Advantages of high quality PE pipe materials

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Creating value in Pipe - basic human needs

- Water supply
- Energy supply (gas, oil, hot water)
- Sewage disposal
- Telecom

Roman times . . .

. . . and today
In Europe, PE&PP pipes have an impressive track record

- 1950’s - first PE pressure pipe installed
- 1970’s - second generation PE for water and gas
  - crosslinked PE (PEX) for hot water
- 1980’s - PP pipe systems for new applications
- 1990’s - bimodal PE100 introduced
  - higher pressures and larger pipes
  - PO pipe markets grow at 6%
- 2000 - high momentum into the new millennium
Key success factor for PE pipes: Flexibility

- Long lengths in coils
- Curving trenches
- Modern installation techniques
  - relining
  - horizontal drilling
  - plowing in
Key success factor for PE pipes:
Weldability

- Cost effective butt welding
- Safe and practical electrofusion
- Leak tight pipeline
  - earthquakes
  - ground movement
  - tree roots
Key success factor for PE pipes: Water neutrality

- No corrosion
- Neutral towards drinking water
- No encrustation
- Low coefficient of friction
Key success factor for PE pipes: Positive image

- Innovation / new generations
- High level of standards
- Safe for gas transportation
- Environmentally friendly
- 100 years reference design time
Water distribution mains and service pipes
Strong PE penetration is foreseen in the diameters above 180 mm

Sources: CDC 1999
Typical estimated installation cost for water pipe

Pipe diameter (mm) vs. Index

- PE100
- PE80
- Ductile Iron
Earthquake pipe failure statistics: Armenia, Colombia

<table>
<thead>
<tr>
<th>Material</th>
<th>Installation Length (km)</th>
<th>Failures per km</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC (water)</td>
<td>99.95</td>
<td>0.80</td>
</tr>
<tr>
<td>Ductile iron (water)</td>
<td>5.69</td>
<td>0.00</td>
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<tr>
<td>Asbestos cement (water)</td>
<td>221.9</td>
<td>0.95</td>
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<tr>
<td>Steel reinforced concrete (water)</td>
<td>1.14</td>
<td>0.00</td>
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<tr>
<td>Galvanised steel (water)</td>
<td>3.81</td>
<td>0.52</td>
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<tr>
<td>Cast iron (water)</td>
<td>1.03</td>
<td>0.97</td>
</tr>
<tr>
<td>Polyethylene (gas)</td>
<td>115.13</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Sources: EPA Colombia, March 1999 and Gases del Quindio E.S.P. Colombia, 1999
Balance of mechanical properties

Long Term Hydrostatic Strength (MRS)

Slow Crack Growth (SCG)  Rapid Crack Propagation (RCP)
Dispersion of additives

Microscope photo of pipe made of natural resin and master batch (100X magnification)
Drinking water quality

Rigorous oganoleptic testing of pipes and granules
Test on real pipe systems to confirm quality
Minimum safety factor of 1,25 for water allowed because:

- Experience with extrapolation methods
- Documented, ready made compounds
- Combination of tests done on pipe and compounds
- System standards (Type test, PVT, BRT)
- Positive track record
Australia case: quality pipes for long lifetimes
Hammersley water transportation project, Australia: project requirements

- Supply of water to a large, remote iron borefield
- Water requirements of 200 l/s
- 60 km of 500 mm pipeline (3000 tons of PE100 material)
- Very stony, uneven and hot terrain
- Corrosive soil and alkaline water
- 20 years service life with low maintenance
Hammersley water transportation project, Australia: cost effective installation
Hammersley water transportation project, Australia: trouble free operation

- Pipeline has been in operation since 1995
- Very few maintenance stops to repair minor welding problems
- No problems with the pipe material
  steel pipeline estimated lifetime: 6 months
- Hammersley is generally happy with their choice of pipe material
Case Story: Indian PE pipe history and relaunch

- HDPE pipes introduced in 1969 followed by decade of steady growth to 35 ktons

- Poor quality pipes in market
  - poor uv stabilisation
  - unsuitable master batch
  - no technical support

- Brittle failures resulted in loss of confidence, AP province ban in 1982 and stagnation

- Two high profile PO pipe seminars in November 2000
  - Mumbai
  - Hyderabad (AP province)

- Establishment of Indian Polyolefin Pipe Association in progress
Weak or poorly enforced raw material standards: everybody loses

Polymer Producer  Pipe Producer  Designer/Consultant  Infrastr. Owner  Consumer

Commoditisation  Unclear design conditions  Poor water quality
Limited commitment  Reputation  Loss of supply
Limited development  Loss of confidence  Repair time & damage

Claims  Water quality/loss
Reputation  Loss of confidence
Commoditisation  Repair/maintenance costs
Conclusion and outlook for the future

- PE water pipe systems have had very strong growth and an impressive track record

- High level of standards and approvals are critical to sustain this growth

- PE pipe industry will remain strongly committed to the water segment