



# Fire resistance of different insulation materials in pitched roofs and timber frame walls

## SUMMARY

Structures insulated with rigid polyurethane insulation (PUR/PIR) products show excellent fire performance in real fire scenarios due to their thermosetting character and high thermal stability. PUR/PIR insulation does not melt nor drip when heated. The char emerging on the surface of the insulation protects the core from decomposition, so the integrity of the structure is maintained for a long time even if heavily attacked by the fire. Structures insulated with PUR/PIR insulation can perform better than or give performance equivalent to structures insulated with other mainstream insulation materials. PUR/PIR insulation performs better than the Euro-classification system for 'reaction to fire' might indicate.

## 'REACTION TO FIRE'

- 'Reaction to fire' tests are appropriate to help establish the performance of surface mounted products exposed to fire within a room.
- The important features are ease of ignition and contribution to any fire already started in a room.
- A Euroclassification system has been developed to assess the 'reaction to fire' for wall and ceiling lining products.

- Euroclasses are based on a series of small and medium-scale tests most notably the Single Burning Item test.
- The Single Burning Item test was specifically developed for lining products and it measures, among other things Total Heat Release (THR) and the Fire Index Growth Rate (FIGRA) which is the rate of initial heat release.
- It is permissible to test wall and ceiling lining products in two ways:
  - > 'in application' i.e. as part of a complete construction; or
  - > 'as placed on the market' i.e. naked.

## 'FIRE RESISTANCE'

- The fire performance of a building structure is determined by its design and the materials used to construct it.
- 'Fire resistance' means the ability of a structural element to sustain the performance of its structural duty, whilst being exposed to the temperatures likely to be encountered in a developed fire for specified periods of time.
- As 'fire resistance' is related to building structures, rather than single materials, complete assemblies are tested under realistic conditions.

- Insulants are generally used within constructions (walls, roofs and floors) that are lined with materials which are incombustible or difficult to ignite.
- In normal circumstances the insulant cannot burn until the barrier is penetrated.

## THE 'FIRE RESISTANCE' OF A PITCHED ROOF STRUCTURE INSULATED WITH PUR/PIR INSULATION

- A pitched roof structure insulated with PUR/PIR insulation was tested in accordance with the European Standard EN 1365-2: 1999 (Fire resistance tests for load bearing elements, Part 2: floors, roofs) by FMPA Leipzig, an international acknowledged testing institute specialised in fire testing.
- The tested assembly consisted of rafters, 19 mm thick tongue and groove timber boards above the rafters, bituminous felt, 100 mm PUR/PIR insulation boards covered with 22 mm oriented strand board (OSB).

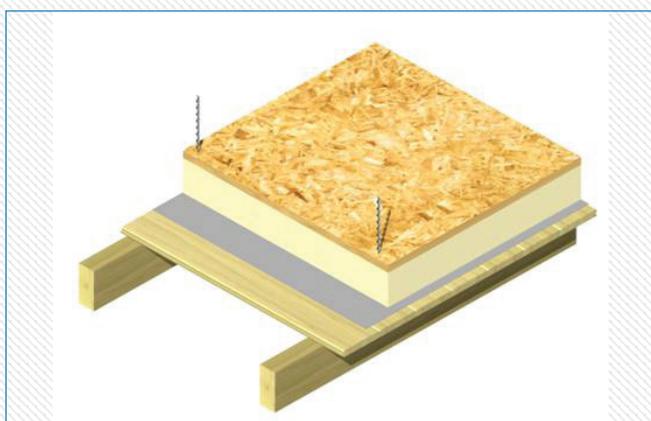


Figure 1: Diagram of the test assembly

- 21 minutes after the start of the test the timber boarding burned through and the PUR/PIR insulation boards were

exposed to the fire.

- Only after 37 minutes a slight increase in temperature was observed on the upper surface of the test rig but the limiting temperature rise of 180 K was never reached during the duration of the test.

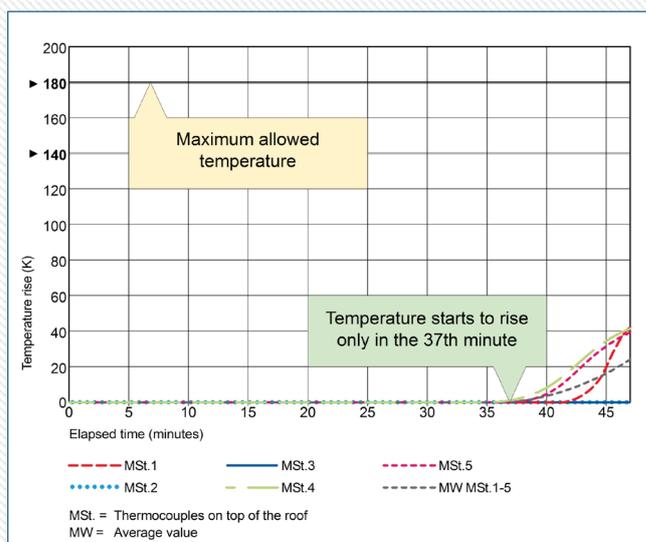


Figure 2: Modest temperature increase on the upper surface of the test rig

- After 41 minutes some smoke was released through a joint but the structure was still not visibly damaged.
- In the 46<sup>th</sup> minute the test had to be stopped to prevent the structure from collapsing because the rafters had been weakened by the fire.
- At the end of the test the PUR/PIR insulation boards were partially charred but had prevented the fire from reaching the upper layers of the test rig.
- The roof structure was classified **REI 45**. This means that three critical criteria were met for a minimum of 45 minutes: stability or mechanical resistance (R), room enclosure (E) and thermal insulation (I).



Figure 3: Test rig at the end of the test

- Pitched roof constructions containing non-combustible non-cellular insulation materials hold REI 30 and REI 45 certification.
- Pitched roof constructions containing PUR/PIR insulation boards can therefore demonstrate equivalent performance to, or better performance than, similar constructions containing non-combustible non-cellular insulation materials.

## 'REACTION TO FIRE' VS 'FIRE RESISTANCE'

- Since 'reaction to fire' is more determined by the products lining a room (generally not insulation materials) the fire performance of insulation has more impact on the 'fire resistance' of an element of construction.
- The Euroclass system for 'reaction to fire' can not give a representative picture of the performance of insulation

materials in 'fire resistance' tests.

- This can be illustrated by 'fire resistance' tests of timber frame walls.

## THE 'FIRE RESISTANCE' OF TIMBER FRAMED WALLS

- A timber frame wall insulated with a 60 mm PUR/PIR insulation board, faced with a composite foil facing on both sides, was tested in accordance with the British Standard BS 476: Part 21: 1987 half hour fire resistance test by Warrington Fire Research Centre (now named Warrington Fire Global Safety).

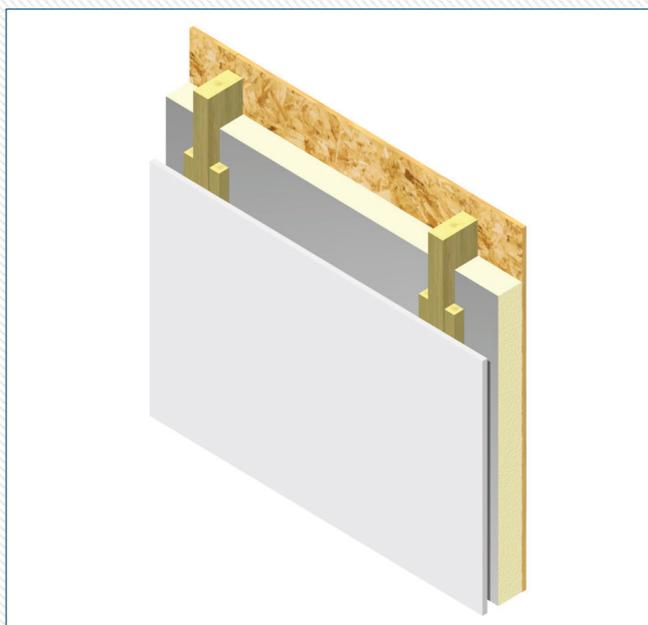


Figure 4: Diagram of the test timber frame wall assembly

- After the 12.5 mm standard plasterboard lining to the test wall failed and the composite foil facing burned off, the PUR/PIR core of the insulation product provided the critical fire resistance for the test to proceed to 36 minutes at which time the test was stopped.

- The fire did not penetrate the insulation product.
- The assembly was therefore awarded a rating of 36 minutes for each of fire resistance, integrity and load bearing capacity.
- Other non-combustible non-cellular insulation materials normally used in timber frame walls in the UK do not contribute to arresting fire penetration in this way; they can simply contract away in the direct heat of the test allowing fire to pass through.
- The non-combustible non-cellular materials normally used in timber frames achieve a Euroclass A1 'as placed on the market', but the PUR/PIR board achieves a significantly worse Euroclass as its facings burn off quickly in the Euroclass test but add little to the fire load.

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