PE Gas Distribution Pipes
Some Key Quality Issues

David Walton, PE100+ Association
Contents

• Background and scope of the PE100+ Association
• Key success factors for pipes made from PE
• PE Pipe model and material quality considerations
• New Developments
• Concluding remarks
PE100+ Association

- Founded on 24th February, 1999 by Borealis, Elenac and Solvay
- Consisting of eight member companies currently - Borealis, Borouge, Ineos, LyondellBasell, Prime Polymer, SABIC, SCG Plastics and Total Petrochemicals
- Supported by Advisory Committee and working closely with other associations
Founding Scope of PE100+ Association

- **Establish** a quality label for PE100+ products
- **Assure** consistent quality at the highest level in the production and application of PE100 pipe materials
- **Promote** usage of PE piping systems in general
- **Focus** towards end-users with more information support
- **Welcome** any polyethylene manufacturer whose materials comply with the enhanced requirements of the PE100+ Association
What does the ‘+’ in PE100+ represent?

• Certified PE100 material consistency of 3 critical properties due to regular testing cycle

• Promotion of quality beyond the raw material to the entire chain of pipes & fittings, installation and maintenance

• Peace of mind due to use ready made compounds without the influence of MB compatibility/consistency, poor homogenisation during extrusion and incomplete testing/certification
# Technical Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>EN/ISO Standard Requirement</th>
<th>PE 100+ Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creep Rupture Strength</td>
<td>Internal pressure test at 20°C and 12.4 MPa</td>
<td>&gt; 100 h</td>
<td>&gt; 200 h</td>
</tr>
<tr>
<td></td>
<td>ISO 1167</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stress Crack Resistance (SCG)</td>
<td>Pipe notch test at 80°C and 9.2 bar</td>
<td>&gt; 500 h</td>
<td>&gt; 500 h</td>
</tr>
<tr>
<td></td>
<td>ISO 13479</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistance to Rapid Crack Propagation (RCP)</td>
<td>S4 test at 0°C</td>
<td>Pc&gt; MOP/2,4 – 13/18</td>
<td>&gt; 10 bar</td>
</tr>
<tr>
<td></td>
<td>ISO 13477</td>
<td>Pc: critical pressure</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>MOP: max. operat. pressure</td>
<td></td>
</tr>
</tbody>
</table>

All tests are performed on 110 mm SDR 11 pipes
Test Rounds

Every 7 months

15 pipes

Each 5 pipes

Bodycote, IIP
Notch Test

TGM
Internal Pressure Test

Becetel
S4 Test

Administrator
GASTEC

Administrator
KIWA/GASTEC

Results

Quality Materials List
PE100+
Association

Manufacturers
<table>
<thead>
<tr>
<th>Product MANUFACTURER</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Borsar® HE3490-LS (black)</td>
<td>Borstar® HE3492-LS (orange)</td>
</tr>
<tr>
<td>Borstar® HE3494-LS (blue)</td>
<td>Borstar® HE3490-LS (black)</td>
</tr>
<tr>
<td>ELTEX® TUB 121 (black)</td>
<td>ELTEX® TUB 125 N 2025 (orange)</td>
</tr>
<tr>
<td>ELTEX® TUB 124 N 2025 (blue)</td>
<td>ELTEX® TUB 121 N 3000 (black)</td>
</tr>
<tr>
<td>Hostalen CRP 100 black</td>
<td>Hostalen CRP 100 blue</td>
</tr>
<tr>
<td>HI-ZEX® 7700 MBK (black)</td>
<td>EVL-H® SP 5505 BK (black)</td>
</tr>
<tr>
<td>SABIC VESTOLEN® A 6060 R (black)</td>
<td>SABIC VESTOLEN® A 6060 R (blue)</td>
</tr>
<tr>
<td>EL-LENE H1000PC (black)</td>
<td>HDPE XS10H (blue)</td>
</tr>
<tr>
<td>HDPE XS10B (black)</td>
<td>HDPE XS10 Orange YCF</td>
</tr>
</tbody>
</table>

Valid until October, 2009
In addition to the Quality Materials List...

Focal Points:

1. Technical topics: To respond to industry technical issues (e.g., Butt Welding Project)
2. East Europe: To set industry standards together
3. Build strong quality image outside Europe: Turkey, India, China, N. America (through PPCA)
4. Continue promotion with industry co-operation: To Create Trust in high quality PE
In 2009 seminars are planned in Turkey, Romania, China & Dubai
south america, brazil, chile, argentina
china
australia
india
iran
south-east asia
south africa
global water
in moraco
stwangje, 16/02/2004
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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 electro fusion
- Leak tight pipeline
  - Earthquakes
  - Ground movements
  - Tree roots
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 life
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Pipe Material Performance Matches Today’s Demands

- Product consistency has increased allowing lower safety factors to be safely implemented.
- “Ready made” compounds are tested by the raw material supplier over a long period of time to demonstrate compliance with the MRS value.
- This level of quality and consistency cannot be achieved by blending natural polymer and additive masterbatch on the extruder.
Balance of mechanical properties

Long Term Hydrostatic Strength (MRS)

Slow Crack Growth (SCG)  Rapid Crack Propagation (RCP)
Long term hydrostatic strength
Long term hydrostatic strength

Now excluded from the ISO specifications ISO4437 & ISO4427
Dispersion of additives

The demand on proper homogenisation can only be met by high quality “ready made” raw material compounds. The requirements are described in ISO 18553.

Unacceptable homogenisation by a single screw pipe extruder (natural resin & master batch)

Perfect homogenisation of 2,25% carbon black by professional compounding equipment

Image taken from ISO 18553
PE pipe model

- Purpose to educate and inform decision makers about PE
- Updated by Jason Consults and Webmaster with expert inputs
- view it on www.pe100plus.net (soon in Chinese!)

- Introduction
- Disclaimer

- Design
- Materials
- Construct.
- Operation
- Maintenance
- Environment

- ISO Standards
Test on real pipe systems to confirm quality

Full scale... ...and internal pressure test
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New Developments based on PE100

• Changing the parameters in the bimodal process enables materials to be “tailor – made” for specific applications.
• Recent developments include
  – PE100 materials for injection moulding
  – High stress crack PE100 materials
  – Others to follow............
High Stress Crack Resistant Materials

• Why do we need these materials?
  – Installation conditions are getting tougher
  – Pipes can get damaged during installation
  – Pipes can experience damage during operation from stones in the backfill material

• How can we evaluate these materials?
  – Need to meet all PE100 requirements
  – Plus increased stress crack resistance for which new tests are required
High Stress Crack Resistant Materials

- New Point Load Test
  - DVGW have adopted a new test - Point Load Test for directional drilling & pipe bursting
  - Simulates stone loading
  - Crack growth accelerated by use of a stress cracking agent and high temperature
  - Sample must pass 8760 hours without failure

- Shorter term FNCT Test Used for Quality Testing
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The High Demands on PE Pipe Materials

• The full cost benefits from PE pipes comes for installation savings due to the flexibility and fusion capabilities of PE.

• High on the benefit list is the ability to use a range of No-Dig methods to renovate old gas and water mains.

• These techniques impart external damage to the pipe which must not develop into cracks.
The High Demands on PE Pipe

• PE pipes are also getting larger in diameter and thicker walled - demanding higher toughness from the PE raw materials.

• Today, PE pipes are also used at higher pressures and with a lower design factor demanding greater consistency of performance.
The Need for High Quality

- PE pipes are replacing products that have performed well and must achieve similar targets.
- These demands can only be met by high quality “ready made” raw material compounds.
- International specifications have been updated to bring in additional safeguards.
- The PE100+ Association has set the additional requirement of consistency by regular testing.
Thank you for your attention