# High-Pressure Plastic Pipe Materials

In this program, researchers evaluated the use of Polyamide 12 (PA12) polyethylene pipe for high-pressure gas-distribution applications. The introduction of new plastic materials — such as PA12 piping (designed to operate at pressures between 100 to 300 psig) — will allow utilities to use plastic pipe at higher pressures and temperatures than possible with current plastic materials.

## *Project Description*

The objective of this project was to evaluate the technical feasibility of using Polyamide 12 (PA12) piping systems at higher operating pressures and larger diameters than conventional plastic gas-distribution piping, without sacrificing flow capacity.

## *Deliverable*

Following a regimen of extensive testing of PA12 materials, researchers developed a comprehensive data base of the physical properties of PA12 pipe and established construction, maintenance, and operating requirements. In addition, PA12 samples were provided to interested OTD members for further evaluation and small-scale field installations.

## *Benefits*

Gas utilities could enhance their system operations throughput if lower-cost plastic piping systems could be used at higher pressures.

It is estimated that the installed cost of PA12 pipe will be less than 30-50% of the installed cost for similarly sized steel pipe. Because the installation procedures for PA12 are similar to that of polyethylene (PE) pipe, minimal crew training is required.

Currently, use of steel pipe is the only accepted alternative for the distribution of natural gas at pressures above 125 psi. With steel pipe, companies must use straight sticks of pipe, and adjacent sections must be welded and/or mechanically coupled. This not only adds to the cost of installation, but also creates potential leak sources. The cost of corrosion protection and maintenance for steel mains can be as high as $700 per mile per year. In comparison, PA12 offers most of the benefits of plastic pipe while extending the range of operating pressures and temperatures. Because of its lower expected life-cycle cost, PA12 provides an ability to also capture new markets that otherwise would be lost to competing energy sources.

## *Technical Concept & Approach*

Researchers evaluated PA12 piping through comprehensive laboratory and field tests of pipe samples up to six inches in diameter.

Primary areas of research emphasis included:

- The development of a technical data base of key mechanical, physical, and chemical properties for PA12 piping materials that can be used to establish industry standards and specifications, and
- The evaluation of pertinent construction, maintenance, and operating practices to ensure compatibility with current practices.

Since 1997, Gas Technology Institute has been investigating a similar product — Polyamide 11 (PA11) — for use at higher pressures, demonstrating the ability of two-inch-diameter PA11 pipe to operate safely at a pressure of 200 psig. Based on successful testing, program sponsors expanded its R&D initiative to other potential piping materials.

PA11 — like PA12 — is a nylon material; however, PA12 contains an extra carbon atom that has a minimal effect on chemical resistance, performance, and strength. As a result, there are no significant differences in the overall strength and long-term performance for PA12 as compared to PA11. The primary advantage for the use of PA12 as compared to PA11 is that, while there is only one current supplier of PA11 materials, PA12 is available through four resin suppliers.

There are a number of plastic pipe mechanical and physical properties that had to be determined to prove that PA12 can be used in high-pressure applications. Investigators tested the key properties that govern the structural integrity of the pipe: the ability of the pipe to bear the stresses caused by gas pressure and ensure that gas is not lost through the pipe wall and its joints.

Specific testing for structural integrity involved:

- Long-term hydrostatic testing
- Tests to determine the pipe's resistance to slow crack growth, and
- Rapid crack propagation testing.

The independent properties determined through these tests established the acceptable range of pipe sizes and service conditions for long-term performance.

A significant part of this program also involved efforts to revise industry specifications and facilitate regulatory approvals to allow for the use of PA12 in high-pressure gas applications.

Tests were conducted on PA12 materials provided by three resin suppliers — UBE, DeGussa, and EMS — to establish PA12's technical and commercial viability.

## *Results*

In addition to the completion of a variety of laboratory tests on PA12 materials from the manufacturers, three small-scale field installations were performed using two-inch SDR11 and six-inch SDR11 pipe sizes operating at 250 psig using different types of backfill materials. The cumulative results of these respective installations validate the ability to use existing construction, maintenance, and operating practices specific to PE for PA12 piping systems.

## *Status*

The program has been completed and a Final Report was issued to OTD investor companies. The cumulative results of the testing and evaluation demonstrated that the PA12 piping system appears to be a promising candidate for use at higher operating pressures in gas distribution systems.

## *For more information:*

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