Activities in Germany and IEA in the field of DH networks

Lifetime prediction of buried preinsulated bonded DH pipes

Stefan Hay I Smart Asset Management - DH Distribution Networks I 28th June 2021

Activities in Germany and IEA in the field of DH networks

District Heating (DH) networks different piping systems used

Needs & goals of DH municipalities

- **Reliable estimation of the remaining service life of DH pipes**
- **Individual (predictive) maintenance strategies**

Research goals:

- **Improve and develop models for lifetime prediction of different DH pipes used**
- **Improve damage statistics**
- **Focus on buried preinsulated bonded pipes**

IEA-DHC – Task shared 6:

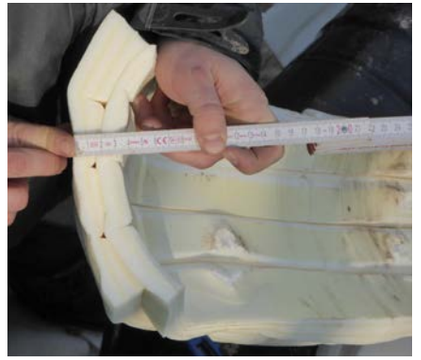
- **Status Assessment, Aging, Lifetime Prediction and Asset Management of DH Pipes**

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Research measurement section Chemnitz, measurement of pipe-soil interaction of DH pipes under cyclically changing operating conditions, Source: AGFW

Lifetime prediction of buried preinsulated bonded DH pipes





Manufacturing in the factory	Pipeline construction
Quality assurance (standards, material certificates)	Quality assurance (testing, training)

Statistics
(statistical ageing models)

Operation

Operating parameters (pressure, temperature, etc.)	Local boundary conditions (laying figure, ground water, etc.)

Stresses / material-based aging models

Data based analysis
Material testing and condition assessment
Prioritisation

Lifetime prediction of buried preinsulated bonded DH pipes

1. Status assessment – part I

» **Collect information on the Pipes**

» **Take samples for investigations in the lab**

Removal of test specimens FWA - straight pipe and 90° bend, Source: AGFW

Entnahmestelle	FWA	Datum: 23.05.2019
Baujahr	**1985**	
Rohrhersteller	**PANISOVIT**	
Produktionsnummer		☒ Nicht bekannt
Betriebstemperatur (max)	$T_{Vorlauf}$ = 130°C	$T_{Rücklauf}$ =50-60°C
Prüfkörper (PK)	☒ gerades Rohr	☒ Bogen
Leitungstyp	☒ Vorlauf	☒ Rücklauf
Nenndurchmesser	DN 150	
Länge des PK	200 cm // 100x100	
Verbund vorhanden	☒ja	☐ nein
Netzplan des Trassenabschnittes	☒ja	☐ nein
Ansprechpartner bei Rückfragen	Telefon: 069 6304-345 E-Mail-Adresse: s.hay@agfw.de	
Verschiebeweg:	<10mm (vorgewärmt)	
Grundwasser:	-	
Überdeckung:	80cm	
Leitungsart:	☐ Hausanschluss ☒ Anschlussleitung / Verteilleitung ☐ Transportleitung	
Vollastwechsel pro Jahr (geschätzt)	3	
Fotodokumentation der Entnahme	☒ja	☐ nein
Besonderheiten	KMR-Bogen 50cm x 50cm mit angeschweißtem KMR-Rohr	

Documentation sheet for the FWA sampling point, Source: AGFW

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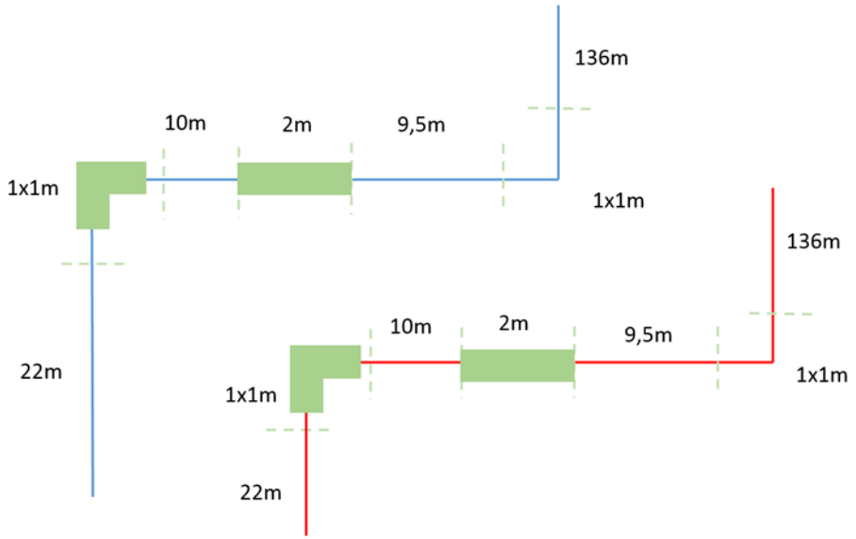
2. Status assessment – part II

- Evaluation of operating parameters
- Stress according to the design
- Evaluation of temperature loads based on data



Schematic representation of the laying figure FWA, Source: AGFW

FWA	Mittel2007-2009	Annahme1985-2006	Gesamt1985-2018
Temperatur [°C]	Dauer [h]	Dauer [h]	Dauer [h]
0	0,333333333	7,333333333	1095,333333
10	0	0	1
15	0	0	1
20	0	0	2
25	0	0	3
30	0	0	0
35	0	0	2
40	0	0	10
45	0	0	11
50	0,333333333	7,333333333	11,33333333
55	1	22	27
60	0,666666667	14,66666667	19,66666667
65	3,333333333	73,33333333	93,33333333
70	758,6666667	16690,66667	19371,66667
75	775,3333333	17057,33333	36383,33333
80	1420,333333	31247,33333	40793,33333
85	970,3333333	21347,33333	33818,33333
90	679,6666667	14952,66667	27311,66667
95	468,6666667	10310,66667	21310,66667
100	492,3333333	10831,33333	17786,33333
105	613,6666667	13500,66667	19990,66667
110	977,3333333	21501,33333	27051,33333
115	1222,666667	26898,66667	32489,66667
120	286,3333333	6299,333333	14282,33333
125	87	1914	5796
130	1	22	134
135	0	0	0
140	0	0	0
145	0	0	0

Evaluation of the operating temperatures according to operating hours at specified temperature levels, Source: AGFW

Lifetime prediction of buried preinsulated bonded DH pipes

3. Status assessment – part III

- Material tests according to standards and recommendations
- Additional material test for the polyurethane foam
- Additional material test for the steel service pipe in the 90° bend

Straight pipes FWA before material testing according to EN 253, Source: AGFW

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4. Lifetime prediction – Analysis of the results

- Use individual boundary conditions and the results of status assessment to identify the dominating aging phenomena
- Compare the results with the minimum of material properties need to withstand the loads in operation
- Estimation on the remaining service life using material based aging models

Measurements on a heating network with insufficient connection of the DH pipes, Source: AGFW

Lifetime prediction of buried preinsulated bonded DH pipes

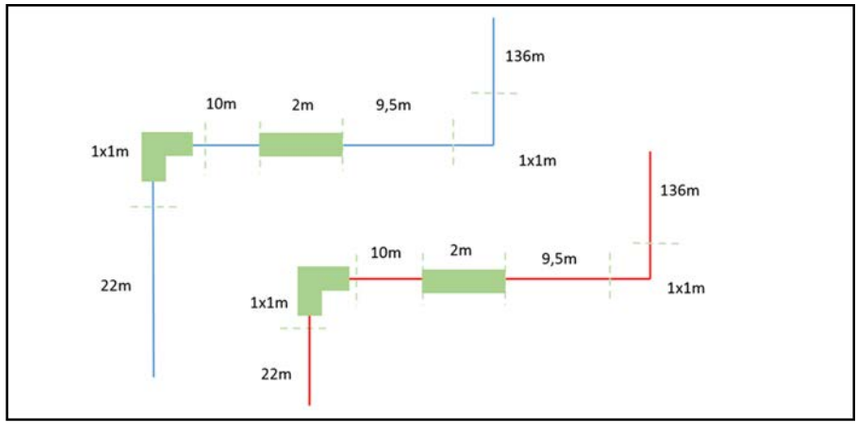
Example on real application „FWA“

Removal and documentation

- Year of construction 1985
- Nominal width: DN 150, standard insulation thickness
- Max. operating temperature: 130°C
- Type of pipe: distribution pipe
- Cover height: 0.8 m

Remarks:

- In the road area Type of installation
- Pre heated installation, preheating temperature 70°C



Schematic representation of the laying figure FWA, Source: AGFW

Removal of test specimens FWA - straight pipe and 90° bend, Source: AGFW

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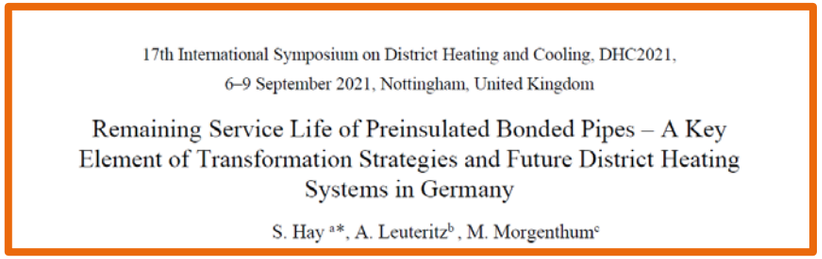
Example on real application „FWA“ - results

- **Axial stresses in the steel (straight pipe / bend) in the permissible range**
- **Number of full load cycles (161 in total) < 250 according to design, with low equivalent stresses in the bend area**
- **Ageing influences detectable in examinations of the steel pipe**
- **Compressive stress in the bend area (PUR) < 10 times compressive strength (PUR, measured)**
- **Shear stress in PUR < axial shear strength (PUR, measured)**
- **Remaining service life of PUR according to Arrhenius estimate 20.65 years, according to estimation by TGA approx. 12 years**



17th International Symposium on District Heating and Cooling, DHC2021,
6–9 September 2021, Nottingham, United Kingdom

Remaining Service Life of Preinsulated Bonded Pipes – A Key Element of Transformation Strategies and Future District Heating Systems in Germany

S. Hay [a]*, A. Leuteritz[b], M. Morgenthum[c]

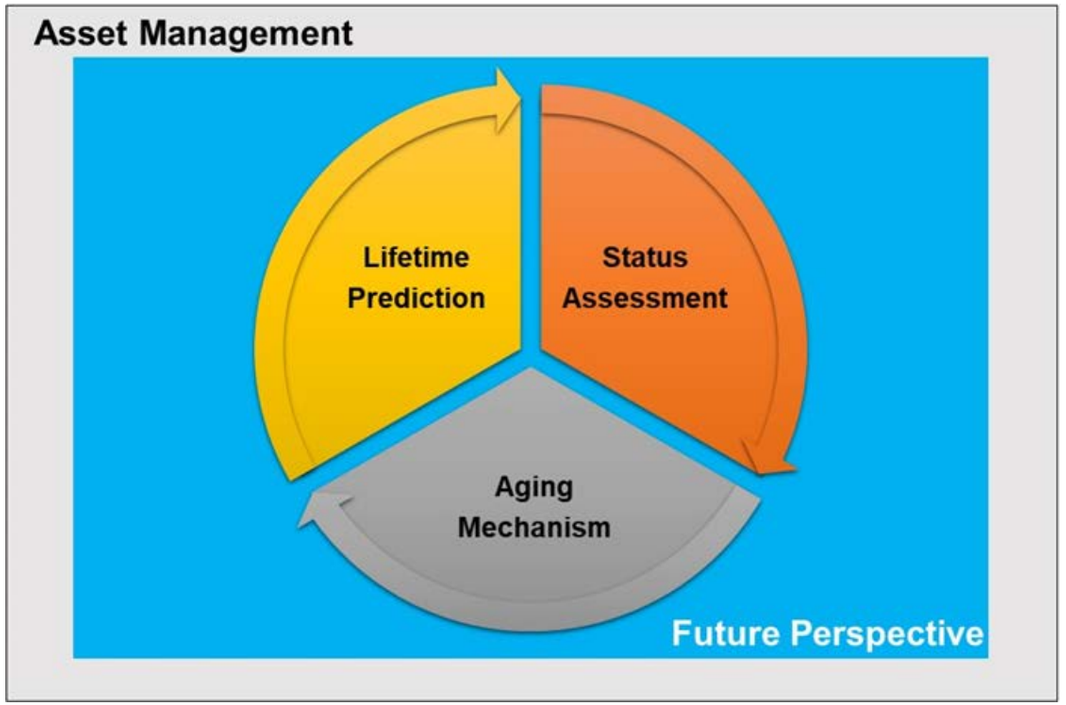
Detailed results will be presented at the IEA-DHC Symposium in Nottingham, http://dhc2021.uk/OnlineProgramme.html

→ **Extraction point "FWA": Properties of the PUR determine the expectations of the remaining service life.**

IEA-DHC – Task Shared 6 Project

Status assessment, ageing, lifetime prediction and asset management of District Heating Pipes

- Collaborative work under the umbrella of the IEA-DHC implementing agreement on District Heating and Cooling
- Exchange of research results & improving existing lifetime prediction models
- Scope on: Directly buried DH pipes (concrete ducts, pre-insulated bonded pipes, 4th Gen. DH pipes)
- Open for further participants



Schematic representation of the interrelationships of the project contents, Source: AGFW

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