Integration of VIP’s into External Wall Insulation System

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With the energetic improvement of construction fabric and the minimum standard of the Energy Conservation Ordinance in new build, heating costs are being lowered and an important contribution is being made to the protection of the environment. Passive houses convincingly demonstrate the potential of modern insulation systems.

Fig. 1: Petrisberg passive house in Trier / Architect Lamberty

Besides curtain facade constructions with a market share of some 30% and cavity insulation (15% market share), constructions with External Wall Insulation Systems (EWIS) have proven themselves for decades with more than 50% market share. The remaining approx. 5% of the market are divided between solar environmental walls on the basis of transparent thermal insulation and glass facades.

External Wall Insulation Systems in particular contribute to the value retention of the building in addition to the energy saving characteristics of a highly insulated facade.

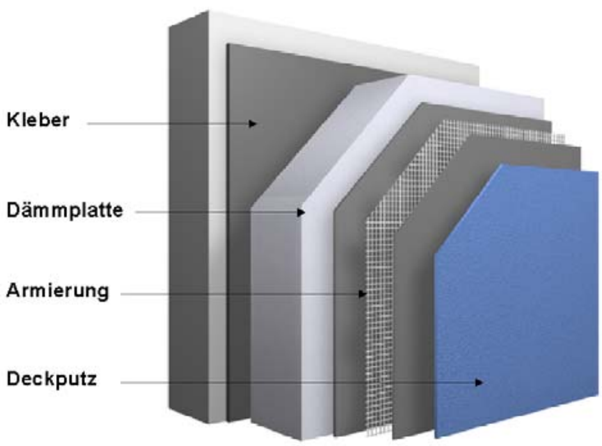
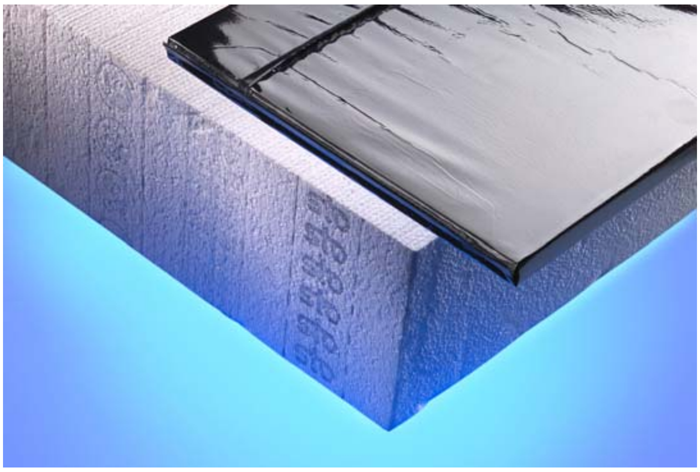


Fig. 2: System construction of a EWIS

With low-energy, ultra- and passive houses, insulation layers of 20 cm and more are required in order to fulfil the high requirements.



With vacuum insulation panels (VIP), the insulation thicknesses can be reduced by a factor of 5 to 10 compared to conventional materials – with the same insulation value.

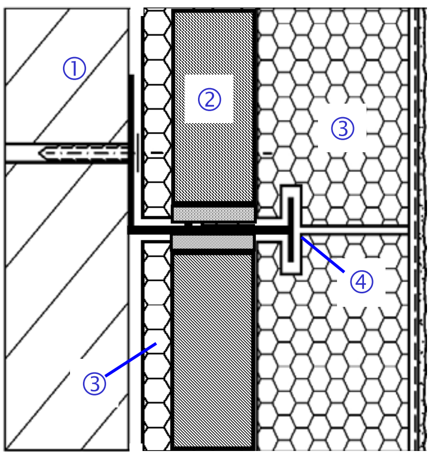
Fig. 3:

VIP and conventional insulation material in comparison

This new quality of thermal insulation will contribute to increased energetic renovation of old builds. Existing reservations ("no space for insulation") can in this way be dispelled.

The concept for vacuum insulation of buildings is based on the use of special, gas-tight surround wraps and an evacuated core of microporous silicon dioxide or aerogel, which is relatively insensitive to increases in gas pressure (thermal conductivity of 0.005 W/mK at 10 mbar and 0.008 W/mK at 100 mbar gas pressure). A critical component of a VIP is the barrier wrap, which must be protected against injury. The integration of VIP into the EWIS system idea offers synergies in this respect.

Already in the year 2000, VIPs were integrated into a mechanically fixed external wall insulation system at the gable of a conservation protected house in Nuremberg. For this object, the 15 mm thin vacuum insulation boards were adhered directly to the wall and additionally secured using a track system with plaster carrier boards of 35 mm XPS foam. A further development of this execution, with which the VIP elements are clearly better protected against damage in the construction process, is shown in figure 4. With this system, the VIP element is already laminated on both sides with EPS, with the EPS front board provided with a groove for the track system. A disadvantage of the integration into mechanically fixed systems is the heat bridge of the retention track, which cannot be sufficiently insulated with the EPS laminate.



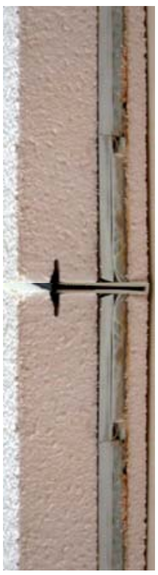


Fig. 4:
Integration of VIP into a mechanically fixed EWIS

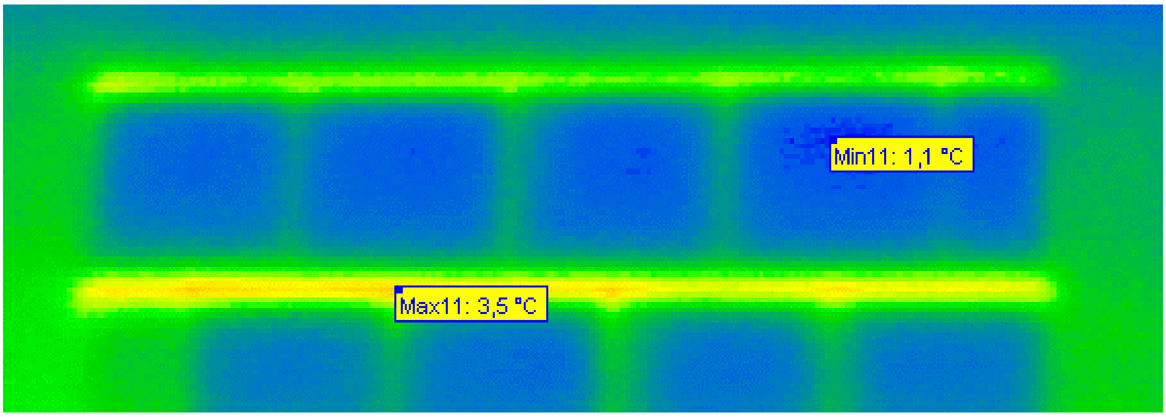


Fig. 5: **Infrared thermograph of a wall with VIPs in a mechanically fixed external wall insulation system. The joints in the area of retention tracks and T-splines are clearly visible.**

Foaming into polystyrene is relatively simple to realise. A surrounding polystyrene mantle protects the sensitive VIP.

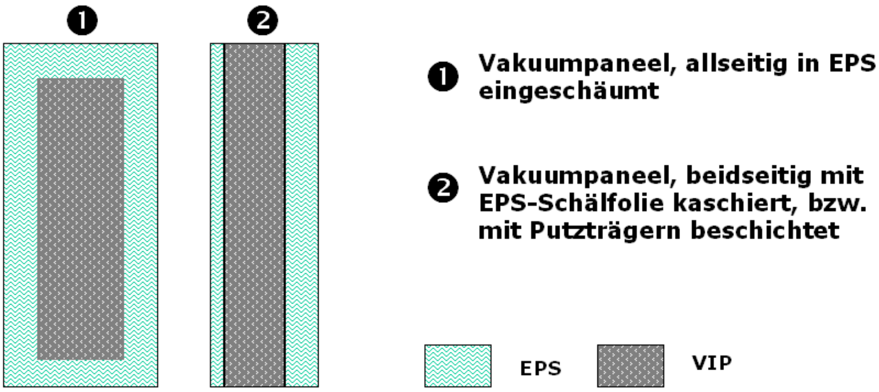


Fig. 6:
VIP/EWIS integration through foaming-in or laminating with EPS

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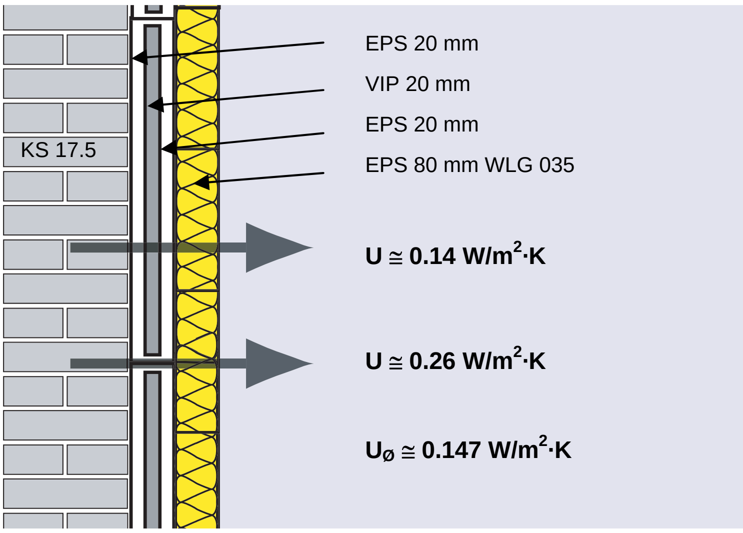
On a passive house in Bersenbrück, the idea of completely foaming VIP in polystyrene was tested in practice. The materials used were 20 mm thick VIPs, that are surrounded on all sides with 20 mm polystyrene WLG 035.



In order to minimise joint markings and heat bridge effects, a second insulation layer with a thickness of 80 mm was applied. The prescribed value of 0.15 W/(m²·K) could thus be achieved with an average calculated U value of 0.147 W/(m²·K).

Fig. 7:
20 mm EPS-laminated VIP's with second insulation layer

Thermographic pictures of the building before and after laying the second insulation material layer show that the original heat bridges in the joint areas were significantly reduced.

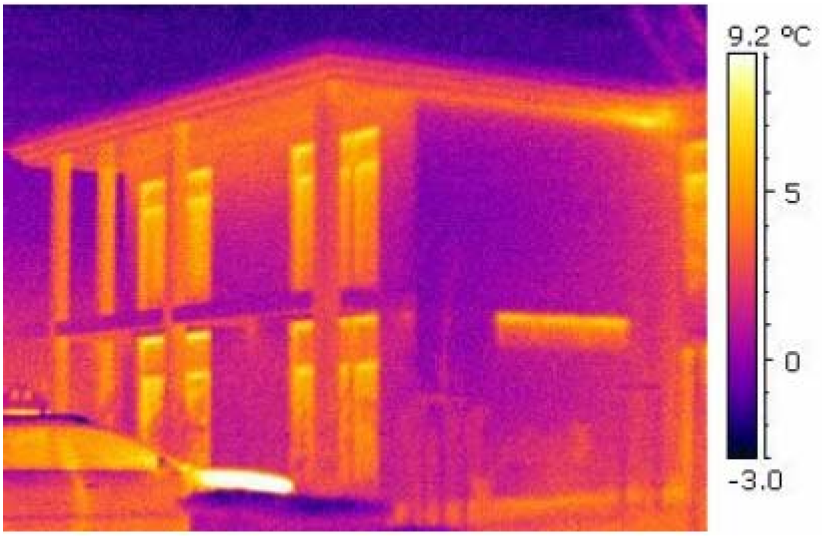


Fig. 8:
Thermograph of the Bersenbrück passive house

The use of a second insulation material layer to reduce heat bridges does not only significantly increase the expenditure on the object. The essential advantage of a VIP façade, the "slimline wall" is largely lost through the total system thickness of 14 cm. Compared to a conventional insulation measure, the insulation material thickness was only roughly halved, with significantly higher expenditure and costs.

Fig. 9: Bersenbrück passive house with VIP elements foamed into 2 cm EPS

These disadvantages can be remedied through a simple front and rear lamination with e.g. EPS. In the context of the construction exhibition of the Trier Regional Garden Show 2004, twelve terraced houses were created with innovative technology. The passive houses by the architects Lamberty/ Schmitz & Hoffmann were partially realised using EPS laminated VIPs. The boards used were 20 mm thick VIPs, that are laminated on the front and rear sides with polystyrene layers. Through this, the VIPs can be jointlessly laid and butt-jointed with minimal heat bridge effects.

Fig. 10: VIPs laminated on both sides with EPS

Fig. 11: Petrisberg/Trier passive house with VIPs laminated on both sides with EPS

In the application of a VIP-integrated external wall insulation system, a facade plan must be created in advance, as subsequent working of the VIP-EWIS insulation boards on site is no longer possible.

The creation of the facade plan takes place by measuring the real facade (as a rule with deviations from the plan) and the "section pattern" based on this for the individual VIP elements.

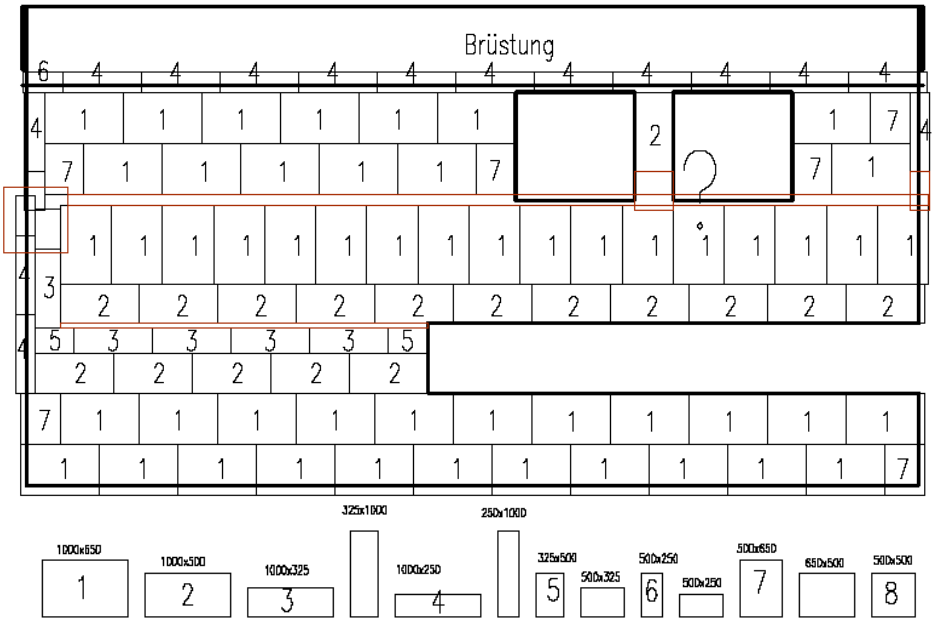


Fig. 12: Facade plan of the Petrisberg/Trier passive house

As an alternative to a lamination of the VIP elements with foam materials, viscoelastic coatings may be used. These coatings, which are both plaster carriers and adhesion bridges for the adhesion of the VIP elements to the façade, must – comparably with the laminates – protect the VIP elements against mechanical damage.

On an institute building at the Fraunhofer ISE in Freiburg in 2004, a facade was insulated with VIP elements, which were previously coated with an organically bound leveller.

Fig. 13: Renovation of a FhG-ISE Institute building with coated VIPs

In the execution of the facade, it again became apparent that with VIP facades, the solution of detail questions is decisive. Not every connection can be carried out optimally.

Fig. 14: Connection to a window using VIP

A short time after adhesion of the VIP elements, several damaged VIPs had to be exchanged. Subsequently, the façade was reinforced in autumn 04 (plaster layer with mesh inlay).

A thermograph taken in spring 2005 shows that further VIP elements have since been ventilated.

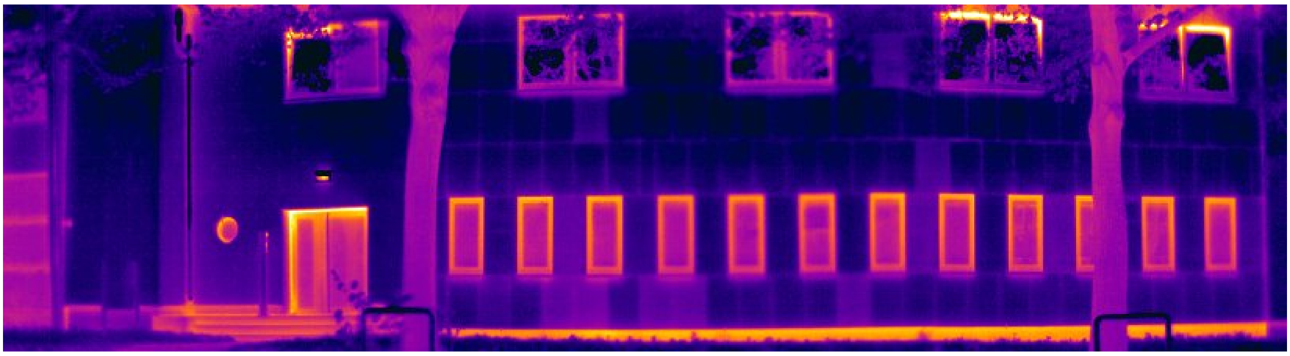


Fig. 15: Thermograph of a VIP facade with ventilated VIP elements

Summary

In a series of research projects, work is being carried out on innovative façade systems with vacuum insulation. Vacuum insulations (VIP) permit slim, highly insulating systems. The integration of VIP into external wall insulation systems (EWIS) is of particular interest, as EWIS is used to a great extent in new build and in old build renovation. The variants shown in this contribution show that the use of VIP in EWIS is fundamentally possible, but that many detail problems remain to be solved.

As external wall insulation systems theoretically have a life expectancy that can match that of the building if maintained properly, high requirements are placed on VIPs. The functional utilisation lifespan of the VIP technology must however still be demonstrated.