PU Europe
Factsheet
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Glossary

- ETICS: Thermal Insulation Composite System
- FIGRA: FIre Growth RAte
- PU: Polyurethane (PUR/PIR)
- SBI: Single Burning Item
- THR: Total Heat Release

Fire barriers in External Thermal Insulation Composite Systems (ETICS)

Are fire barriers required for PIR insulation products?

Introduction

Insulating new and existing buildings is a priority to meet energy savings and GHG (greenhouse gas) emission reduction targets, as well as for reducing energy bills for occupants. Those buildings are increasingly insulated with ETICS (External Thermal Insulation Composite System). PIR/PUR products exhibit outstanding thermal performance thanks to their low lambda value, which translates into reduced thicknesses of the ETIC system they are part of.

Besides energy insulating performance, other product characteristics are critical for project developers, architects, regulators and other stakeholders. Fire safety performance is one of the key priorities of the PU industry, and this factsheet aims to clarify and give evidence on the role of fire barriers in ETICS [1].

What is the fire performance of PIR rigid insulation boards?

Polyurethane rigid foam is a thermoset product, which in case of a fire does not melt nor produce burning or non-burning droplets. Depending on the composition of the product, featuring or not a facing, up to class B reaction to fire classification according to EN13501-1 can be reached by PIR products [2]. However, in most cases the classification of PIR/PUR products is class E, and they are used safely in many end-use applications.

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Figure 1: Class E PIR foam insulation product during and after a small burner test (EN ISO 11925-2)

The example in **Figure 1** shows the performance of a class E PIR foam without facing, tested according to EN ISO 11925-2. The foam is ignited at the beginning of the test by the burner but the initial flame on the product ceases quickly after a first flash which does not reach the limiting mark (150 mm). The product does not melt, and no flaming droplets appear.

In addition, even class E PIR foams can show limited Total Heat Release (THR) according to EN13823 (Single Burning Item). If they are classified as class E, in most cases this is due to a short initial flash, which leads to a high FIGRA (FIre Growth RAte) value but does not cause a high THR.

Figure 2 shows an example for a typical heat release curve of a class E PIR foam in the SBI test. After a short peak, the heat release ceases and the THR value for many products would allow even a classification up to class B. In some cases, for PIR products a class B classification can be reached in the SBI test.

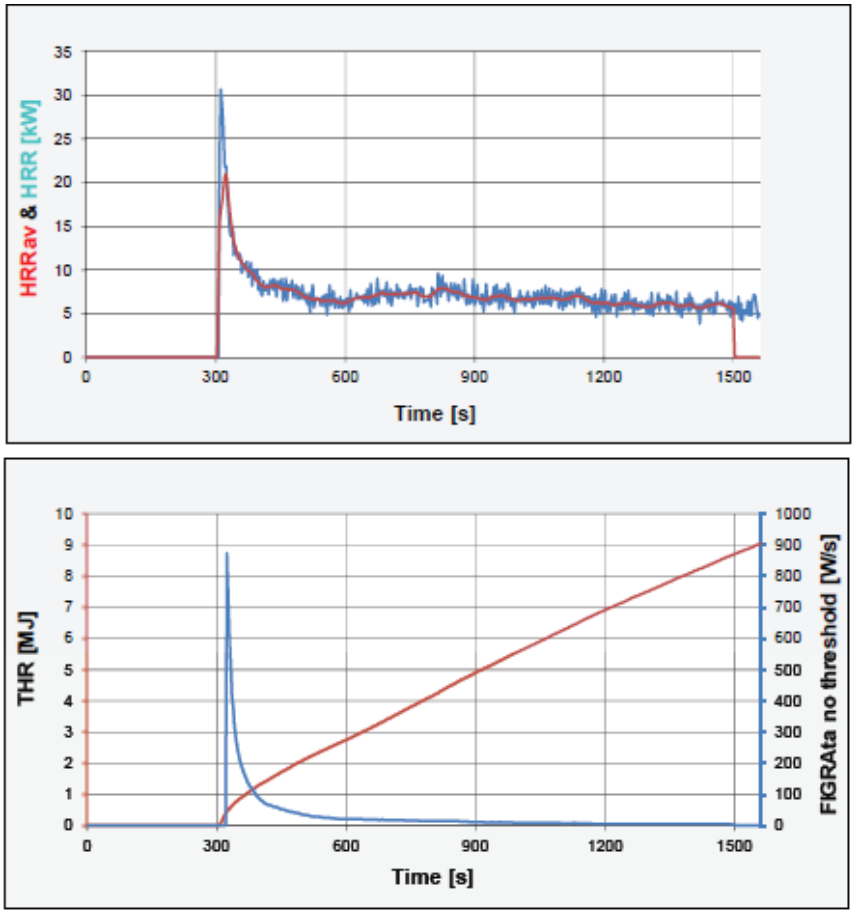

Figure 2: Example of the result of a class E PIR product tested according to EN13823 (SBI) (source MFPA Stuttgart, test report)

In addition, it has been proven in tests according to EN16733 that PIR foam/products do not exhibit a smouldering nor glowing combustion behaviour (see **Figure 3** below – before 20 minutes test-duration, all thermocouples are cooling down, and no continuous glowing combustion is observed). This has for example been acknowledged in the German legislative framework (MVVtB).

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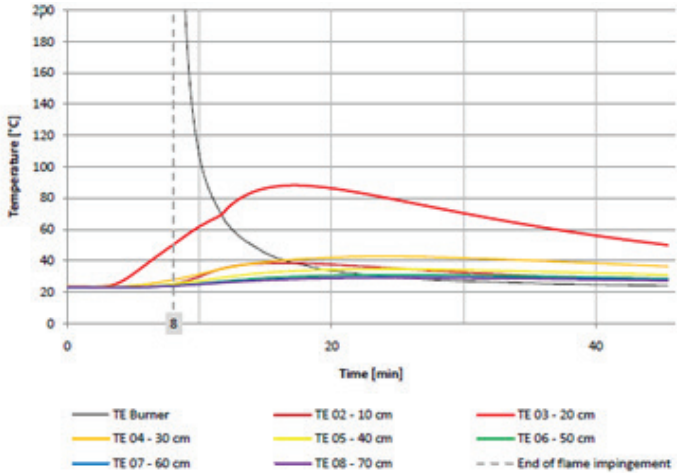

Figure 3: Example of a test result according to EN16733 for PIR foam (CEN/TC 127 WG4)

Fire performance of rigid PIR insulation foam boards classified E, or better:

- **is not easy to ignite;**
- **shows only limited flame spread;**
- **protects the insulation material underneath due to the charring behaviour of its surface;**
- **does not melt or drip;**
- **does not show propensity to undergo continuous smouldering.**

What is an ETICS?

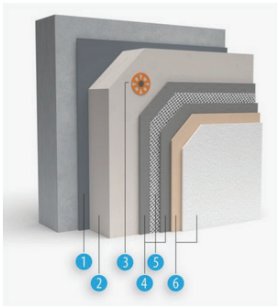

Figure 4: Typical layers of an ETICS (source https://www.ea-etics.com/)

An ETICS is an External Thermal Insulation Composite System, consisting of:

1. Adhesive
2. Thermal insulation board
3. Mechanical fixing devices (e.g. plate anchors) (optional)
4. Base coat
5. Reinforcement (e.g. glass fibre mesh)
6. Finishing layer: finishing coat with a key coat (optional) and/or decorative coat (optional)

Fire spread in/ on ETICS with and without fire barriers

A fire can always spread on the outer face of an ETICS, depending on the composition and quality of the rendering layer. If the rendering is damaged, the fire can directly impact the insulation layer. If fire spread on or within the complete insulation layer is possible, fire barriers are needed to stop further fire spread upwards and, in some cases, laterally. In addition, for products which show continuous smouldering behaviour fire barriers can stop it and avoid hidden fire spread.

The following table summarises the relevant factors for fire spread in case of a fire comparing PIR insulation and thermoplastic insulation products.

Parameters/conditions/ fire development stages	Important properties	Thermoplastic insulation	PIR (thermoset insulation)
Fire spreading on the surface (rendering/ finishing layer)	Thickness and composition, organic and flame-retardant content, of the rendering/finishing layer	Independent from type and reaction to fire classification of the insulation product	
Fire on the façade with the rendering layer remaining intact – Performance of the insulation layer (not directly exposed to fire)	Performance of the insulation layer when heated, melting behaviour	Melting	Charring, off-gassing, no melting
		Not enough oxygen available for igniting the insulation layer	
Fire having damaged the surface layer (holes, falling of parts of rendering...)	Quality and thickness of reinforcement layer and mortar	Flame impingement on insulation	
Fire performance of the insulation layer after burn-through/falling down of outer layers and direct exposure to fire	Type, quality and composition of insulation product	Burning and melting, formation of a cavity behind the rendering, further melting, dripping and flame spread up to the top of the façade or to the next fire barrier	Surface ignition near direct fire exposure and charring of surface. Only limited spread of fire (the next fire barrier will potentially not be reached)
Fire barrier performance	Melting behaviour, persistence of interconnection of fire barrier and outer layer and wall behind the ETICS	Flame spread within the ETICS behind the rendering will be stopped (assuming the fire barrier does not melt and stays connected)	Fire barrier will not be reached as PIR foam above the area of direct flame impact will not melt or burn away, but char and stay stable
Special case – Fire barriers above and around doors and windows	Melting behaviour, persistence of interconnection of fire barrier and outer layer and wall	No ignition of insulation product as long as the rendering stays undamaged and the fire barrier works	Not needed, because only the exposed edge of the foam will ignite, char and then protect the remaining foam below the charring layer and further above

How do fire barriers work?

"ETICS relying on PIR products, at least reaction to fire class E, do not need to be designed with fire barriers since there is no melting nor smouldering of the insulation product".

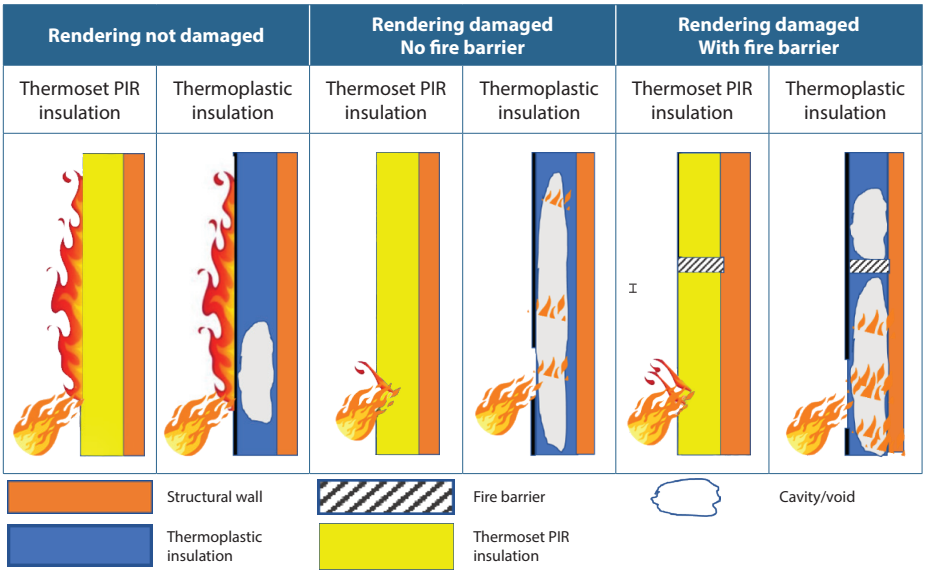

Figure 5: Simplified visuals of the flame spread on and in an ETICs, with and without fire barriers, for two types of insulation product families

Fire barriers will stop the spread of fire behind a façade cladding or rendering layer. This is only necessary if the insulation layer can melt or burn and hence create cavities where sufficient oxygen can be available for further fire spread behind the remaining rendering. In this case, a fire barrier, which does not melt or shrink and stays connected with the outer mortar layer and the structural wall, is needed. In addition, if the insulation products exhibit continuous glowing and/or smouldering behaviour, having façades with fire barriers can help to stop this process. ETICS relying on PIR products, at least reaction to fire class E, do not need to be designed with fire barriers since there is no melting nor smouldering of the insulation product.

In some countries, notably Switzerland **[3]**, thermoplastic insulation ETICS systems relying on PIR insulation for its fire barriers have been approved. Furthermore, successful tests have been done in Germany: when PIR fire barriers are mounted in a way that they maintain the connection with the rendering under extreme fire loads, they remain stable and work.

Figure 6: Example of a PIR fire barrier after test of an ETICS with EPS according to DIN 4102-20 (source Mfpa Leipzig)

Experience and evidence

"If the rendering burns through and/or falls down partly, [...], the PIR foam can show flaming at the exposed surface for a limited time. After that, the surface chars and protects the remaining material".

Figure 7: BS 8414-1 test of an ETICS relying on PIR after 39 minutes

Tests of PIR insulated ETICS without fire barriers [4]

- Numerous tests, in Germany in particular, of ETICS kits relying on PIR insulation have been performed successfully according to the DIN standard 4102-20, labelled as "medium fire exposure test" according to the European Commission.
- A comparative mid-scale test performed in Italy demonstrated the similar performance of the PIR and mineral wool tested systems which did not include fire barriers (see PU Europe factsheet n° 24B).
- A large-scale test according to BS 8414-1 was performed with an ETICS relying on PIR insulation and passed successfully the BR 135 assessment criteria.

As per the outcome of the tests listed above, and if a PIR insulated ETICS is constructed with a suitable rendering, meaning that not prone to fire spread and sufficiently stable over time, the following effects can be observed:

- Local bubbles on the outside of the rendering may appear and even open, due to the off-gassing of the heated PIR behind the outer layer – this might cause small and non-persistent flames, not causing further spread of the fire.
- If the rendering burns through and/or falls down partly, under direct exposure to a fire source, the PIR foam can show flaming at the exposed surface for a limited time. After that, the surface chars and protects the remaining material.

Fire performance during the ETICS construction phase

A DIN 4102-20 test performed in Germany demonstrated that the tested PIR insulated ETICS performed well before the rendering was applied. The PIR insulation board product, classified E according to EN13501-1, showed only limited fire spread and self-extinguished (see **Figure 8**).

18 minutes after the start of the test	End of the test (gas burner extinguished – the foam does not burn anymore)

Figure 8: Fire of an ETICS without fire barriers during construction – Test according to DIN 4102-20 before rendering is applied (naked PIR product of class E)

Summary for ETICS relying on class E PIR insulation products

- Fire spread on the outside of a PIR insulated ETICS is mainly governed by the performance of the outer layer.
- If the rendering is damaged or falls apart, the PIR insulation product can ignite locally but its fire spread is limited even without the presence of fire.
- PIR insulation does not melt and drip and does not show significant fire spread. Therefore, no fire barriers are needed.
- Various tests on ETICS without fire barriers with PIR products have shown that sustained flaming does not spread significantly on the surface of PIR foam exposed directly to the fire.
- Under specific situations, PIR itself may even work as a fire barrier.

Rigid PIR insulation boards, class E or better, in ETICS:

- **Quality of external rendering is crucial for fire spread on the outside of the ETICS.**
- **PIR insulation product can be ignited locally, when the covering layer is damaged, but it will not spread fire within the system.**
- **It will not melt and produce burning or non-burning droplets.**

PIR insulated ETICS can be constructed safely without fire barriers.

Disclaimer

While all the information and recommendations in this publication are to the best of our knowledge, information and belief accurate at the date of publication, nothing herein is to be construed as a warranty, express or otherwise.

Notes:

1. This factsheet does not cover polyurethane products made on-site, such as sprayed or dispensed polyurethane
2. Polyisocyanurate (PIR) is the newest generation of polyurethane foams. PIR has an optimised fire performance and superior thermal resistance and dimensional stability
3. For an example of an ETICS with EPS insulation and PIR fire barriers, visit https://www.sgvso.ch/wp/wp-content/uploads/2018/02/VAWD-System-Brandriegel_2018_V5_handout.pdf
4. The information in this section contains examples of the limited fire spread of PIR insulated ETICS without fire barriers. The results are valid only for the tested products and constructive details