Case Study

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ADVANCEMENTS IN CORRUGATED PLASTIC PIPE

Used in Non-pressure Pipelines for Storm Water, Farm Fields, Detention Systems and Sanitary Sewers

by
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Polyethylene, a thermoplastic resin, was first produced in 1933 and during the next twenty years petrochemical industry chemists continued to advance the manufacturing process to diminish costs while yielding better grades. In the early 1950s, chemists at the Phillips Petroleum Company developed an economical process and delivered a new grade of polyethylene - PE - called high-density polyethylene -- HDPE. At that time, it became possible to create various grades of PE and soon the resin was being used in a wide variety of products and applications.

The very first use of HDPE was for baby bottles. Using it instead of glass was the start of HDPE replacing traditional materials due to its improved physical properties. It didn't break like glass, it was less expensive to produce and it was safe. Today, HDPE has replaced glass for bottles and metal for pails, drums, gas tanks, and is used for many other applications including packaging, and pipeline components and systems. According to a PLASTICS NEWS December 2016 report, the sales of HDPE in North America and Mexico are nearly 16 billion pounds with more capacity coming on-stream this year.

For pipe, the grade of HDPE used now is very different from early generation materials, and even very different from other HDPE materials used in today's consumer applications – like packaging, film, bottles, etc. Pipe grade HDPE is a highly-engineered compound that is designed for long-term service in critical applications and put through a series of rigorous testing procedures before it is available for manufacturing.

Solid wall HDPE pipe began replacing metal pipe in oil and gas gathering systems in the late 1950's. In the early 1960's gas utilities started replacing failing iron pipes with polyethylene, and because of its successful performance history, 95 percent of all new gas distribution systems installed today are PE pipe. Soon, corrugated HDPE pipe started to replace clay pipe in agricultural drainage systems. Then in the late 1980's large diameter corrugated HDPE pipe began to replace metal and concrete in storm water culverts. The material itself has continued to evolve into what is now their third and fourth generation of development, each with improved performance capabilities.

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Thermoplastic piping systems are sustainable and environmentally responsible for pipe selection. They are energy efficient during manufacturing and provide peak protection from contamination during service. Plus, they require significantly less energy to fabricate, transport and install than metal or concrete alternatives. With superior resistance to corrosion and abrasion, plastics piping systems also supply long service life, excellent joint performance and offer leak-free protection – all adding up to exceptional value.

First for Farms

For centuries, farmers knew that proper field drainage, along with irrigation, was a key part of increasing crop yields and used clay tiles. Research studies show that soybean yields increased 43 percent and corn 30 percent when fields are 'tiled'.

With the advent of HDPE resin and the ability to make corrugated pipe, the ag market became the starting point of more pipe development. In less than one generation, corrugated HDPE pipe displaced a product that had been used for hundreds of years. Larger diameters soon followed to provide for new applications especially in DOT and other public storm drainage projects.

Polymer for Performance

A pipe grade HDPE resin is a compound and consists of a polyethylene copolymer, also known as the resin, to which colorants, stabilizers, antioxidants and other ingredients have been added to enhance the properties of the material. The formulation yields HDPE pipe which is very tough, durable and strong.

HDPE pipe materials are almost exclusively classified as thermoplastics because they soften and melt when sufficiently heated and then harden when cooled. This process can also be reversed, allowing the resin to be recycled into other applications at the end of the pipe's service life.

As one of the most tested materials, HDPE pipe provides performance that has been widely documented, and is persistently being validated through ongoing laboratory research and in decades of 'in-field' service. Design engineers in other utilities continue discovering benefits and identifying new uses for HDPE products. For example, because polyethylene produced for pipe is an engineered resin, it provides the pipe with a very favorable strength-to-weight ratio. Some of the reasons for HDPE pipe's wide and varied applications include the material's ease of handling and freedom from attack by soils, chemicals, ambient water and moisture. And it will not corrode or rust. Because HDPE is a non-conductor of electricity, it is immune to the electrochemical-based corrosion process that is induced by electrolytes such as salts, acids and bases.

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HDPE pipe is not vulnerable to biological attack or tuberculation, is resistant to bio-clogging, and maintains high, consistent flow capacities throughout the service life of each system. This translates into less wear and tear providing significant savings to an operating utility.

In addition, miles of corrugated HDPE pipe can be installed quickly because diameters less than six inches can be purchased in large coiled reels with thousands of feet of pipe, especially to tile farm fields.

Codes for Compliance

Beyond the standards for the material formulated to make corrugated HDPE pipe, it is important to note that the pipe is manufactured, certified, and installed in accordance with numerous industry standards from organizations such as AASHTO, ASTM, CSA Group and the American Railway Engineering and Maintenance-of-Way Association (AREMA). Plus, it is approved for use by the FAA and Departments of Transportation, and other federal and local agencies. These national standards are regularly reviewed by the variety of industry organizations and their memberships. Efforts are continually made to keep the standards current, enhance and strengthen test criteria and advance for raw material and post-manufactured pipe. The testing protocol can be extensive and even extreme. For example, one test for the railroad industry was conducted by the Transportation Technology Center, Inc. at the Facility for Accelerated Service Testing (FAST) in Pueblo, Colorado where it operates a test bed for railroad track. The methodology for this test included repeatedly running a train consisting of four locomotives and eighty rail cars weighing 315,000 pounds over 48-inch corrugated HDPE pipe with just four-feet of cover between the top of the pipe and the bottom of the rail. In addition to the dynamic performance evaluation, the long-term impact of heavy, static loads on the pipe was assessed by parking the cars, with one set of wheels on the track directly over the same pipe for six weeks. Following this test and upon review of accumulated data, the approved use of HDPE pipe was added to the AREMA manual.

By submitting products and passing independent tests, manufacturers assure customers that their products meet the requirements of the standards, including the requirements on physical properties, joining, and installation methods.

Coupling Confidence

Initially, the only joining mechanisms for corrugated HDPE pipe were banding couplers that secure two plain-end pipes together to form a soil-tight connection. This type of coupler is still commonly used in agriculture applications, when making fitting connections in the field, and in other applications. Higher

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integrity joints between pipe sections were developed during the 1980's with bell-bell coupling systems, typically used more for sanitary sewer than storm water drainage systems. Then the integral bell and spigot type coupling was perfected. This remains the most commonly used joining method for dual-wall corrugated HDPE pipe. The next generation of couplers has an extended inner sleeve which provides more engagement for the pipe sections. This can help in situations where watertight integrity is needed and where field verification tests are performed on the joints.

Future Unfolds

While today, corrugated thermoplastic pipe is available in sizes up to a 60-inch diameter, there are projects currently underway by machinery manufactures to make the pipe in 72 and even 84-inch diameters.

One of the latest developments in the United States is the availability of polypropylene pipe in diameters up to 60 inches with a structural core that provides higher stiffness and beam strength. The engineered grade of polypropylene is resistant to chemicals, even sulfuric acid found in sanitary sewer lines.

The practicality of HDPE and polypropylene pipe systems has become recognized. These materials are now being used in greater volumes for sewer and drainage projects. Resin availability is increasing; pipe manufacturers are adding production capacity; and new developments in both raw materials and pipe system designs are illustrating thermoplastic pipe applications are smart and reliable choices. The industry will continue engaging in advancements - just as the industry has done for more than a half a century. As a thoroughly vetted and progressive solution, thermoplastic pipe systems will be delivering exceptional services and meeting the world’s demands for generations to come.

For additional information, go to the Plastics Pipe Institute's website: www.plasticpipe.org.

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About PPI:

The Plastics Pipe Institute, Inc. (PPI) is the major North American trade association representing all segments of the plastic pipe industry and is dedicated to promoting plastic as the materials of choice for pipe and conduit applications. PPI is the premier technical, engineering and industry knowledge resource publishing data for use in the development and design of plastic pipe and conduit systems. Additionally, PPI collaborates with industry organizations that set standards for manufacturing practices and installation methods.