

Plastic Pressure Pipe Materials in US/Canada

Presentation to ICC 815 Committee

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Plastic Pressure Pipe Materials in US/Canada

Outline

1. Recap of the usage of PB in US/Canada
2. Introduction to plastic pressure pipes (codes, tubing vs. pipe, wall types)
3. Pipe and tubing materials: CPVC, PEX, PE-RT, PP-R & PP-RCT

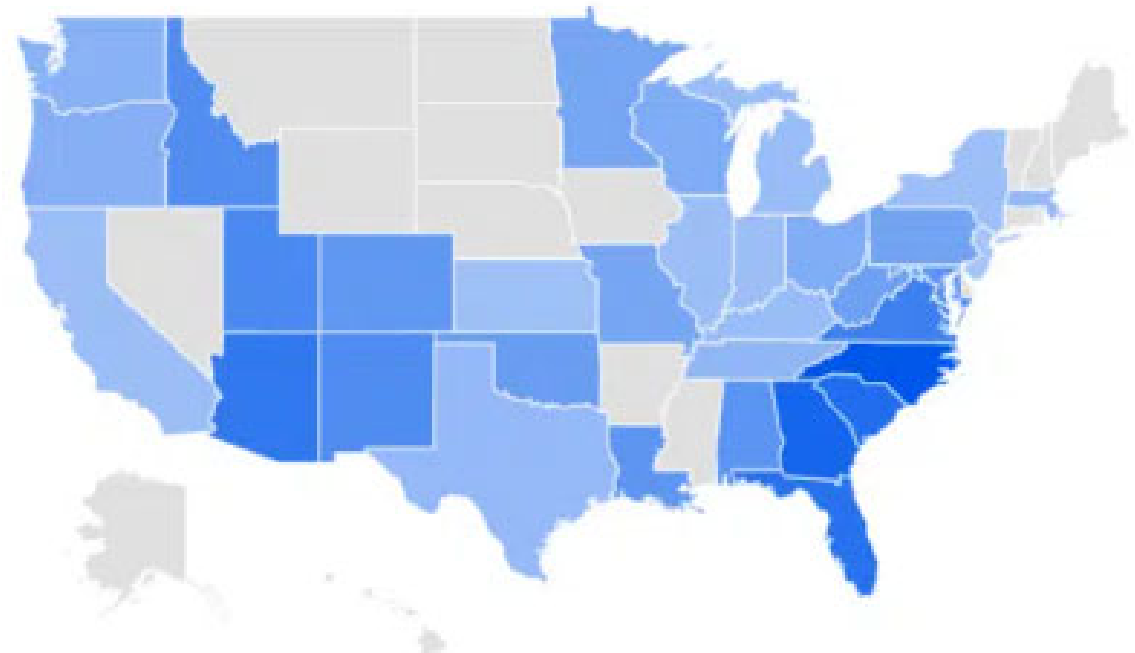
Note: Other plastic pressure pipe materials (e.g., PEX-AL-PEX) are less commonly used in NA for hot- and cold-water distribution systems



1. Polybutylene (PB) Piping Systems

Introduction

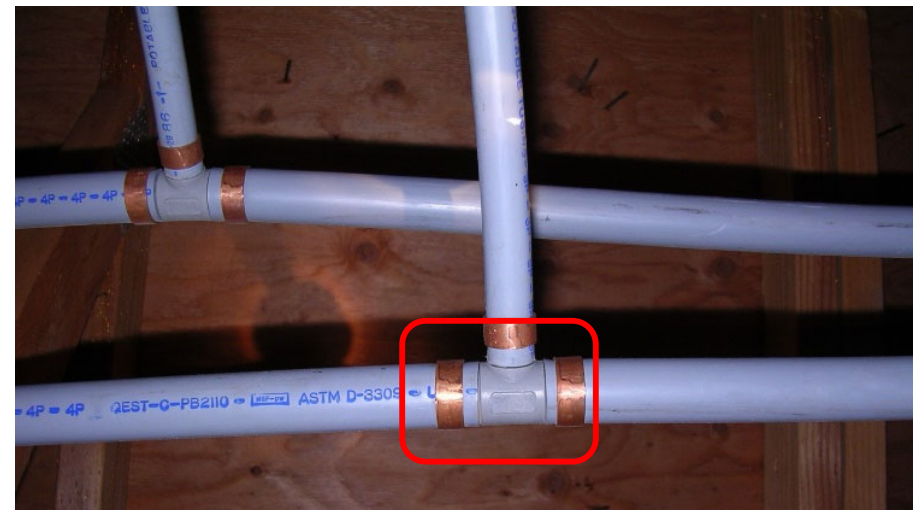
- Polybutylene (PB) piping systems were introduced for hot- and cold-water plumbing into North America in the 1970s as an alternative to copper
- **Darker blue** = states of greater usage



Polybutylene (PB) Piping Systems

Introduction

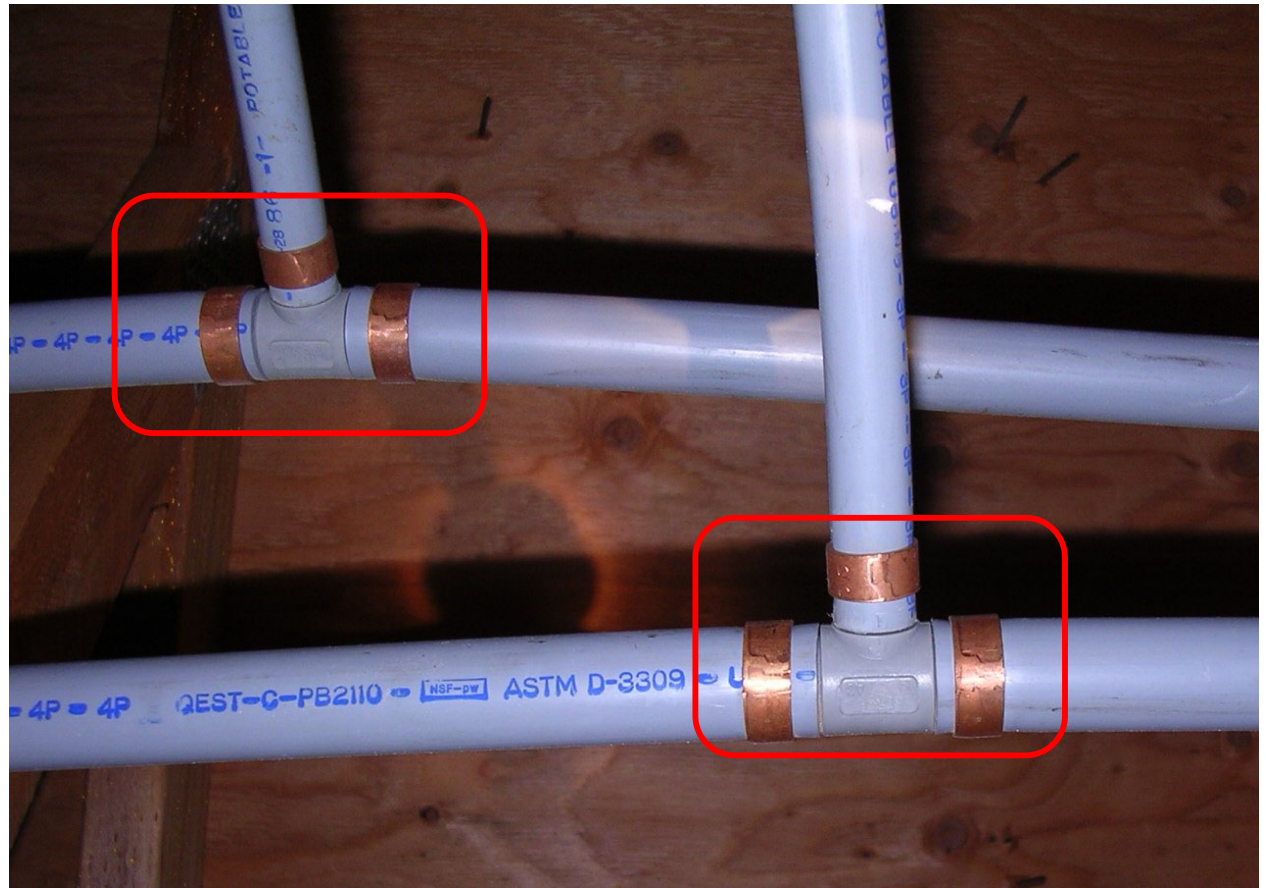
- By the 1980s, some PB piping systems experienced premature oxidative (brittle) failures in potable water distribution systems, mostly in fittings
- Many failures were attributed to the material **polyacetal** (also called polyoxymethylene or **POM**) used to mold the plastic fittings
- ASTM F845 was the standard for POM crimp ring fittings



Polybutylene (PB) Piping Systems

Fitting issues

- Molded gray fittings in PB systems weren't actually made of PB
- This image shows crimp ring style fittings molded of POM
- POM fittings had poor resistance to hot chlorinated water



Polybutylene (PB) Piping Systems

Fitting issues

- Polyacetal plastic fittings can degrade quickly, lose ductility, and crack

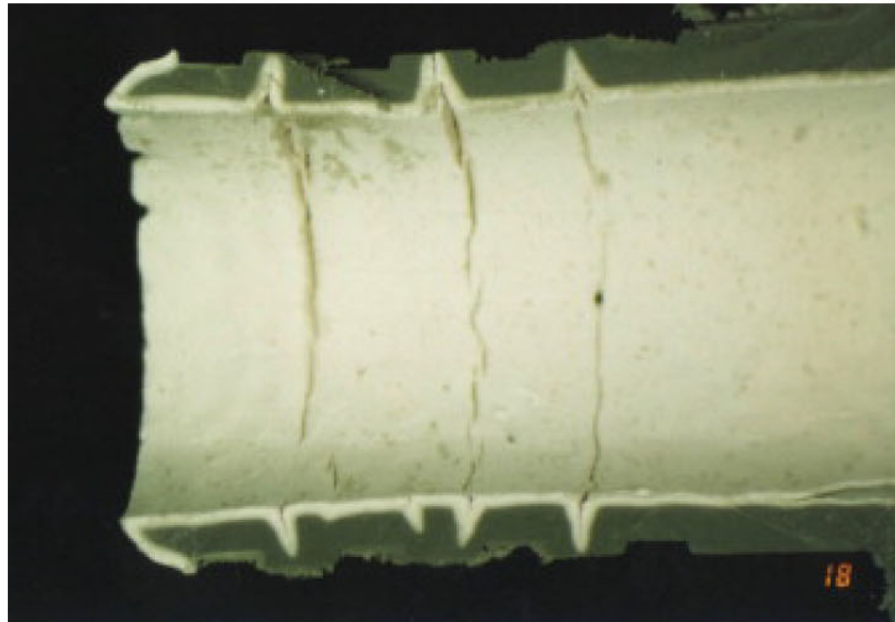


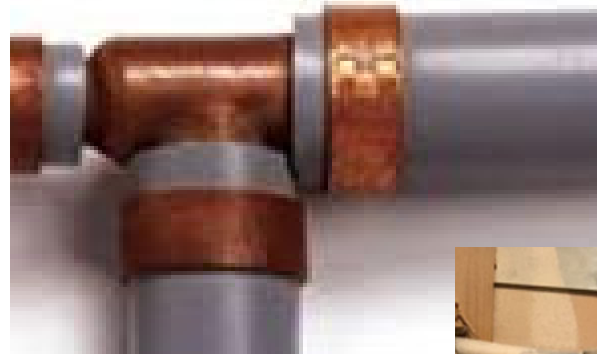
Figure 6.88. Field failure of polyacetal crimp fitting showing degradation and cracking.

Polybutylene (PB) Piping Systems

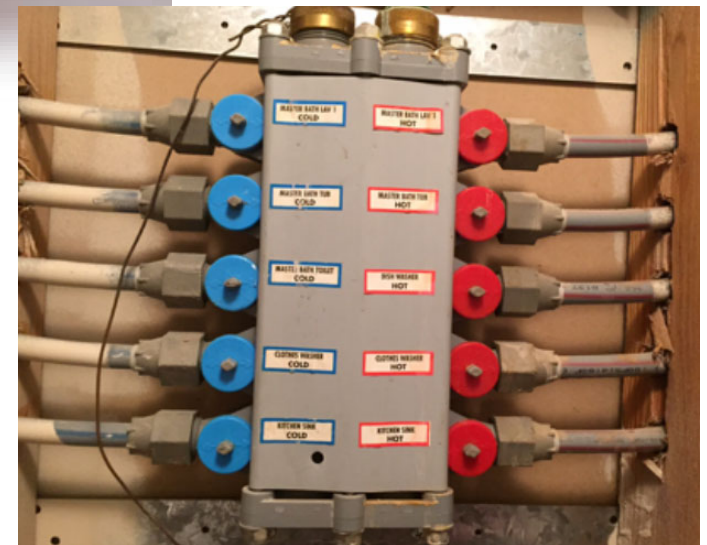
Fitting issues

- PB tubing manufacturers switched to metal fittings (copper or brass)

- This image shows crimp ring style fitting molded of drawn copper



- ASTM F1380 was standard for metal crimp ring fittings for PB
- Home-run plumbing systems with manifolds were introduced to eliminate fittings in the walls



Polybutylene (PB) Piping Systems

Downfall of PB for plumbing

- Some failures of the PB tubing material itself were attributed to insufficient resistance to hot chlorinated water or other manufacturing defects or installation errors
- E.g., Kinking, gouges, cuts



Polybutylene (PB) Piping Systems

Downfall of PB for plumbing

- Due to litigations and class action settlements in North America, Shell chose to stop supplying pipe grade PB resin in Canada and USA in 1995/1996

Cox vs. Shell Oil Company (Polybutylene Pipe)

A nationwide class-action lawsuit against Shell Oil Co. and Hoechst Celanese Corporation was filed on behalf of owners of houses, mobile homes and other structures with Polybutylene (PB) piping installed between Jan. 1, 1978 and July 31, 1995. Shell and Hoechst Celanese supplied raw materials used in the manufacture of the pipes, which plaintiffs claimed were defective and prone to leaking. The lawsuit was settled in November 1995. Under the settlement, the defendants committed **over \$1 billion** to a settlement fund to compensate those who sustained property damages or repair costs as the result of using PB plumbing.

Misconduct Type
Consumer Affairs

Enforcement Agency
Non-Governmental

Contracting Party
None

Court Type
Civil

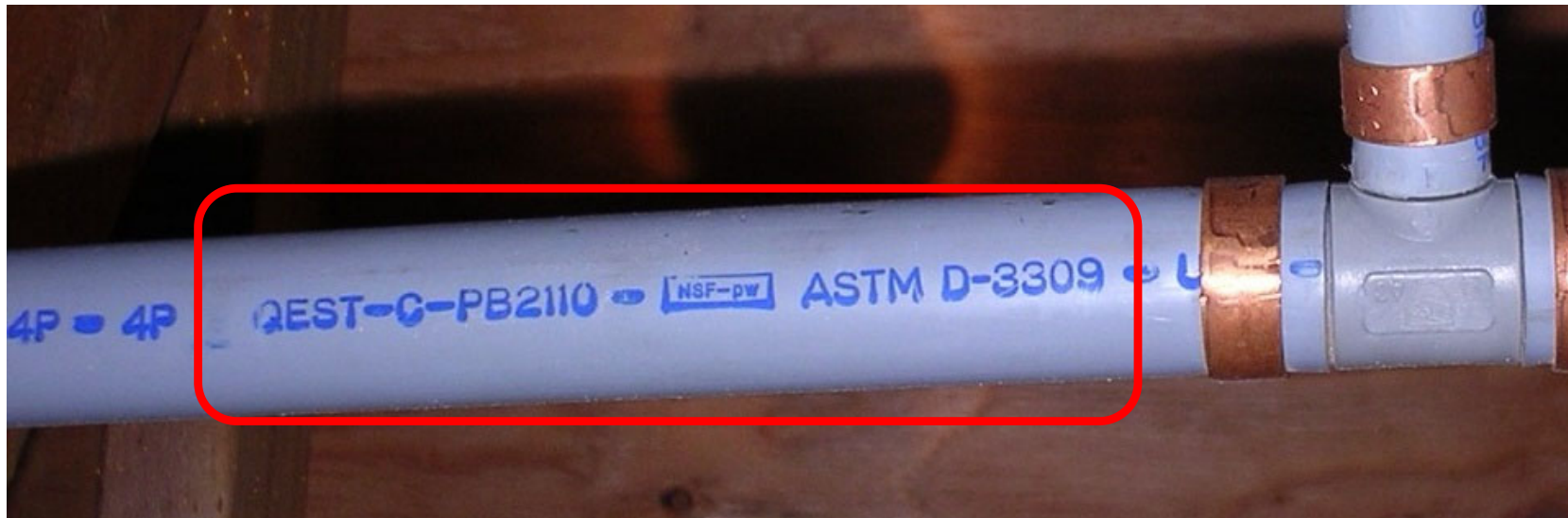
Disposition
Settlement

Date of Settlement
11/17/1995

Polybutylene (PB) Piping Systems

Identifying PB for plumbing

- The PB product standard ASTM D3309 was withdrawn in 2010, and the material has since been removed from plumbing and mechanical codes in USA and Canada
- “**PB2110**” was the material code. US Brands were “**Qest**” and “**Vanguard**”



2. Introduction to Plastic Pressure Pipes



Introduction to Plastic Pressure Pipes

Example of plumbing code approval for materials by reference to standards - 2024 ICC International Plumbing Code

605.4 Water distribution pipe. Water distribution pipe and tubing shall conform to NSF 61 and shall conform to one of the standards listed in Table 605.4. Hot water distribution pipe and tubing shall have a pressure rating of not less than 100 psi (690 kPa) at 180°F (82°C).

TABLE 605.4—WATER DISTRIBUTION PIPE

MATERIAL	STANDARD
Chlorinated polyvinyl chloride (CPVC) plastic pipe and tubing	ASTM D2846; ASTM F441; ASTM F442; CSA B137.6
Chlorinated polyvinyl chloride/aluminum/chlorinated polyvinyl chloride (CPVC/AL/CPVC)	ASTM F2855
Copper or copper-alloy pipe	ASTM B42; ASTM B43; ASTM B302
Copper or copper-alloy tubing (Type K, WK, L, WL, M or WM)	ASTM B75; ASTM B88; ASTM B251; ASTM B447
Cross-linked polyethylene (PEX) plastic tubing	ASTM F876; CSA B137.5
Cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) pipe	ASTM F1281; ASTM F2262; CSA B137.10
Cross-linked polyethylene/aluminum/high-density polyethylene (PEX-AL-HDPE)	ASTM F1986
Ductile iron pipe	AWWA C115/A21.15; AWWA C151/A21.51
Galvanized steel pipe	ASTM A53
Polyethylene/aluminum/polyethylene (PE-AL-PE) composite pipe	ASTM F1282
Polyethylene of raised temperature (PE-RT) plastic tubing	ASTM F2769; CSA B137.18
Polypropylene (PP) plastic pipe or tubing	ASTM F2389; CSA B137.11
Stainless steel pipe (Type 304/304L)	ASTM A312; ASTM A778
Stainless steel pipe (Type 316/316L)	ASTM A312; ASTM A778

Introduction to Plastic Pressure Pipes

Clarification on “Tubing vs. Pipe”

- “**Tubing**”: the actual Outside Diameter is 1/8 inch (3.8 mm) larger than the nominal size
- “**Pipe**”: the actual Outside Diameter matches that of steel pipe of the same nominal size

- **Tubing** uses nominal sizes such as **NTS 3/4**
 - Also known as Copper Tube Size or **CTS**

- **Pipe** uses nominal sizes such as **NPS 3/4**
 - Also known as Iron Pipe Size or **IPS**

- **Tubing** is widely used for residential plumbing (sizes NTS 2 and below)
- **Pipe** is typically used in commercial plumbing, fire protection, and industrial applications

- While people often use “tubing” and “pipe” interchangeably, there is a difference

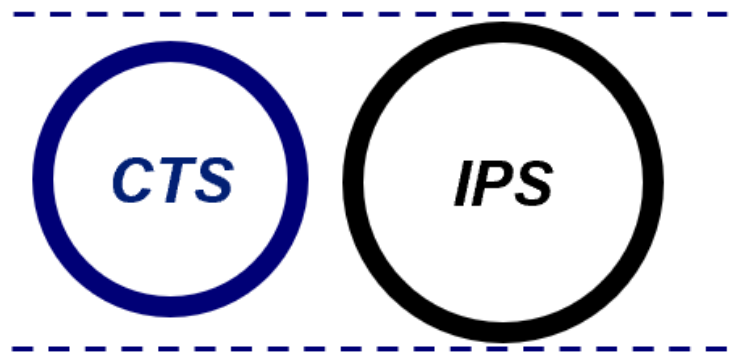
Introduction to Plastic Pressure Pipes

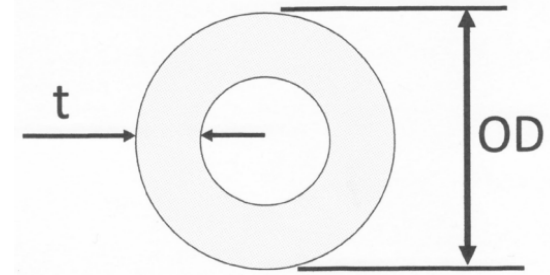
Clarification on “Tubing vs. Pipe”

- “**Tubing**”: the actual Outside Diameter is 1/8 inch larger than the nominal size
- “**Pipe**”: the actual Outside Diameter matches that of steel pipe of the same nominal size

- **IPS** pipes are typically larger than **CTS** pipes

- Example: CTS 1 Tubing OD = 1.125” (28.6 mm)
IPS 1 Pipe OD = 1.315” (33.4 mm) 15% larger





Introduction to Plastic Pressure Pipes

Universal Requirements: Dimension Ratios

- **Many*** versions of plastic pipe and tubing use a *Standard Dimension Ratio (SDR)*
- *Standard Dimension Ratio - the ratio of outside diameter to wall thickness, calculated by dividing the average outside diameter of the tubing by the minimum wall thickness*

- PEX tubing is **SDR 9** (wall thickness is 1/9 of the OD)
- CPVC plumbing tubing is **SDR 11** (wall thickness is 1/11 of the OD)
- CPVC fire protection pipe is **SDR 13.5** (wall thickness is 1/13.5 of the OD)

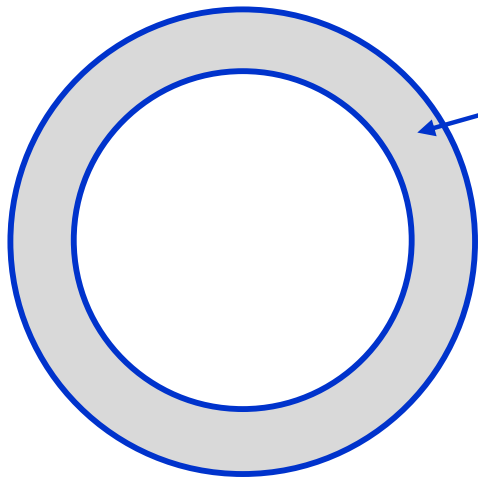
- Within a *Standard Dimension Ratio*, each diameter of the pipe/tubing type has the same pressure capability & rating (e.g., ¾, 1, & 2 SDR 9 PEX has the same pressure rating)

Exception: Pipes that follow **Schedule 40/80 dimension schemes*

Introduction to Plastic Pressure Pipes

Universal Requirements: Dimension Ratios

- **Many*** versions of plastic pipe and tubing use a *Standard Dimension Ratio (SDR)*
- **PEX tubing** (ASTM F876, CSA B137.5) is **SDR 9** (i.e., wall thickness is **1/9** of the OD)



Introduction to Plastic Pressure Pipes

Universal Requirements: Dimension Ratios

- **Many*** versions of plastic pipe and tubing use a *Standard Dimension Ratio (SDR)*
- **CPVC tubing** (ASTM D2846) is **SDR 11** (wall thickness is **1/11** of the OD)
- Used for plumbing applications



Courtesy Lubrizol

Introduction to Plastic Pressure Pipes

Universal Requirements: Dimension Ratios

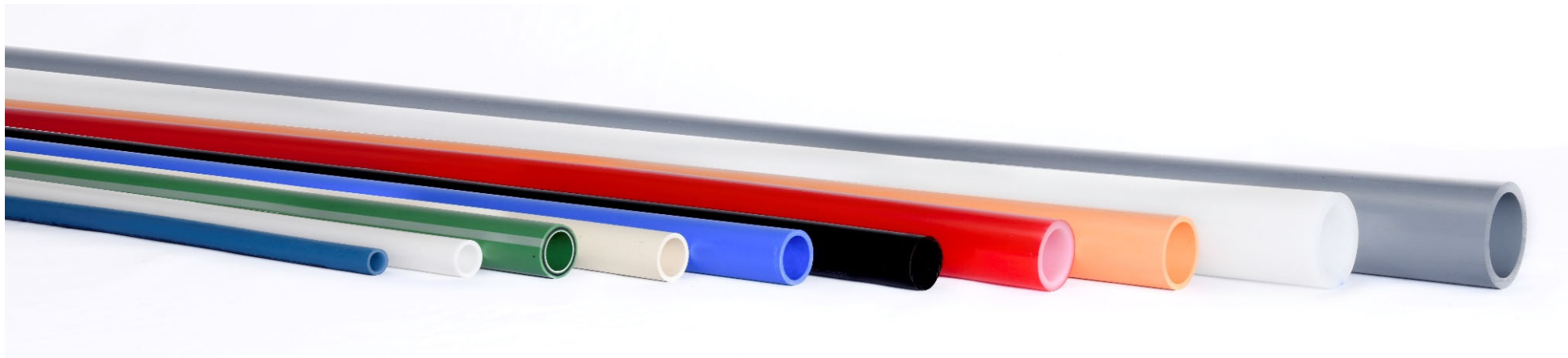
- **Many*** versions of plastic pipe and tubing use a *Standard Dimension Ratio (SDR)*
- **CPVC pipe** is **Schedule 40** or **80** (ASTM F441) or various **DRs** (ASTM F442)
- Used for commercial plumbing, industrial, and HVAC applications



3. Pipe & Tubing Materials

Introduction of the most common plastic pressure pipe & tubing materials

- CPVC
- PEX
- PE-RT
- PP-R & PP-RCT



CPVC Pipe & Tubing Materials

Chlorinated Polyvinyl Chloride: Introduction

- CPVC is PVC that has been chlorinated via a *free radical chlorination reaction*
- CPVC material is produced by adding a chlorine molecule (C) to PVC
- The chlorine added to PVC gives CPVC higher temperature performance and improved fire and corrosion resistance
- CPVC pipe is a **distinct material from PVC pipe**, with additional capabilities



CPVC Pipe & Tubing Materials

Configurations

- CPVC is provided in straight lengths
- Copper Tube Size (CTS) diameters ½ to 2, SDR 11 wall type
- Iron Pipe Size (IPS) diameters ½ to 24, Schedule 40/80 and several SDRs
- Fittings are molded in both CTS and IPS sizes
- Specific compounds for plumbing, hydronics, industrial, and fire protection applications

Common types: CPVC 4120-05, CPVC 4120-06 (material designation codes)



CPVC Pipe & Tubing Materials

General Capabilities

- CPVC pipe and tubing systems are pressure-rated for operation up to **200°F (93°C)**
- Actual pressure ratings depend upon wall type (e.g., SDR 11, SDR 13.5, Schedule 80)
- The wall type dictates the actual wall thickness

- E.g., **SDR 11 CPVC tubing** has standard hydrostatic pressure ratings of **400 psi @ 73°F (2,750 kPa @ 23°C)** and **100 psi @ 180°F (690 kPa at 82°C)**



CPVC Pipe & Tubing Materials

Product Standards

- **ASTM D2846:** CTS tubing & fittings for potable water; sizes ¼ to 2 nominal
- **ASTM D2855:** Standard Practice for the Two-Step Method of Joining PVC or CPVC Pipe and Piping Components with Tapered Sockets
- **ASTM F437:** Schedule 80 Threaded CPVC fittings
- **ASTM F438:** Schedule 40 Socket-type CPVC fittings
- **ASTM F439:** Schedule 80 Socket-type CPVC fittings
- **ASTM F441:** Schedule 40 and 80 pipe sizes; sizes ¼ to 16 nominal
- **ASTM F442:** IPS pipe sizes; sizes ¼ to 12 nominal
- **ASTM F493:** Solvent Cements for CPVC pipe and fittings
- **CSA B137.6:** All sizing types; sizes ¼ to 12 nominal



CPVC Pipe & Tubing Materials

Product Standards and Test Requirements

- Product standards establish capabilities and test requirements, such as:
 - Materials
 - Workmanship
 - Dimensions and tolerances for pipe, socket fittings, transition fittings
 - Quick burst pressures
 - Long-term (sustained) pressure ratings
 - Thermocycling resistance for transition fittings
 - Solvent Cement and Adhesives
 - Test Methods
 - Marking requirements
 - More...



CPVC Tubing Materials

Tubing & Fittings Markings

Required markings include:

- Size and wall type: e.g., $\frac{1}{2}$ **SDR 11**
- Manufacturer's name or tradename
- The standard: **ASTM D2846**
- Pressure ratings: **400 psi @ 73°F 100 psi @ 180°F**
- Material designation of compound: **CPVC 4120**
- Certification mark: e.g., NSF-pw, CSA symbol, ICC-ES report #, etc.



Markings on Fittings:

- Manufacturer's Name
- ASTM D2846
- CPVC 4120
- Certification (NSF-pw, etc.)

$\frac{1}{2}$ SDR 11 Manufacturer Name CPVC 4120 400 PSI @ 73°F PSI @ 180°

CPVC Piping Materials

Pipe & Fittings Markings

Required markings include:

- Size and wall type: e.g., **2 SCH 80**
- Manufacturer's name or tradename
- The standard: **ASTM F441**
- Pressure ratings at **73°F** and **180°F** (these vary)
- Material designation of compound: **CPVC 4120**
- Certification mark: e.g., NSF-pw, CSA symbol, ICC-ES report #, etc.



Markings on Fittings:

- Manufacturer's Name
- ASTM F438/F439
- CPVC 4120
- Certification (NSF-pw, etc.)

2" SCH 80 Manufacturer CPVC 4120-05 400 PSI @ 73°F 100 PSI @ 180°

CPVC Materials – Code Compliance

Code Compliance

- **Plumbing:** CPVC pipe, tubing, and fittings are listed within model codes such as the *International Residential Code (IRC)*, *International Plumbing Code (IPC)*, *Uniform Plumbing Code (UPC)*, *National Plumbing Code of Canada (NPC)* and *National Standard Plumbing Code (NSPC)* for plumbing
- **Mechanical:** CPVC pipe, tubing, and fittings are listed within model codes such as the *International Residential Code (IRC)*, *International Mechanical Code (IMC)*, *Uniform Mechanical Code (UMC)*, and *Uniform Solar, Hydronics, and Geothermal Code (USHGC)* for hydronic piping



CPVC Joining Systems

Fittings/Joining

- CPVC pipe, tubing, and fittings are joined via:
 - i. Solvent Cement
 - ii. Push-fit Fittings
 - iii. Grooved mechanical fittings
 - iv. Flanged connections

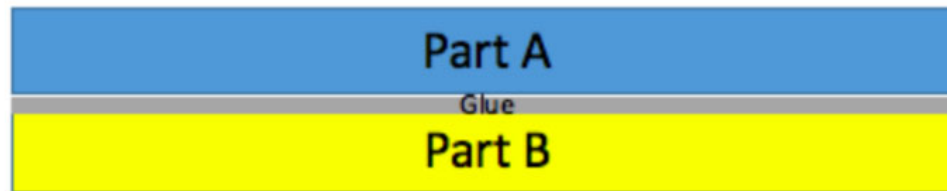


CPVC Joining Systems

Fittings/Joining: Solvent Welding is Not Gluing

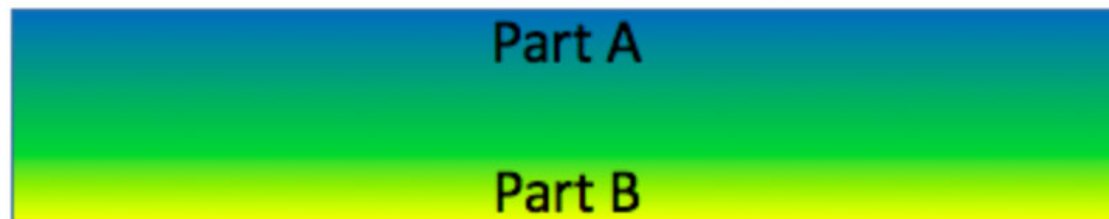
- *Glues* work by providing a sticky layer between two components to create a bond

Gluing



- **Solvent welding** requires the two components to come into contact as the solvent cements allow the parts to molecularly bond with each other (different than *glues*)

Solvent Welding



CPVC Joining Systems

Fittings/Joining

- i. Solvent Cement joints use liquid cement that “welds” pipes to fittings for secure joints
- Available in nominal sizes from 1/2 in. to 24 in.
 - Specific processes are described in material standards and installation manuals

Solvent welding is a form of welding that uses chemistry and geometry rather than heat to produce a permanent molecular bond. When the right mixture of solvents and radial pressure are applied the pipe and fitting become permanently bonded, functioning as a single component.



Courtesy Lubrizol (x2)



CPVC Joining Systems

Fittings/Joining

- i. Solvent Cement joints use liquid cement that “welds” pipes to fittings for secure joints
- Available in nominal sizes from 1/2 in. to 24 in.
 - Specific processes are described in material standards and installation manuals
 - Certain solvent cements are **one-step**, meaning no primer is required
 - Other solvent cements are **two-step**, meaning primer is required
 - Refer to manufacturer instructions and local code requirements

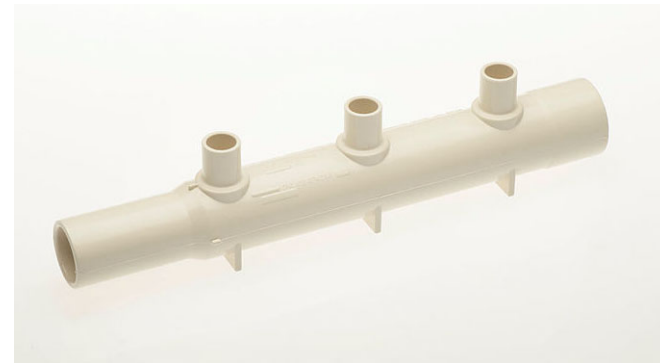
Example of One-Step primer & solvent cement



CPVC Joining Systems

Fittings/Joining

- i. Solvent Cement joint fittings are available in tees, elbows, couplings, caps, transition fittings, and multi-port tees



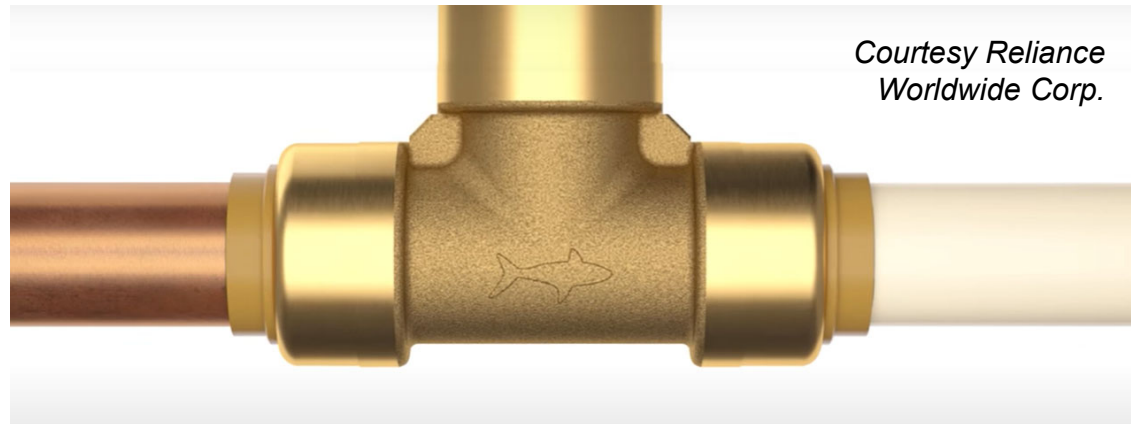
CPVC Joining Systems

Fittings/Joining

- ii. Push-fit Fittings are intended for copper, CPVC, and PEX tubing
 - Available in nominal sizes from 1/2 to 2
 - Follow manufacturer instructions for installation



ASSE 1061 Push-fit fittings
Available in lead-free brass



*Courtesy Reliance
Worldwide Corp.*

CPVC Joining Systems

Fittings/Joining

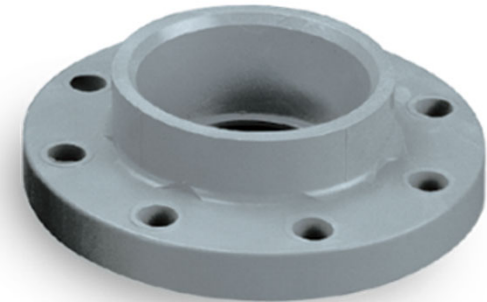
- iii. Grooved mechanical fittings connect pipes to fittings, once pipe ends are prepared
- Specific processes are described in material standards and installation manuals



CPVC Joining Systems

Summary

- CPVC pipe, tubing and fittings are joined via:
 - i. Solvent Cement
 - ii. Push-fit Fittings
 - iii. Grooved mechanical fittings
 - iv. Flanged connections



PEX Tubing Materials

Focus on PEX tubing and fittings

- Introduction, history, configurations, advantages, capabilities, standards, test requirements, markings, code compliance, joining systems, compatibility

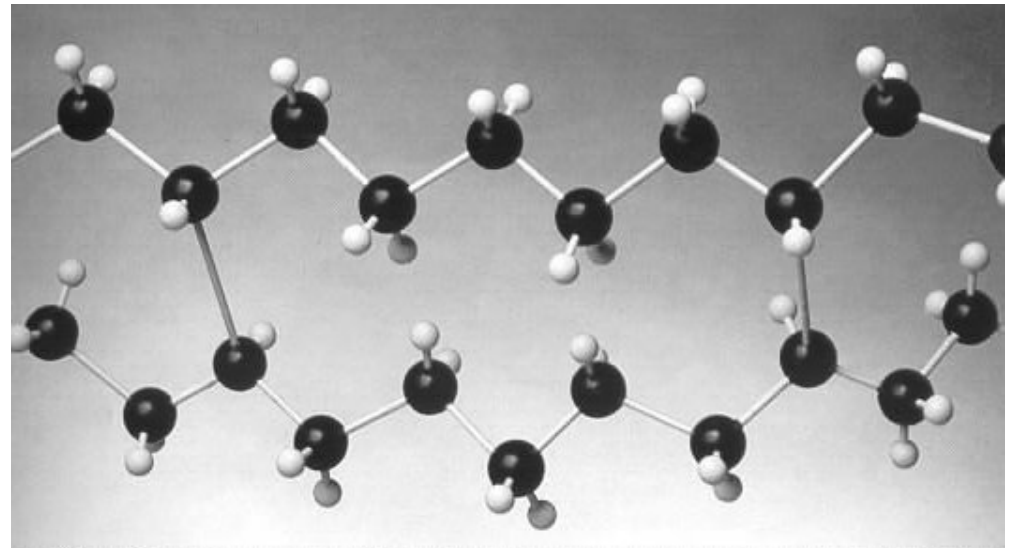


PEX Tubing Materials

Crosslinked Polyethylene: Introduction

- A flexible high-temperature pressure piping system; rated for operation **up to 200°F**
- “Crosslinked Polyethylene is a polyethylene material which has undergone a change in molecular structure using a chemical or a physical process whereby the majority of the polymer chains are chemically linked.”

Source: ASTM F876, CSA B137.5



PEX Tubing Materials

Crosslinked Polyethylene: History

- Introduced for radiant heating in the early **1970s** in Europe (~50 years ago)
- Introduced to USA and Canada in early **1980s** for heating and plumbing
- PEX tubing systems are used for water service lines, hot- and cold-water distribution, radiant heating and cooling, outdoor snow and ice melting, residential fire protection, geothermal ground loops, district heating & cooling, turf conditioning, and more

Common types:

- PEX 1006, PEX 3206, PEX 5106 (material designation codes*)

*For PEX, the 1st digit refers to chlorine resistance, the 2nd digit refers to UV resistance, and the 3rd & 4th digits refer to hydrostatic strength



PEX Tubing Materials

Configurations

- PEX tubing is available in coils or straight lengths, depending on the customer preference, the diameter, and the application
- Copper tube size diameters from 1/4 to 4 nominal
- PEX is available in natural, white, or colors such as red, white, blue, black, orange, etc.



Courtesy BOW x 3

PEX Tubing Materials

Product Standards

- **ASTM F876**: PEX tubing requirements; nominal diameters ¼ to 6
- **ASTM F877**: PEX tubing systems – fittings, manifolds, valves, assemblies
- **ASTM F2788**: IPS sizes in nominal diameters 3 to 54; DN sizes 16 to 1,000
- **ASTM F3253**: PEX tubing with oxygen diffusion barrier (for hydronics)
- **AWWA C904**: PEX Water Service Line in nominal sizes ½ to 3
- **CSA B137.5**: PEX tubing systems in diameters ¼ to 6 (harmonized with F876)
- More than ten ASTM standards for various fitting designs (later...)



PEX Tubing Materials

Product Standards and Test Requirements

- Product standards establish capabilities and test requirements, such as:
 - Materials
 - Workmanship
 - Dimensions and tolerances
 - Degree of Crosslinking
 - Quick burst pressures
 - Long-term (sustained) pressure ratings
 - Excessive pressure-temperature capability
 - Hot-bend and cold-bend tests
 - Thermocycling resistance
 - Chlorine resistance
 - UV resistance
 - Marking requirements
 - More...



PEX Tubing Materials

Short-term Burst Pressure

- Product standards have requirements for short-term burst pressure
- **PEX Tubing & Fitting Assembly Minimum Burst Pressure Requirements:**
 - ASTM F876: 475 psig at 73°F (3.27 MPa @ 23°C); 210 psig at 180°F (for tubing)
 - ASTM F877: 475 psig at 73°F; 210 psig at 180°F (1.45 MPa @ 82°C) (for connections)
- Fittings/connections must have same capabilities as the tubing
- All PEX fitting standards refer to ASTM F877 for test requirements



PEX Tubing Materials

Long-term (Sustained) Pressure

- Product standards have requirements for long-term (sustained) pressure ratings:
- **PEX Tubing & Fitting Assembly Minimum Sustained Pressure Requirements:**
 - ASTM F876: 160 psig at 73°F (1,103 kPa @ 23°C); 100 psig at 180°F (for tubing)
 - ASTM F877: 160 psig at 73°F, 100 psig at 180°F (690 kPa @ 82°C) (for connections)
- Fittings/connections must have same capabilities as the tubing
- All PEX fitting standards refer to ASTM F877 for test requirements



PEX Tubing Materials

Three Key Properties with Categories for Performance:

PEX performance categories as per ASTM F876:

1. Chlorine Resistance
2. UV Resistance
3. Hydrostatic Design Strength (HDS), related to pressure ratings

Look for minimum code “PEX 1006” on the PEX markings for potable water PEX:

½ Inch PEX 1006 ASTM F876 AWWA C904 CSA B137.5

For hydronics, “PEX 0006” is acceptable

PEX Tubing Materials

Tubing & Fittings Markings

Required markings include:

- Size and wall type: e.g., ½ Inch SDR 9
- Manufacturer's name or tradename
- The standard: **ASTM F876** (others are optional)
- PEX tubing material designation code: **PEX 1106**
- Pressure ratings: **160 psi @ 73°F** and **100 psi @ 180°F**
- Footage mark (at least every 5 feet)
- Certification mark (e.g., NSF-pw, CSA symbol, ICC-ES report #, etc.)

Markings on Fittings:

- Manufacturer's Name
- ASTM Fxxx (optional)
- Certification (NSF-pw, etc.)

½ Inch SDR9 Manufacturer ASTM F876 PEX 1106 100 psi @ 180°F 75 FT

PEX Materials – Code Compliance

Code Compliance

- **Plumbing:** PEX tubing and fittings are listed within model codes such as the *International Residential Code (IRC)*, *International Plumbing Code (IPC)*, *Uniform Plumbing Code (UPC)*, *National Plumbing Code of Canada (NPC)*, and *National Standard Plumbing Code (NSPC)* for plumbing
- **Mechanical:** PEX tubing and fittings are listed within model codes such as the *International Residential Code (IRC)*, *International Mechanical Code (IMC)*, *Uniform Mechanical Code (UMC)*, and *Uniform Solar, Hydronics, and Geothermal Code (USHGC)* for hydronic piping



PEX Joining Systems

Fittings/Joining

- PEX fittings work on principle of **compression seal** (tubing compressed over fitting ribs)
- PEX fittings are produced from **lead-free brass alloys** and **engineered polymers**
- **Polysulfone (PLS)** and **polyphenylsulfone (PPSU)** are thermoplastic polymers known for their toughness, stability at high temperatures, and chlorine resistance
- These are the typical polymers used for PEX fittings and manifolds

Collection of PEX fittings from multiple manufacturers



PEX Joining Systems

PEX Fitting Standards

- **ASTM F877**: PEX tubing “systems” performance – fittings, manifolds, valves, etc.
- **ASTM F1807**: Metal insert fittings joined with copper crimp ring
- **ASTM F2159**: Polymer insert fittings joined with copper crimp ring
- **ASTM F1960**: Metal and polymer “cold-expansion” fittings joined with PEX ring
- **ASTM F2080**: Metal “cold-expansion” fittings joined with metal compression-sleeve
- **ASTM F2098**: Stainless steel clamps for use on F1807 and F2159 fittings
- **ASTM F3347**: Metal insert fittings using stainless steel press sleeve
- **ASTM F3348**: Polymer insert fittings using stainless steel press sleeve
- **ASSE 1061**: Push-fit Fittings



PEX Joining Systems



ASTM F1807 Crimp ring fitting
Available in lead-free brass



ASTM F1807 copper crimp ring (not to scale!)



ASTM F2159 polymer crimp fitting



Typical Crimp ring fitting assembly tool

ASTM F1807 Crimp Assembly



PEX Joining Systems



O
R



ASTM F2098 stainless steel clamps are used with F1807 and F2159 crimp fittings as an alternative for the copper crimp ring

ASTM F1807 brass fitting

ASTM F2159 polymer fitting



Special tools are used for these s/s clamps – each type of clamp specifies its own tool



PEX Joining Systems

PEX: Fittings/Joining

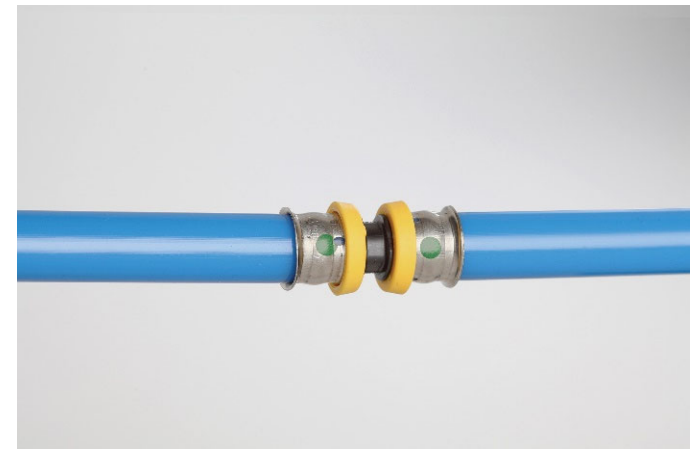
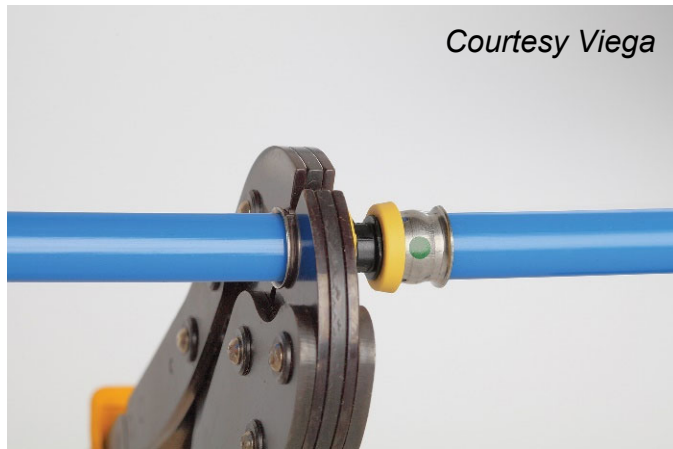


Courtesy Uponor

ASTM F1960 Cold-expansion fitting using a PEX ring
Available in polymer and lead-free brass



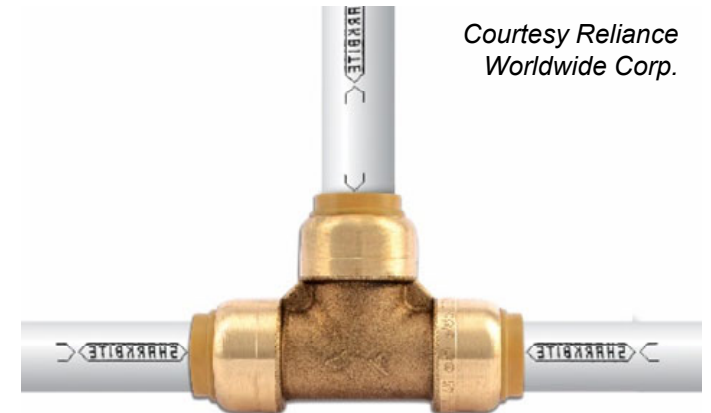
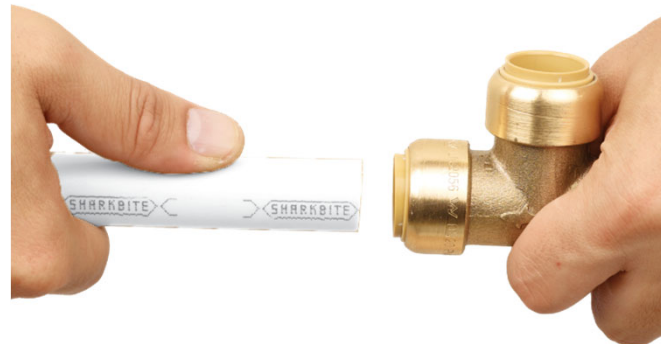
PEX Joining Systems



ASTM F3347/F3348 Press fittings using stainless steel sleeve
Available in lead-free brass (F3347) and polymer (F3348)



PEX Joining Systems



*Courtesy Reliance
Worldwide Corp.*

ASSE 1061 Push-fit fittings
Available in polymer and lead-free brass



PEX Joining Systems



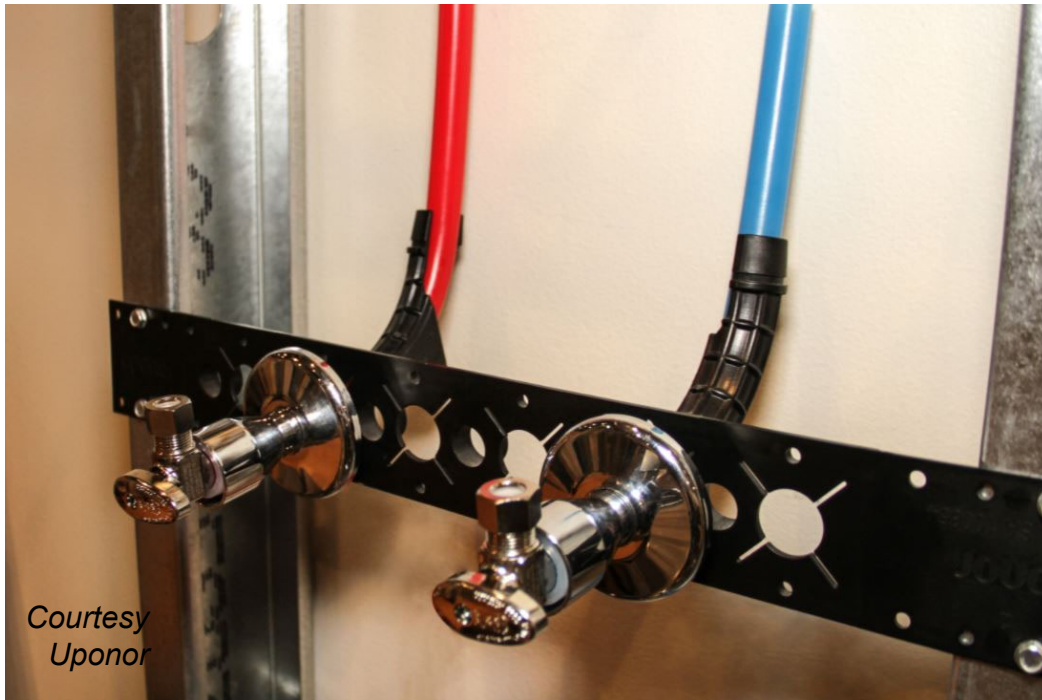
ASSE 1061 Push-fit fittings
Available in polymer and lead-free brass



PEX Joining Systems

Fittings/Joining

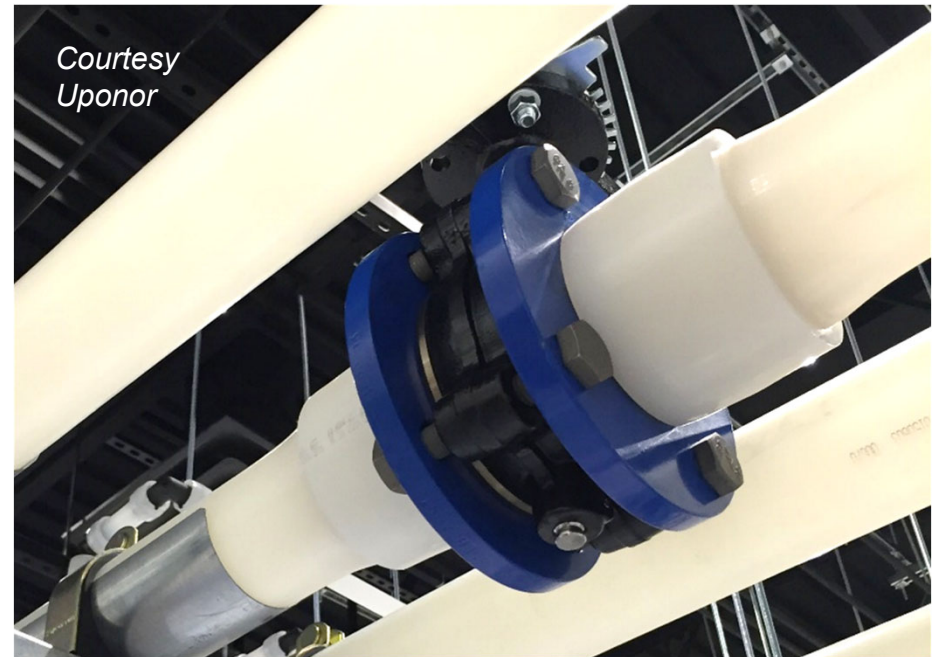
- A variety of transition fittings, valves, and adapters are available
- Snap-on support bends are often used in place of elbow fittings



PEX Joining Systems

Fittings/Joining

- A variety of transition fittings, valves, and adapters are available
- Press fittings, flanged fittings



PEX Joining Systems

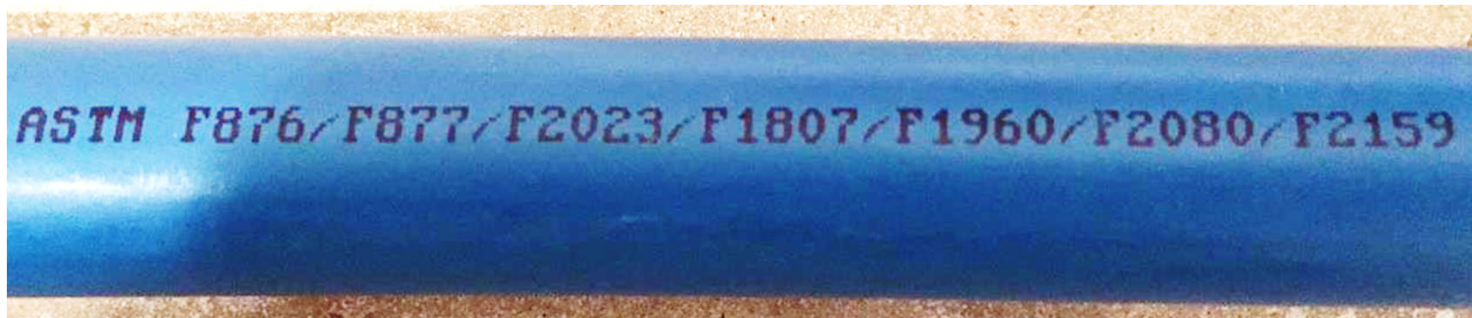
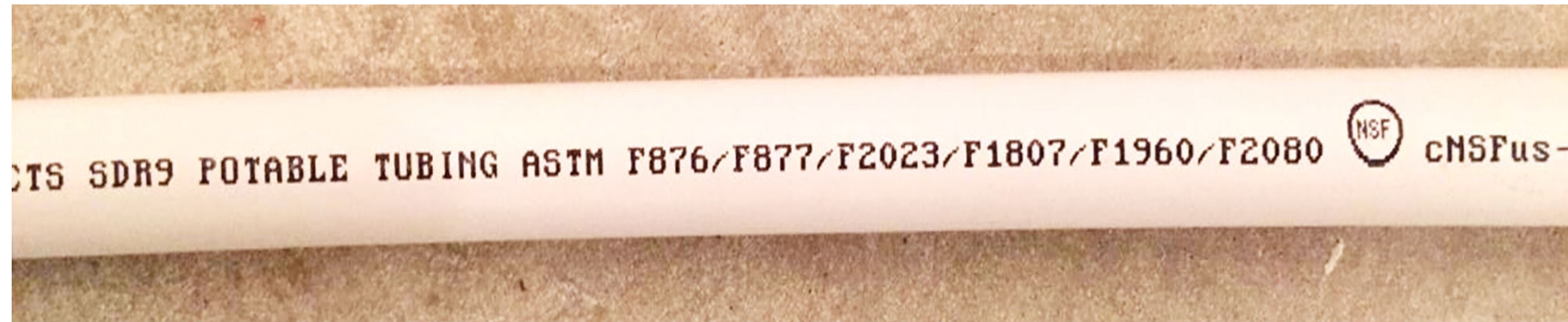
Fittings/Joining

- **Not all PEX fittings are approved for use with all PEX tubing**
 - **Some combinations are not approved!**
- Tubing manufacturers must test and certify each specific fitting design before they can recommend them for use with their tubing
- The standard designation(s) of the fitting system(s) for which the tubing is recommended by the tubing manufacturer and that is specifically qualified for use with PEX is **marked on the tubing**
- In other words, look for markings such as “F1807”, “F1960”, “F2080”, “F2159”, “F3347”, “F3348”, or “ASSE 1061” on the tubing print line to show compatibility and approval

PEX Joining Systems

Fittings/Joining

- Look for markings such as “F1807”, “F1960”, “F2080”, “F2159”, “F3347”, “F3348”, or “ASSE 1061” on the tubing print line to show compatibility and approval



PEX Plumbing Manifolds

Several styles of manifolds are available in various materials

- Copper, polymer
- Valved, valveless (also known as “multiport tees”)
- According to standards, manifolds are tested as PEX fittings according to ASTM F877



PE-RT: Polyethylene of Raised Temperature

- PE-RT is modified HDPE with enhanced capabilities to withstand higher temperatures
- Strong and tough material suitable for applications up to **180°F (82°C)**
- Same dimensions as PEX tubing; predominantly available as Tubing (CTS)
- PE-RT tubing can be joined via **heat fusion** (e.g., PE-RT fittings) or using most **PEX fittings**
- Produced according to ASTM F2769 and/or CSA B137.18
- Recognized in all model codes for plumbing & mechanical piping

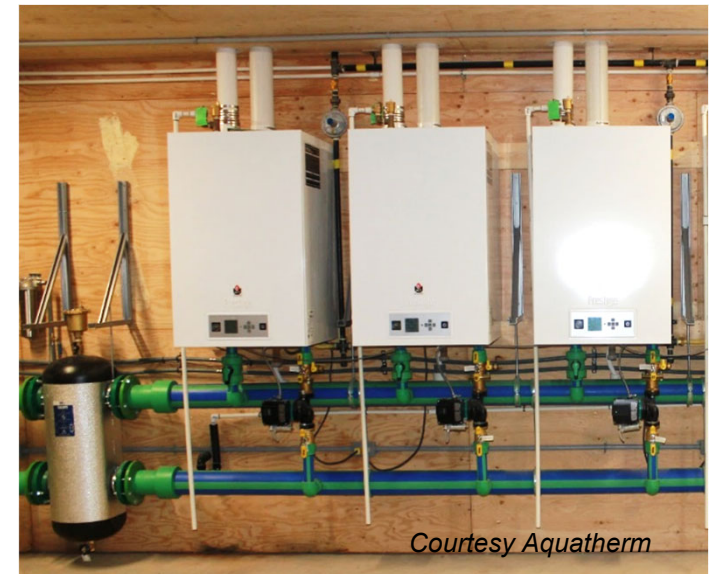
Common type:

- PE4710 (PE material designation code)



PP-R & PP-RCT: Polypropylene

- PP-R & PP-RCT are high-temperature plastic pressure piping materials first used for plumbing and hydronic heating in the 1980s in Europe; introduced to NA in the 2000s
- Provided in straight pipe lengths in DN (metric) diameters (e.g., 25 mm, 75 mm, etc.)
- Produced according to ASTM F2389 and/or CSA B137.11
- Recognized in all model codes for plumbing & mechanical piping

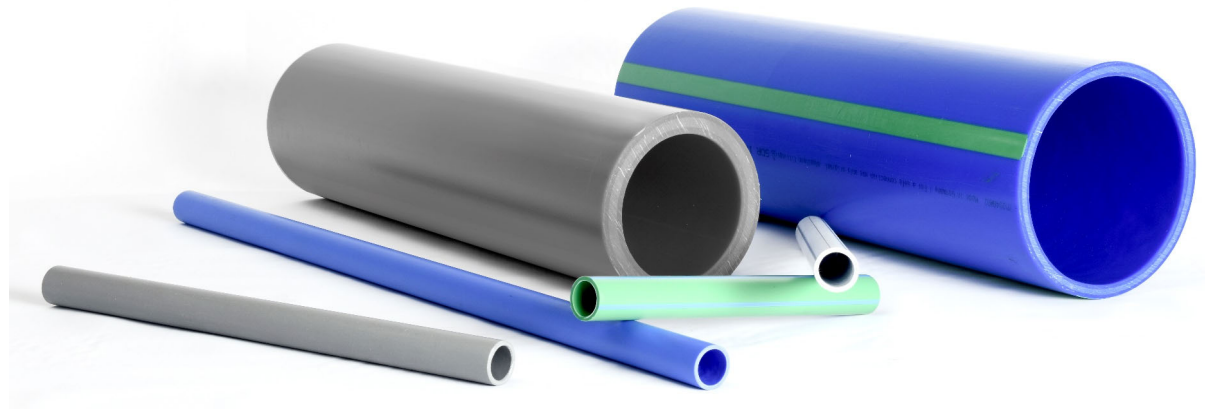


Courtesy Aquatherm

PP-R & PP-RCT: Polypropylene

Two types of polypropylene pressure pipe materials

- *Random copolymerized polypropylene (PP-R)* is a high-temperature plastic pressure piping system developed used for plumbing and hydronic applications
- *Polypropylene random copolymer with modified crystallinity & temperature resistance (PP-RCT)* is a stronger grade of PP material with higher tensile strength, higher pressure rating for the same wall thickness



PP-R & PP-RCT: Polypropylene

PP-R & PP-RCT Connections

- Connections are typically via **heat fusion (socket, butt, and electrofusion)**
- Various mechanical fittings (e.g., grooved) and adapters are also available
- Prefabrication can save significant time and reduce installation costs



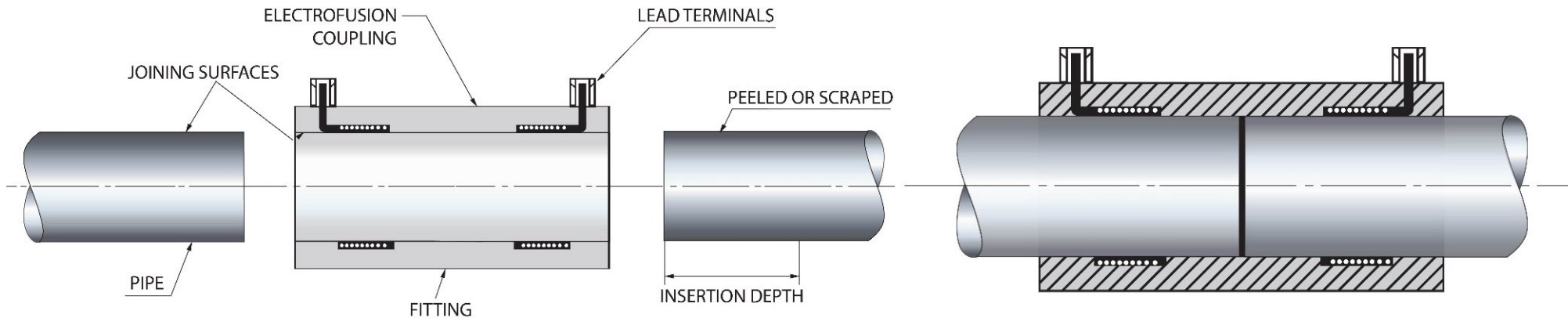
Basic fusion steps: 1. Heat 2. Press 3. Cool



PP-R & PP-RCT: Polypropylene

PP-R & PP-RCT Connections

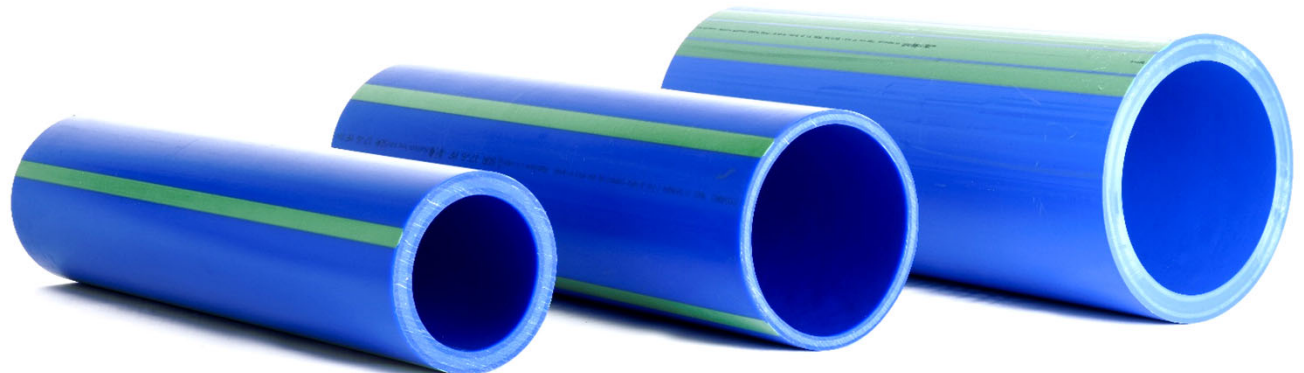
- **Electrofusion** joints have embedded copper wires that heat the fitting and the pipe, welding them; a computerized electronic machine controls the process



PP-R & PP-RCT: Polypropylene

PP Summary

- Strong rigid piping material with high temperature capabilities (typically rated for **176°F**)
- Fiber-core reinforcement layers reduce longitudinal thermal expansion/contraction
- Available in diameters from 16 mm to 710 mm (soft conversions ½ inch to 28 inch)
- Available in various wall types and thicknesses (e.g., SDR 7.4, SDR 9, SDR 11, SDR 13.5, etc.), depending on the required pressure rating
- Reliable fusion joining with a wide variety of fitting shapes and sizes



Plastic Pressure Pipe Materials in US/Canada

Summary

1. Recap of the usage of PB in US/Canada
2. Introduction to plastic pressure pipes (codes, tubing vs. pipe, wall types)
3. Pipe and tubing materials: CPVC, PEX, PE-RT, PP-R & PP-RCT

Note: Other plastic pressure pipe materials (e.g., PEX-AL-PEX) are less commonly used in NA for hot- and cold-water distribution systems



Plastic Pressure Pipe Materials in US/Canada

Presentation to ICC 815 Committee

30-Oct-23

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