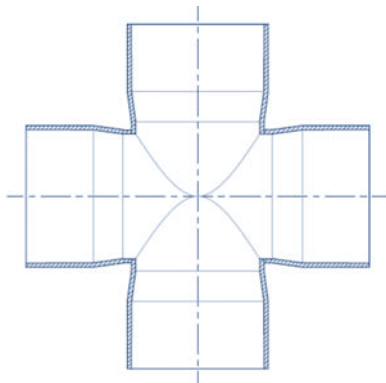
Size : 14"~24"

90°Elbow



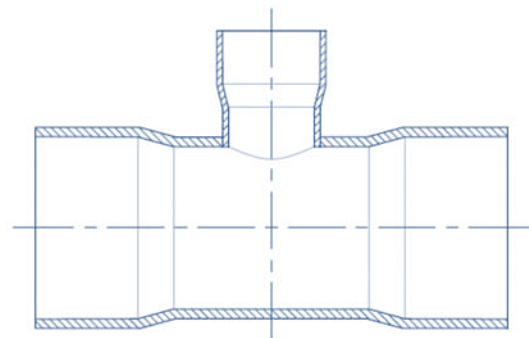
Size : 14"~24"

Cross



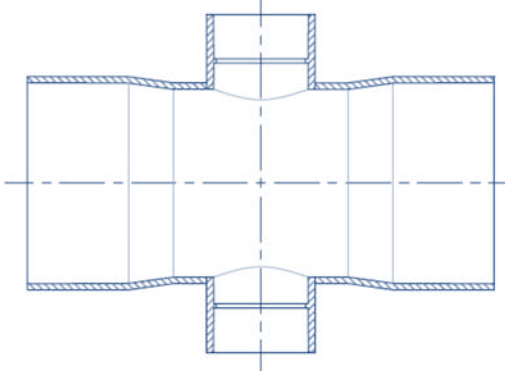
Size : 8"~24"

Reducer Tee



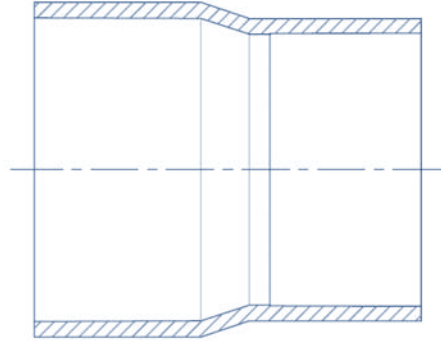
Size : 12" ~ 24"

**Reducer Cross**



Size : 8"~24"

**Reducer Coupling**



Size : 6"~24"

Note : Fabricated fittings are customer made items and they are available upon request.

For further details, please contact our sale rep.





CPVC Advanced  
Industrial Piping System  
CPVC工業管路系統



Thermoplastic Valves  
塑膠閥門(凡而)



UPVC Industrial Piping System  
UPVC工業管路系統



CPVC High Performance  
Fire Sprinkler System  
CPVC高效能消防管路系統



PVC-M1 Cable Tray  
防火耐燃電纜線槽



Clear PVC Piping System  
PVC透明管路系統



CPVC/HT-PVC Sheet  
CPVC / HT-PVC板材



CPVC Hot & Cold water Distribution System  
CPVC 熱水管道系統



**鑾琪塑膠股份有限公司**  
Hershey Valve Co., Ltd.

43541 台中市梧棲區中港加工出口區經二路16號  
No.16, Jing 2nd Rd., Wuchi, Taichung,  
ChungKang Export Processing Zone, 43541 Taiwan, R.O.C.  
Tel : +886-4-2659 5377 Fax : +886-4-2659 5288  
Http : //www.hershey.com.tw  
E-mail : info@hershey.com.tw

