global insulation
CONFERENCE & EXHIBITION

Vacuum Insulation Panels

Status and Future Trends

Roland Caps

President of VIPA International

Chief Research Officer and Founder of va-Q-tec AG

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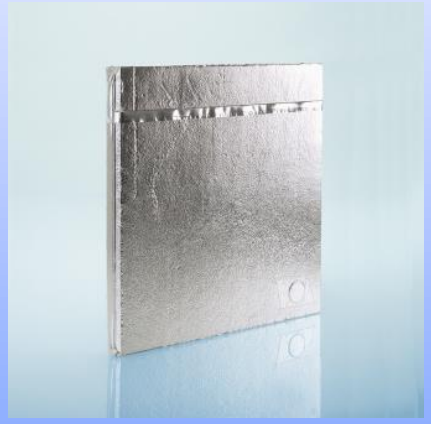
Vacuum Insulation Panels (VIPs)



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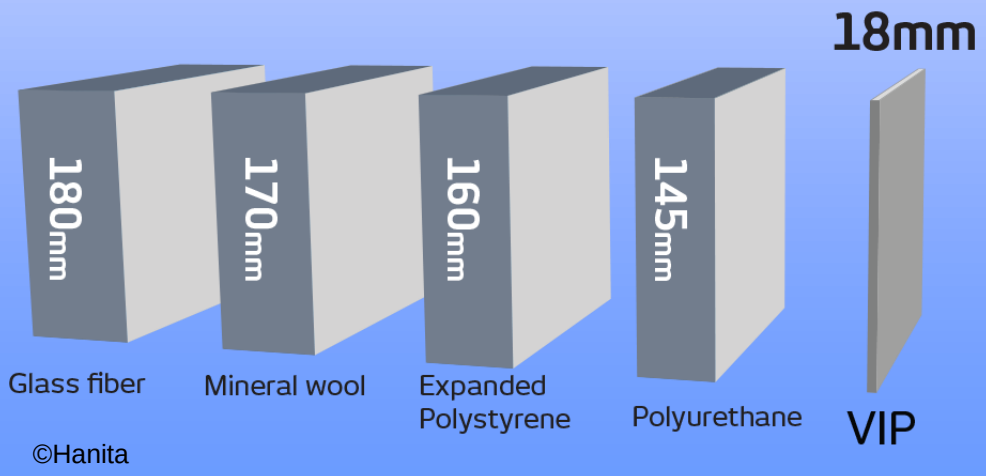
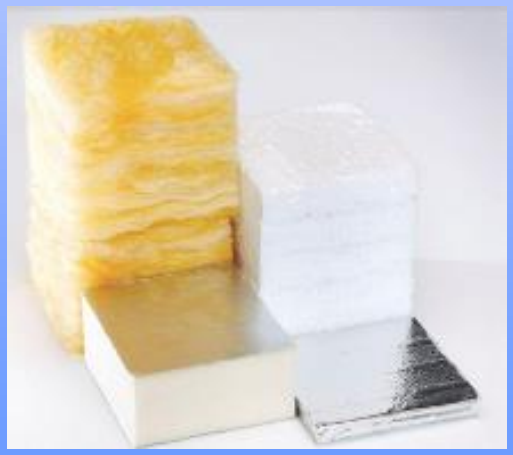
- Ultra-thin, high-performing insulation
- Can be up to 20 times more effective than existing insulation products
- Rigid, highly-porous core material encased in a thin, gas-tight outer envelope evacuated and sealed

Advantages of VIPs

- Thermal conductivity between 0.002 and 0.008 W/(m·K) after production
- Extremely low insulation thicknesses (10 mm to 40 mm)
- Stable, long-term thermal performance when installed correctly and protected from damage and penetration
- New design and construction possibilities

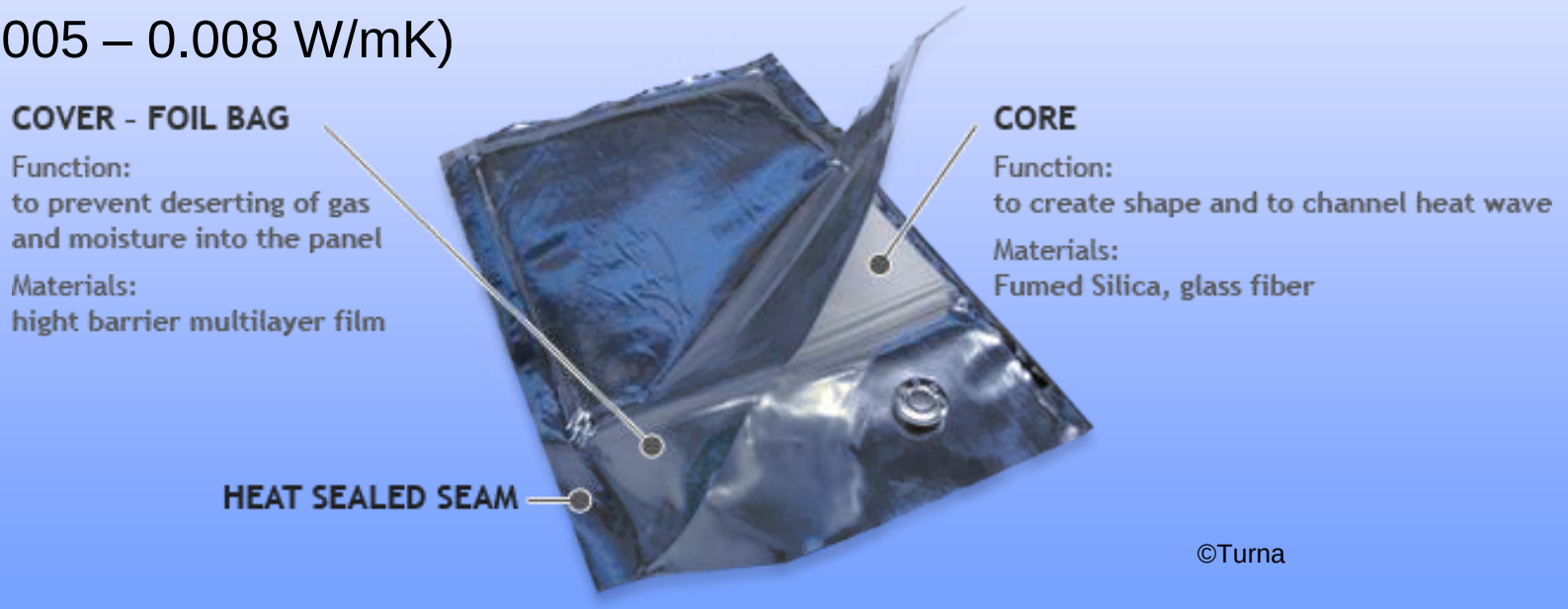




Core Materials

Lowest possible thermal conductivity to ensure the VIP's best performance. Core material classes comprise basically three structures:

- (micro-porous) powders (0.0035 – 0.006 W/mK)
- fibres (0.002 – 0.004 W/mK)
- foams (0.005 – 0.008 W/mK)



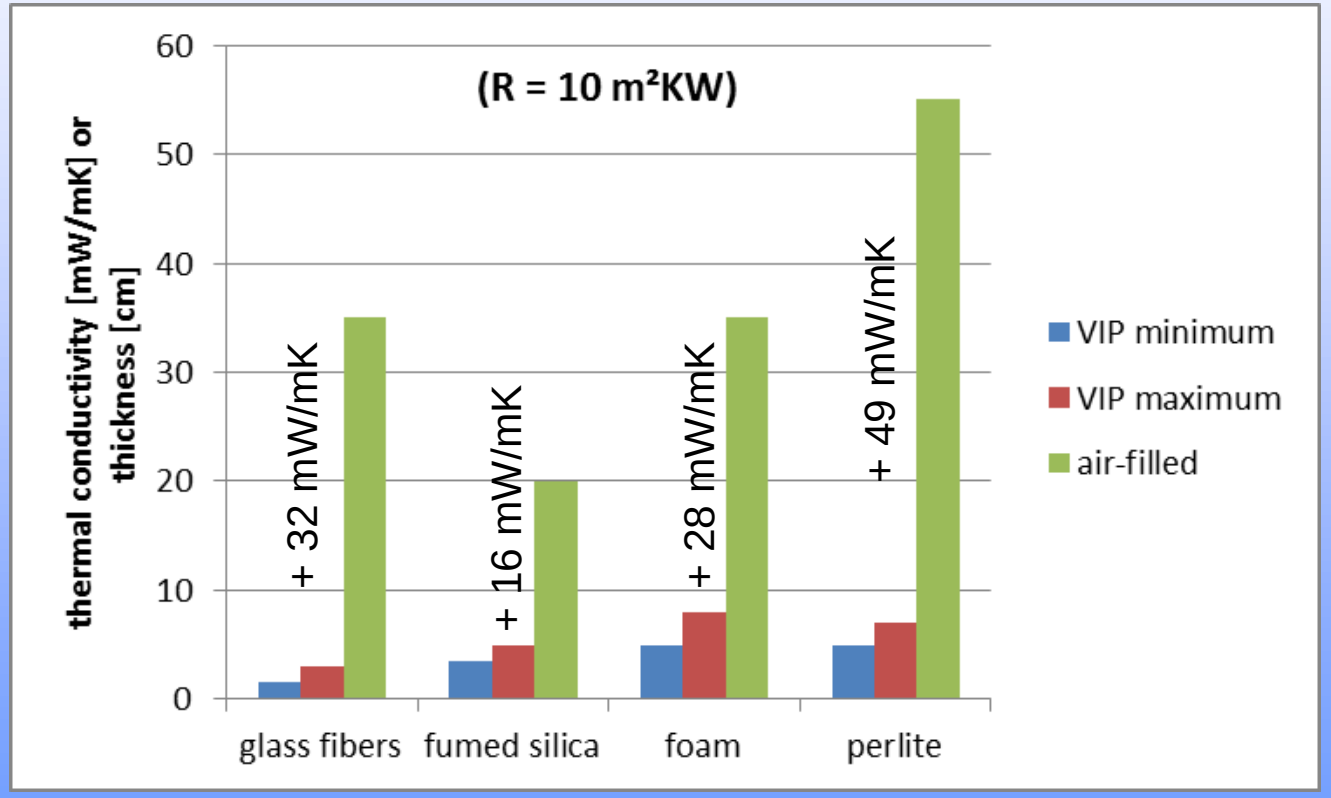
Most common core materials: fumed silica and glass fibres
Further: open-cell polymer foams, e.g. special polyurethane or polystyrene foams

Overview Core Materials

core	thermal conduc-tivity	density	pore diameter	costs per mass	costs per volume	service life time
fumed silica	o/+	o	++	o	o	++
glass fiber	++	-	-	+	o	o
PU foam	-	+	-	+	+	-
perlite powder	-	-	o	++	++	o

The ideal core material: low costs per mass, low density, small pores, low thermal conductivity, long service life time

Core Materials Evacuated and in Air



Nano-Porous Core Materials

⇒ Knudsen-effect: mean free path is limited by core structure

- **silica aerogels**
- **pyrogenic silica powder**
- **nano-foams**

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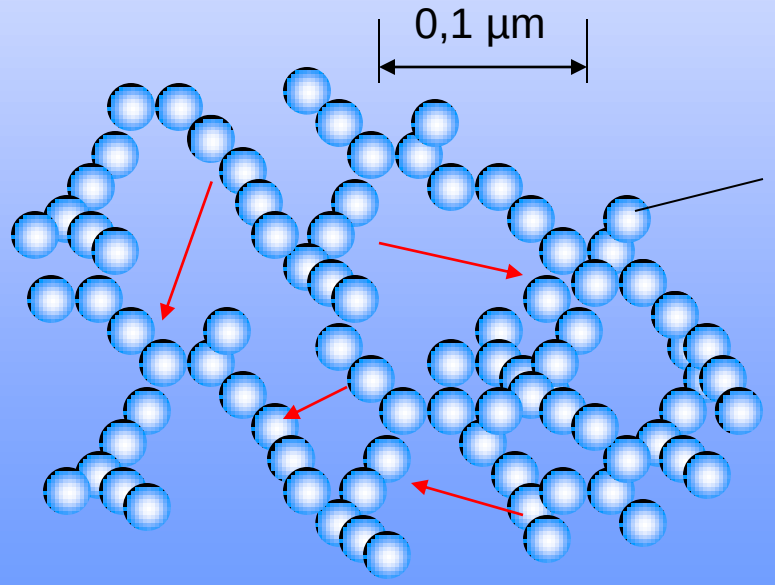
free air molecule



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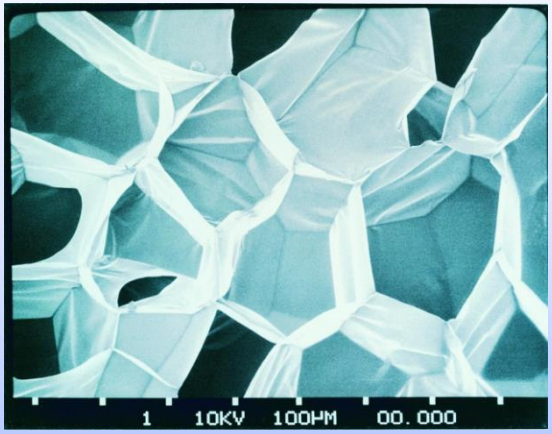
air molecule in core structure

New Developments of Core Materials

Organic nano-foams:



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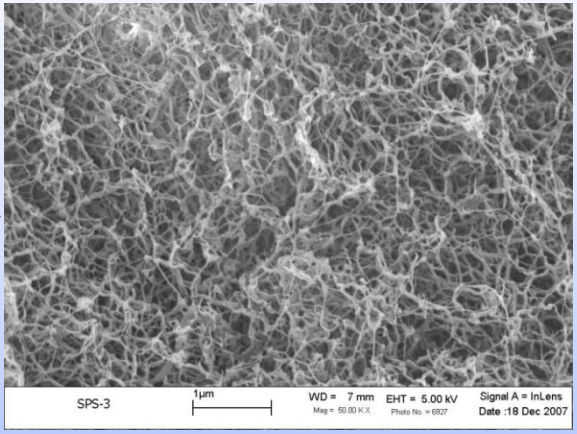

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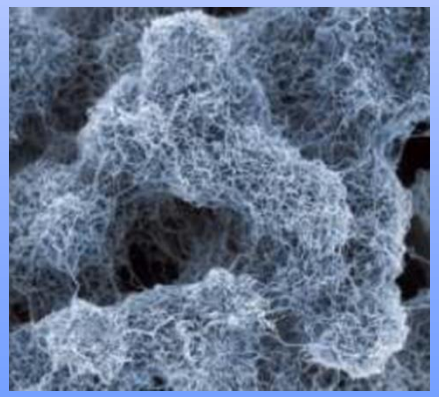
pore sizes are reduced from 100 µm downto 0,1 µm by sol-gel process

⇒only moderate vacuum of 10 mbar necessary
⇒long service life time
⇒in air thermal conductivity between 15 and 20 mW/mK
⇒rigid boards

Nano-Foams

Example: „Slentite“ from BASF

- open porous **polyurethane** aerogel
- rigid boards
- pilot plant now finished
- costs ???



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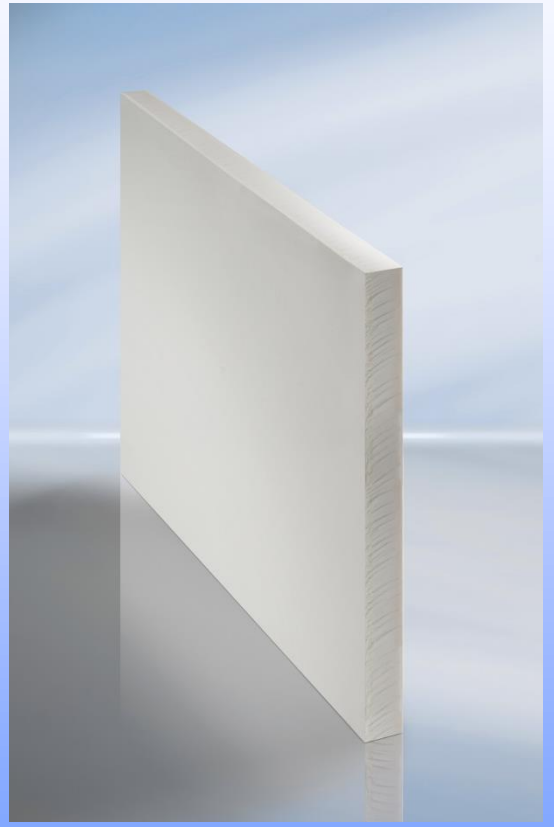

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Other nano-foam concepts are currently under research

Envelope

Gas impermeability, low thermal conductivity and sufficient puncture resistance are the main factors influencing the selection of envelope materials for VIPs.

Materials used to provide the VIP envelopes:

- aluminium-metallised high barrier plastic laminates
- aluminium film laminates
- stainless steel films or sheets

Envelope

State of the art of metallized high barrier films:

0.01 $cm^3/(m^2$ day) air permeation
0.01 $g/(m^2$ day) water vapour permeation

Barrier films with improvements by a factor of 4 – 10 are possible
=> factor of 4 – 10 longer life times

Barrier film is a major cost part
of the total material costs of VIP

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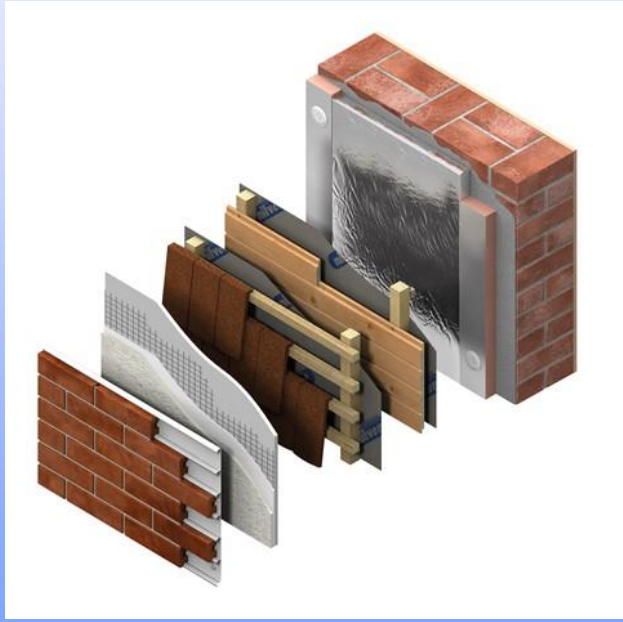
Applications

Buildings



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Appliances

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Transport

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Case study 1: VIP technology delivers optimum thermal performance with a minimal build-up to care housing in North Yorkshire, U.K.

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The Problem

The Meadowfields Extra Care Housing Scheme in Thirsk will incorporate 52 apartments along with a number of community features such as a restaurant, hair dressers and a new public library. The building roof comprises two pitched sections either side of a flat roof which sits above the central corridor. Even with premium performance rigid thermoset insulation, there was insufficient space in the central area to create the necessary fall whilst maintaining the target U-value of 0.15 W/m².K.

The Solution

To tackle this problem, the architect working on the project decided to install a Vacuum Insulation Panel (VIP) on the roof of the building. The vacuum insulation technology contributes to an aged thermal conductivity of 0.007 W/m·K, with a thinnest possible build-up.

Case study 2: Vacuum insulated boxes provide the UK NHS Blood and Transplant with a transportation solution for blood components nationwide

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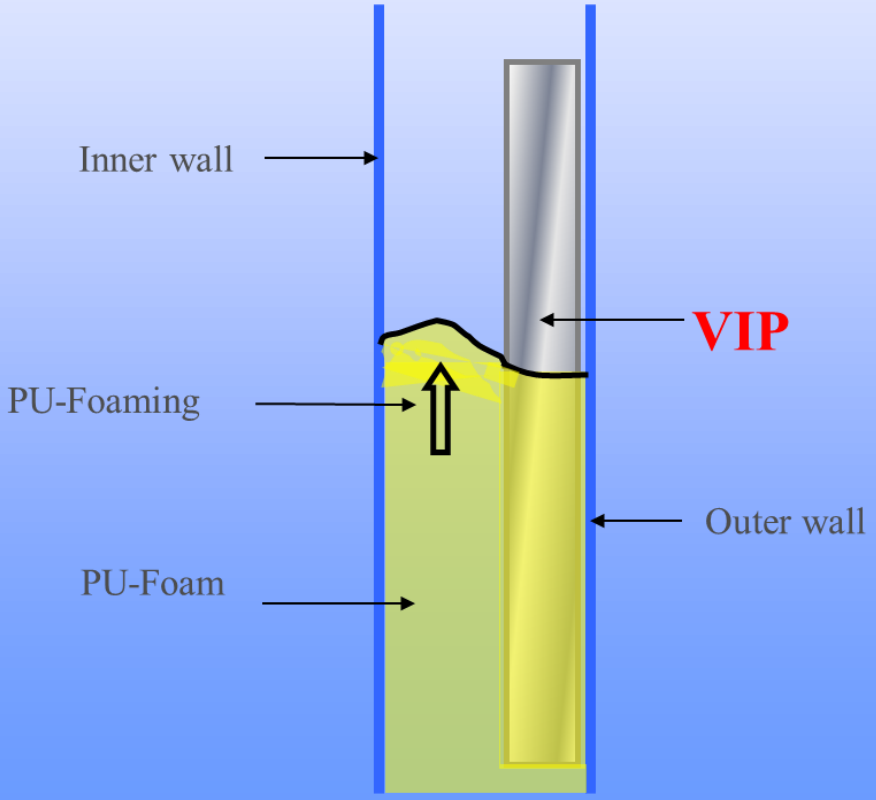
The Problem

NHS BT supplies two million blood units to hospitals in England and North Wales each year. The required transportation solution must be cost efficient per use, simple to operate and carry, and suitable for short and long distances.

The Solution

Since 2009, NHS BT uses a customised box which meets thermal, health and safety requirements for blood and blood products. Vacuum Insulation Panels (VIPs) in the box walls protect the blood units from extreme ambient temperatures, Phase Change Materials (PCM) inside maintain specific temperature ranges for several days. The customisable outer fabric bag enables easy and secure handling

Largest Market: VIPs in refrigerators/ freezers



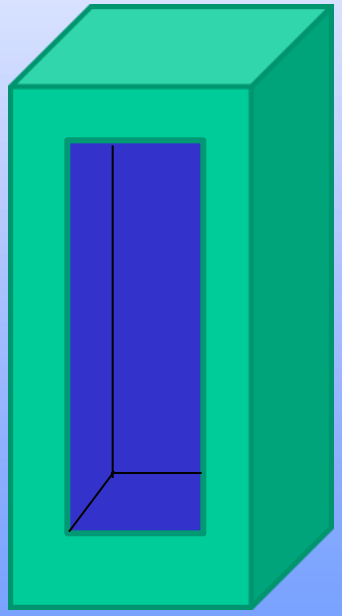
Up to now VIPs mostly are foamed into double wall of freezer together with PU

$\Rightarrow$ saving energy

but not space

but: **VIPs save space!**

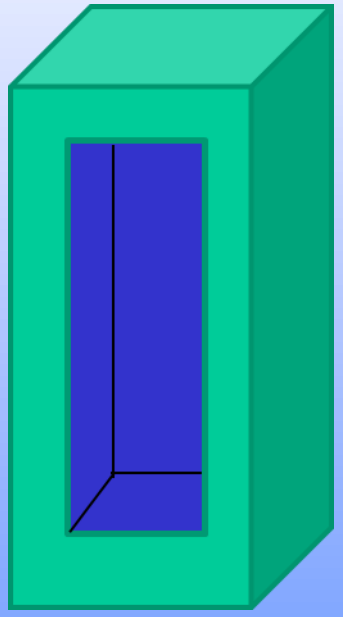
Assumption:
Wall construction is either by VIPs or PU only

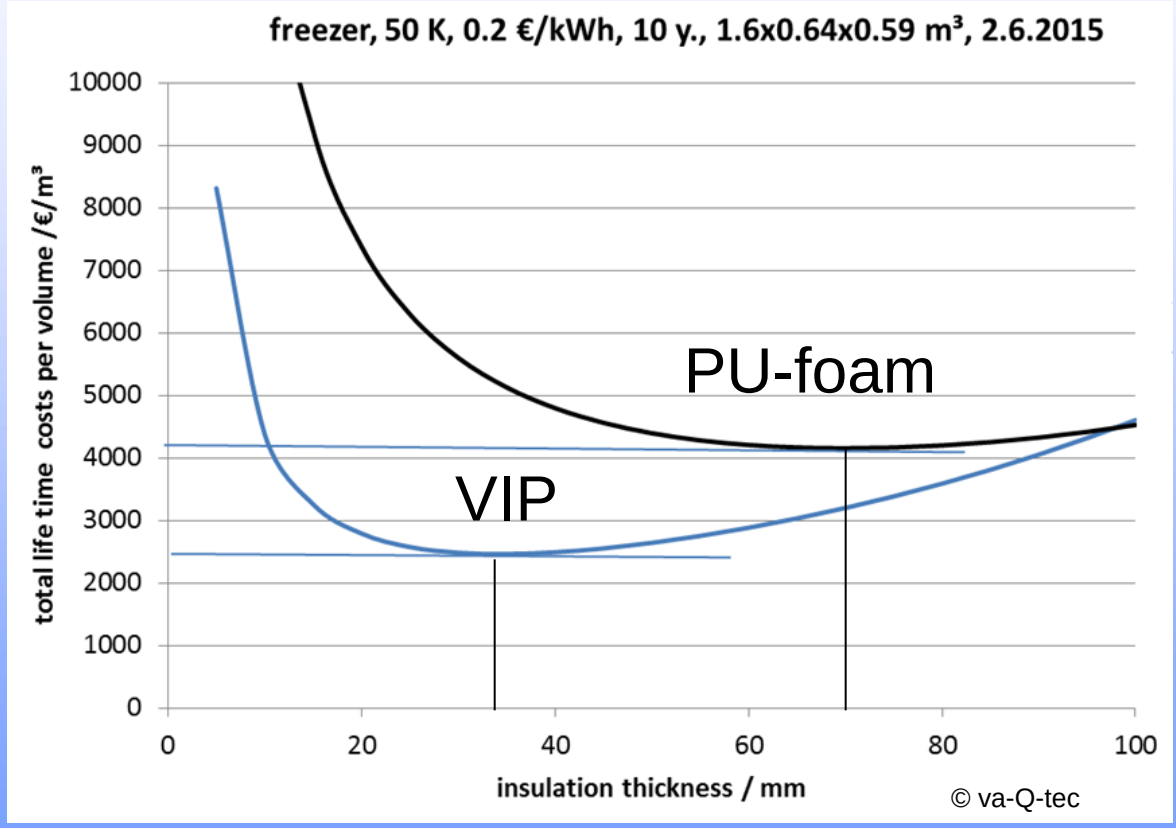


Calculation of
total costs of freezer
per volume of usable space [€/m³]
during service life time
including energy and insulation costs

as function of insulation thickness

Total life time costs per usable volume [€/m³]





40% costs saving by VIP in comparison to PU foam!

Standardisation: Ageing Process

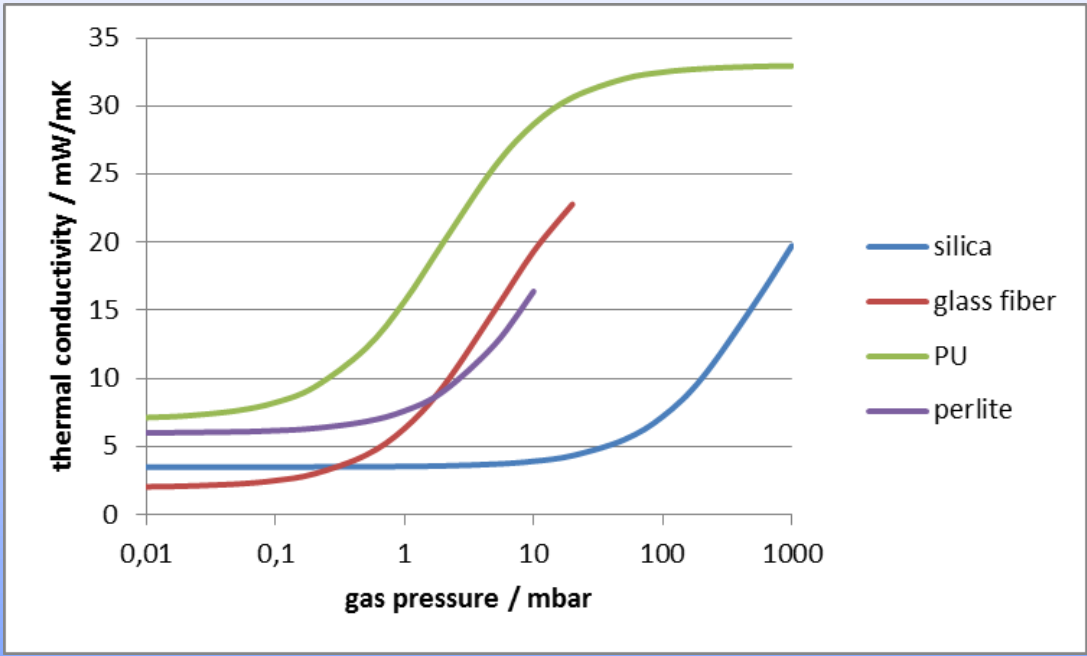
- VIPs have lower thermal conductivity compared to standard insulation materials but there is not yet an agreed method to test the durability and ageing of the panels along the years (in the buildings application)

- The development of reliable methods to measure the ageing process of VIPs in the building sector is of utmost importance for the industry

- VIPA International is working together with the ISO (TC 163/SC3/WG11), the CEN (TC88/WG11) and the IEA-EBC (Annex65) on measurement methods for the ageing process of VIPs

- VIPA International commissioned a set of studies to FIW which will be available early 2016 and will hopefully fasten the standardisation process

Aging: Pressure Dependence of Thermal Conductivity



$\lambda(p) = \lambda_0 + 26/(1 + p_{1/2}/p)$

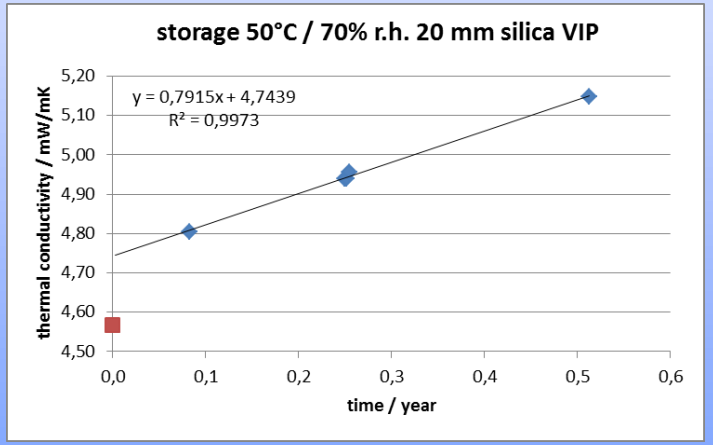
p: gas pressure, $p_{1/2}$: typical gas pressure of core

Testing Life Time: Accelerated Aging

- VIPs are stored at climate 50°C/ 70 % r.h. for 6 months
- Thermal conductivity, mass and gas pressure are measured every two months

Results:

– thermal conductivity increase per year
– increase of moisture content per year
– increase of gas pressure per year



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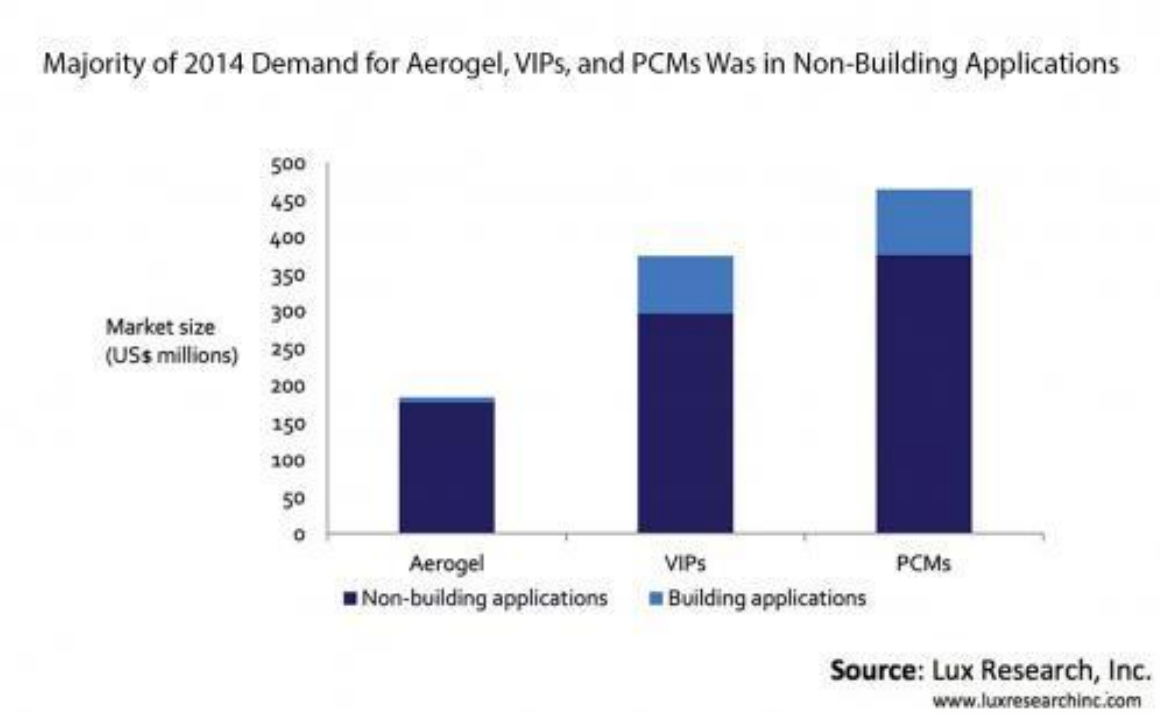
Extrapolating results to standard climate 23 °C / 50 % r.h. =>

Declared value of mean thermal conductivity for 25 years

Market Size of VIPs: Study of Lux Research



Market Outlook

BOSTON, MA – July 28, 2015 – The biggest markets for advanced insulation materials such as aerogels, vacuum insulation panels (VIPs), and phase-change materials (PCMs) are outside of building applications.

However, collectively these applications will grow over 17% annually reaching $1.9 billion in 2019, up from $849 million in 2014, according to Lux Research.

Source: Lux Research Inc.
www.Luxresearchinc.com

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VIPA International is the association representing the interests of the global vacuum insulation panel industry. Membership includes VIPs manufacturers, material and equipment suppliers and academia

- Contribute to the standardisation process (funding of technical studies)
- Shape a better regulatory environment for VIPs
- Be a forum for discussion for the industry players
- Raise awareness and visibility to VIPs
- Dialogue with policy makers and stakeholders

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Thank you very much for your attention!

Vacuum Insulation Panel Association

Email: VIPA-international@kelleneurope.com
Phone: +32 2 761 1681
Website: http://vipa-international.org

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