

*Connections is a series about the materials and equipment that make up the water supply transmission and distribution infrastructure, without specific reference to a particular manufacturer or proprietary product line. Columns are reviewed by subject matter experts and are intended to present useful information that will help Opflow readers make informed decisions about the materials and equipment they choose and use. Direct comments and questions about the series to editor Gay Porter DeNileon, gporter@awwa.org.*

## PVC Pipe

# Flexibility and Corrosion Resistance Key to Popularity

When Hurricane Ivan swept through the islands off the Florida Gulf, the water system, along with everything else, took a beating. But, amazingly, when the underground polyvinyl chloride (PVC) pipe was exposed by the high winds and water surges, much of the pipe stayed intact. The strength and flexibility of the plastic pipe helped it withstand the ferocious thrashing of the storm.

Historical accounts of the invention of PVC vary, with some claiming that PVC was invented accidentally in Germany in 1912 by a chemist who reacted acetylene with hydrochloric acid. Other accounts state that PVC was first discovered in the late 19<sup>th</sup> century. Either way, accounts agree that PVC pipe was first manufactured and used for water distribution and wastewater collection in Europe in the mid-1930s and migrated to North America soon after World War II.

PVC pipes are manufactured from polyvinyl chloride resin, a polymer comprised of ethylene, derived from natural gas or petroleum, and chloride, derived from salt. Small quantities of other ingredients are compounded with the resin to enhance process ability, improve durability, and add color. Under heat and pressure, the inert dry PVC compound is converted into a viscous mass, which is extruded to make pipe.

The manufacturing process produces almost no waste. Any pipe that is not up to standard or destroyed as a result of testing can be ground up and reprocessed. The production process also consumes less energy than the manufacturing of similar lengths of pipes made from other materials.

### Uses of PVC Pipe in Water Systems

PVC potable water pipes are manufactured in diameters of 4 in. to 24 in. for distribution and 14 in. to 48 in. for transmission. Smaller diameters are used in rural water systems. PVC pressure pipe is generally manufactured in 20-ft lengths. In the water and wastewater industries, PVC piping is used for

- ▶ Potable water mains and fire protection



- ▶ Recycled or grey water piping
- ▶ Gravity sanitary sewers
- ▶ Sewer force mains
- ▶ Gravity storm sewers and culverts
- ▶ Water service lines and interior piping
- ▶ Drain-waste-vent piping
- ▶ Various industrial pipe applications
- ▶ Irrigation piping

A buried-pipe market study funded by Uni-Bell PVC Pipe Association conducted in 2000 found that in 1999 PVC pipes accounted for 66 percent of the new underground water pipe market in 14 industrialized nations for diameters 4 in. and larger and more than 74 percent of the sanitary sewer market.

According to the *Piping Handbook*, seventh edition, more than “90 percent of rural water distribution mains and over 40 percent of municipal mains are made of PVC. ... Over 85 percent of the newly installed underground building sewer connections are made of PVC. ... About 80 percent of new single-family dwellings utilize either PVC or ABC drain, waste, and vent piping. Most drainage systems, including those for building foundations, leaching fields, agriculture, and road construction now consist of thermoplastics piping, mostly polyethylene (PE) and PVC. ... Another [fast-growing application]

is the rehabilitation of older sewers, drains, and pressure pipelines by the insertion of new PE or PVC pipes.”

### Benefits of PVC Pipe

The most widely used thermoplastic pipe for water distribution mains in North America, PVC is strong, lightweight, durable, chemically resistant, and does not corrode. The interior of PVC pipe is exceptionally smooth, typically with a C value of at least 150. Because PVC does not corrode, there is also no tuberculation by corrosion by-products. PVC does not serve as a nutrient, which makes it resistant to biological degradation from bacteria and other microorganisms. PVC provides the lowest biofilm formation potential of all the common water pipe materials being used.

“The subsequent cost and work-time advantages of PVC have ... been persuasive,” said Roy Brander, Sr. Infrastructure Engineer, Waterworks, City of Calgary, Alberta. “In short, we’ve never looked back from going to PVC.”

PVC’s ability to withstand some longitudinal bending gives it a significant advantage in buried applications. The use of flexible joints also enhances a pipe’s ability to yield to external pressure such as ground movement, uneven settlement of pipe

Photos courtesy of Uni-Bell PVC Pipe Association



bedding, or seasonal variations in soil conditions. PVC pipe is well suited to applications where abrasive conditions are anticipated, although potable water is not at all considered abrasive to PVC.

An additional benefit is that PVC can be manufactured in different colors, which eliminates the need to paint the pipes to identify them per use. It is also easy to print identifying marks on the pipe.

### Fittings and Installation

The primary methods of joining PVC piping are through the use of

elastomeric gasket seals or solvent cementing. Both provide leak-free performance. The most common joining system for water pipe 4 in. and larger is the gasketed-bell-and-spigot joint. In addition, thermal fusion or butt-weld joints are available for joining PVC pipes. This technology has increased PVC pipe usage for directionally drilled, trenchless installations and for pipeline rehabilitation and relining. Furthermore, a wide range of mechanical restraint devices and high-deflection couplers and bends are available.

PVC pipe that meets AWWA Standards can be easily cut with handsaws or power saws. Fittings are used for changes in line direction or size and for branch connections and are available in a variety of designs and materials, including PVC, cast iron, and ductile iron.

While PVC itself is inert and does not add anything to water chemistry, the pipe should not be installed in areas where there is known soil contamination by high concentrations of low molecular weight organic solvents or where the potential exists for high concentrations of organic solvents to leach into the soil, because the solvents could permeate the pipe, contaminating the water, and eventually soften the plastic pipe. Pipe gaskets are also vulnerable to high-concentration organic solvents.

### PVC Pipe Association

The Uni-Bell PVC Pipe Association, <[www.uni-bell.org](http://www.uni-bell.org)>, a nonprofit research and technical trade organization, represents all segments of the gasket-joint PVC pipe industry. Uni-Bell has a staff of engineers to assist utilities, designers, regulators, public health officials, and standard setters with information and research about PVC pipe. The organization also produces several related products, including a handbook, design software, and instructional videos.

### AWWA Standards and Manual for PVC Pipe

- ▶ C900-97 Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Distribution
- ▶ C905-97 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. (350 mm Through 1,200 mm), for Water Transmission and Distribution
- ▶ C907-91 Polyvinyl Chloride (PVC) Pressure Fittings for Water—4 In. Through 8 In. (100 mm Through 200 mm)
- ▶ C908-01 PVC Self-Tapping Saddle Tees for Use on PVC Pipe
- ▶ C909-02 Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 In. Through 24 In. (100 mm Through 600 mm), for Water Distribution
- ▶ M23, *PVC Pipe — Design and Installation*, second edition