Polyamide (PA11 and PA12) Use in High Pressure Natural Gas Distribution Systems: Installations and Performance Review

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Why Polyamide (PA11 or PA12)?

> In the past 40 years, the natural gas distribution industry has transformed from a near-exclusive metallic distribution piping network to a near-exclusive thermoplastic piping distribution network.

> The metal to plastic transformation has saved U.S. natural gas utilities in excess of $10 Billion in installation and maintenance costs.

### Potential Installed Cost Savings

Average Cost per ft. to Install Gas Distribution Mains

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>PE Cost/Ft ($)</th>
<th>PE Avg Cost/Ft ($)</th>
<th>Stl Cost/Ft ($)</th>
<th>Stl Avg Cost/Ft ($)</th>
<th>Cost Diff/Ft ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot;</td>
<td>4.00 - 9.32</td>
<td>6.66</td>
<td>12 - 35</td>
<td>23.5</td>
<td>$16.84</td>
</tr>
<tr>
<td>4&quot;</td>
<td>8.00 - 15.56</td>
<td>11.78</td>
<td>16 - 32</td>
<td>24</td>
<td>$12.22</td>
</tr>
<tr>
<td>6&quot;</td>
<td>10.00 - 32.00</td>
<td>21</td>
<td>33 - 75</td>
<td>54</td>
<td>$33.00</td>
</tr>
</tbody>
</table>

**PA Pipe Savings:**

1. Installed costs (including the opportunity for alternative installation methods)
2. Reduced maintenance (corrosion) costs
PA11 AND PA12

Overview

> GTI conducted a comprehensive research program to validate the feasibility of PA11 and PA12 gas piping systems
  — Lab testing and field experiments
  — Up to 6” diameters and 250 psig

> Sponsored by Operations Technology Development (OTD) and PA resin manufacturers

> Developed a full-set of installation, operation and maintenance procedures for the use of PA piping systems

> Generated a body of data supporting the use of PA11 and PA12 in high-pressure distribution systems
PA11 AND PA12

ASTM Standards

> Developed the necessary standards and listings to allow the use of PA11 and PA12

  ─ F2785 “Standard Specification for Polyamide 12 Gas Pressure Pipe, Tubing, and Fittings”
  ─ F2945 “Standard Specification for Polyamide 11 Gas Pressure Pipe, Tubing, and Fittings”
  ─ F2145 “Standard Specification for Polyamide 11 (PA 11) and Polyamide 12 (PA12) Mechanical Fittings”
  ─ Standard Specification for Butt Heat Fusion Polyamide (PA)
  ─ and more…
PA11 AND PA12

Field Evaluations

> Over 10 years of actual in-service performance
  ─ Up to 250 psig (17 bars) operating pressure
  ─ Up to 6” pipe

> Basis for permitting the use of PA11 and PA12 by revising 49CFR Part 192 (Federal Code)
PA11 AND PA12

Field Demonstrations

> Several field demonstrations were performed to evaluate the handling, installation process, in-service stress conditions, etc.

> Installations used various pipe sizes, climatic conditions, pressures, fittings, and installation practices
PA11 AND PA12

Field Demonstrations

- Coiled and stick PA pipe
- Heat and electrofusion processes
- And more…
PA11 AND PA12

Butt Fusions

> Developed and evaluated butt fusion procedures
> Trained and certified operators
PA INSTALLATION

6” Pipe for National Fuel

> 6” SDR 11 pipe approximately 800’ in length operating at 250 psig (17 bars)

> Connected using qualified PA12 joining procedures and 6” PA12 EF Couplings

> Pressure test to 375 psig (26 bars)

> Installation completed in 2006

Wet and Cold Environments plus tight bend radius – 250 psig
PA INSTALLATION

4” Pipe for WE Energies

> Wisconsin installation
> Cold environment – 250 psig (17 bars)
> All butt fused joining
PA INSTALLATION

4” Pipe for MichCon (DTE Energy)

> Cold environment – 330 psig (22 bars)

> Combination of electrofusion and butt fusion joining

> Pressure test at 450 psig (30 bars)
PA INSTALLATION

Georg Fischer Central Plastics

Hyperplast Piping System (PA11 resin)
PA INSTALLATION

Atmos Energy Steel Replacement

<table>
<thead>
<tr>
<th>Location</th>
<th>Length (Feet of Pipe)</th>
<th>Size</th>
<th>Installation Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project 1 Frost, TX</td>
<td>6,000</td>
<td>4&quot;</td>
<td>2010</td>
</tr>
<tr>
<td>Project 2 Coolidge, TX</td>
<td>55,440</td>
<td>4&quot;</td>
<td>2010</td>
</tr>
<tr>
<td>Project 3 Grossbeck, TX</td>
<td>7280</td>
<td>4&quot;</td>
<td>2010</td>
</tr>
<tr>
<td>Project 4 Hubbard, TX</td>
<td>16040</td>
<td>4&quot;</td>
<td>2011</td>
</tr>
<tr>
<td>Project 5 Frost, TX addition</td>
<td>7600</td>
<td>4&quot;</td>
<td>2011</td>
</tr>
<tr>
<td>Project 6 Waco, TX I-35 Bore</td>
<td>600</td>
<td>4&quot;</td>
<td>2011</td>
</tr>
<tr>
<td>Project 7 Grossbeck, TX add-on</td>
<td>14,000</td>
<td>4&quot;</td>
<td>2011</td>
</tr>
<tr>
<td>Project 8 Priscilla TX and Hubbard</td>
<td>24,000</td>
<td>4&quot;</td>
<td>2012</td>
</tr>
<tr>
<td>Project 9 Ferris TX</td>
<td>23,360</td>
<td>4&quot;</td>
<td>2012</td>
</tr>
<tr>
<td>Project 10 Various (service tubing, risers, transitions)</td>
<td>2,000</td>
<td>1&quot;</td>
<td>various</td>
</tr>
</tbody>
</table>

Total Footage to Date 156,320
Miles of Pipe 29.61
Meters 47,652
PA INSTALLATION

4” PA11 Pipe for Atmos Energy
PA INSTALLATION

4” Pipe for PA12 Energy West

> 4” SDR 13.5 pipe approximately 3 miles in length operating at 160 psig (11 bars)

> Connected using qualified PA12 joining procedures

> Pressure test to 342 psig (24 bars)

> Installation completed July/Aug 2009
PA INSTALLATION

4” Pipe for PA12 Energy West
PA INSTALLATION

4” Pipe for PA12 Energy West
PA INSTALLATION

1” PA12 Services for Energy West

> Electrofusion fittings and PA tubing used to provide gas service to homes along the route
  
  — 1” PA tubing
  
  — Electrofusion fittings

> Service tees, EFVs, and anodeless risers
PA INSTALLATION

6” Pipe for PA12 Atmos Energy

> Mississippi installation
> 6” SDR 13.5 pipe approximately 1500’ in length operating at 160 psig (11 bars)
> Connected using qualified PA12 joining procedures
> Pressure test to 300 psig (21 bars)
> Installation completed August 2009
PA INSTALLATION

6” Pipe for PA12 Atmos Energy
PA INSTALLATION

2014 PA12 Project (In Progress)

> Install 4” SDR 11 industrial line from cogeneration plant to chemical plant

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Dimension</th>
<th>Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTE Walbridge, Marietta OH, USA</td>
<td>Aug 2014</td>
<td>4” SDR 11</td>
<td>200 psig (14 bars)</td>
</tr>
</tbody>
</table>
PA Piping System Advantages

> **Operating Considerations**
  - Can operate up to 250 psig (17 bars)
  - Coil and stick pipe available
  - Diameters up to 6”
  - Uses same equipment that you already use for PE

> **Benefits**
  - Lower installation costs compared to steel piping systems
  - Eliminates maintenance costs due to corrosion protection
  - Similar benefits of using PE pipe but can now be extended for applications up to 250 psig
PA Piping System Advantages

Available Piping Systems:

> Various fittings currently exist including:
  
  ─ Inline fittings
  ─ Couplings
  ─ Tees
  ─ Risers and transitions
  ─ Excess flow valves
  ─ And more…

> Multiple resin, pipe, and fitting suppliers
Connect With Us

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