New generation of pre-insulated Thermoplastic Reinforced Service (TRS) pipes for DH networks

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Flexible pre-insulated pipes have proven track record in district heating networks. High reliability and ease of use allowed them to become one of the key components in modern hot water based heating applications.

Benefits of Plastic Flexible Pipe solutions:

- **Plastic solutions**
  - No corrosion

- **Flexibility**
  - Convenient and low cost installation

- **Long length**
  - Fast installation – minimal time loss

- **Less fittings**
  - Quality no weld joining
Typical flexible pre-insulated pipes consist of mono-layer plastic liner, polymer heat insulation foam and protective outside jacket.

Conventional PEX monolayer pre-insulated DH and Hot Water flexible plastic pipes have application limits in working temperatures, working pressures and maximum coilable diameters:

- Max work. temperature (short-term) - 95°C
- Max work. pressure for big diameter pipes (Ø63-160mm) - 0.6 MPa
- Max coilable diameter of 0.6 MPa (SDR 11) carrier pipes - Ø140 mm
- Max coilable diameter of 1.0 MPa (SDR 7.4) carrier pipes - Ø63 mm
Rigid pre-insulated steel core pipe systems (KMR) can be used in many DH network applications in a wide range of temperatures (typically up to 130°C), pressures (typically up to 2.5 MPa), and diameters (typically up to 800 mm).

Due to their rigid structure and steel cores, KMR pipes have several problems:

- **Steel core**
  Corrosion potential

- **Short lengths**
  Labor intensive, long and costly installation

- **Rigid design**
  Complex solutions

- **Welded connection**
  Joining quality, weld corrosion
Due to physical limits, conventional flexible plastic pre-insulated pipes can be used in limited DH Network applications.
Thermoplastic Reinforced Service (TRS) DH Pipes

**West European DH Network applications**

<table>
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<th>Application</th>
<th>Pressure (MPa)</th>
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<tr>
<td>Biomass DH</td>
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<tr>
<td>Local DH</td>
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<tr>
<td>Second Loop</td>
<td>0.6</td>
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<tr>
<td>Second Loop Plus</td>
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<th>Temperature (°C)</th>
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<th>First Loop Plus</th>
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**East European DH Network applications**

Elevated working temperature and pressure Thermoplastic Reinforced Service (TRS) pipes were initially developed for East European mega district heating networks with special requirements in higher temperature, higher pressure and larger pipe diameter applications.
**First Generation of TRS Pipes**

**TRS 95R-10** – the first generation of TRS pipes was developed and implemented in 2004 for East European *Second Loop* DH application with following technical requirements:

- **95°C** max temperature for variable conditions
- **80°C** continuous operating temperature for 30 years service life (*according to EN 15632*)
- **1.0 MPa** working pressure
- **40 ÷ 160 mm** service pipe diameter range

High-modulus fiber reinforced mesh was applied to withstand required pressures without pipe wall thickness increase.

Unique *extra-flexible* construction allows to broaden pipe diameter range from 40 mm to up to 160mm – a significant step for 1.0 MPa pre-insulated flexible pipes.
Additional Benefits of TRS Pipes

Due to reduced carrier pipe wall thickness, TRS 95R-10 has smaller carrier pipe OD compared to conventional flexible monolayer plastic solutions, which allows for larger carrier pipe diameters, makes the system more flexible and better insulated with the thicker PUR layer.

Thermal self-compensation caused by low aramid mesh thermal expansion coefficient is another significant benefit of TRS pipes.
Modern polymer materials, pipe multi-layer and reinforced structure concepts, together with sophisticated process control tools and innovative equipment solutions allowed to design and implement in 2010-2011 heating season **TRS 115R** pipes - the second generation of TRS pipes with *increased both working temperatures and pressures*:

- **115°C** working temperature (short-term)
- **1.6 MPa** working pressure

**New design features:**
- Optimized fiber mesh structure
- High temp adhesive layers
- Improved stabilization package
- Leak detection for plastic pipes

**TRS 115R-16 Structure:**

1. **PEXa liner**
2. **High temp. adhesive**
3. **Aramid fiber high temp. composite**
4. **High temp. adhesive**
5. **Oxygen barrier**
6. **Core pipe jacket**
7. **Polyurethane foam**
8. **Diffusion barrier jacket**
9. **All-in-one leak detection system**
TRS 115R-10 pipes were developed for typical East European elevated temperature Second Loop DH networks with a following technical requirements:

- **115°C** max temp for variable conditions
- **105°C** continuous operating temp for 30 years service life (100°C currently confirmed, 105°C confirmation in progress)
- **1.0 MPa** working pressure
- **40 ÷ 160 mm** service pipe diameter range

TRS 115R-16 pipes with improved fiber reinforced elevated temperature composite provide **1.6 MPa** working pressures at **105°C** continuous operating temperatures (**115°C** max for variable conditions)

Optional leak detection system is designed to fit conventional KMR control units.

**Benefits:**
- Elevated temp and pressure
- 100% plastic solution
- Smooth ID surface
- Large diameters

**Challenges:**
- Multi layer process control
- Fiber winding process control
- High performance fitting design
- Unique leak detection design

1.6 MPa + 105°C + 160mm => 30 years
Designed for typical East European second loop temperature profile with maximum working temperature of 115°C pre-insulated TRS 115R-10 pipes have service life above 30 years with working pressures of P=1.0 MPa.

Hydrostatic strength tests conducted according to ISO 9080 proved required long term reliability of pre-insulated TRS 115R-10 pipes.

In comparison with TRS pipes calculated capabilities, the actual temperature profile of one of the West European Biomass DH networks during the coldest year (2006) within the last 12 years (yellow) is introduced.
Innovative fitting design with high temperature polymer sleeve provides TRS pipes user-friendly installation and higher joining reliability for large diameter pipes compared to traditional connecting solutions (no pipe expansion, low instrument clamping forces).
The new high temperature and pressure TRS 135R-10 pipe for DH networks has completed performance verification testing and 2 year pilot installations and will be commercially available for the 2015 heating season.

**Third Generation of TRS Pipes**

**TRS 115R-16 Structure:**
1. High temp. liner
2. High temp. adhesive
3. Aramid fiber high temp. composite
4. Diffusion barrier jacket
5. High temp. oxygen barrier
6. Core pipe jacket
7. Polyurethane foam
8. Diffusion barrier jacket
9. All-in-one leak detection system

**New design features:**
- Optimized fiber mesh composite
- High temp engineering resin liner
- High temp adhesive and barrier layers

- 135°C working temperature (short-term)
- 1.0 MPa working pressure
Further improved TRS 135R-16(25) carrier pipes with fiber reinforced high temperature composite will provide up to 2.5 MPa working pressures at 120°C continuous operating temperatures (135°C max for variable conditions) at maximum pipe coilable diameters up to 160mm.

- **135°C** max temperature for variable conditions
- **120°C** continuous operating temperature for 30 years service life
- **1.6 (2.5) MPa** working pressure
- **40 ÷ 160 mm** service pipe diameter range

**1.6 (2.5) MPa + 120°C + 160mm => 30 years**

This revolutionary plastic solution will allow to implement plastic flexible pre-insulated pipe system in district heating networks with high operating temperatures, where only steel pipes could operate.

**Benefits:**
- High temp and pressure
- 100% plastic solution
- Smooth ID surface
- Large coilable diameters

**Challenges:**
- Complex production process
- Multi thread mesh winding
- High pressure fitting design
TRS pre-insulated pipes were developed according to East European DH networks applications requirements. Temperature and pressure ranges of TRS pipes allow them to cover the majority of DH applications.

West European DH Network applications generally have lower operating parameters compared to East European DH networks.
Pre-insulated TRS pipe system has potential to cover a wide range of hot water based DH applications in up to 160 mm coilable pipe diameters.
TRS pipes – New Product Development Approach for Modern DH Networks

Thank you for your attention!