



# COOL DH development of new PE-RT multilayer PE-RT & Low temperature district heating systems

What is the right choice?



The project has received funding from the European Union's Horizon 2020 research and innovation programme under the grant agreement n° 767799 - COOL DH - H2020-EE-2016-2017/H2020-EE-2017-RIA-IA



# The right choice of pipe system

The right choice of pipe system shall always be taken based on a Total Cost of Ownership evaluation

Steel pipe system

Flexible pipe system

Single or twin

Insulation series

Diffusion barrier's

Recycling potential

Installation



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# Flexible pipe with PE-RT media pipe

- PE-RT media pipe

New

- PE-RT has never been used as a media pipe in flexible pipe systems for district heating applications until now
- SDR 7,4 media pipe (SDR 11 would be an alternative)
- PE-RT as a HDPE for the media pipe that can withstand higher temperature than standard HDPE that for example is used for the casing on the pre-insulated pipe (RT = Raised Temperature)
- PE-RT is recyclable in contrary to for example PEX
- PE-RT can be welded

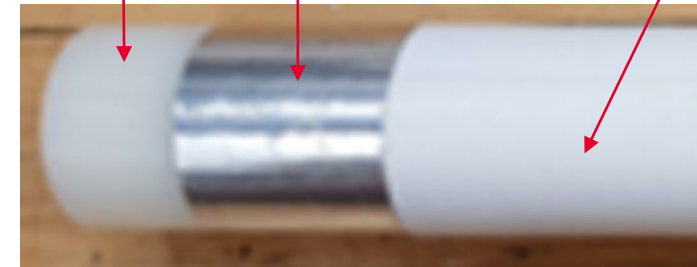
New

- On the PE-RT for the COOL DH project is an aluminum barrier
  - The function of the aluminum barrier is:
    - Prevent oxygen diffusion from outside into the media
    - Prevent water vapor diffusion from the media out to the insulation and having the risk of water condensing in the foam with higher heat loss as a result. This issue is a known problem on plastic pipe systems. No plastic pipe systems in the large dimension coils on the market with a water vapor diffusion barrier
- Outside the aluminum barrier is installed a PE-RT protection layer

PE-RT  
SDR 7,4

Aluminum barrier

PE-RT protection  
layer



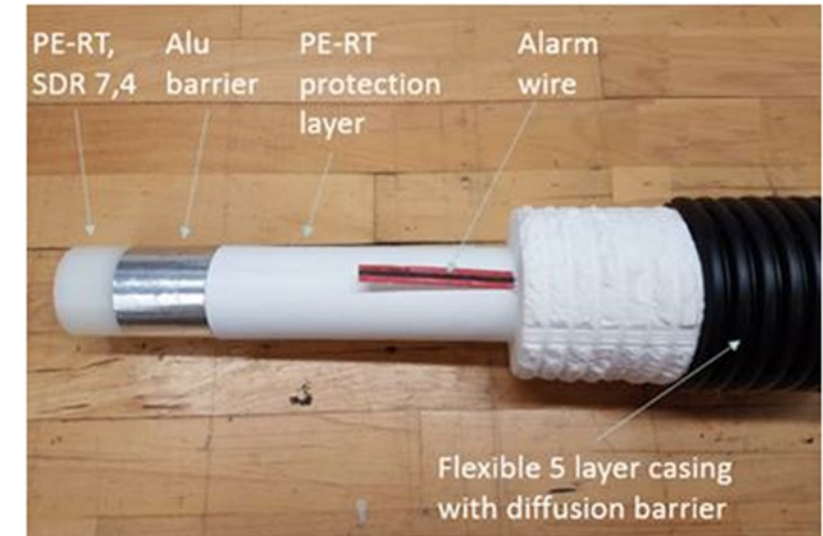
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# Flexible pipe with PE-RT media pipe

New

- The pre-insulated PE-RT pipe is produced with a surveillance wire
  - Type of surveillance wire is 3dc
  - 3 conductors each 0,75mm<sup>2</sup> (stranded wire and not solid) embedded in one cable
  - The conductor in the middle (marked with black) is used as a reference conductor in replacement of a steel service pipe
  - The 3dc system can be used in systems with a plastic career pipe
  - The 3dc cable is used to monitor the entire pipe system by means of impedance measurement on the cable
  - The cable is fully insulated also at connections
  - Measuring principle
    - The impedance is measured between the 2 outmost alarm wires in the cable (marked with red) and the black reference conductor



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# Tests performed in the CoolDH project

- Internal tests at LOGSTOR before starting the external test
- Tests at external test institutes
- Detailed reports are available

Type of test	Requirement	Comment
Hydrostatic testing of the PE-RT media pipe	Test shall run for minimum 15000 hours when tested at 110°C according to ISO 1167:2006	Requirements met
PE-RT media pipe tested for oxygen tightness	Oxygen diffusion of media pipe shall not exceed 1,8 mg/m2d when tested at 80°C according to ISO 17455	Requirements met
PE-RT media pipe tested for water vapor tightness	No requirements in the standards	See result
The coupling including a diffusion barrier is tested for water vapor tightness	No requirements in the standards	See result
Test of fittings used for PE-RT	Tested for: Internal pressure Bending test Pull-out test Vacuum test Thermal cycling test Pressure test According to EN15632-2:2010, EN-ISO 21003-5:2008, EN ISO 22391-5:2010	Requirements met



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# Test of the PE-RT media pipe – Hydrostatic pressure testing

- The hydrostatic pressure testing is performed at Element according to ISO 1167:2006 at 110°C using water on the inside media and air as outside media. The accuracy for temperature<sup>1</sup> and pressure<sup>1</sup> is better than  $\pm 1^\circ\text{C}$  and  $\pm 2/-1\%$  respectively. The measurements of the wall thickness<sup>1</sup> are accurate within  $\pm 0.02$  mm and the diameter<sup>1</sup> within  $\pm 0.1$  mm
- Test shall run minimum 15000 hours
- Internal tests at LOGSTOR before starting the external test
- Tested externally at "SWEDAC ACKREDITERING"
- The requirements for the tests were met
- Detailed report is available

Element Materials Technology

ELEMENT/P-20/107-v1

Appendix B.4

Plastic Pipes

2020-08-24

## HYDROSTATIC PRESSURE TESTING

Sample	T	Start date	Reg date	d <sub>em</sub>	e <sub>min</sub>	p	σ	Burst time	Burst mode	Test time	Remark
	[°C]	[yy-mm-dd]	[yy-mm-dd]	[mm]	[mm]	[bar]	[MPa]	[h]		[h]	
7510-1	110	180920	200607	32.10	4.41	7.65	2.40	15 000	stopped		1
7510-3	110	180920	200607	32.10	4.42	7.65	2.40	15 000	stopped		1
7510-7	110	180920	200607	32.11	4.42	7.65	2.40	15 000	stopped		1

## PIPE REMARKS

<sup>1</sup> The sample is fitted with Poly(vinylidene difluoride), PVDF fittings

## RESULT

A total of 3 pipe samples were put on test and all samples have burst or been stopped on the clients request. The results are only valid for the material with Element code 7510. The test results are summarized below.

T	NO. OF SAMPLES	HOOP STRESS	MIN BURST TIME
110°C	3	2.4 MPa	> 15 000 h



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# Tests of the efficiency of the aluminum diffusion barrier - oxygen

- Tested for oxygen tightness
  - Requirement in EN15632-2 is that oxygen diffusion of service pipes shall not exceed 1,8 mg/m<sup>2</sup>d at 80 °C when tested according to ISO 17455
  - EN15632 is the European standard for “District heating pipes – Pre-insulated flexible pipe systems – part 2: Bonded plastic service pipes – Requirements and test methods”
- Tested externally at Kiwa
- The requirements for the tests were met
- Detailed report available

Kiwa report LC 16019-1

## Determination the oxygen permeability

Plastics piping systems with an oxygen barrier layer



### Overview test results

Characteristic	Test method	Requirement	Measured	Passed*
Pipe or piping system				
Oxygen permeability	ISO 17455	@80°C: $F_{O_2, day} \leq 3,6$ mg O <sub>2</sub> /m <sup>2</sup> ·day (ISO 21003-2)	@80°C: $F_{O_2, day} = 0,07$ mg O <sub>2</sub> /m <sup>2</sup> ·day	Yes

\* The conclusions are not part of the accreditation scope



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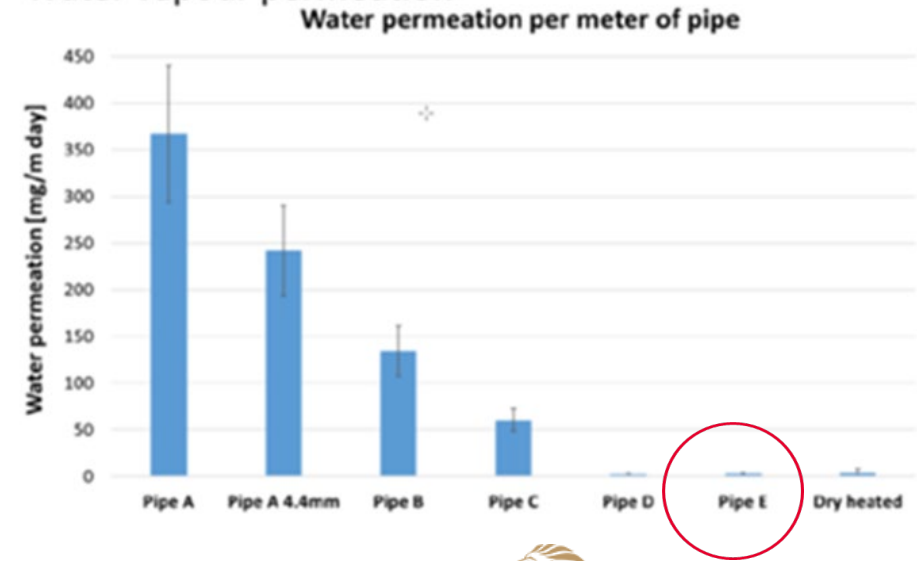


# Tests of the efficiency of the aluminum diffusion barrier – water vapor

- The PE-RT pipe is tested for water vapor tightness
  - No requirements in the European standards
  - But the challenge with water vapor diffusion is real and especially in Denmark a lot of energy companies stopped using plastic media pipe due to the issues with water vapor diffusion
    - If the water vapor will not diffuse out into the surrounding ground, it will condensate as water in the insulation
  - Internal tests at LOGSTOR before starting the external test
  - Tested externally at Danish Technological Institute
  - A 5 m long pipe has been tested
  - We have tested the water permeation per meter of pipe for different type of media pipes
  - Pipe E is the media pipe used in the COOL DH project
  - We consider it as proven that water vapor diffusion issue is solved with a PE-RT pipe with an aluminum diffusion barrier and a protection layer as the pipe used in the COOL DH project

Pipe	type	Reference standard	Dimension	Barrier
Pipe A	Pex-A	EN15875	32 x 2,9	EVOH (DIN4726)
Pipe B	Pex-A	EN15875	32 x 4,4	100% oxygenbarrier UV resistant Nano-Metall- Surface
Pipe C	PE-RT II (2388)	EN22391	32 x 4,4	Alu foil laminate with 9 micron alu, PET and LDPE layers. Applied by winding with an overlap of approx 15 mm. Skin layer of PE copolymer
Pipe D	MLT PE-RT/ Alu /PE-RT (2388)	EN21003	32 x 3	Alulayer longitudinal welded - thickness 0,3 mm
Pipe E	PE-RT II (2388)	EN22391	32 x 4,4	Alu foil laminate with 9 micron alu, PET and LDPE layers. Applied with longitudinal overlap bonding of approx 10 mm. Skin layer of PE RT II

## Water vapour permeation



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# Tests of the efficiency of the aluminum diffusion barrier – water vapor

- The coupling including a diffusion barrier is tested for water vapor tightness
  - The aluminum foil on the PE-RT pipe is removed with a width of 20 cm 7 places on a 5 m long pipe
  - An aluminum foil is wrapped around this place to simulate what shall be done around couplings
  - Internal tests at LOGSTOR before starting the external test
  - Test externally at Danish Technological Institute



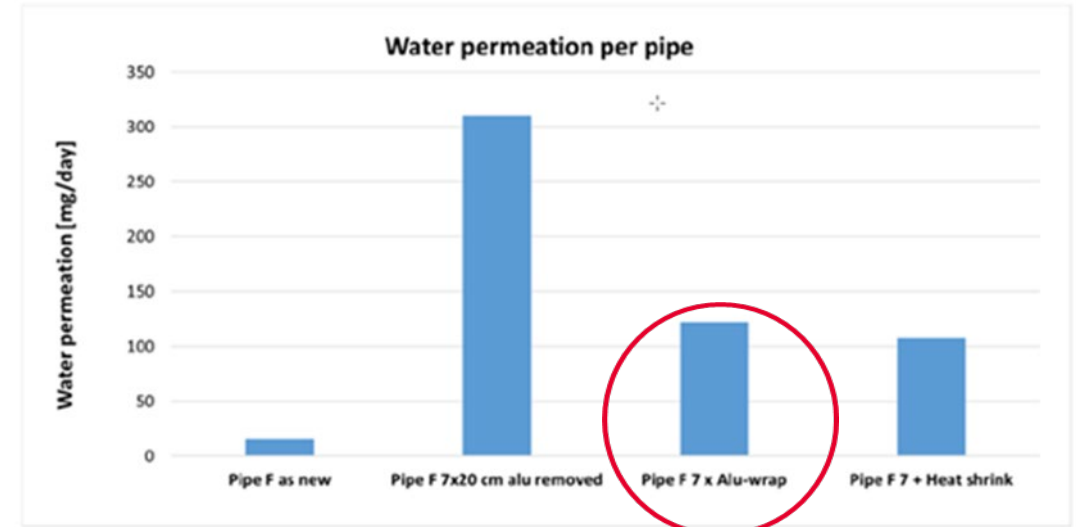
Figure 2, Pipe with section of alu-foil removed.



Figure 3, Pipe with alu-wrap over section without original alu-foil



Figure 4, Pipe with heat shrink and cable binders on top of alu-wrap.



Pipe	Producer	type	Reference standard	Dimension	Barrier
Pipe E	LOGSTOR	PE-RT II (2388)	EN22391	32 x 4,4	Alu foil laminate with 9 micron alu, PET and LDPE layers. Applied with longitudinal overlap bonding of approx 10 mm. Skin layer of PE RT II
Pipe F	LOGSTOR	PE-RT II (2388)	EN22391	33 x 4,4	Alu foil laminate with 9 micron alu, PET and LDPE layers. Applied with longitudinal overlap bonding of approx 10 mm. Skin layer of PE RT II. Pipe F is as pipe E but with 7 x 20 removed skin and alu layer to evaluate this effect

- The solution at the joint is not as diffusion tight as the PE-RT pipe itself
- Continuous measurements on the surveillance system shall determine if water vapor diffusion at couplings is a practical issue

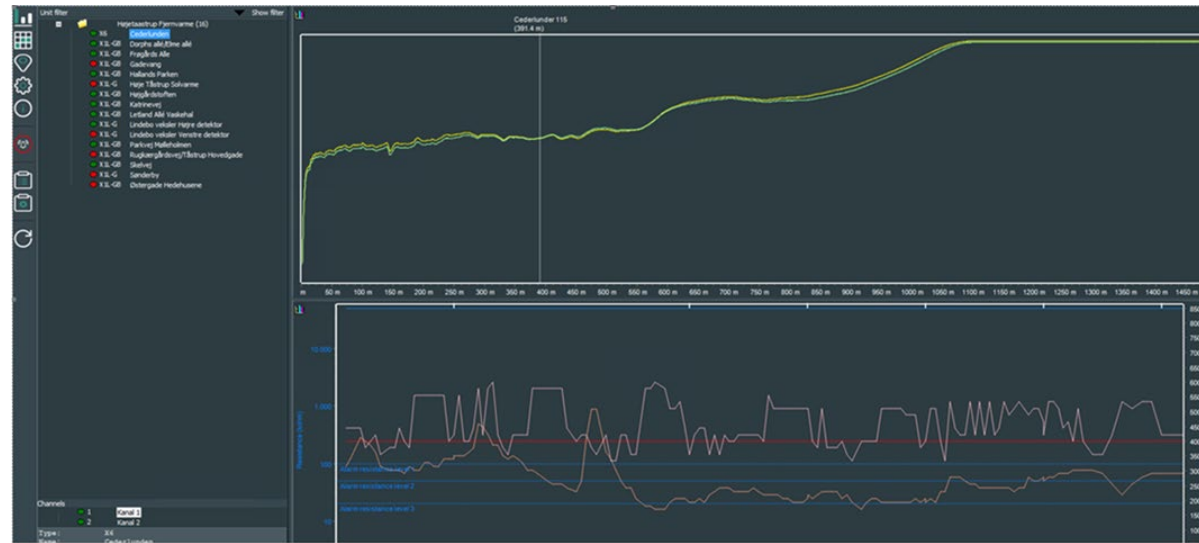


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# Surveillance system in Høje Taastrup

- A Detector X6 for impedance measurement on the 3dc wire has been installed for the complete project
- A reference measurement has been done
- The system is continuously surveilled and compared to the reference measurement
- LOGSTOR service technician is following the surveillance system together with Høje Taastrup



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# Test of fittings used for PE-RT

- Tested for
  - Internal pressure test
  - Bending test
  - Pull-out test
  - Vacuum test
  - Thermal cycling test
  - Pressure cycling test
- Internal tests at LOGSTOR before starting the external test
- Tested externally at Danish Technological Institute
- The requirements for the tests were met
- Detailed report is available

**TEST REPORT**  
TYPE TEST (TT)

REPORT NO.  
846530

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Page: 1 of 2  
Date: 25 July 2019  
Int.: ARP/PPST/MRQ  
Appendices: 1

**Applicant:** Logstor A/S  
Danmarksvej 11  
DK-9670 Løgstør  
Denmark  
**Contact person:** Peter Rønneberg  
Email: [per@logstor.com](mailto:per@logstor.com)

**Product:** System test of fittings Doria 32 mm, WRIW 32 mm, Jentro 63 mm, Hela 63 mm  
Pipes: Multilayer pipe DN32 mm and PE-RT pipe DN63 mm

**Sampling site:** Logstor A/S  
Danmarksvej 11  
DK-9670 Løgstør  
Denmark

**Samples:** Information about sampling site was provided by the applicant. Sampling was carried out by the applicant and the samples were received by DTI on 29 January 2019.

**Test site:** Danish Technological Institute, VA Testing and Inspection (DTI)  
Kongsvang Allé 29  
DK-8000 Aarhus C, Denmark

**Test period:** 30 January - 28 June 2019

**Test methods:** EN 15632-2:2010  
EN ISO 21003-5:2008  
EN ISO 22391-5:2010

**Results:** The requirements of the test methods mentioned above were met.

**Terms:** Accredited testing was carried out in compliance with international requirements (EN ISO/IEC 17025:2017) and in compliance with Danish Technological Institute's General Terms and Conditions regarding Commissioned Work Accepted by Danish Technological Institute. The test results apply to the tested products only. This test report may be reproduced in extract only if the Laboratory has approved the extract in writing.

**Signature:** *Alan R. Pedersen* Alan R. Pedersen  
Metrology Engineer  
*Flemming Petri Stenfeldt* Flemming Petri Stenfeldt  
Consultant

**ILAC-MRA** **DANAK**  
Test No. 336

25-07-2019 11:23:03  
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# Electrofusion couplings for PE-RT

- The intention for the project was to qualify an electro fusion coupling for joining the PE-RT media pipes in the field
- Electro fusion couplings for PE-RT exist but not in the wall thickness that is needed for a SDR 7,4 pipe
- We have not been able within the scope of the Cool DH project to find a supplier that can supply the couplings in the needed wall thickness



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# Production of the PE-RT media pipe

- A separate production line has been built in order to be able to produce PE-RT media pipes  $\varnothing 20 - 110$  mm for the COOL DH project



PE-RT extruder line



Coiling machine for the PE-RT pipe

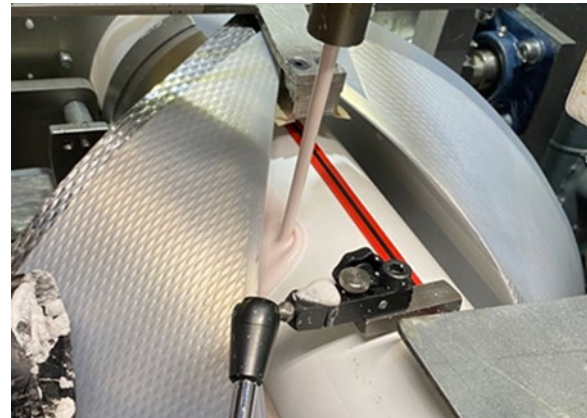
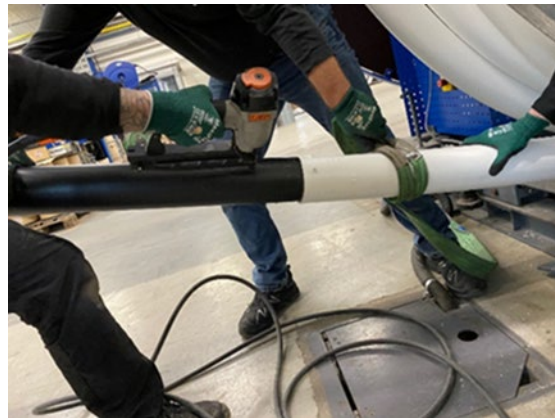


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# Production of pre-insulated $\varnothing 110/180$ PE-RT

- Due to the high wall thickness of a SDR 7,4 pipe dimension  $\varnothing 110$  mm it is a challenge to produce this dimension
- The media pipe is very stiff when un-coiling the pipe in the start of the production process
- It is creating safety issues for the production employees during production of that specific dimension
- This issue would be less if media pipe is **SDR 11**



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# Considerations for the future

- Estimate market potential
- Qualification of the pipe for domestic water applications
- Qualification of Electro fusion coupling (Straight- and T-coupling)
- SDR 7,4/11
- Needed dimensions of media pipe
- The challenge that PE-RT is not included in the European standard EN15632-2
- There will be a new low temperature standard which will include PE-RT - Expected to be valid from Q1 2023

Question:

Is there a market for this new flexible pipe system



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Thank you for your attention  
Questions ?



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