Vacuum insulated panels.

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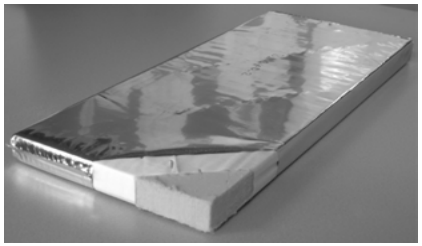
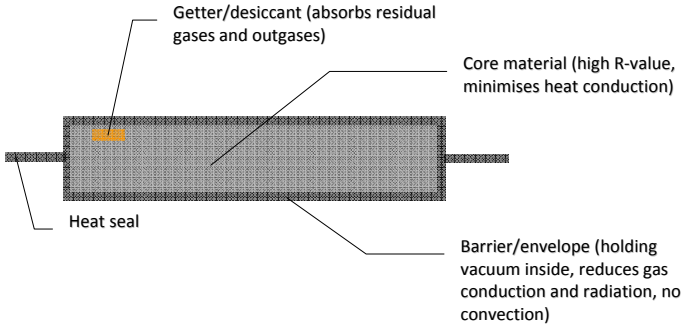
Energy Thrift

- Energy consumption by buildings takes about 28% of overall energy use worldwide.
- 45% of overall energy usage in Western countries.
- UK building regulations require increasing standards of thermal insulation levels
- Many systems will struggle to achieve forthcoming standards.
- Wall thicknesses are becoming a particular problem

Vacuum Insulation



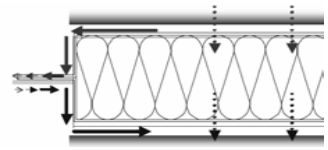
Typical Vacuum Insulation Panel



Vacuum insulated panels

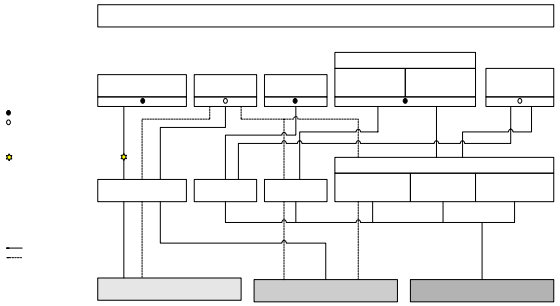
Resistance to heat transfer

- Convection: reduced to extremely low levels as a result of removal of air and gas.
- Conduction: Selection of low conductivity core material essential. Edge conditions can easily dominate.
- Radiation: Particularly problematic in hollow panels. Complex radiative transfer possible in panels with cores.



Edge conduction

Vacuum Insulation Typology



Fumed Silica

- Fumed silica was invented by Harry Kloepferat Degussa in 1942.
- Now it is a commonly used core material for VIP.
- Fumed silica is a fumed silicon dioxide, notable for its unusual particle characteristics, small pore size, high surface area and purity.

K value of insulation materials

Insulation material	k_{core} *(mW/mK)*
Glass fibres	35
EPS, PUR	30-25
Fumed silica	20
VIP	4

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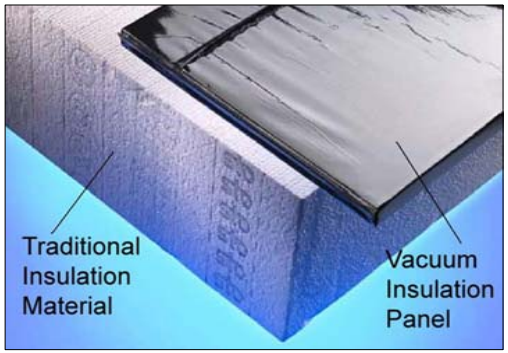
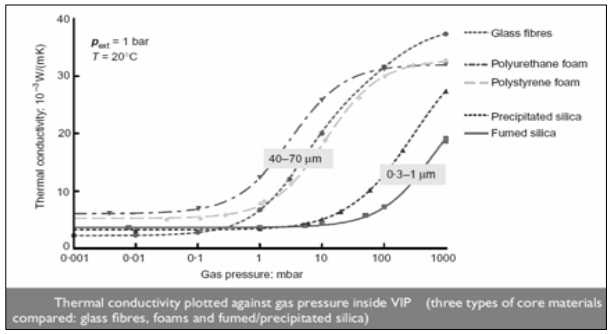
Relative Thickness



Effect of Gas pressure

- Gas pressure within panels influences thermal conductivity.
- Core materials respond differently to pressure variations.



Thermal conductivity plotted against gas pressure inside VIP (three types of core materials compared: glass fibres, foams and fumed/precipitated silica)

Life expectancy

- Construction applications require longer life expectancy than most other applications.
- 12 years required for refrigerator applications. 60 years potentially required for construction applications?

Depends on:

- The initial vacuum level of the panel.
- The permeation rate of the membrane film or envelope.
- The degree of out-gassing (if any) of the core material and membrane film.
- The permeation rate of the membrane seals.
- The quality and effectiveness of the getter and desiccant.
- The effect of pressure rises on the specific core material.

In Use Performance Monitoring

24 schemes:

- 14 refurbishment
- 10 new build

Applications:

- walls
- floors
- ceilings
- roofs
- doors

VIP-manufacturers:

- lambdasave GmbH
- Porextherm GmbH
- Vaku-Isotherm GmbH
- Variotec GmbH & Co. KG
- Va-Q-tec AG

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Schemes

Summary of Findings

VIP area: 4635 m²
VIP area analysed: 3231 m²

Surface temperature above upper limit of expected value: 268 m² = 8.3%.

Surface temperature below upper limit of expected value: 139 m² = 4.3%.

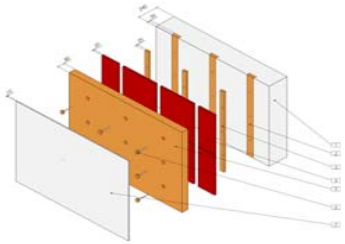
However 3 schemes were poorly constructed, subtracting these:

VIP area: 3070 m²
VIP area analysed: 1806 m²

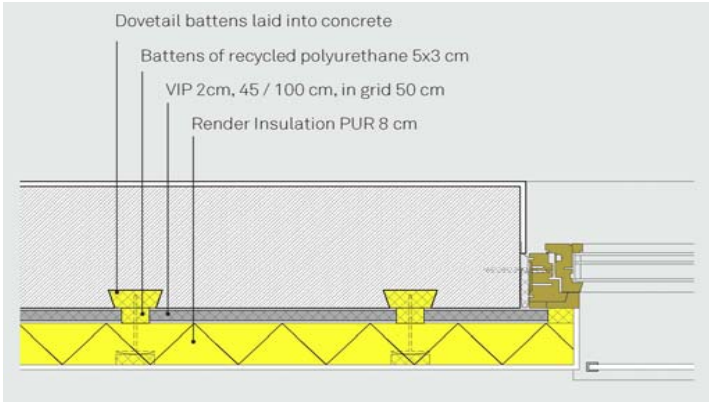
Surface temperature above upper limit of expected value: 21.2 m² = 1.2%.

Surface temperature below upper limit of expected value: 45.7 m² = 2.5%.

Seitzstraβe 21, Munich



Cladding detail



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Construction 1

Construction 2

Construction 3

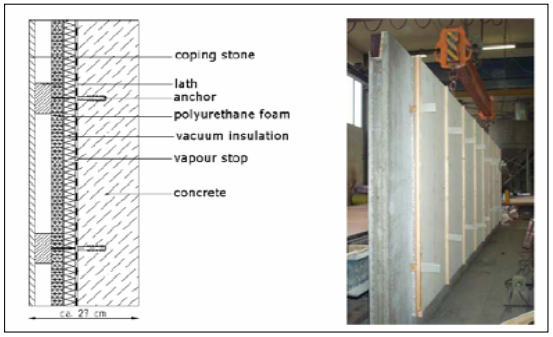
Construction 4

Vacuum insulated panels

Construction 5

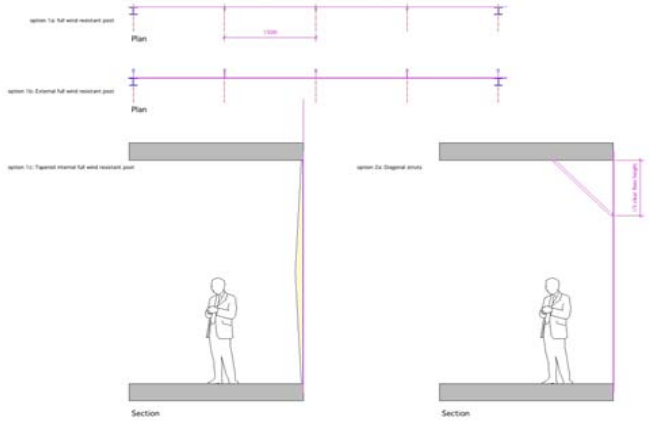
Completed Cladding

Example Application



Average U-value 0.15W/m^2 K. Total thickness 270mm.

Thin Wall Systems



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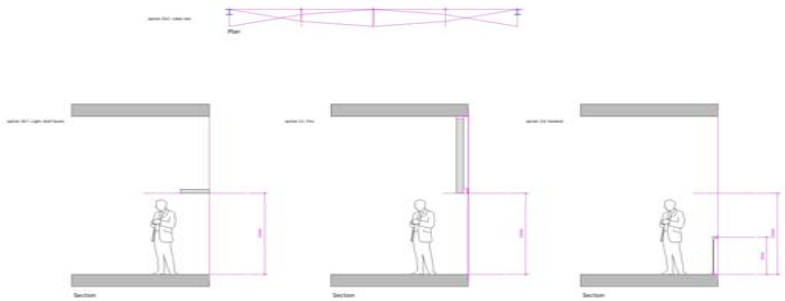
Thin Wall Systems



Potential Applications: Commercial Buildings

- Thin wall technology offers significant rental benefits
- VIP panels can be used in conjunction with both modern infill wall systems and strongback systems
- Market tolerant of cost premiums
- Potentially the initial market for the technology

Economic Case: Commercial Buildings

Composite Panel Based Walls:

Total thickness typically 297-327mm, U Value typically .3-.35 W/m^2/K

UK Rental Values:

£/m^2/pa.	Bristol	Birmingham	London
New High Specification	240	300	850
New Medium Specification	150	250	500
Mainstream Corporate Entry Level	90	120	325

Economic Case: Commercial Buildings

Assume 8 storey building with 32 x 14m floor plates:

Total floor area is 3584m^2, Total perimeter is 736m^2

Floor area given over to conventional 300mm wide external walls is 221m^2

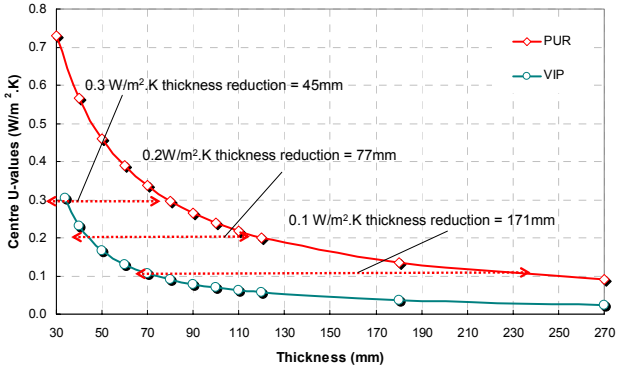
Floor area required for VIP based external walls (assuming 30mm panel, 100mm wind post/lining zone) is: 96m^2

Assuming rental income of £500/m2/pa, and design life of 60 years, net present value of saving PV(C) given by PV(C)=C [1-(1+d) $^{-m}$]/d where C is the additional rental, d is the discount rate (assumed to be 3%) and m the period.

PV(C)=£1,730,000

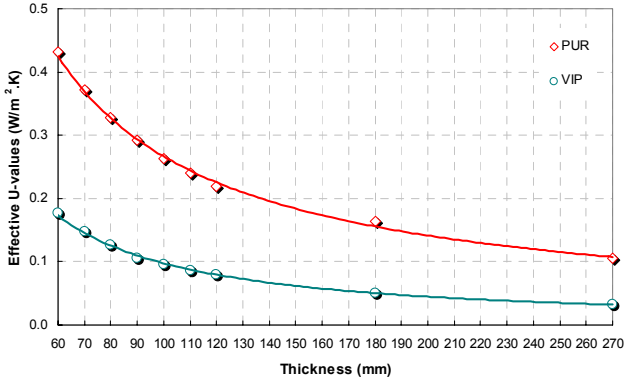
Or using a simpler 7 year return rule the value of the additional rental is £437,000

Cost Justification 2: Centre Panel 'U' Values



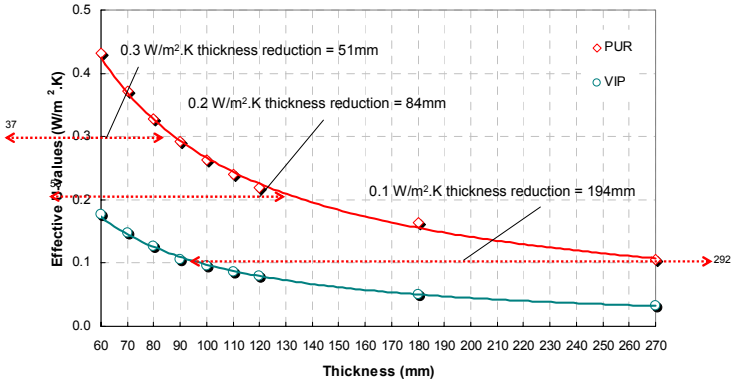
Calculations based on PU k = 0.025W/m.K. VIP k = 0.006W/m.K

Cost Justification 3: Overall Panel 'U' Values



Calculations based on 2000x1200 panel size, PU k = 0.025W/m.K, VIP k = 0.006W/m.K

Cost Justification 4: Overall Panel 'U' Values



Calculations based on 2000x1200 panel size, PU k = 0.025W/m.K, VIP k = 0.006W/m.K

Cost Justification 5: Trend Comparison 1

Centre Panel

U value	*Centre Panel Thickness PU (mm)*	*Centre Panel Thickness VIP (mm)*	*% Thickness Reduction*
0.1	245	74	70
0.2	121	44	64
0.3	79	34	57

Overall Panel

U value	*Overall Panel Thickness PU (mm)*	*Overall Panel Thickness VIP (mm)*	*% Thickness Reduction*
0.1	292	74	75
0.2	137	44	68
0.3	88	34	61

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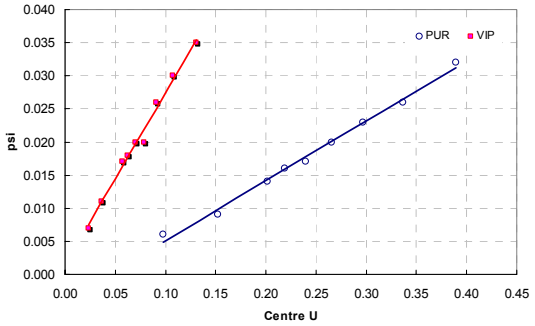
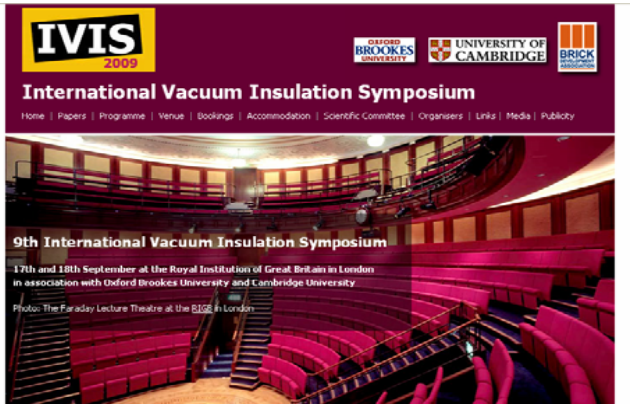
Cost Justification 5: Trend Comparison 2



Conclusions

- Studies have shown that the extra costs associated with VIP may be offset against maximised rental income as a result of thinner walls
- The technology appears particularly appropriate for relatively low 'U' value applications where the difference in physical thickness between vacuum systems and conventional systems is disproportionately great.
- Vacuum systems are one of the most realistic opportunities for step change in thermal performance.

Further information



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