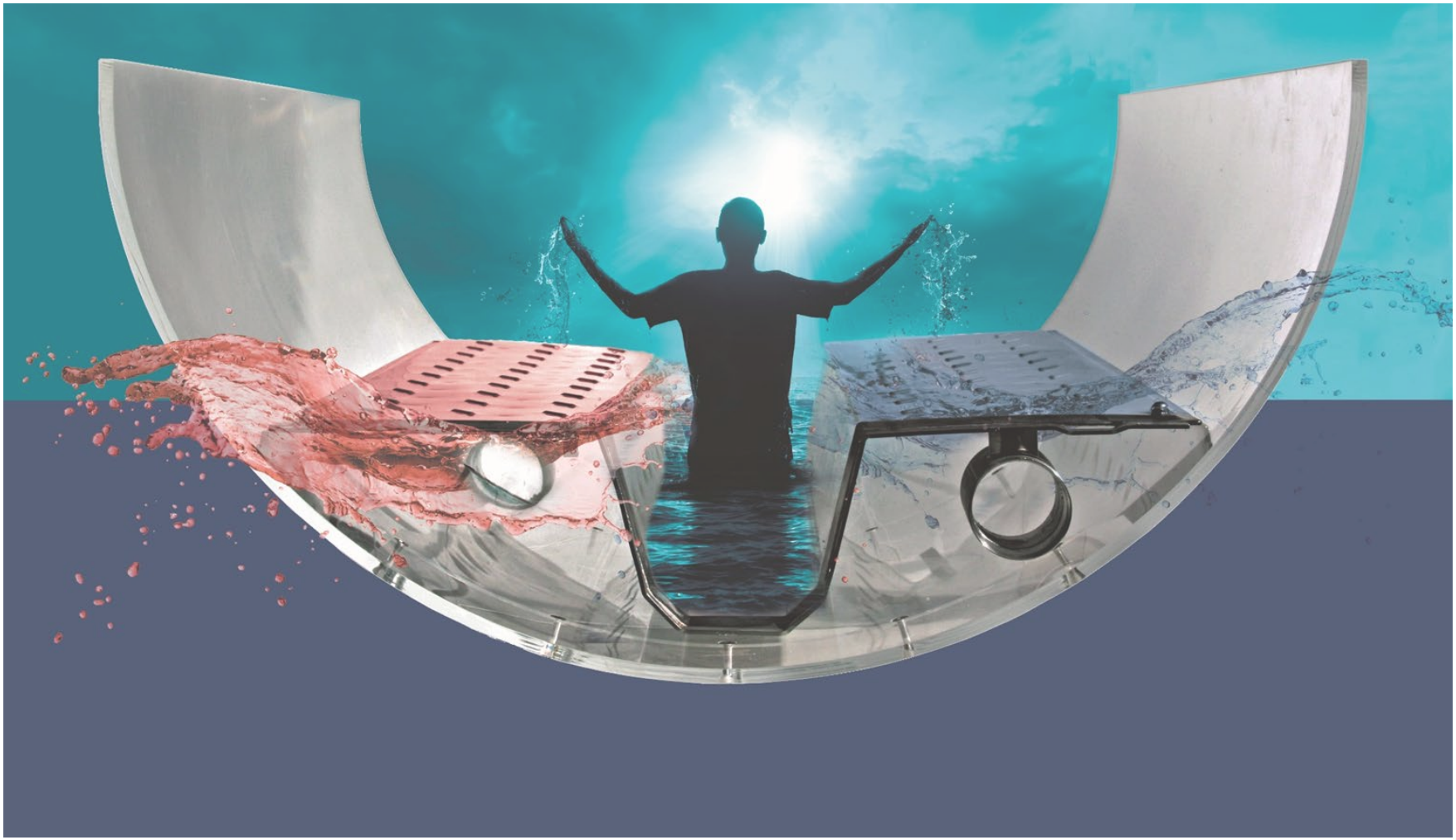
Energy from Wastewater

Green heating and cooling with Therm-Liner from UHRIG



UHRIG Group, December 28, 2023

About us: UHRIG Group

UHRIG

Company

- German company from the wastewater sector with 120 Employees, founded in 1964
- Headquarters: City of Geisingen, in the greater Stuttgart area
- Focus: Civil engineering, Construction of large sewers in urban areas
- Known for innovative and patented solutions

Energy from Wastewater

- Development of patented heat exchanger system THERM-LINER since 2007
- 110+ Therm-Liner plants installed throughout Europe
- Oldest system in operation for 15 years
- Market leader in Europe
- Demand increasing rapidly

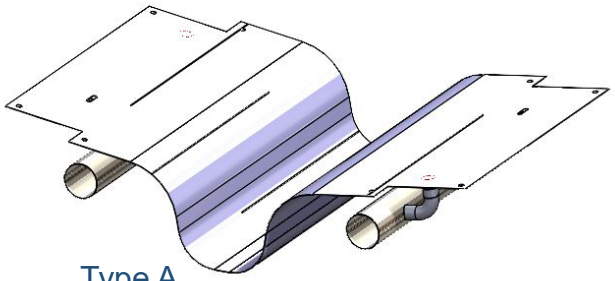
Business Focus

- Source side: Public sewer network
- Demand side: Buildings / heat networks
- Plant sizes: 50 kW - 8 to 10 MW

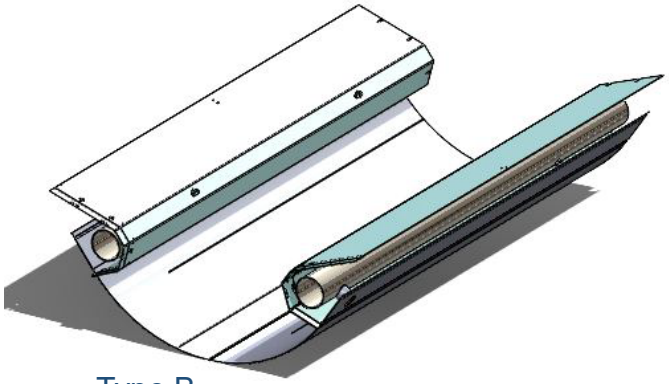
Our product: UHRIG Therm-Liner

- Developed for retrofitting in existing and new public sewers
- Always tailor-made for the relevant sewer system
- Does not affect the operation of the sewer in any way
- Easy to install using the existing manhole structure
- Easy to remove or expand at any time
- Easy to recycle and reuse
- Equipped with monitoring
- Patented and certified

USP Therm-Liner
Internal solution
No external space required
Passive system with low maintenance



Type A



Type B

UHRIG scope of work: components & interfaces

UHRIG

Heat exchanger

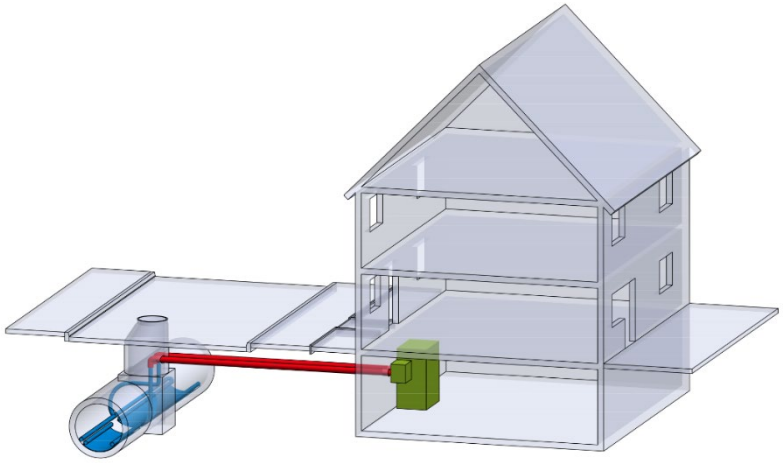
- Heat exchanger system extracts energy from wastewater
- Wastewater flows over heat exchanger system which then continuously supplies thermal energy

House connection

- Connects heat exchanger and heat pump = feed and return line
- Brings the transfer medium (water or water-glycol mixture) to the heat pump back and forth

Heat pump

- Regulates the temperature level in the heating circuit in the building or in the heating network
- Needs electrical power to raise the temperature level of the thermal energy



UHRIG services		Costs
Heat exchanger	☑	$ 700 - 1,400 per kW capacity
House connection	(☑)	distance dependent
Heat pump	☒	$ 350 - 550 per kW capacity

UHRIG approach: keep it simple

Step 1: Finding customers

- We search for projects: new buildings, existing buildings, heating networks
- We check if there is a public sewer available nearby
- If there is a match, we calculate the energy potential and talk to the customer

Step 2: Offering a turnkey solution

- We offer the component heat from wastewater turnkey ready
- We help designing an energy concept based on heat from wastewater
- We support the creation of a contract for the use of the sewer

Step 3: Setting up the right business model

- Goal: Take away initial investment from the customer
- Therefore, a third party (Energy Company) finances and operates the plant
- Customer gets heat/cold sold over 15 to 20 years at a fixed price per kWh

UHRIG Therm-Liner: good starting conditions

Source side: Wastewater

- Sewer size: > 800 mm (30“)
- Wastewater flow rate: > 10 l/s (9,510 GPH)
- Sewer located near the project area: 0 - 900 m (0 - 2,952 ft)

Demand side: building / heating network

- Every building with more than 20 residential units
- Residential and commercial buildings
- Heating networks

Heating system

- Low temperatures in the heating system
- Surface or floor heating
- Heating and cooling in the project
- Many hours of use

UHRIG Therm-Liner: references

- 110+ Therm-Liner plants installed throughout Europe
- Outputs from a few kW to many MW. Many plants used for heating and cooling
- Proven technology: Oldest plant in operation for 15+ years

Stuttgart, Germany, 2018

- Thermal output: 2,100 kW
- Sewer profile: Box 2,400 (94 inch)
- Flow rate: 170 l/s (2,694 GPM)
- Use: New building (residential & commercial use)

Wangen, Germany, 2019

- Thermal output: 300 kW
- Sewer profile: Circular 1,900 (75 inch)
- Flow rate: 50 l/s (792 GPM)
- Use: Feeding into existing heating network

UHRIG Therm-Liner: contact persons

UHRIG North America Office

Mr. Frank Urro

Renewable Energy Strategist

Head of North America Business Unit

Massachusetts, USA

T +1 978-528-4478

M urro@uhrig-bau.com

I www.uhrig-bau.com

UHRIG Headquarters Germany

Mr. Stephan von Bothmer

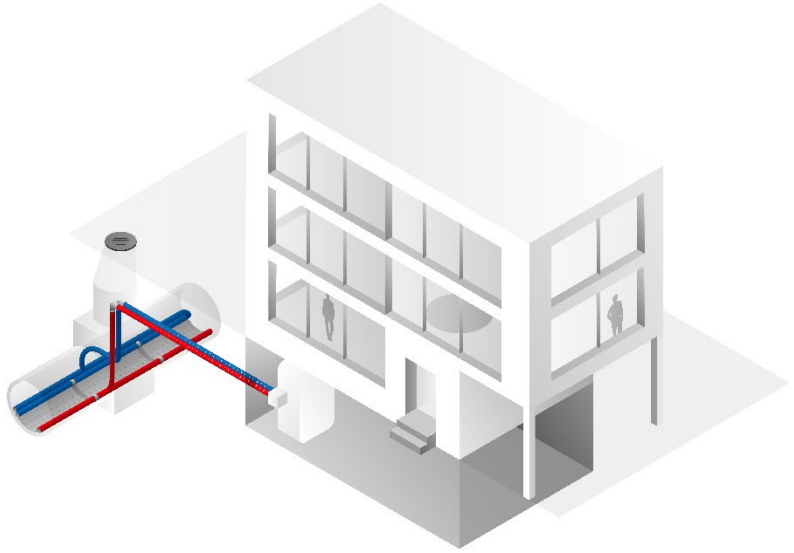
Head of Global Business Unit Energy from Wastewater

Geisingen, Germany

T +49 7704 806 48

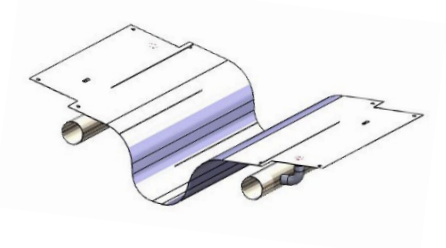
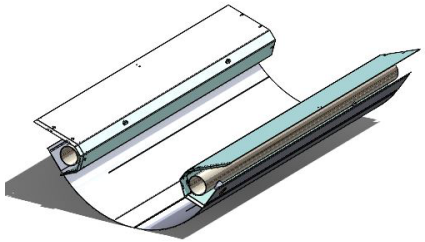
M s.bothmer@uhrig-bau.de

I www.uhrig-bau.de



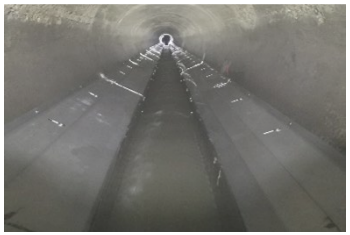
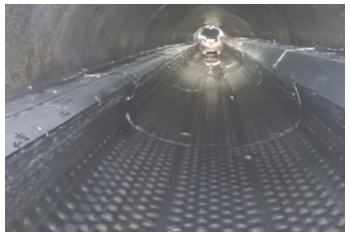
UHRIG Therm-Liner
Technical details

UHRIG Therm-Liner: standard types

Module type	Type A	Type B
Features	Increasing overflow area per m Increase in flow velocity	Exactly adapted to sewer shape Lowest cross-section reduction
Sewer types	Gravity sewers	Gravity sewers
Fastening	Hold down devices Quick lock sleeves	Hold down devices Quick-Lock sleeves
Pipes	Below the module	Above the module
		

Form A and B are used in different variants, depending on the sewer shape and the starting conditions

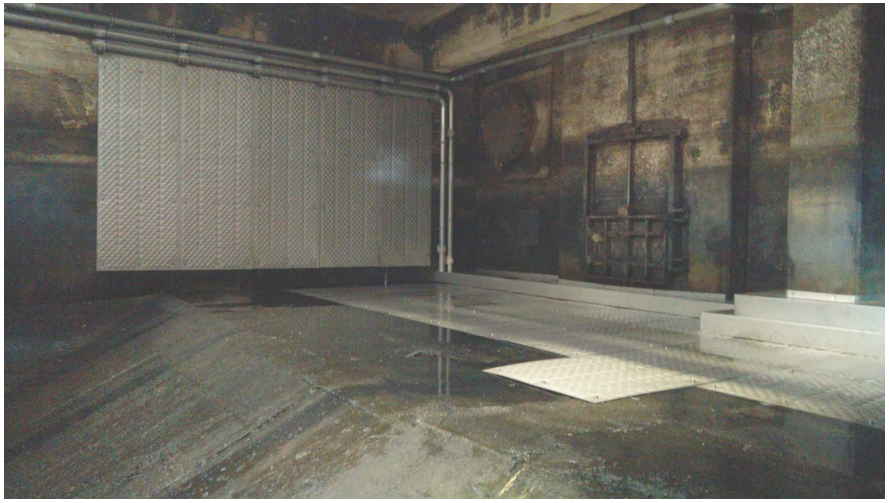


UHRIG Therm-Liner: tailor-made solutions

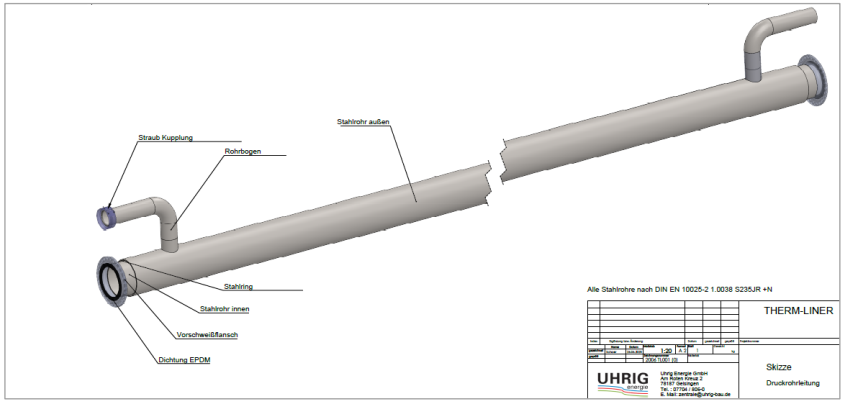
Further patented, customized solutions are available for:

- Treatment plants
- Pressure lines
- Bypass solutions for gravity sewers
- Heat exchangers for basins



Basin, Rotterdam, Netherlands 2021

Treatment plant, Karlsruhe, Germany, 2018



Bypass, Hamburg, Germany, 2023 (under construction)

UHRIG Therm-Liner: production and material

Production, material, certification
Production ► Ready-to-install pre-production of the individual modules at UHRIG headquarters in Germany ► Installation and connection work on site
Material ► Austenitic stainless steel. Material grade 1.4404 AISI 316L ► Safety-related design according to BGV D4 and EN 378 ► Connection system according to DIN 86128-1 and 86128-2
Standards and certificates for production and installation ► ISO 14001 Environmental management system ► ISO 45001 Occupational health and safety management system ► ISO 9001 Quality control and quality assurance system ► Installation according to German DWA M114 standards
Commissioning and pressure test ► System filled, vented via the heat exchangers and tested according to DIN EN 805 ► Maximum operating pressure of the entire system: 2.5 bar

UHRIG Therm-Liner: serial production

UHRIG

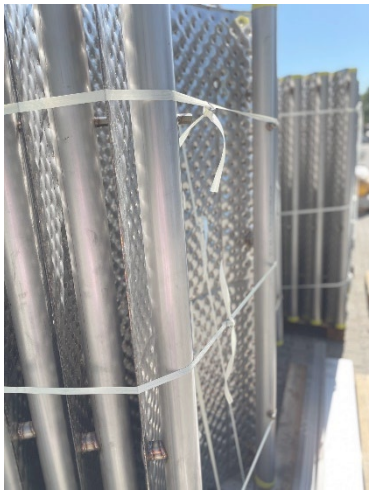
Sustainable production, material recycling

Production

- Until 2020, all Therm-Liner systems were manufactured by hand at the headquarters in Geisingen
- In 2021, UHRIG has automated production with a specially developed serial production
- The complete production runs with PV power, which is generated on the roof of the production hall

Material

- The Therm-Liner system consists largely of austenitic stainless steel. 1.4404 AISI 316L
- At the end of the project period, the plants are deinstalled, the material recycled and reused



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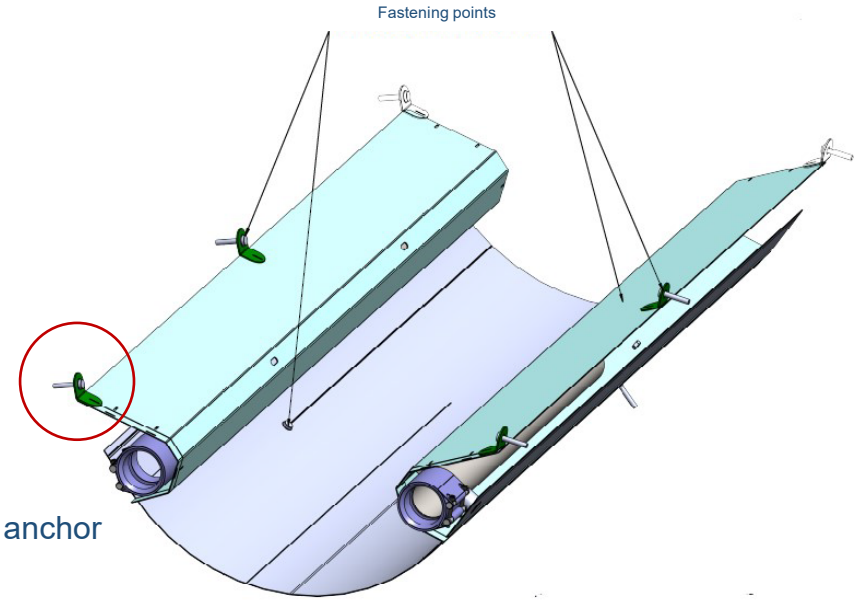
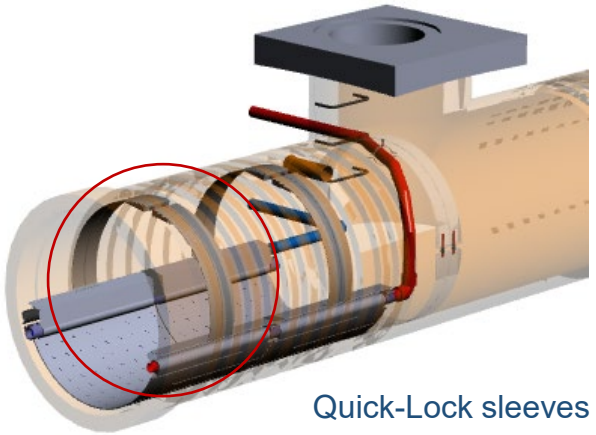
UHRIG Therm-Liner: fastening options

	Expansion anchor	Quick Lock sleeves
Sewer material	Concrete, stone, clinkered	Synthethic materials
Fastening tool	HKD expansion anchor	Quick-Lock Sleeve
Fastening mode	Hold down devices	Clamping of Quick Lock sleeve
Fastening points	Sewer botttom and sewer walls	Therm-Liner module
Sealing of fastening points	Cement mortar	---



Expansion anchor

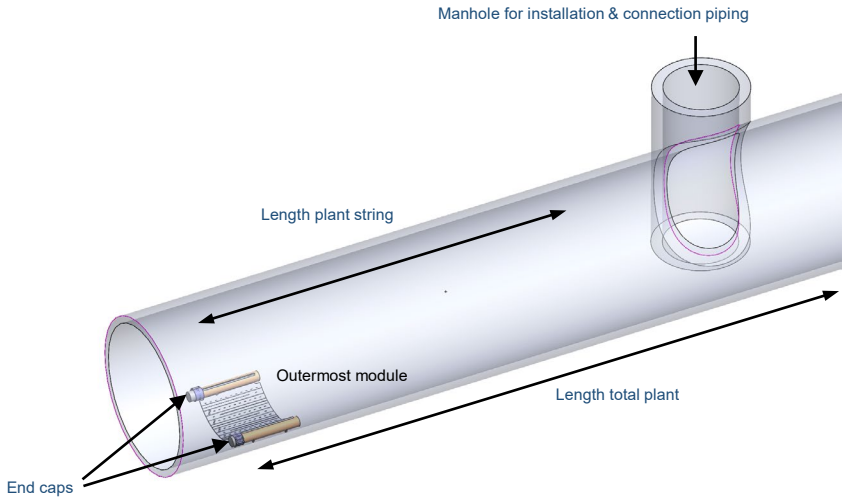


Quick-Lock sleeves

UHRIG Therm-Liner: installation*

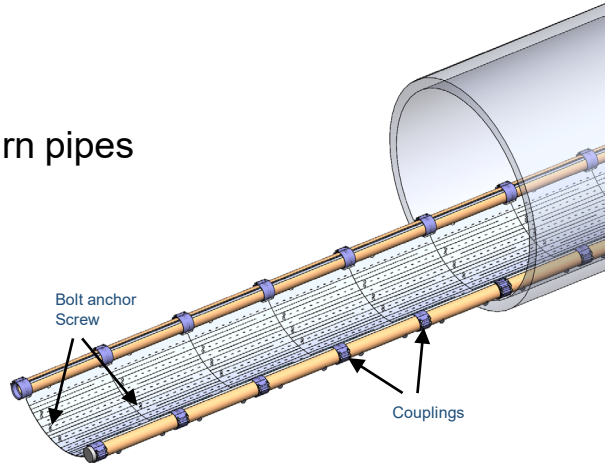
Step 1

- Calibrate sewer
- Determine position of the outermost module
- Insert outermost module
- Attach end caps to feed and return pipe



Step 2

- Push the couplings for follow-on module onto the supply and return pipes
- Align follow-on module and connect modules with couplings
- Fix each module with bolt anchors and screws
- Perform pressure test with air

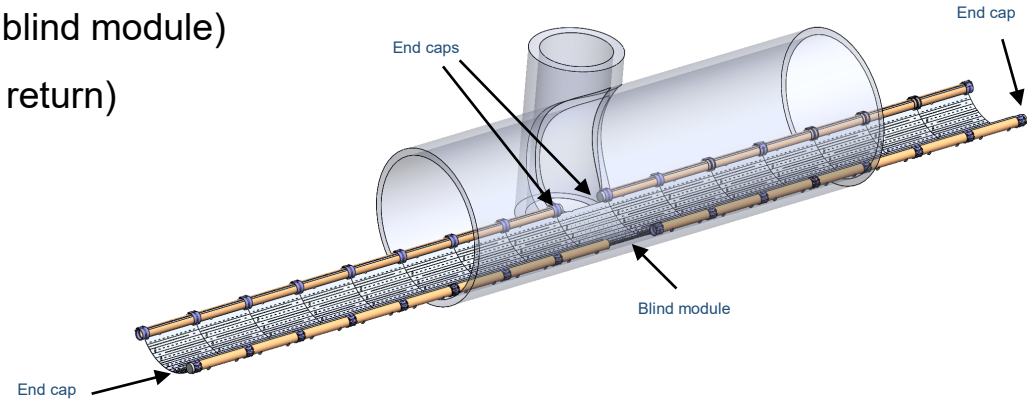


**Each installation is unique and requires, for example, a different water management. This illustration is a classic standard case*

UHRIG Therm-Liner: installation*

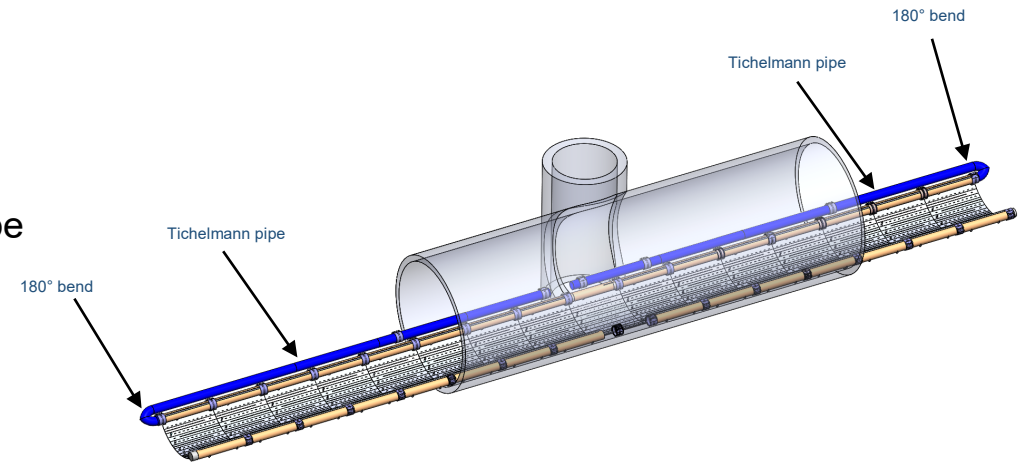
Step 3

- Install the remaining modules (including blind module)
- Attach end caps to both pipes (feed and return)



Step 4

- Set 180° bend / line
- Calibrate and lay out the Tichelmann pipe
- Fix Tichelmann pipe (e.g. cable tie)
- Perform pressure test with air

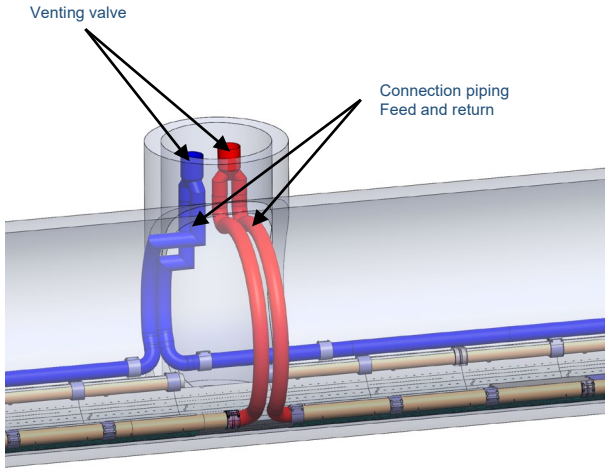


**Each installation is unique and requires, for example, a different water management. This illustration is a classic standard case*

UHRIG Therm-Liner: installation*

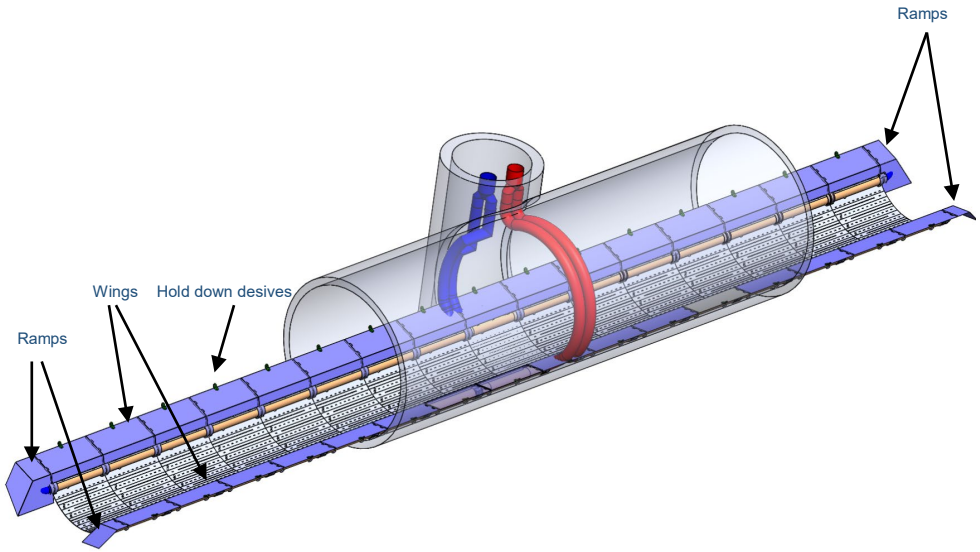
Step 5

- Assemble connection piping
- Mount venting valves
- Fill up plant with water / water glycol
- Vent and check plant



Step 6

- Fix wings and hold down devices
- Prepare and install ramps



**Each installation is unique and requires, for example, a different water management. This illustration is a classic standard case*

UHRIG Therm-Liner: dewatering for installation

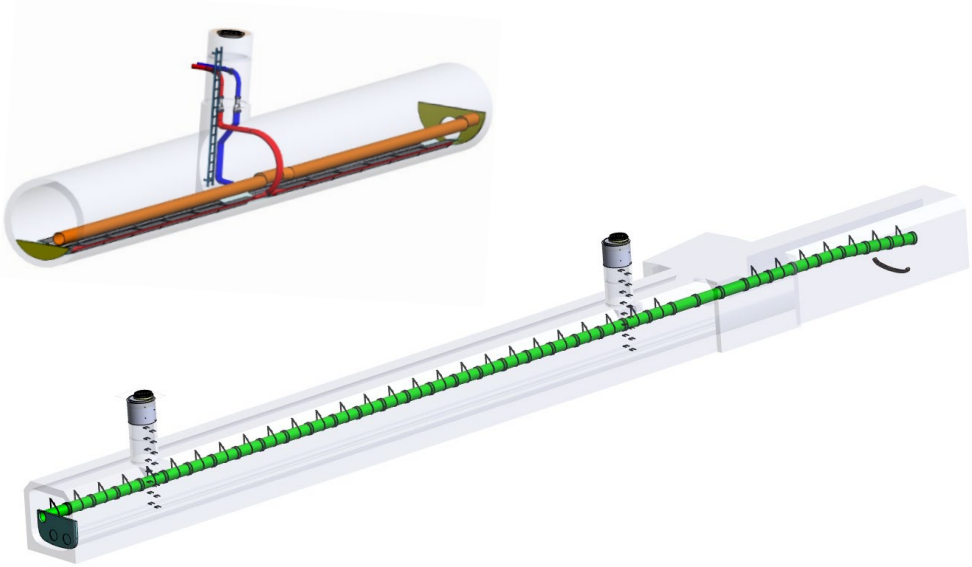
Internal bypass

Basic conditions for the installation

- The installation of the Therm-Liner plant equipment requires dry conditions
- Wastewater must be diverted with an internal or external bypass during installation
- As soon as it rains, the sewer must be temporarily abandoned

Internal bypass

- Wastewater can be diverted internally with a baffle plate and a laterally suspended pipe
- UHRIG installs approx. 50 to 80 modules per week. The standard case installation takes 2-4 weeks



UHRIG Therm-Liner: dewatering for installation

UHRIG

External bypass

Basic conditions for the installation

- The installation of the Therm-Liner plant equipment requires dry conditions
- Wastewater must be diverted with an internal or external bypass during installation
- As soon as it rains, the sewer must be temporarily abandoned

External bypass

- Wastewater can be discharged externally. It is pumped out of the sewer and later fed back again
- UHRIG installs approx. 50 to 80 modules per week. The standard installations take 2-4 weeks

UHRIG Therm-Liner: operation

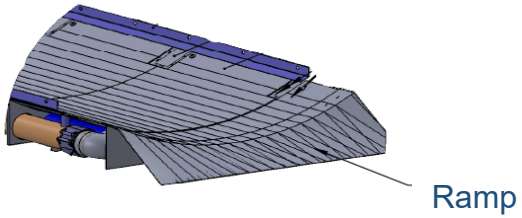
Biofilm formation and clogging risk

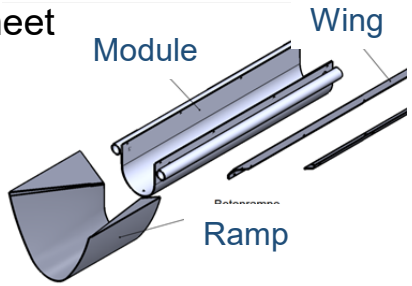
Biofilm

- Biofilm formation on the surface of the heat exchanger is calculated from the beginning
- Plants are oversized by design to compensate for biofilm. Biofilm is not avoidable, but predictable

Ramps to prevent clogging

- In front of the first module, a ramp ensures a smooth transition to the system
- The ramp is made of concrete or stainless steel sheet





Design to prevent clogging

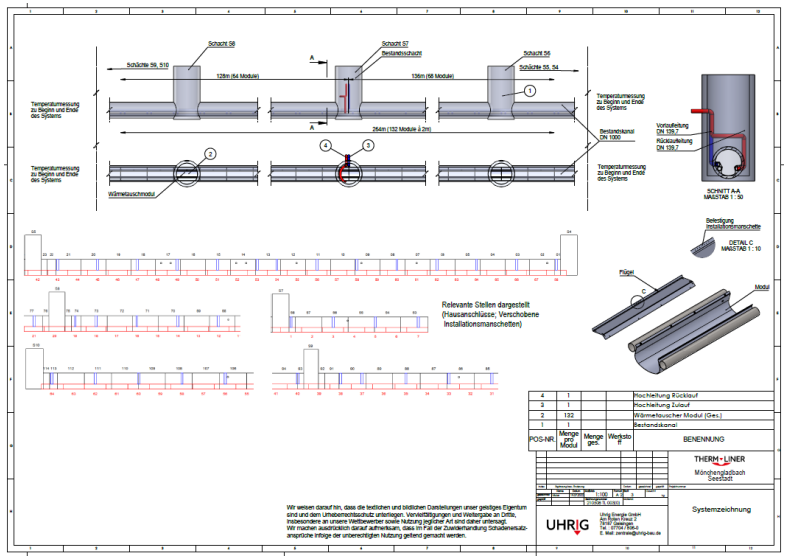
- Therm-Liner systems do not offer any points of attack for deposits or blockages
- The plant is designed so that the wastewater, including all solids, flows over the plant smoothly

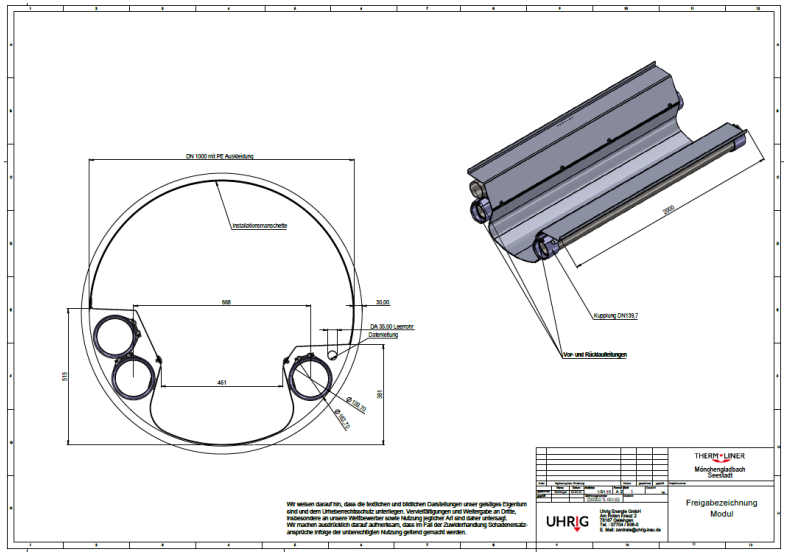




UHRIG Therm-Liner: approval process

- Approval documentation standardized in Europe. Idea: Benefit from these templates in all markets
- Comprehensive documentation to be submitted upfront for plant construction





Phase	Task	Basis
1. Early phase	► Clarification of the feasibility in the relevant sewer section ► Clarification of which cross-section reduction in the sewer is tolerable	► First system design of UHRIG based on the existing data ► Continued updates in between to sewer network operator by UHRIG thereafter
2. Permit phase	► Final approval of the project	► Full documentation by UHRIG

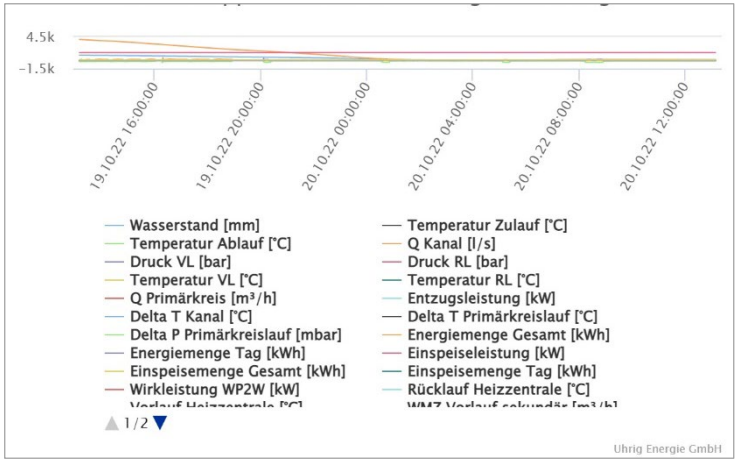
UHRIG Therm-Liner: monitoring

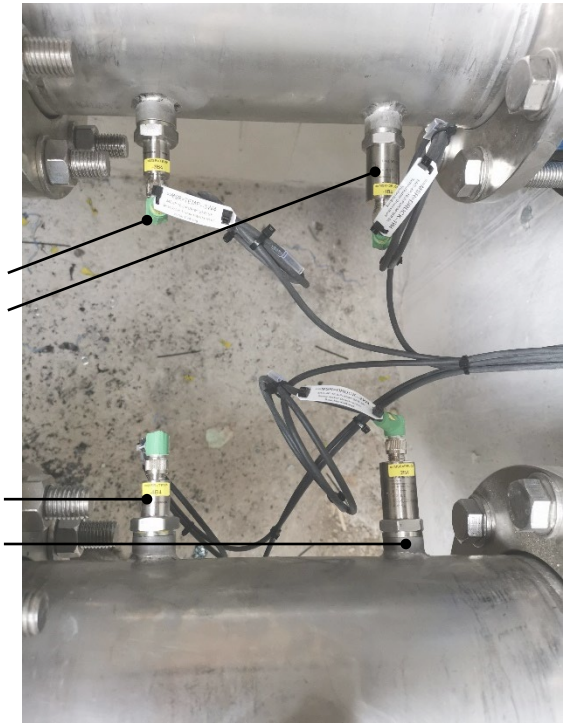
UHRIG monitoring system collects sensor data

- Temperature in the feed and return line of the heat exchanger system
- Operating pressure in the feed and return line of the heat exchanger system
- Flow rate in the feed or return line of the heat exchanger
- Temperature of the wastewater upstream and downstream of the heat exchanger system (in the sewer)
- Wastewater flow rate at the beginning or end of the heat exchanger system (in the sewer)

Advantages of the UHRIG monitoring system

- Collection and processing of all parameters in real time
- Customer access to monitoring of the plant 24/7 online





House connection: technical details

- Connecting heat exchanger and heat pump with feed and return line
- Installed at a depth of between 0.8 and 1.2 m as uninsulated polyethylene (PE) pipes
- Implementation in open construction or as a flush drilling

Connection in the trench

Interface outside heating central

Interface inside heating central