Waterworks and Sewerage Hardware
VC pipe’s unsurpassed qualities and performance have made it the material of choice for water and wastewater applications since it was first introduced in the North American market some 60 years ago.

Besides being cost effective to produce and extremely durable, PVC is also easy to assemble and transport, and its versatility allows it to be adapted to the needs of an evolving market place.

**History**

Although PVC was discovered by accident in the 19th century, the first known PVC pipes only began being produced in 1934. It was during World War II in Germany that the industry got off the ground, as a result of the need to rebuild the large number of water and wastewater lines destroyed by Allied bombings, and due to the short supply of steel brought on by the production of military equipment.

Before the war and even during the war, the technology for processing PVC was rather primitive, consisting mostly of machinery used for making rubber or celluloid. After the war, however, advances in PVC technology were made, including the development of better lubricants and stabilizers, as well as machinery specifically designed for PVC processes.

Introduced in North America in 1951, PVC pipe has become the most widely used plastic piping material on the continent. By 2004, 3.2 million kilometres of PVC water and sewer pipe had been laid throughout North America, giving it an estimated 78% share of the water pipe market, and 81% of the sanitary sewer pipe market on the continent.

**Properties**

Available in sizes ranging from 3 mm to 1,200 mm (1/8” to 48”) for pressure pipe applications — and up to 1,500 mm (60") for non-pressure pipe — the material has been widely celebrated by the engineering community. For instance, the magazine *Engineering News-Record*, which chronicles milestones in the construction industry, recognized PVC as one of the top 20 of the last 125 years, noting it was the most revolutionary of the polymers developed over that time.

Among the leading reasons for PVC’s dramatic market growth are its superior durability, joint integrity and corrosion resistance. As well, PVC pipe is impervious to nearly all chemicals found in domestic and industrial wastewater, making it an extremely long-lasting and cost-effective solution for use in sanitary sewers.

A 1994 survey by the American Water Works Association Research Foundation, gave PVC pipe a life expectancy rating of 4.1 on a scale of 1 to 5, the top mark among all other pipe materials. Another study by the same organization quantified the life expectancy of PVC pipe at more than 110 years — making excellent for long-term asset management and sustainability. As well, in 1995, a National Research Council of Canada study found that PVC had a failure rate of 0.7 breaks per 100 km of pipe laid, the lowest among materials studied.

Additionally, PVC’s ultra-smooth surface means less energy is required to pump water from source to tap. Dr. Bryan Karney, professor of civil engineering at the University of Toronto, says a national program to replace older pipes with hydraulically efficient plastic pipes could reduce Canada’s greenhouse gas emissions by up to 5%.

Municipalities that have adopted this technology have achieved dramatic results. In 1978, Calgary implemented a more open procurement policy allowing PVC. As a result, half of its 4,000 km water distribution system now consists of this material. Its water main break rate, at 0.2 per 100 km, is the lowest in Canada.
Use of corrosion-proof piping materials is essential to the long-term financial management of water and wastewater systems. By making extensive use of PVC, Calgary and Edmonton save an estimate $5 million a year in water main repair costs. But this is only part of the savings. The biggest financial benefit will come from lower replacement costs over the long term. If the Calgary approach were adopted nation-wide, hundreds of billions could be saved over the next century.

With corrosion being the leading cause of over 850 water main breaks occurring every day throughout North America, Calgary and Edmonton provide the example to follow to fight this problem.

On top of its corrosion resistance, PVC has both the flexibility and rigidity needed for building municipal piping systems that offer structural integrity and longevity.

In practical terms, this ability to flex under excessive loads means PVC pipe develops fewer cracks, thereby reducing leakage, tree-root damage and operating costs. PVC pipe’s rigidity also translates into its ability to handle external loads up to 75,000 kg/m2 (about 40 metres of ground cover) and internal pressure up to 2,100 kPa.

Such versatility is attributable to the raw materials that go into making PVC pipe. The major component used is polyvinyl chloride, which can be blended with other ingredients, such as pigments, lubricants and stabilizers, to give the finished product specific characteristics. PVC pipe compound properties, which may be found in industry standards, include base resin, tensile strength, elastic modulus in tension, deflection temperature under loading, and Izod impact strength.

Two types of PVC pipe are manufactured in North America: 1) unplasticized PVC (PVC-U); and molecularly oriented PVC (PVC-O). What distinguishes them is the way they are manufactured – which establishes the orientation of the molecules and determines the pipe’s impact resistance, tensile strength and ability to absorb and dissipate energy.

PVC-U is the most common material found in the manufacture of pipe, while PVC-O has a different molecular orientation which gives it enhanced physical and mechanical properties such as increased resistance to impacts.

The evolution of PVC piping material is but one example of how the industry adapts and improves the technology. Among other innovations produced by R&D are the various types of joints for connecting piping networks.

Although bell and spigot joints remain the primary connection used, since they provide watertight seals and allow PVC to be connected with other piping materials, butt-fused joints were introduced into the market in 2003. Unique among its features, the butt-fused joint allows for the installation of seamless PVC piping networks. With sizes ranging from 7.6 cm to 91.4 cm (3” to 36”), and larger sizes to be available soon (106.7 cm to 121.9 cm (42– 48“), butt-fused joints can be used for both water and wastewater systems.

Among other advancements in PVC pipe technology are products and methods designed to meet the demand for trenchless construction, particularly in high density urban areas. These include sliplining and close-fit pipe lining for use in rehabilitating piping systems, as well as horizontal direct drilling for new construction. Their clear advantage: they allow for minimal surface excavation when installing or renewing underground infrastructure. Options include segmented systems, and integral joint bell and spigot restraint systems.

**Standards**

With such a range of products, innovative developments, and growing use throughout North America, PVC pipe must meet the requirements of strict industry standards.

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These are provided by various organizations, including the Canadian Standards Association (CSA), American Society for Testing and Materials (ASTM), the American Water Works Association (AWWA), and the National Sanitation Foundation (NSF). These standards, besides ensuring uniform product quality, govern such criteria as wall thickness, surge allowances, pressure capacity, stiffness, etc.

CSA revises its standards on a continual basis, publishing updates about every three years.

A success story

First introduced in North America some 60 years ago, PVC pipe has become the most widely used material in water and waste water systems as a result of its unique combination of qualities. Moreover, ongoing improvements in joining materials, standardization programs, as well as increasing acceptance by designers, contractors and purchasing agents, will continue to ensure its place as industry leader for years to come.

For more about PVC pipe’s unique qualities, see the latest edition of The Handbook of PVC Pipe: Design & Construction, available on Uni-Bell’s Web site at www.uni-bell.org.

About the author

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