

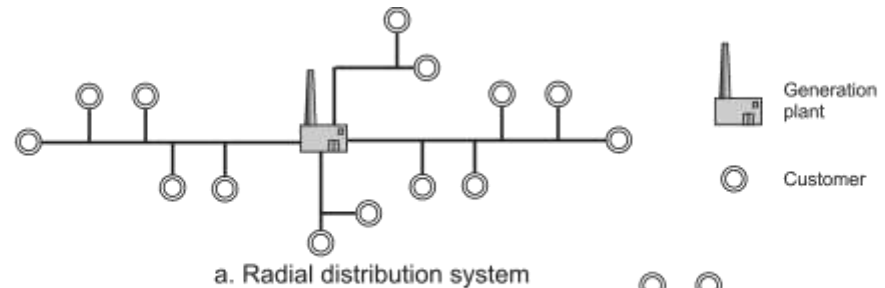
Trenchless Construction for District Heating networks



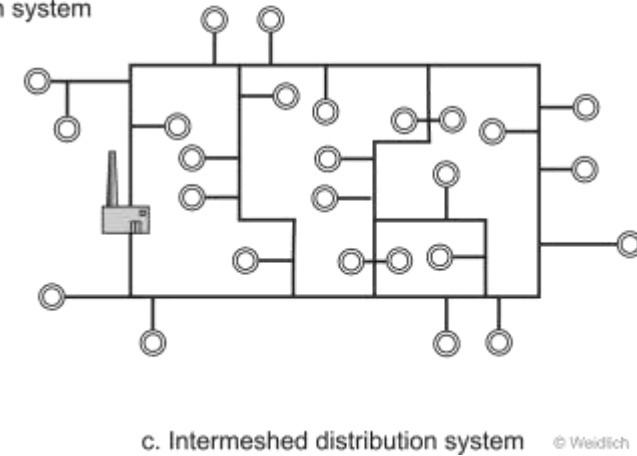
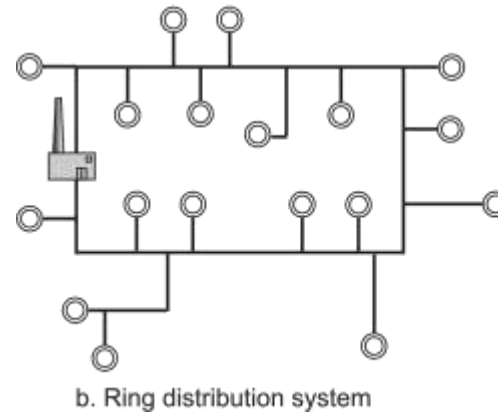
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Combining Trenchless Technology and District Heating



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Combining Trenchless Technology and District Heating

Trenchless Technology: Installation problem.



District Heating pipelines: Operation problem.

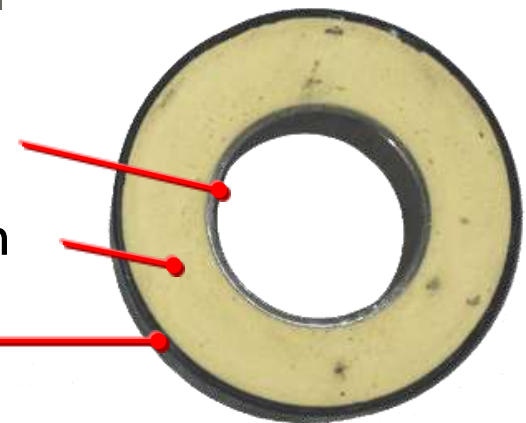
Characteristics of District Heating pipes



Steel medium pipe

PUR insulation foam

PE-coating



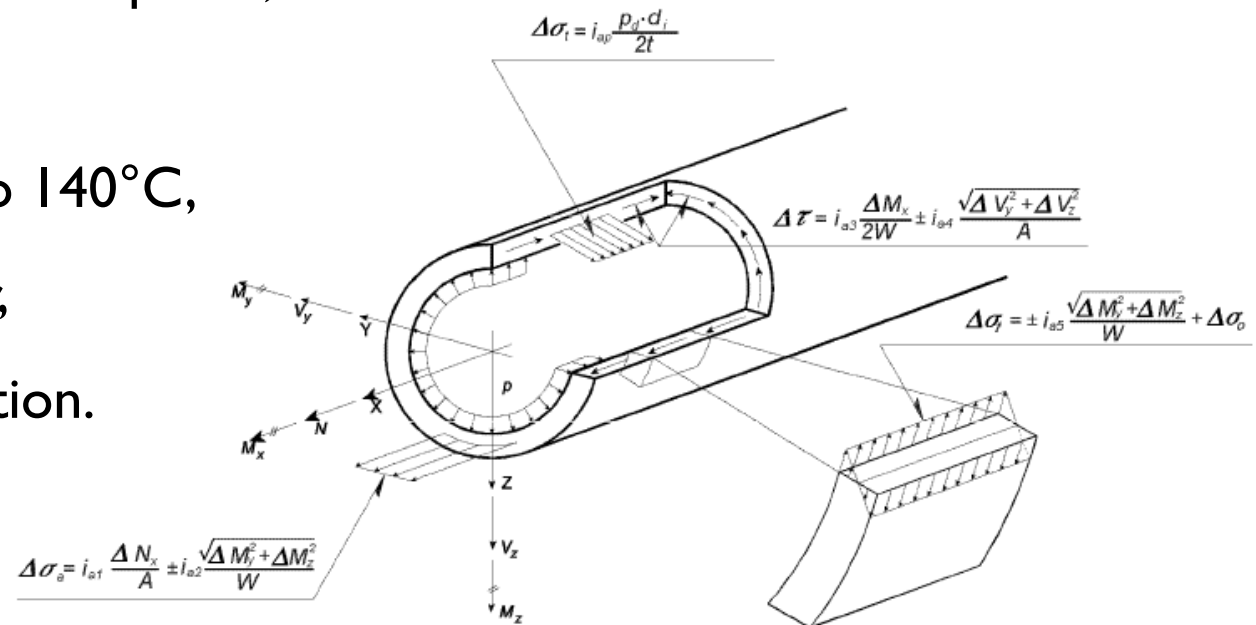
Structural Analysis

Structural analysis is required, because of

Temperature up to 140°C,

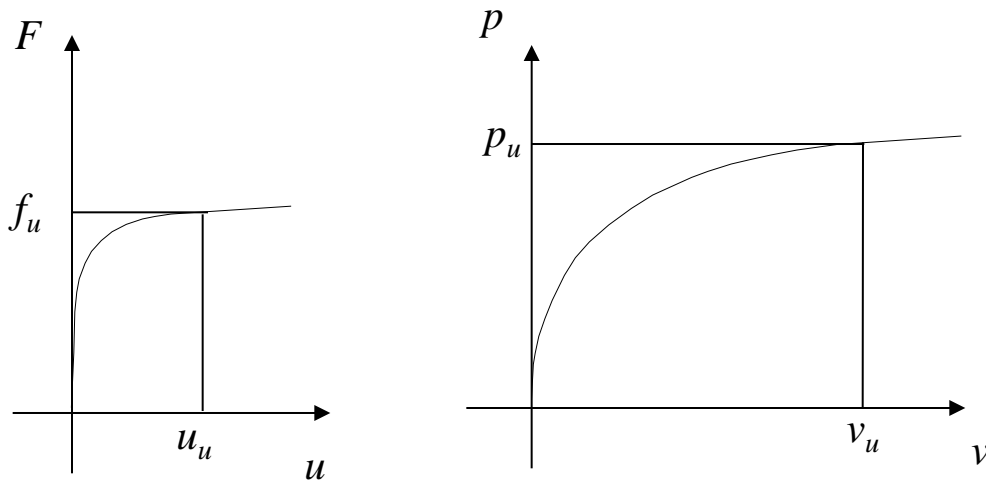
Pressure of 25 bar,

Pipe – soil interaction.



Source: EN13941

Characteristics of DH pipelines



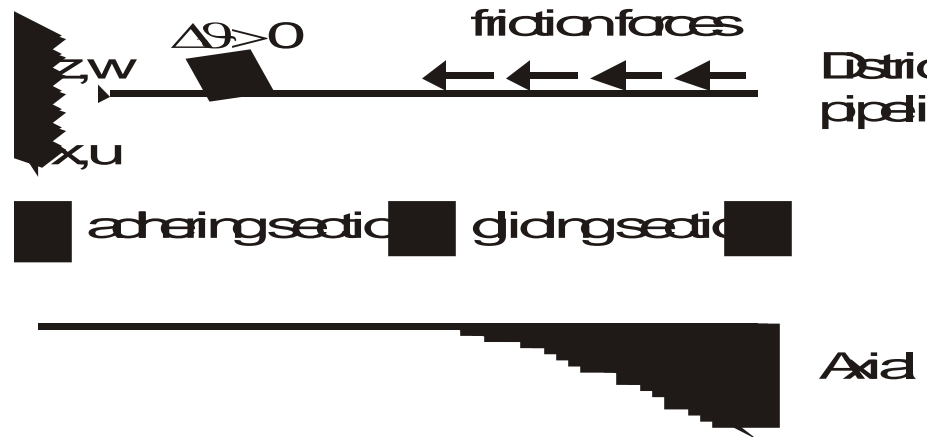
[DIN EN 13941:2007]



[Foto: Weoidlich]

- friction forces $f - u$ (axial interaction)
- bedding pressure $p - v$ (lateral interaction)

Characteristics of DH pipelines

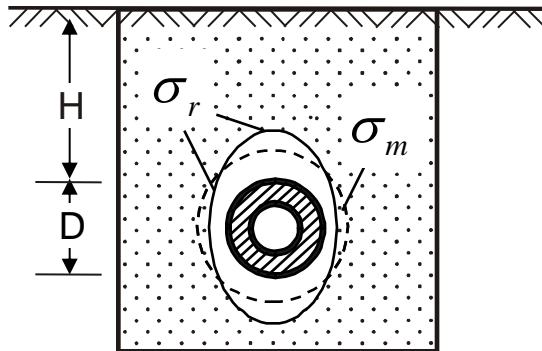


Normal stresses in the adhering section:
$$N_H = -EA\alpha_t \left(\Delta\theta_M - \Delta\theta_M^{(0)} \right)$$

Length of the gliding section:
$$l_G = \frac{EA\alpha_t \left(\Delta\theta_M - \Delta\theta_M^{(0)} \right)}{F_{Ru}^{(0)}}$$

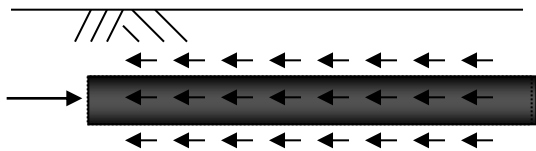
Maximum displacement:
$$w_{\max} = \frac{F_{Ru}^{(0)} l_G^2}{EA \cdot 2}$$

Characteristics of DH pipelines



$$F_{Ru} = \mu * \frac{D}{2} \int_0^{2\pi} \sigma_r d\Psi$$

$$\sigma_m = \gamma * \left(H + \frac{D}{2} \right) * \frac{1+k}{2}$$



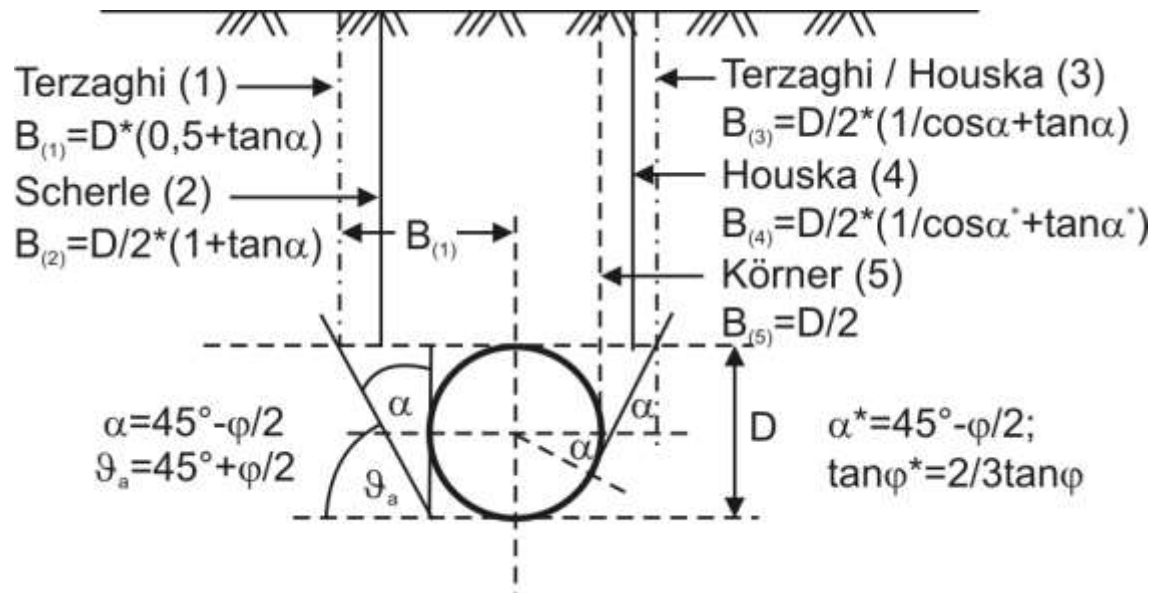
$$F_{Ru} = \mu * \left(\pi * D * \gamma * \left(H + \frac{D}{2} \right) * \frac{1+k}{2} + G''_{Rohr} \right)$$

Contact pressure

Contact pressure is not clearly understood.

Main influences:

- Acting earth pressure
- Use of bentonite suspensions
- Temperature
- Time / Durability of the pipe



Because of that, the use of trenchless technology in the DH sector is still seen with caution. In Germany today ATV A 161 is used.

Cyclic interaction

30 years of service lead to cyclic loads.

Pipe type	Equivalent full action cycles in 30 years according to EN13941
Major pipelines	100
Main pipelines	250
House service connections	1000

[DIN EN 13941:2007]

Standard and technical rules

EN13941:2003, „Design and installation of preinsulated bonded pipe systems for district heating

EN253:2009, „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“

FW401:2007, „Laying and structural analysis of plastic jacket pipes for district heating networks “

FW420:2004, „Part 1 bis 5, „Flexible district heating pipeline systems “

EN489:2009, „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.“

ATV127:2000, „Statische Berechnung von Abwasserkanälen und -leitungen“

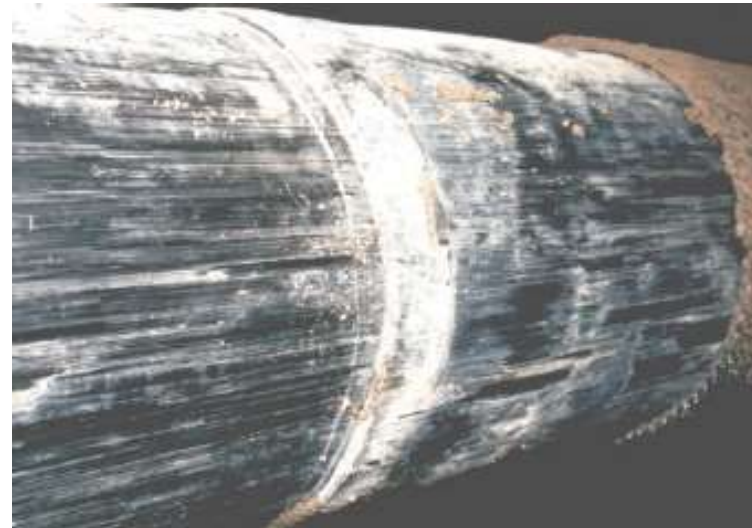
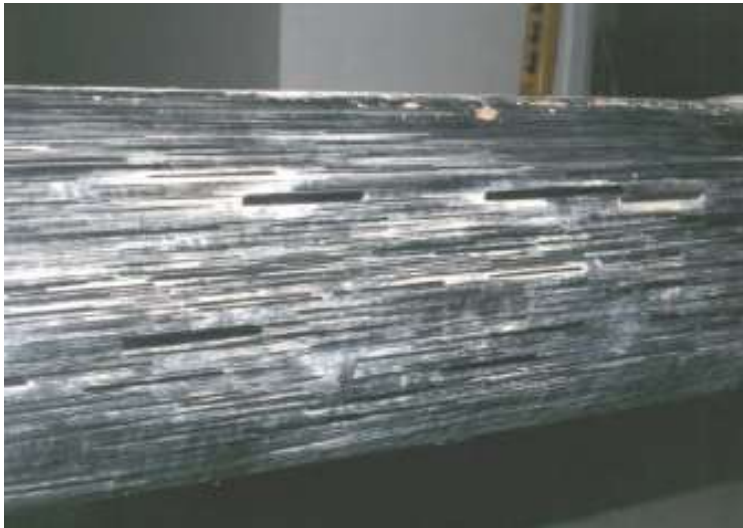
Pipe quality requirements: PE-coating

Strong interaction between soil and pipe during installation



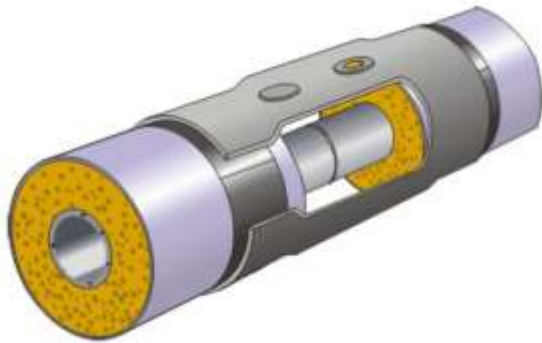
Pipe quality requirements: PE-coating

Strong interaction between soil and pipe during operation



Coarse soil environment will affect the pipe coating and the joints due to cyclic loading.

Pipe quality requirements: Joint systems

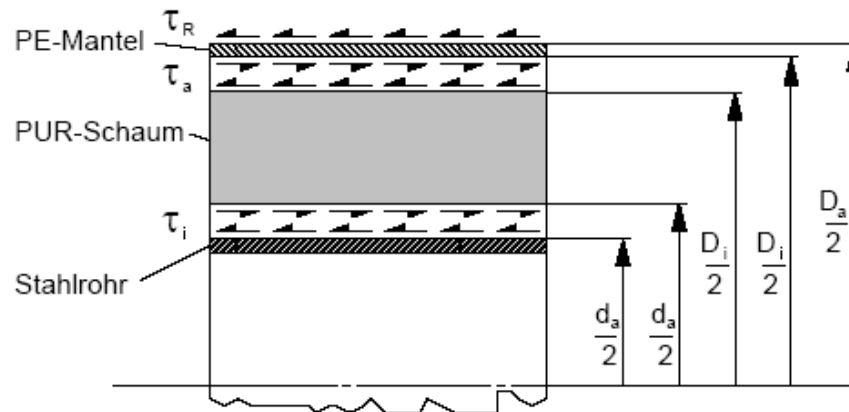


Damage of joints after 23 cycles in laboratory test using rough bedding material

Pipe quality requirements: PUR-foam

Stress-strain coupling between the medium pipe, insulation foam and the PE-coating is necessary.

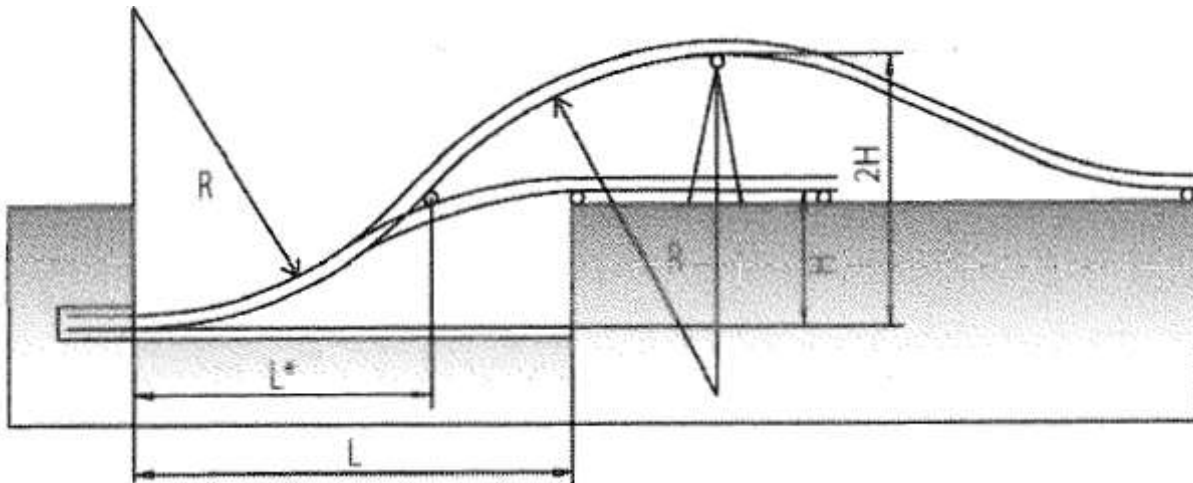
The allowed shear stress in the foam is $\tau_{ax} < 0,04$ MPa for operation.



The possible pulling forces are restricted by the maximum shear stress in the PUR-foam.

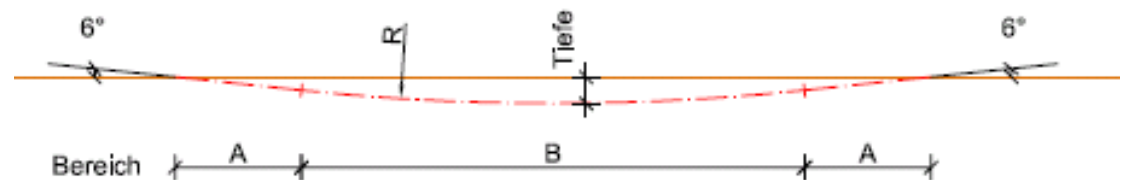
Pipe quality requirements: Steel medium pipe

Pipe curving means additional bending and stress in the pipe



$$R_{\text{design}} = C * \sqrt{D_a * S}$$

$$R_{\text{elast}} = \frac{E * D_a}{2 * \sigma_{\text{bzul}}}$$



Characteristics of trenchless technology

Use of bentonite slurries as a friction reducer.



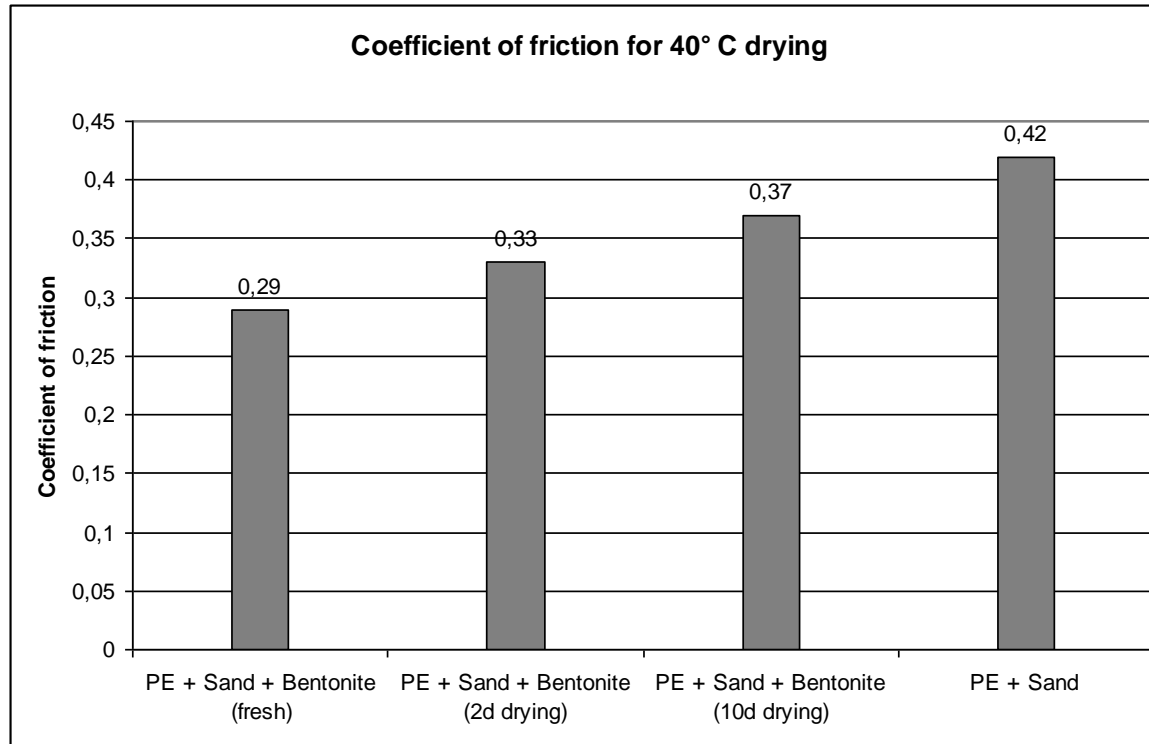
Reduction of technological barriers

Temperature dependence of bentonite suspensions for drilling



Classification tests showed no influence of the temperature for typical coating temperatures of 20°, 30° and 40° degrees.

Reduction of technological barriers



In some tests a temperature dependent behaviour of bentonite-sand mixture was observed.

Outlook

Combining Trenchless Technology and District Heating



Combining Trenchless Technology and District Heating is promising for preinsulated bonded district heating pipes.
