ASBP The Alliance for Sustainable Building Products

INSULATING TRADITIONAL WALLS

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NATURAL FIBRE INSULATION GROUP

The Challenge – For Existing Traditional Walls

- Save energy whilst
- Managing a safe moisture/humidity balance and
- Creating a comfortable living space and
- Retaining and protecting existing features and character

Thermal Efficiency – Don’t Get Hung Up on U-Values

U – Value (W/m^2K)

How much energy (heat) is lost per second for every sq.m of building element for each degree of temperature difference from inside and out.

Lambda(λ) or k – Value (W/mK)

The amount of heat moving through 1m thickness of a material for every degree of temperature difference either side of the insulation. Because λ is based on 1m of material it doesn’t vary with insulation thickness.

Both are steady state measurements so they ignore the ability of the materials to absorb and release heat.

Energy Savings

The difference between energy loss from the insulated element and energy loss from the uninsulated element.

Building Regulations L – Renovated and Retained Elements

Solid Walls should meet the limiting values in table 4.3 which contains 2 limiting values for solid walls:

a) Threshold – 0.70 W/m^{2}K – the maximum we should be looking to achieve.

b) Improved - 0.30 W/m^{2}K – the principle target.

Regulations allow a very sensible degree of latitude for solid wall upgrades and more so for historic buildings.

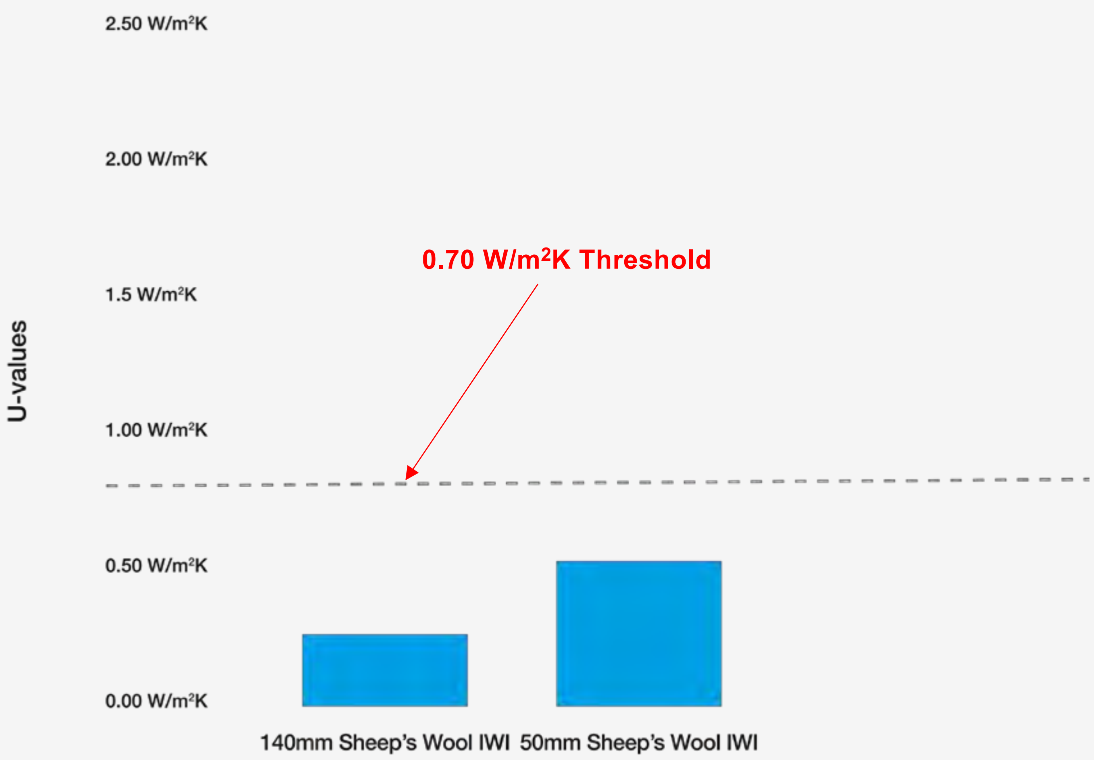
Any U-value below 0.70 W/m^{2}K for IWI/EWI is in the “allowable zone”.

0.70 W/m^{2}K is achievable with 50mm or less of almost all commercially available insulation including NFI.

Insulation	U-Value (220mm Solid Wall)
25mm PIR Fixed with Battens (50mm total)	0.45 W/m2K
40mm Wood Fibre	0.69 W/m2K
50mm Sheep's Wool	0.63 W/m2K
50mm Diathonite Insulated Plaster	0.64 W/m2K

Insulation thickness is not a barrier to achieving limiting values for IWI and EWI in sold walls.

Comparing Different Thickness of Insulation

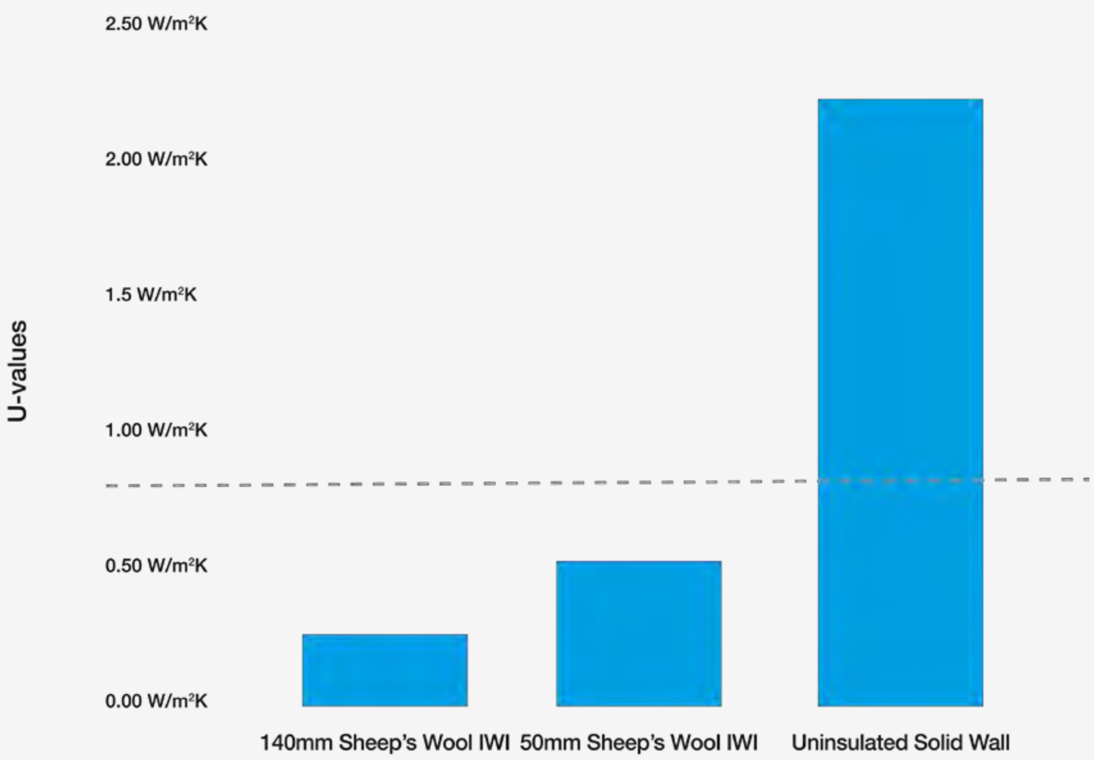


U-value tells us the energy **loss** per sq.m for every degree of temperature difference.

So when we compare U for one insulated element with another we are only comparing energy **loss** of each.

Insulation upgrades exist to **save** energy so we should compare energy **savings** rather than energy loss.

U-Value of the Uninsulated Element is Key

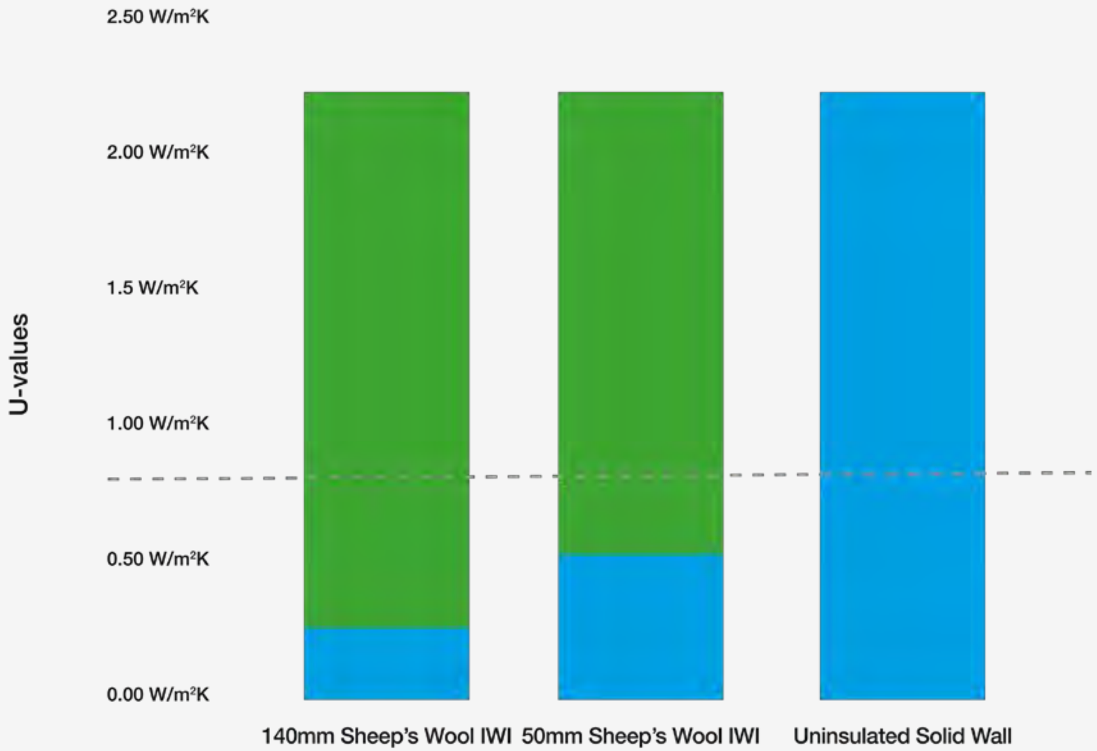


U-value for almost any level of insulation is much lower than the uninsulated element.

The uninsulated element provides the reference for energy savings.

Energy savings are the difference between u-value of uninsulated element less U-value of insulated element.

Thickness Has Less Impact on Energy Savings Than You Think

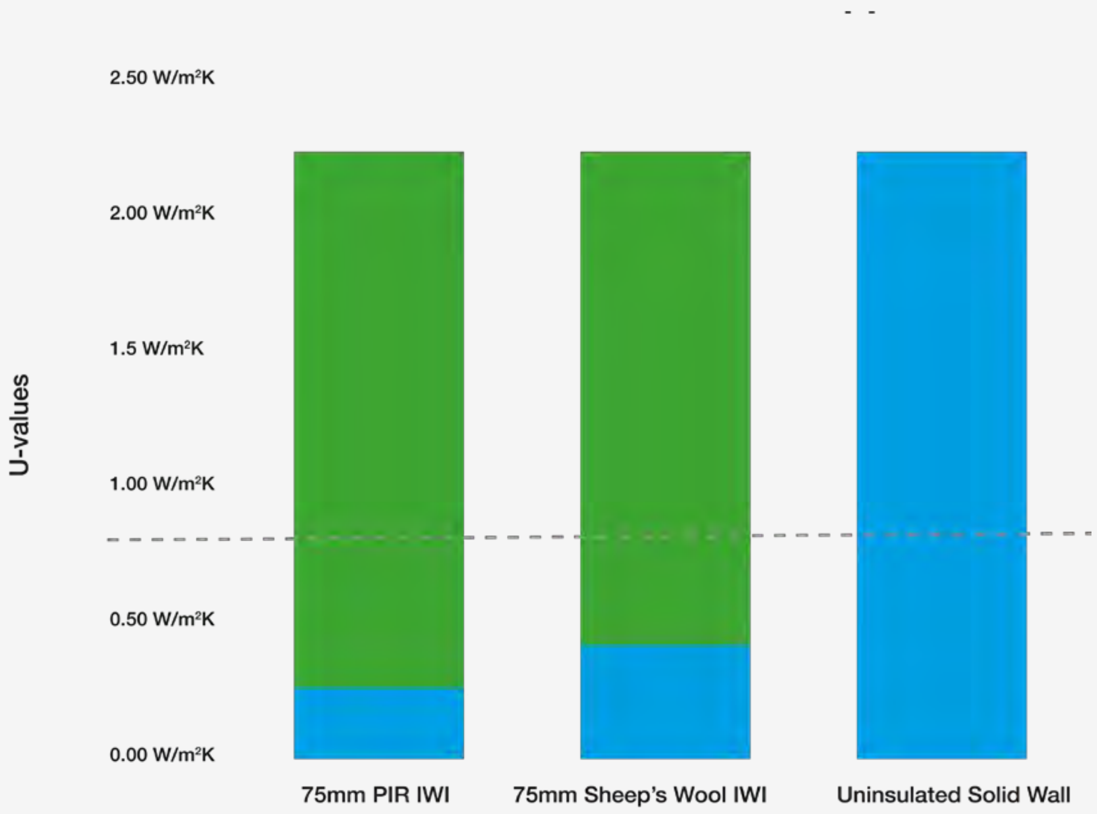


Even thin insulation layers provide significant savings.

50mm Sheep's Wool provides >80% of the savings from 140mm with 70% less insulation.

Energy savings provide the means for calculation ROI.

Comparing Insulation with Different Thermal Conductivities



75mm Sheep’s Wool v’s 50mm PIR + Low E cavity (75mm total).

U-value comparison shows 50% performance difference between PIR & Sheep’s Wool.

Energy Savings comparison shows 8% difference in performance.

How Much Insulation is Enough

	U-Value	Energy Savings	Annual Energy Savings (AES)/ m^2	AES/m^2	15 Year Payback Limit	Potential Savings against 0.30
	W/mK	W/mK	kWh/m^2.yr	£/m^2	£/m^2	%
Uninsulated solid brick wall	2.21	0	0			
	0.70	1.51	26.97	£4.06	£60.84	79.1%
40-50mm sheep's wool, hemp wood fibre	0.65	1.56	27.86	£4.19	£62.86	81.7%
	0.60	1.61	28.75	£4.32	£64.87	84.3%
	0.55	1.66	29.65	£4.46	£66.88	86.9%
60-75mm sheep's wool, hemp wood fibre	0.50	1.71	30.54	£4.59	£68.90	89.5%
	0.45	1.76	31.43	£4.73	£70.91	92.1%
	0.40	1.81	32.33	£4.86	£72.93	94.8%
120-140mm sheep's wool, hemp wood fibre	0.35	1.86	33.22	£5.00	£74.94	97.4%
	0.30	1.91	34.11	£5.13	£76.96	100.0%

0.65 – 0.70 W/m^2K – The point where doing something is substantially better than nothing.

0.45 – 0.50 W/m^2K – Best "bang for buck", half the insulation >90% of the savings.

What is Breathable Insulation?

- **Phenolic Foam Boards** – high vapour resistance and non-sorptive = **non-breathable**
- **Mineral fibre** – low vapour resistance and non-sorptive = **vapour open**
- **Natural fibre insulation** – low vapour resistance and sorptive = **breathable**

Sorption

Natural Fibre Adsorbs Moisture

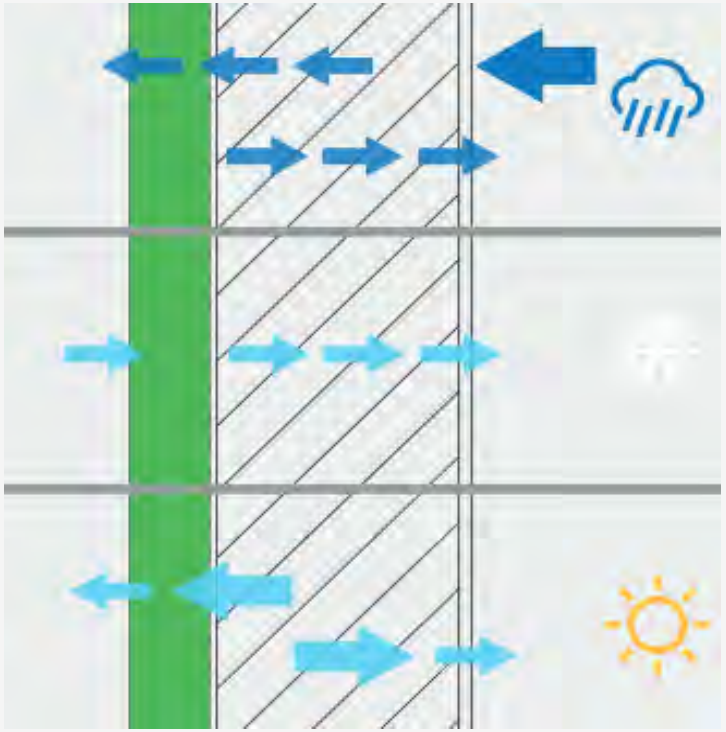
Relative Humidity High

Natural Fibre Desorbs Moisture

Relative Humidity Low

Breathability is not a substitute for ventilation

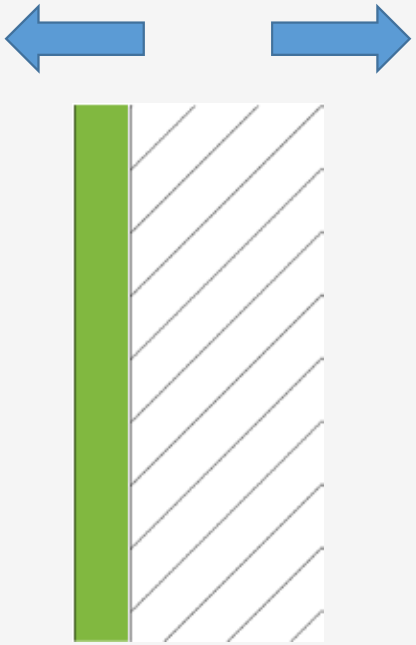
The Building Fabric and Moisture Movement



- External rain – Process – moisture transport through sorption and capillary action - influenced by the water absorption co-efficient of the external face.
- Internal moisture – Process - moisture transfer through diffusion from the inside <u>to the</u> outside – influenced by the internal and external water vapour resistance values.
- Sunshine – Process - moisture transfer through diffusion from the inside <u>and</u> the outside – influenced by the internal and external water vapour resistance values.

And all of these processes need to be considered simultaneously in order to provide a robust, long term solution which ensures a comfortable internal climate.

The Building Fabric and Moisture Movement - IWI

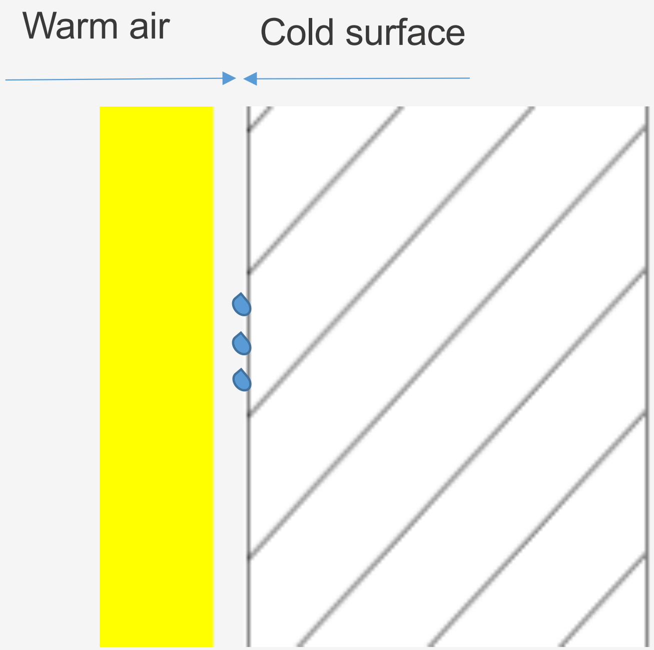


- External walls have to deal with this moisture movement. **Very important to have ext. wall in good condition.**
- When we introduce an internal insulation layer and start heating the internal air space we increase the moisture load.
- How the wall then continues to deal with these processes is critical.
- So what are the consequences of using a material with either a high or low vapour resistance?

Insulation Types - High Vapour Resistance, Low Sorption

- Materials such as PIR / PUR / EPS / XPS have a high vapour resistivity non-sorptive.
- Block moisture from entering the fabric from inside which can result in higher internal humidity levels.
- The way the moisture moves through the fabric is changed.
- But surely less moisture in the fabric is a good thing?

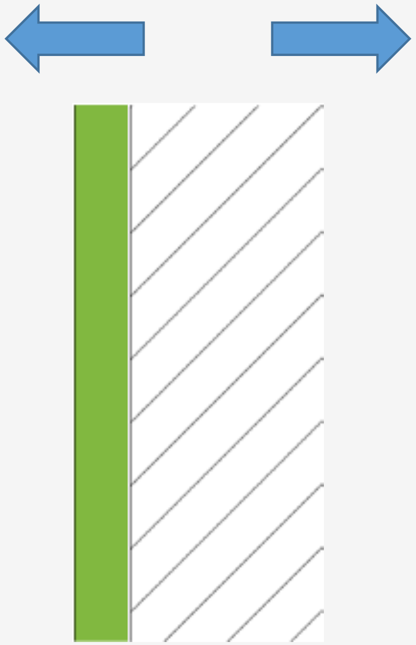
Insulation Types - High Vapour Resistance, Low Sorption



- Standard U-value calculations will suggest that this is the best approach as moisture within the fabric is reduced.
- These types of systems are generally battened or via a dot and dab plaster approach.
- Creates a cavity within the fabric where moisture can form.
- Any warm air that penetrates the insulation layer will reach the cold wall and condense. Liquid water is produced and can accumulate and become trapped within the fabric.

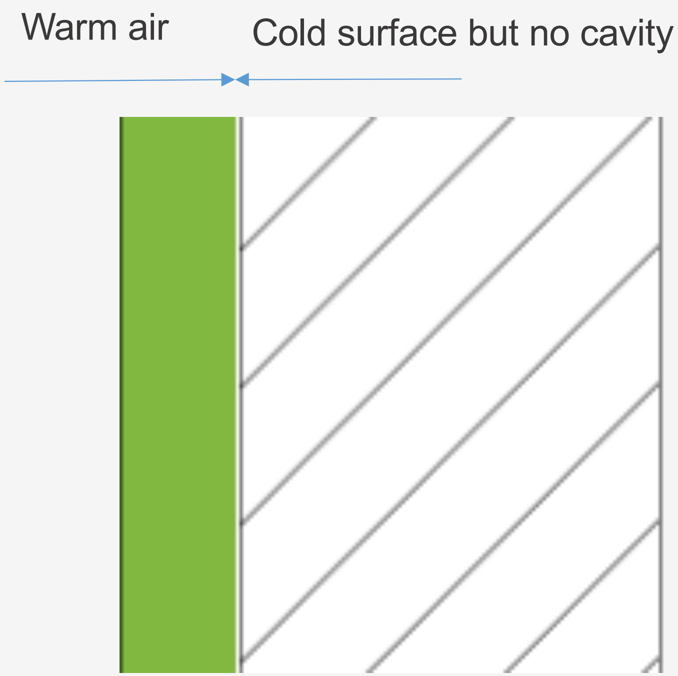
This can mean long term structural risk for brickwork or timber elements and the risk of mold forming and appearing on the inside of the wall surface.

Insulation Types - Low Vapour Resistance, High Sorption



- Natural materials have low vapour resistivity and high sorption.
- This means that they can adsorb water, store it at source and either release it back to the inside or pass it through to the fabric where it can then escape through the external face.
- The way the moisture moves through the fabric is kept the same.
- This ensures lower risk as liquid water can not accumulate.

Insulation Types - Low Vapour Resistance, High Sorption

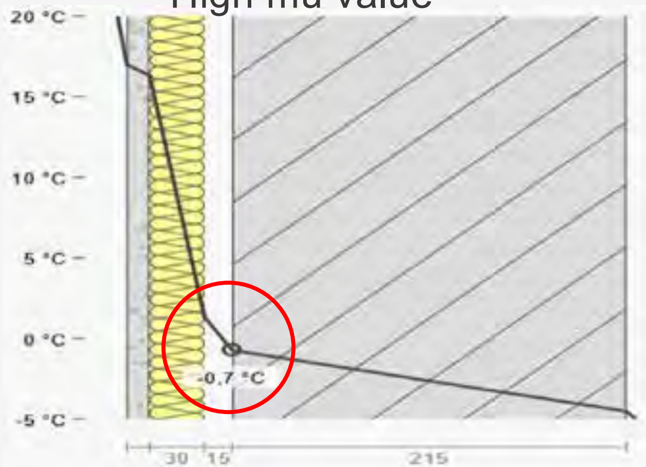


- Standard U-value calculations to not accurately asses the ability of materials to both absorb and evaporate moisture or its ability to pass water on through capillary action.
- These types of systems are generally direct bonded with a lime or clay bonding coat or flexible NFI pushed close to surface in studs.
- This means no cavity for moisture to accumulate so lower risk of mold forming or condensation.
- The benefit of true breathability comes at the wall-insulation interface.

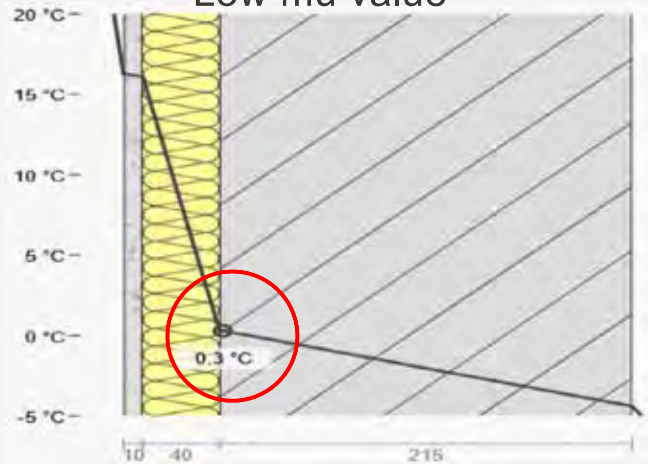
Interface at the Wall is Critical

Regardless of insulation type the interface between the insulation layer and the cold external wall surface is the area where condensation is most likely to form.

High mu value



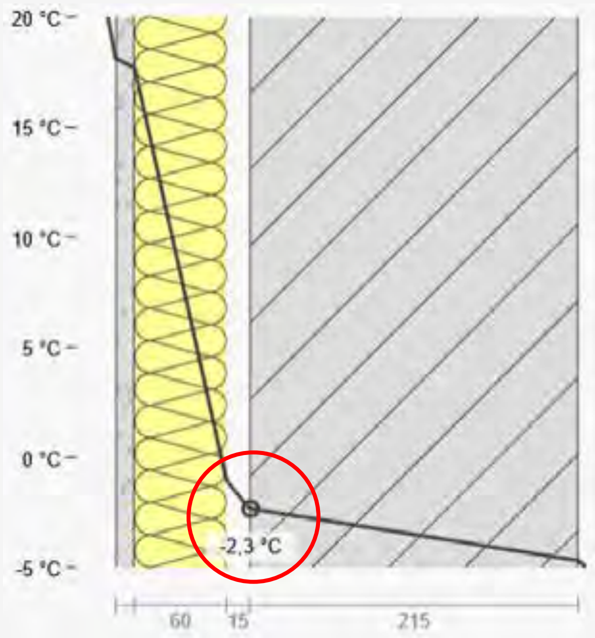
Low mu value



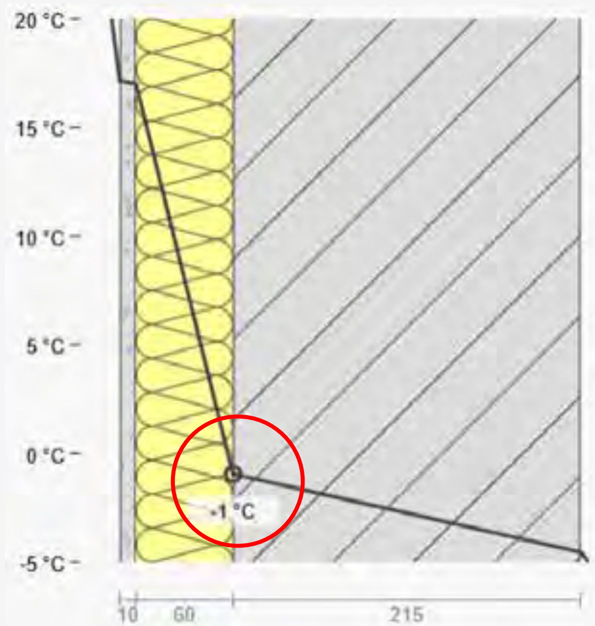
Insulation Thickness Impacts the Interface Temperature

The thicker the insulation layer the lower the temperature potential at this interface.

High mu value



Low mu value



Thermal Comfort

- **Warm**
  - How much heat is lost/saved
  - How heat is captured by the building fabric – Thermal Effusivity
  - How heat is transferred and stored – Thermal Diffusivity
- **Dry**
  - Ventilation
  - Balance humidity within the fabric
- **Safe**
  - High indoor air quality
  - Low environmental impact

Heat Capture, Rate of Transfer & Storage

- Not something you glean from a U-value but strongly influences what solution is best.
- Heat capacity – the amount of energy a material can absorb and store.
- Thermal effusivity – how quickly a material captures heat i.e. how warm to the touch it is.
- Thermal diffusivity – how quickly heat moves through a material.

In Numbers

Product	Thermal conductivity W/mK	Density kg/m3	Specific heat capacity J/kgK	Volumetric Heat Capacity J/m3K	Thermal Effusivity (J/m2Ks1/2)	Thermal Diffusivity (J/m2Ks1/2) x E-7
Expanded Polystyrene	0.032	16	1130	18080	24	17.70
High performance MW	0.035	33	840	27720	31	12.63
PIR insulation	0.022	30	1500	45000	31	4.89
Extruded Polystyrene	0.035	32	1130	36160	36	9.68
Sheep's Wool	0.035	31	1800	55800	44	6.27
Hemp Wool	0.038	45	2100	94500	60	4.02
Flexible Wood fibre	0.036	60	2100	126000	67	2.86
Cellulose	0.038	60	2100	126000	69	3.02
Cork	0.038	120	1900	228000	93	1.67
Wood fibreboard	0.038	160	2100	336000	113	1.13
Diathonite Cork Render	0.037	220	1200	264000	99	1.40
Eco Cork Render	0.1	900	1200	1080000	329	0.93
Lime Plaster	0.8	1400	1000	1400000	1058	5.71
Gypsum plaster	0.4	1000	950	950000	616	4.21
Concrete	2	2400	880	2112000	2055	9.47
Sand Stone	2.299	2600	1000	2600000	2445	8.84

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Scenario One

- **Home for busy working-away occupants, only used infrequently and for short periods of time.**
- Infrequent occupation, particularly in winter months, lends itself to a lighter weight, lower thermal mass lower diffusivity insulation so that the interior heats up faster.
- Less heat would be required overall for occupancy style with a low thermal mass building.
- Sheep’s Wool is a good choice.

Scenario Two

- **Internally insulated house with lots of glazing, particularly southerly, with large heat gains in Spring and Autumn. High occupancy evenings & weekends**
- More frequent occupation, particularly in Spring and Autumn, requires some attenuation of solar gains to prevent overheating.
- With wood fibre insulation, heat gains through the day are absorbed by the internal linings of the walls (amongst other things) and buffer internal temperature gains.
- High thermal effusivity of materials ensures effective heat transfer back to the internal environment as temperature drops, reducing heating requirements.
- Woodfibre board or cork would be a good option.

Scenario Three

- **Relatively thin, dark coloured masonry walling, facing south, with little or no overhang.**
- Mid-summer hot day, peak external temps - 30C at 4pm.
- High occupation, particularly during summer months, thermal mass and decrement delay help stabilise internal temperatures.
- Pushing internal peak heat to later in the day allows cool air to be drawn in from outside.
- Reduces reliance on the need for cooling

Takeaways

- Don't get hung up on U-values and don't ignore energy savings
- Breathability plays a key role at the wall-insulation interface
- Breathability is not a substitute for ventilation
- Cavities at the wall-insulation interface can increase condensation risk
- Good internal wall insulation requires good external wall condition
- Heat gain, transfer and storage play a significant role in what’s right for you

Thank you

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