New materials and constructions for improving the quality and lifetime of district heating pipes including joints

Olle Ramnäs
Ulf Jarfelt

Chalmers University of Technology, Sweden

Subcontractors / Collaborating partner

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- Swedish Research Institute, Sweden
- Powerpipe Systems AB, Sweden
- B.C. FOAM s.p.a, Italy

Collaborating partner

- MIT (Massachusetts Institute of Technology), USA

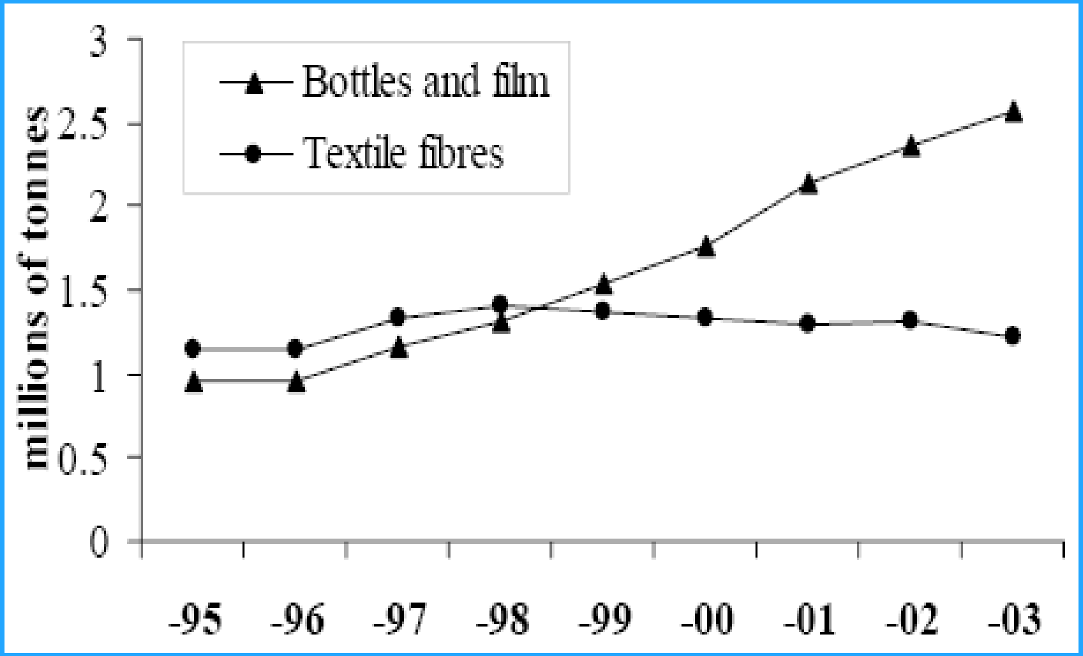
Objectives/goals

The efficiency of polyethylene terephthalate (PET) foam has been studied

- Economy
- Mechanical properties
- Thermal (Insulating) performance
- Environment

Background - Use of PET

PET used for bottles and film in Europe has increased almost threefold since 1995, while the use for textile fibres has remained more or less static

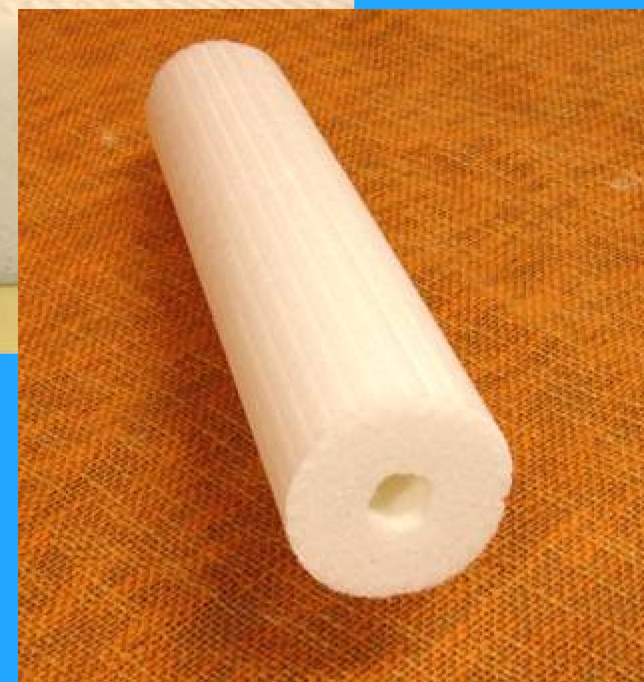


Development of PET foam

Time	Blowing agent	Density $kg \cdot m^{-3}$
↓	HCFC 142b/HCFC 22	85
	HFC 152a	95-114
	Cyclopentane	55

Development of PET foam

Thick PET foam boards and pipe jackets have been produced



Density: 55-60 kg/m^3

Cell size: 0,9 mm

Blowing agent: Cyclopentane

Economy

- The price of PET and PUR foam have been about the same during the last years (*2.0 EUR/kg ,Sept. 2007*)
- The possibility of utilising recycled material in the production of PET foam will decrease the material costs

Mechanical properties

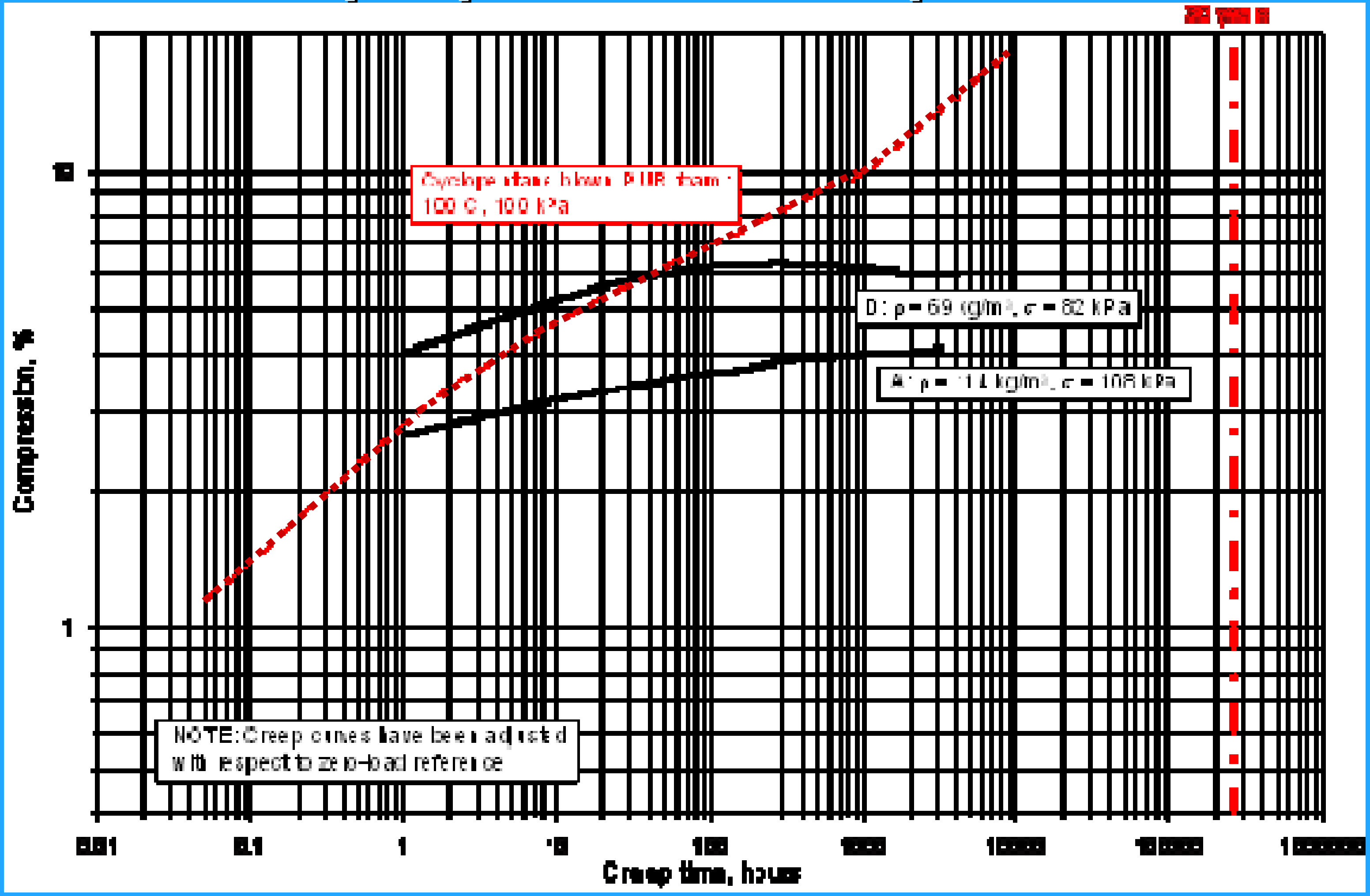
Adequate mechanical properties are needed (*EN 253 and EN13941*)

- Creep behaviour
- Water permeability and vapour resistance
- Water absorption
- Glass transition temperature
- Tensile and compressive strength
- Flexibility – bending properties

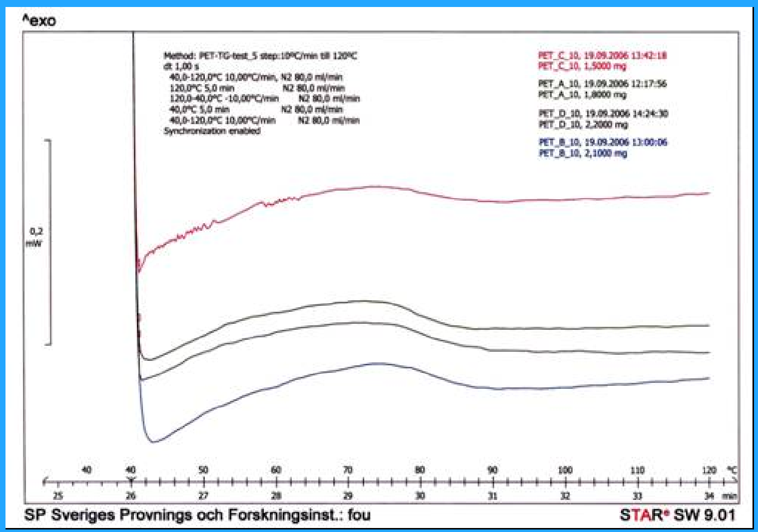
Mechanical properties – Creep behaviour

The creep properties of PET foam seem to be very good. Extrapolation of the creep curves to 30 years of technical service does not indicate any significant creep deformation, neither at room temperature nor at 80 ºC.

Mechanical properties - Creep

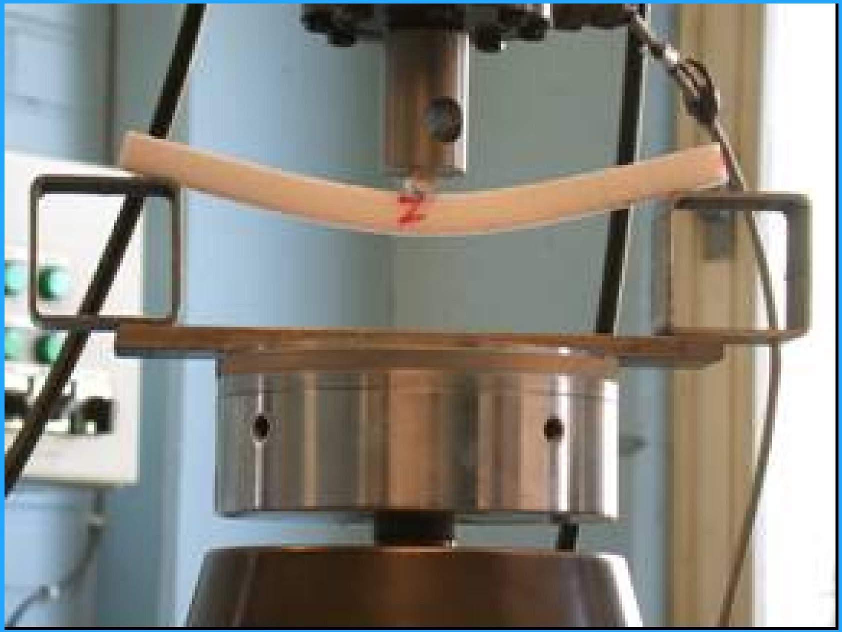


Glass transition temperature



The results verify that the PET materials turns softer at approximately 80 ºC, as could also be seen from the short-term compressive strength measurements at different temperatures

Flexibility



The material can easily be processed to withstand bending strains to a sufficient degree for flexible district heating pipes.

Thermal performance (insulation)

- If a PET and a PUR foam can be produced with the same blowing agent and the same cell size and density, the thermal conductivity will be about the same.
- However, since the insulating foam will be used for a very long time, the foam exhibiting the slowest gas diffusion will have the best long term thermal performance (LTTP)

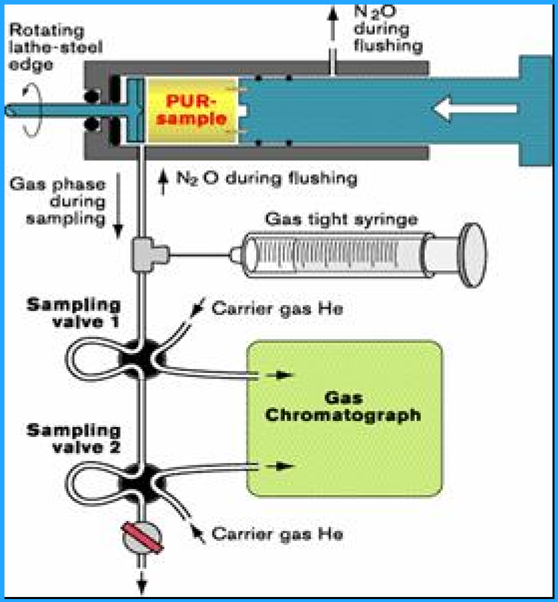
Thermal conductivity

A newly produced PUR foam has a little lower thermal conductivity than a new PET foam. The difference depends mainly upon smaller cells in the PUR foam.

In the future a new PET foam will probably exhibit the same thermal conductivity as a PUR foam.

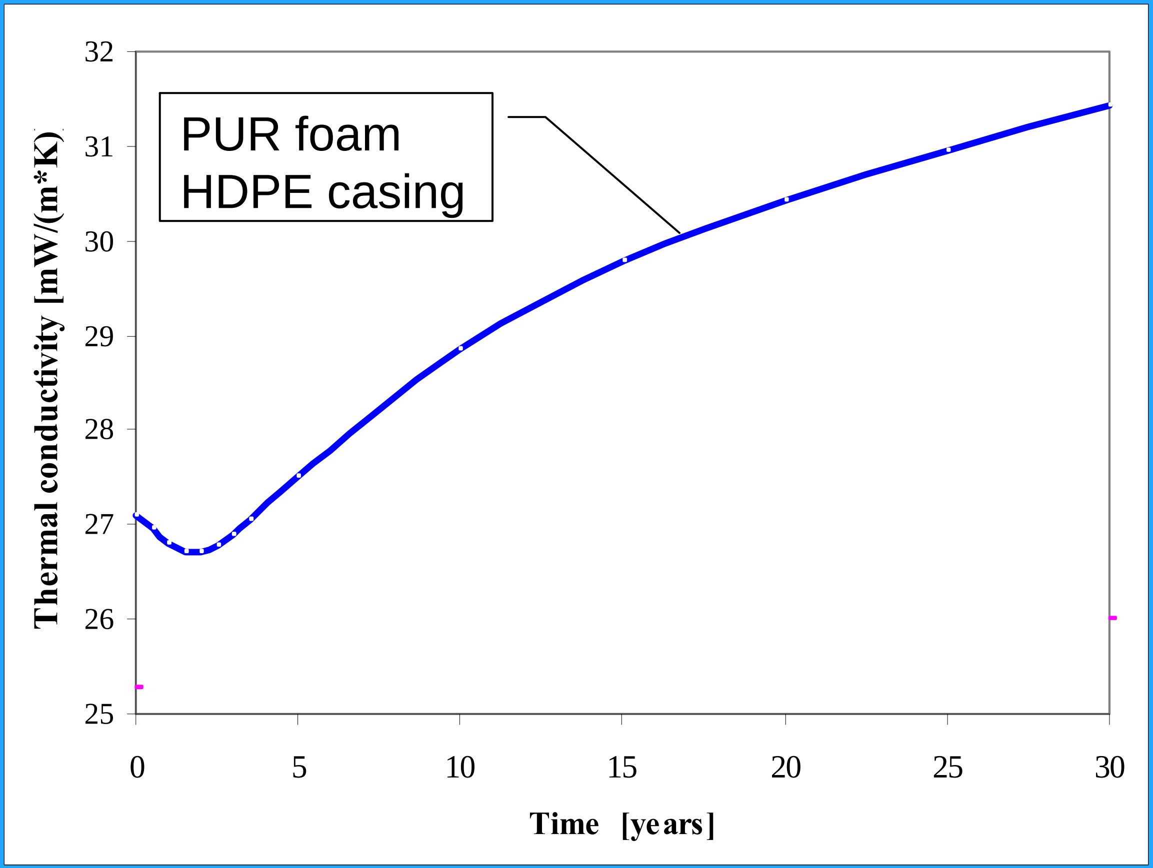
Long-term-thermal-performance (LTTP)

The results from the determination of the diffusion properties give a clear cut indication that the long term thermal performance of a PET foam is better then that of a PUR foam.

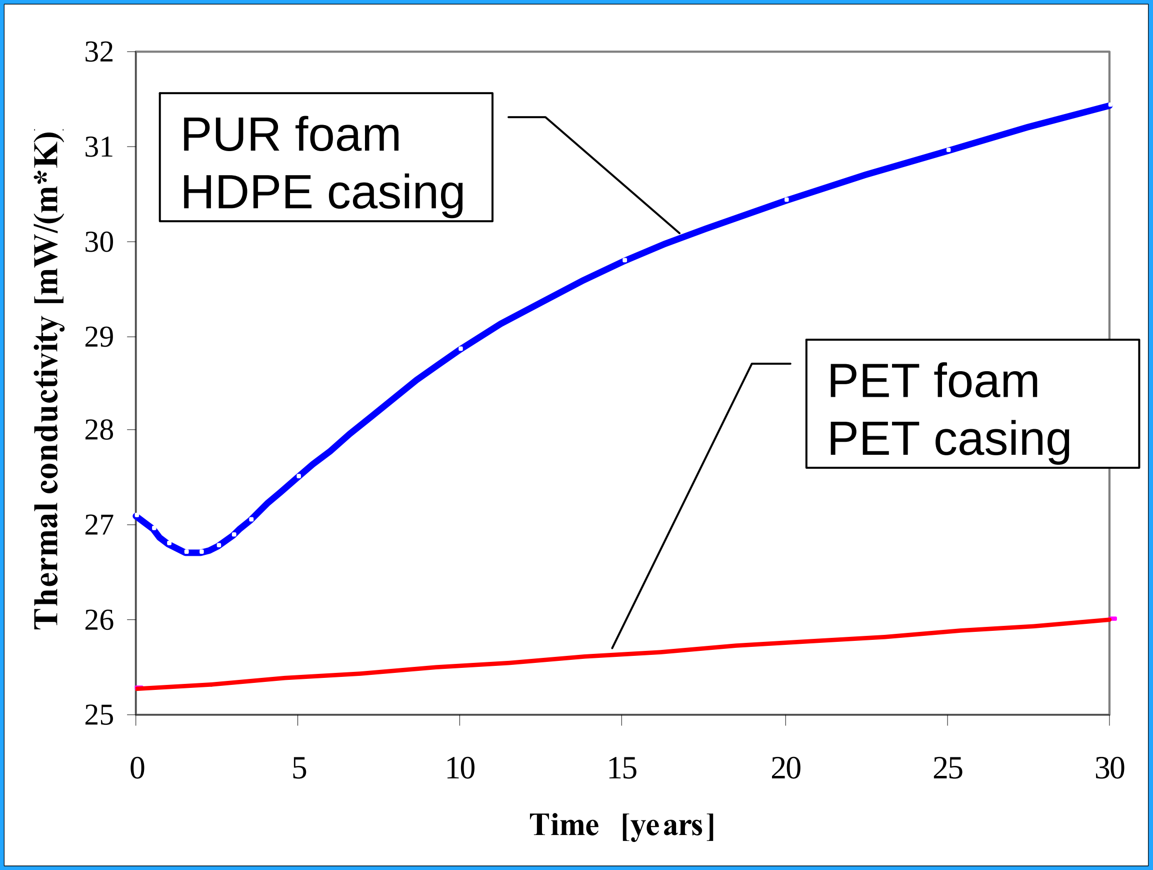


The effective diffusion coefficients of oxygen, nitrogen, carbon dioxide and cyclopentane in a PET foam are about 5-15 times lower than those in a PUR foam.

Thermal conductivity over time for a DH pipe (DN 40/125)



Thermal conductivity over time for a DH pipe (DN 40/125)



Comparison PUR and PET insulated DH pipes

Type of pipe		Equivalent over a 30 years	
Insulation	Casing	Thermal conductivity of the foam λ_{eq} ($W \cdot m^{-1} \cdot K^{-1}$)	Heat flow Q_{eq} ($W \cdot m^{-1}$)
PUR	HDPE 3 mm	0.0294	13.3
PET	PET 3 mm	0.0256	11.6
PET	PET 1 mm	0.0261	11.8
PET	No casing	0.0288	13.1

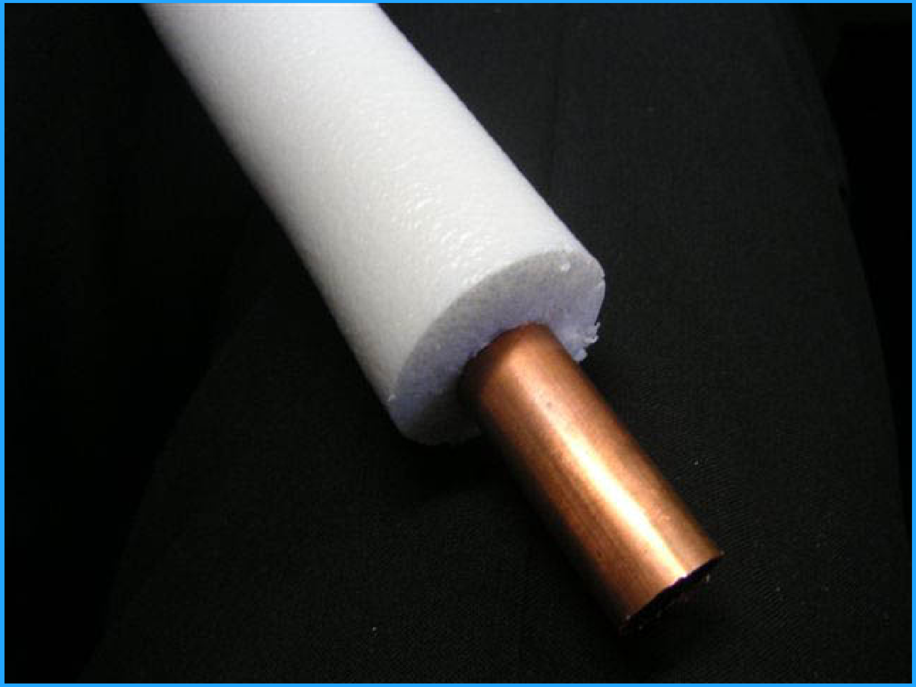
Environmental performance

- Superior insulation capacity during a long time is important to minimize the heat losses and the environmental impact caused by the energy production
- The use of recycled material will increase resource efficiency
- There is a need to find alternatives to PUR foam, due to the toxicity of the isocyanates, one of the main components in PUR foam production.

Conclusions

■ Economy	+/=
■ Mechanical	-/=
■ Insulation	++
■ Environment	+

Conclusions



According to the present study PET foam seems to have the potential to compete successfully with cyclopentane blown PUR foam as insulating foam for district heating pipes of small dimensions at low temperatures (<100˚C).

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B.C. FOAM s.p.a., Volpiano, Italy

Mr. Göran Johansson

Powerpipe System AB, Sweden

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