LOGSTOR

Are preinsulated pipe systems according to the European standards over engineered for low temperature systems

13.11.2018

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The LOGSTOR Group & global presence

Global presence

LOGSTOR Group
- Headquarters in Denmark
- 1,300 employees
- Annual turnover > 230 MEUR
- Owner: Triton Fund III

Facts:
- 7 plants and 2 mobile production units
- 14 Sales Units
- Joint Venture in Dubai
- Distributors in more than 20 countries
- More than 4,000 km pre-insulated pipes every year
- More than 200,000 km LOGSTOR pipes supplied to data
- Since February 2017 Powerpipe/Sweden belongs to the LOGSTOR Group

Different type of District Heating Pipe networks

- Transmission pipe line from the production plant to a city or between cities
  - Steel pipe systems
- Distribution pipe lines in the streets in the city
  - Steel pipe systems (to the major extend)
  - Plastic pipe systems/flexible systems
- Service pipe lines between the distribution pipe line and the final customer (appartments, institutions, one-family houses)
  - Steel pipe systems
  - Flexible systems

European standards for preinsulated pipe systems

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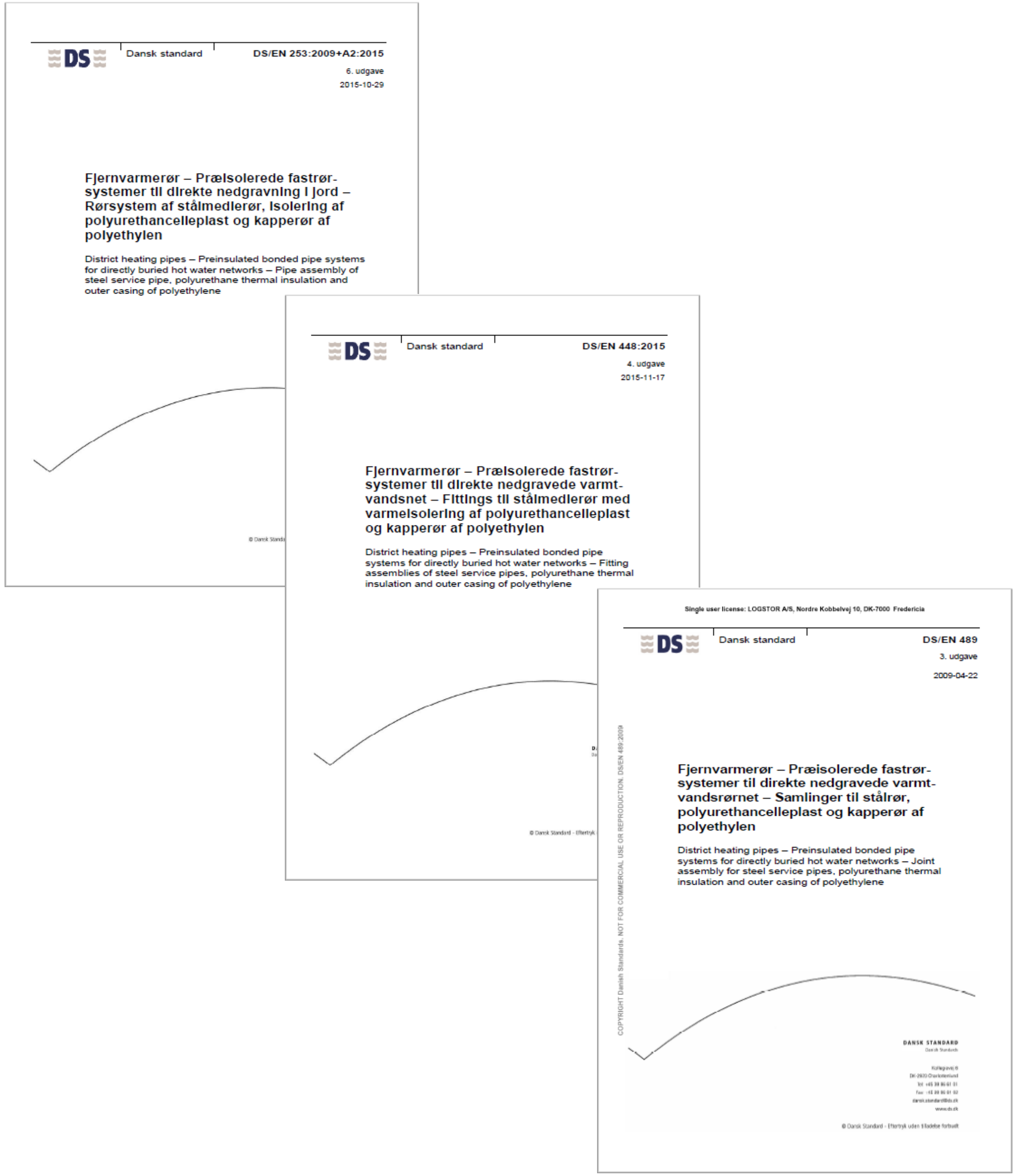
- The minimum requirements to the preinsulated components and system is defined in European standards
  - EN253 – pipes
  - EN448 – Fittings
  - EN488 – Steel valves
  - EN489 – Joints
  - EN15698 – Twin pipes (part 1 and 2)
  - EN13941 – Design and installation
  - EN14419 – Surveillance system
  - EN15632 – Flexible systems
    - Part 1 – general and test methods
    - Part 2 – Bonded plastic service pipes
    - Part 3 – non bonded system with plastic service pipes
    - Part 4 – Bonded system with metal media pipes



Scope for the standards related to steel pipes

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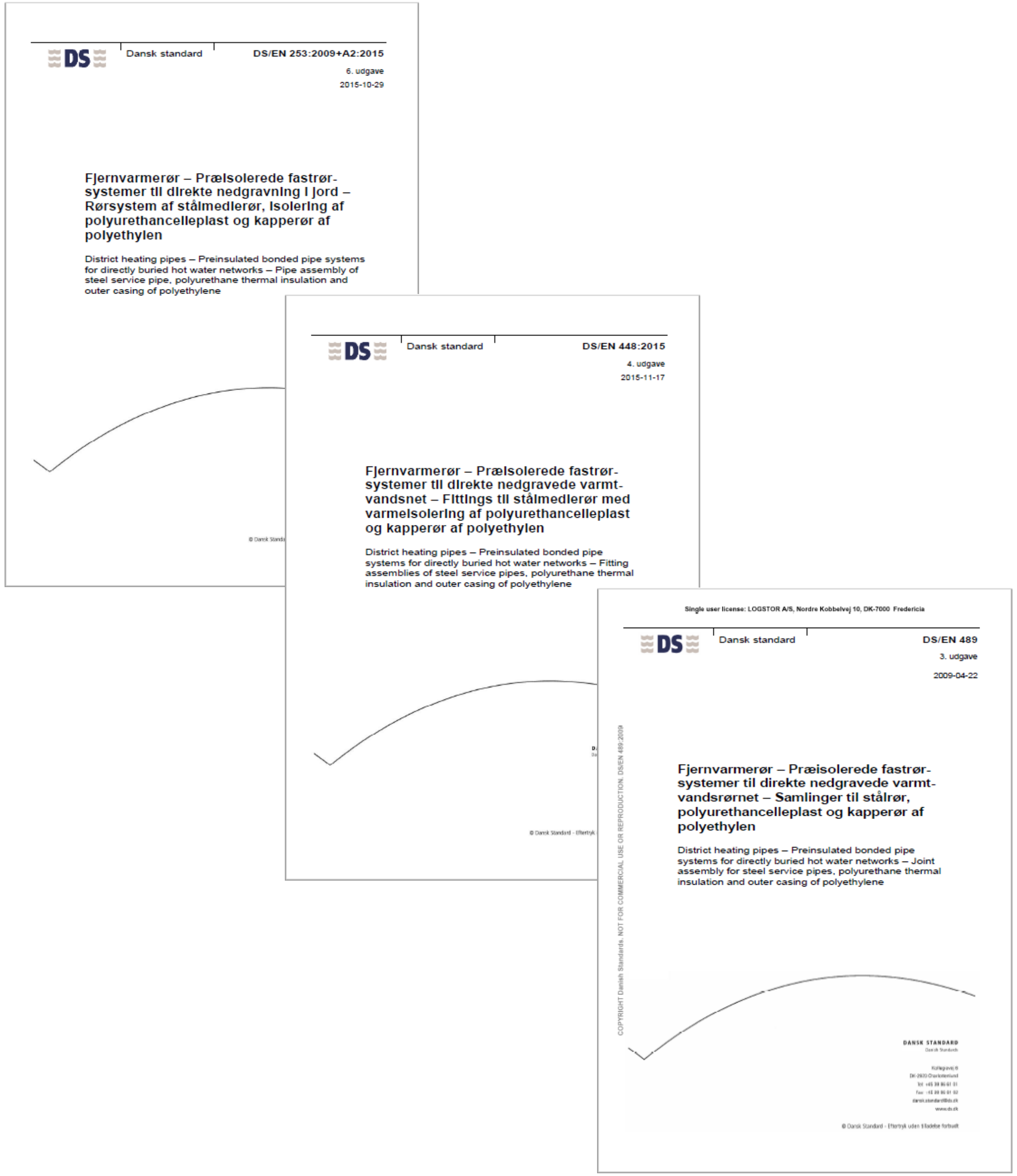
- Directly buried hot water networks
- Steel service pipe
- Minimum service life of 30 years
- Continuous operation with hot water at various temperatures up to 120 °C
- Individual intervals with a peak temperature of 140 °C. The sum of these intervals must in average not exceed 300 hours a year



DS | Dansk standard | DS/EN 253:2009+A2:2015

6. udgave

2015-10-29

Fjernvarmerør – Præisolerede fastrør-systemer til direkte nedgravning i jord – Rørsystem af stålmedierør, isolering af polyurethancelleplast og kapperør af polyethylen

District heating pipes – Preinsulated bonded pipe systems for directly buried hot water networks – Pipe assembly of steel service pipe, polyurethane thermal insulation and outer casing of polyethylene

DS | Dansk standard | DS/EN 448:2015

4. udgave

2015-11-17

Fjernvarmerør – Præisolerede fastrør-systemer til direkte nedgravede varmt-vandsnet – Fittings til stålmedierør med varmeisolering af polyurethancelleplast og kapperør af polyethylen

District heating pipes – Preinsulated bonded pipe systems for directly buried hot water networks – Fitting assemblies of steel service pipes, polyurethane thermal insulation and outer casing of polyethylene

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DS | Dansk standard | DS/EN 489

3. udgave

2009-04-22

Fjernvarmerør – Præisolerede fastrør-systemer til direkte nedgravede varmt-vandsrørnet – Samlinger til stålrør, polyurethancelleplast og kapperør af polyethylen

District heating pipes – Preinsulated bonded pipe systems for directly buried hot water networks – Joint assembly for steel service pipes, polyurethane thermal insulation and outer casing of polyethylene

4 DH heading for low temperature systems

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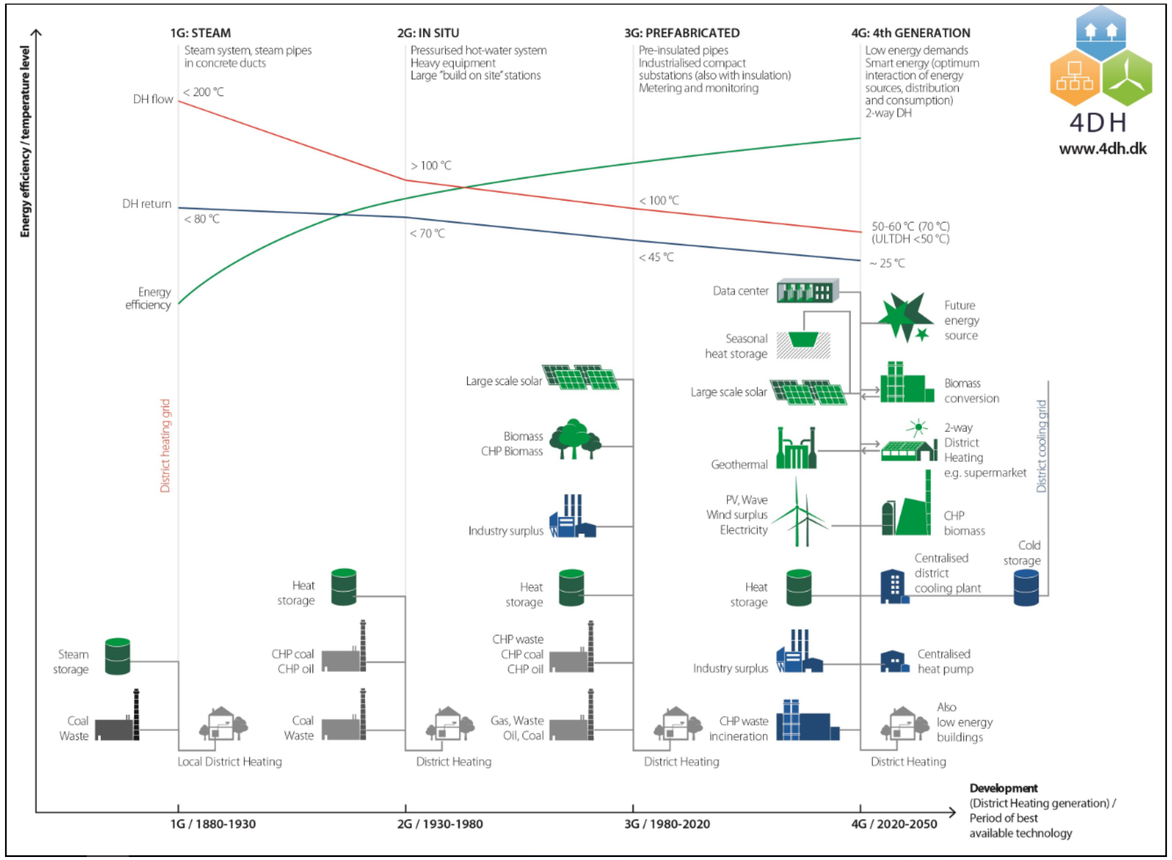
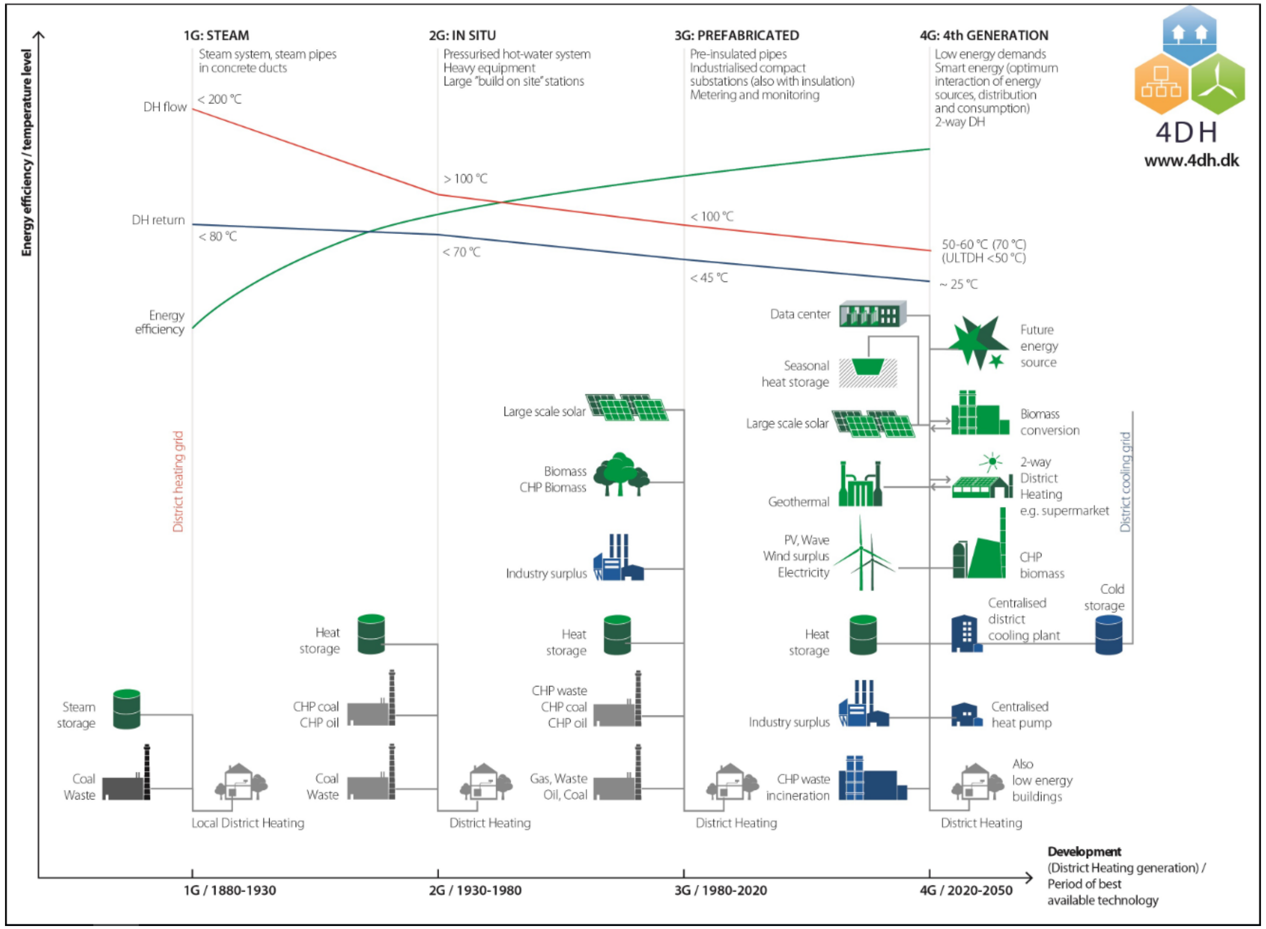
- Most projects are required to comply with the European standards no matter the actual system temperature
- 4 DH projects is heading against low temperature systems
  - A process that has started
  - It will take long time
- The risk is that preinsulated systems will be over engineered and too expensive for low temperature systems



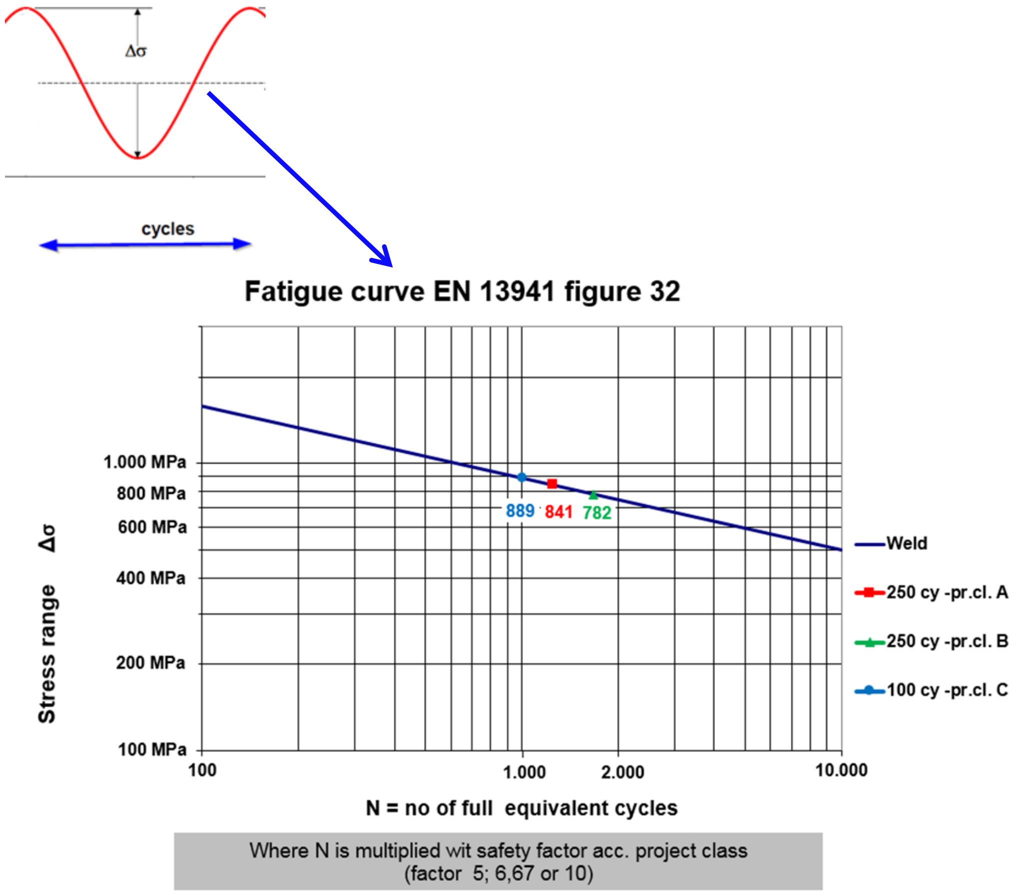
4 DH heading for low temperature systems

- Higher temperature systems gives higher cost for the
  - media pipes
  - PUR insulation
  - casing
  - specific preinsulated components
  - static design
  - contractor work
- Miss the opportunity of choosing the optimum media pipe

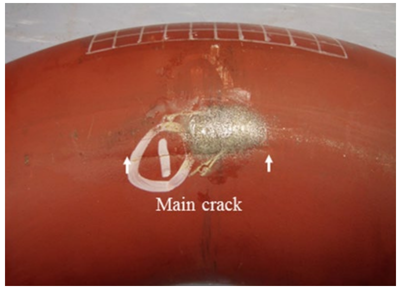


Steel media pipe

- Fatigue stress
  - According to the standard the safety factor is between 5 – 10 depending on the project class
  - For main pipe lines number of full action cycles over life time (30 years) is defined to 250 cycles according to the standard
  - In project class A (small and medium size with low axial stress) the safety factor is 5
  - So preinsulated components are calculated for 1250 full action cycles
  - With low temperature systems can we base calculations on a lower safety factor ?
  - This will result in lower cost on products and cheaper design



N	Pr-class	γ_{fat}	N_{des}	Δσ all-weld
250	A	5	1250	841 MPa
250	B	6,67	1668	782 MPa
100	C	10	1000	889 MPa



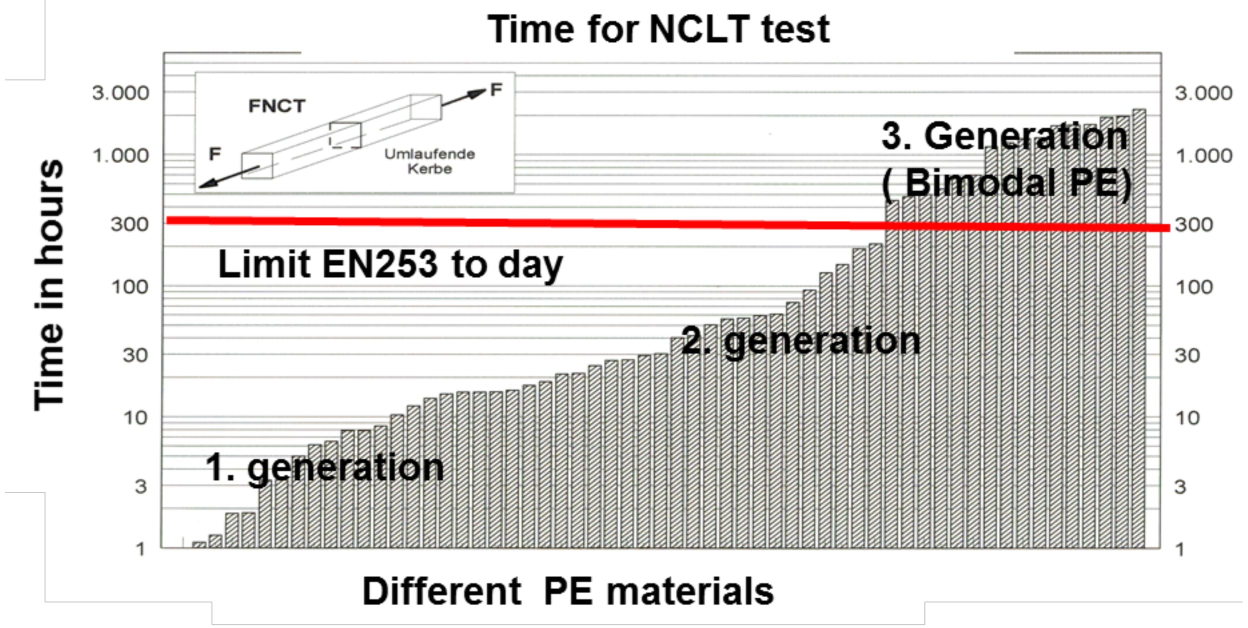
Steel media pipe

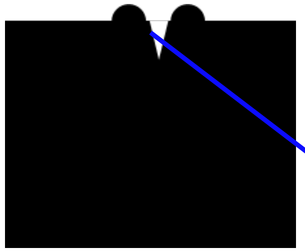
- Steel pipe quality
  - Changing from P235TR1/TR2 to P235GH
  - Mechanical proporties of P235TR1 is stated at room temperature
  - Mechanical proporties of P235GH is stated at a higher set of temperature
  - Is this needed for low temperature systems ?
  - P235GH is 7% more expensive than P235TR1
  - We have 30+ years good experience with steel 37 (P235TR1)

Requirements	TR1	TR2	P235GH
Notch bar impact test	None	At 0°C or -10°C	At 0°C or -10°C
Manufacturing method	Cold, no heat treatment	Annealed, normalized	Annealed, normalized
Weld seam excess	Inside 1.5 mm	Inside 0.5 mm + 0.05xT	Inside 0.5 mm + 0.05xT
Yield strength at elevated temperature	Not available	Not available	Available
Test certificate	2.2 – optional 3.1-3.2	3.1 – optional 3.2	3.1 – optional 3.2
Chemical analysis	Limited	Extended	Full
PED	Not allowed	Allowed	Allowed

HDPE casing

- Quality of the casing material has developped over the last decays
- Thickness of the casing is defined by requirement to withstand the following loads
  - Production
  - Stock
  - Transport
  - Installation
  - Operation where pipe is mooving in the ground
- With low temperature systems the axial moovements in the ground will be lower (Fewer full load temperature cycles). Resulting in lower load on the casing during life time
- In theory the wall thickness of the casing can be 2,5 – 3 mm independantly from the size of pipe
- Today wall thickness according to requirement in the standard is 3 – 10 mm. The higher diameter the higher wall thickness
- Potential saving is possible on low temperature systems





Failure in PE is coming from small cracks

HDPE casing

- In todays standards it is only allowed to use rework on the HDPE casing from our own production
- This is to secure that all requirements in the standard are full filled
- Think about if we could make a preinsulated pipe with casing made of different kind of rework
- Compromising some of the requirements in the standards but still good enough for low temperature pipe systems (life time minimum 30 years)

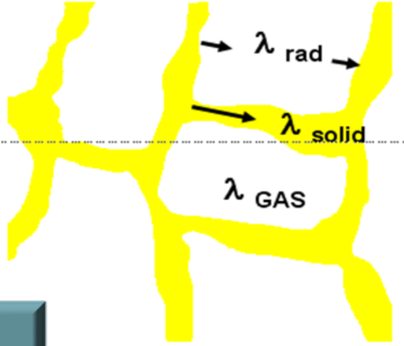
PUR (insulation material)

- In the standard there is a requirement of maximum 0,029 W/mK in lambda value
- The standard has minimum requirements to the mechanical proporties
  - Density of the foam
  - Compressive strength
  - Axial shear strength
  - Long term creep resistance
- With low temperature systems it will be possible to have lower requirements to the mechanical proporties
- When lowering the requirements to the mechanical proporties it is possible to improve the heat loss proporties
- This will lead to lower heat loss cost over life time

Heat conductivity

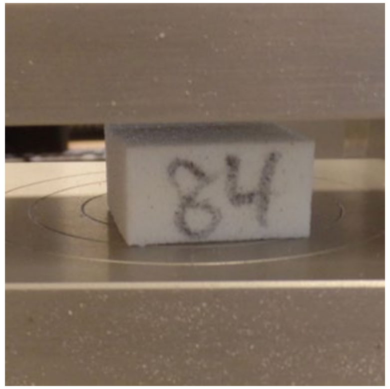
$\lambda_{PUR} = \lambda_{solid} + \lambda_{radiation} + \lambda_{GAS}$

λ_{GAS} is app. 2/3 of λ_{PUR}

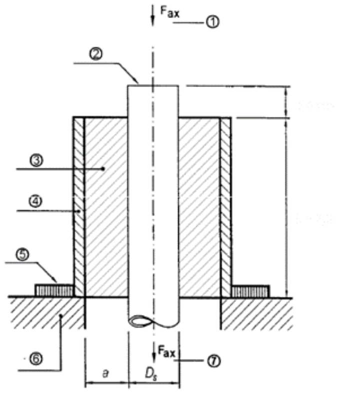


PUR foam:	Certificate / average value λ – pipe
Traditional prod.	0,0257 / 0,027 W/mK
Axial Conti prod. Spiro Conti prod.	0,0223 / 0,023 W/mK 0,0241 / 0,025 W/mK

Mechanical proporties



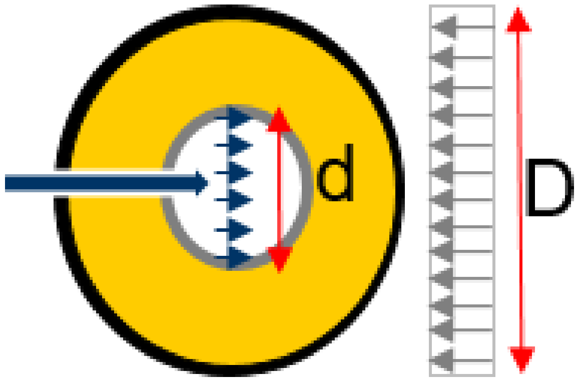
$\sigma_{compression}$



τ (sheer)

PUR (insulation material)

- Mechanical proporties
  - Creep value (compressive strength is based on max 15% deformation over 30 years with a constant load of 0,25 MPa
  - Safety factor 1,5
- Bends are in reality not laying with a constant load
- Can we use lower safety factor when systems are build with lower temperture ?
- With lower safety factor we can avoid or minimize the use of foam pads and make cheaper design



The preinsulated pipe (sandwich construction)

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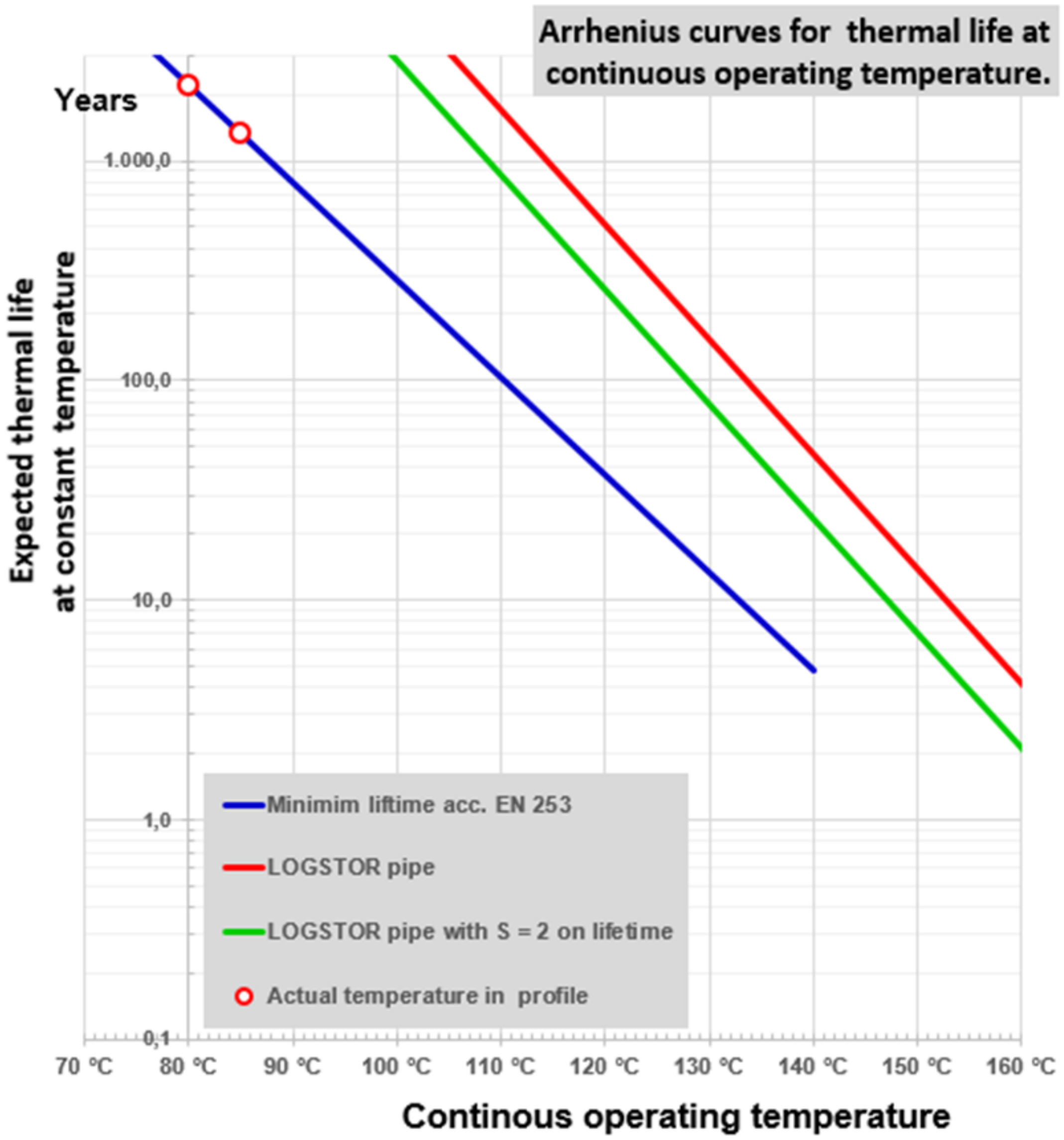

Actual temperature in profile	Expected thermal life at constant temperature		Operating period in a year for actual profile
	Minimim liftime acc. EN 253	LOGSTOR pipe with S = 2 on lifetime	
65 °C	10.193 Years	15.663.295 Years	190,0 days
55 °C	28.324 Years	139.809.575 Years	90,0 days
75 °C	3.668 Years	1.990.053 Years	64,0 days
80 °C	2.201 Years	741.127 Years	20,0 days
85 °C	1.320 Years	283.729 Years	1,0 days

Expected thermal lifetime with variations in temperature and operating period as in actual profile	
Sum of days pr year:	365 days
Max temperature in profile:	85 °C

	Minimim liftime acc. EN 253 (Blue Curve)	LOGSTOR pipe with S = 2 on lifetime (Green curve)
Expected thermal lifetime based on above temperature profile:	> 100 years	> 100 years

The preinsulated pipe (sandwich construction)

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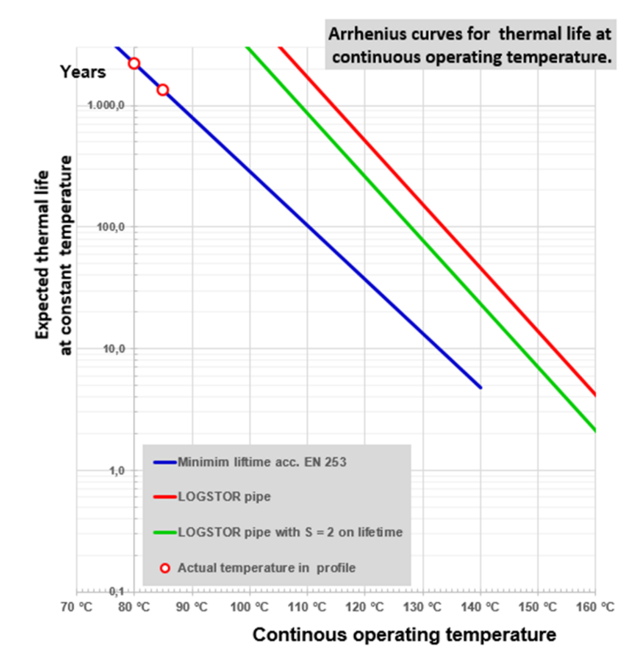
- Life time on pipe systems shall be minimum 30 years on a system with continuous temperature 120 °C and peak temperatures 140 °C
- That are the design criterias for the preinsulated components
- Life time on district heating networks at other temperatures can be calculated based on the so-called Arrhenius equation
- With set of temperatures between 55 – 85 °C calculated life time will far more than 1000 years
- Nice – but do we need that ?
- Or can we reduce on some requirements and save cost



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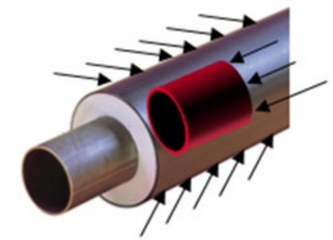

Sheer test at 140 C minimum 0,08 Mpa
Friction force on casing gives less than 0,027 Mpa (steel)
We need the sheer strength but do we need more than 1000 years

The preinsulated pipe (sandwich construction) - design

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- Examples on first time moovements
  - 65°C DN 100/225 ΔL= 19 mm
  - 75°C DN 100/225 ΔL= 27 mm
  - 110°C DN 100/225 ΔL= 66 mm
- Design with the right set of temperatures instead of using the normal design temperatures
- Saving on the cost of handling the expansion of pipes in the ground

Shallow pipe burial

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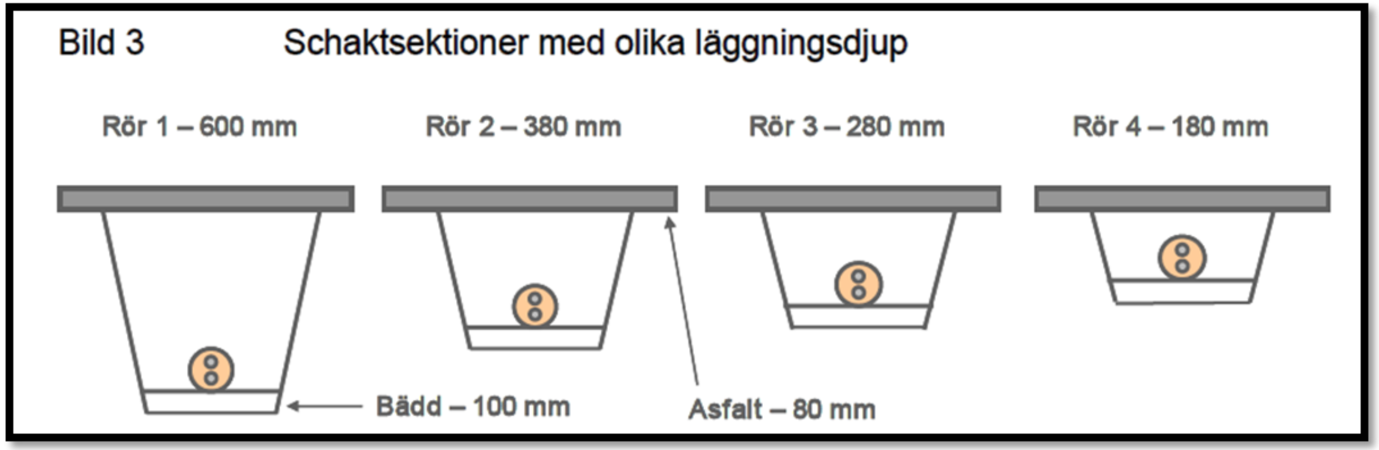
- Disadvantages by using more shallow pipe burial
  - Larger moovements
  - Increased risk for vertical instability and buckling of the pipe line throug the overfill
- With the low temperature systems the risk of vertical instability and buckling of the pipe line through the overfill is minimized
  - Due to lower stress in the steel pipes
- Cost saving on contractor cost by using more shallow burial



Does the standards prevent development ?

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- PEXb as an example
- PEXb where cross linking will happen when taken into operation with hot water
  - Full filled all requirement to tests described in the standards (temperature, pressure, life time etc etc)
  - Full filled all requirements from the standard except for 1 – it would not be cross linked when delivered but when taken into operation
  - Would even be better compared to other PEX types on certain parameters
  - Would be cheaper material
- PEXb that would cross link when taken was not voted into the standard

- Going in the direction of low temperature systems
- There will be a need of developping new materials that are optimal for low temperature systems
- How do we prevent that existing standars are blocking for needed new development ?

The need for an additional standard ?

Is there a need to extend the standards to cover low temperature district heating systems as well ?


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Questions ?
13.11.2018
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