



Applications for polyurethane insulation

Today's solution for tomorrow's needs



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What is it?

It helps to keep our buildings warm and our food chilled, it is usually hidden, but you can find it everywhere from sports stadia to hospitals, cold stores to houses, and it is one of the most important weapons we have to combat climate change. The 'it' in all of these cases is insulation.

Polyurethane or PU insulation includes both PUR and PIR and is one of the most effective insulation materials commonly available today. It is lightweight, easy to handle and install, and its very low thermal conductivity means that a much thinner layer than most other insulation materials is needed to get the same level of energy efficiency. It is also extremely versatile and can be used just about anywhere.

Where is it used in our daily lives?

Users may not be aware of it, but PU is all around them, whether it is in shoe soles, mattresses, steering wheels or bumpers. Due to its outstanding thermal insulation properties, it is the material of choice in fridges, cooling trucks and hot water tanks.

As PU is a very low emission product and kind to skin, it is also widely used for medical devices, upholstered products and clothing.

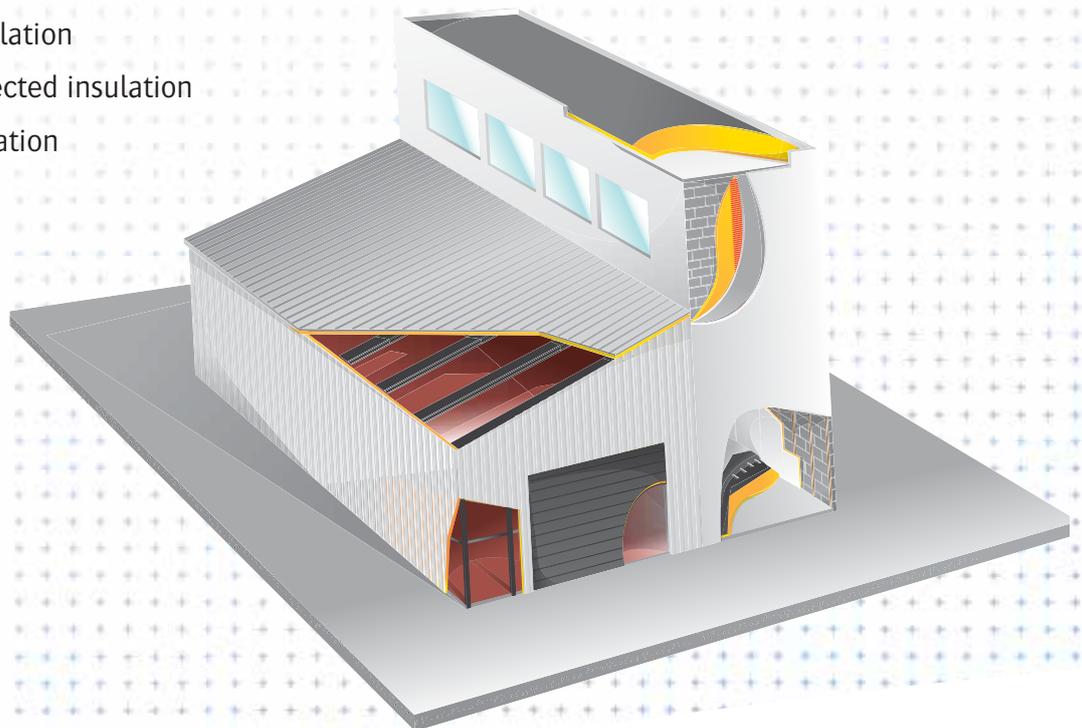




How can it be used in building insulation?

Because it is so versatile, PU insulation (PUR / PIR) is commonly used in a number of different ways:

- ▶ Insulation boards
- ▶ Insulation block
- ▶ Insulated panels
- ▶ Structural insulated panels
- ▶ Spray insulation
- ▶ Cavity injected insulation
- ▶ Pipe insulation





Insulation boards and block

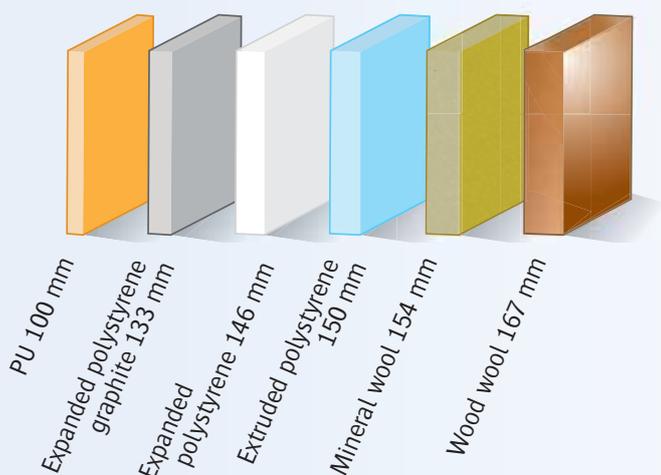
Probably one of the best known applications, PU rigid insulation boards can be used for walls, floors or roofs, behind rain screens or under soffits. The boards are usually faced with a wide range of materials, such as paper, cork, bitumen, glass fleece or plasterboard, but are most likely to be faced with aluminium foil.

One of the many benefits of PU insulation is its ability to be cut or shaped and to hold the required form. Block is simply PU foam insulation that is manufactured in block which can be cut to size and shape for specific purposes and can be used for all elements of a construction, including pipe work.

Insulation boards and block in housing

In Europe around 40 % of all energy used is in buildings, and more than 60 % of that comes from heating and cooling them. Providing good insulation for houses is one of the simplest and most important things we can do to reduce energy consumption and combat climate change. PU insulation is one of the most effective insulation materials around and can achieve very high levels of thermal performance with minimal thickness. In fact with lambda values (thermal conductivity) starting from as low as 0.022 W/m·K, equivalent insulation performance (U-values) can be achieved with considerably less thickness than other commonly used insulation materials. It can be used for either new build or refurbishment as described in the examples below.

Insulation thickness at equal thermal insulation value





Walls

Whether you are constructing a timber frame building or a masonry cavity wall, PU insulation makes it easy to achieve the U-values you want. The fact that this can be done without great thickness means that the best use is made of the available space and other construction costs are kept down, such as the depth of timber studs or the length of fasteners.

But it isn't just inside walls that PU insulation plays a part: in solid walls it can be used either internally as insulated plasterboard or externally behind render. Obviously if it is to be used internally the thinner the better, so here PU has a major advantage over other types of insulation when it comes to making the most out of available living space.

Another clear benefit of PU insulation is that it will not sag or slump over time, and it is easy to fit and install, lessening the likelihood of gaps or thermal bridging, and providing greater assurance of performance over the life of the building. It is also a simple job to seal joints, allowing far greater levels of airtightness to be achieved, which in turn provides even better thermal performance.

Pitched roofs

The use of rafter level insulation is rapidly increasing to create a warm roof space which can then be used for a warm storage area or may be fully converted to a "room in roof". PU insulation boards offer flexibility to the specifier; they can be used over rafter, between rafters or under rafter. The use of PU insulation boards to insulate a pitched roof is equally applicable for new build or refurbishment. The thermal performance and flexibility offered by PU insulation boards means that the pitch of the roof can be insulated to current standards and beyond without sacrificing valuable headroom. There is no need to bear the cost of deeper joists.

Installing PU insulation above the roof timbers has multiple benefits. Having insulation over the rafters reduces the risk of cold bridging and, provided a breathable sarking membrane is used, offers the opportunity for a airtight construction.





The greatest energy saving potential lies in buildings...
A large energy saving potential remains untapped.
Techniques exist to cut existing buildings' consumption
by half or three quarters.¹

Flat roofs

PU insulation boards are the most commonly used insulation product in flat roof applications. The boards offer, as a result of their excellent thermal performance, the thinnest method of achieving or exceeding current U-value requirements.

PU insulation offers dimensional stability and good compressive strength whilst being much lighter and easier to handle than other insulation products. PU insulation has the ability to withstand foot traffic; this is an essential characteristic, especially when used in modern flat roofs waterproofed with single-ply membranes. Unlike some fibrous insulation materials, PU insulation will not depress under foot traffic which could cause water ponding, membrane failure and water penetration.

The best solution to eliminate ponding is to design an adequate fall to the roof. Tapered PU insulation is one of the most cost effective methods of introducing a fall to flat roof. It is also significantly lighter than screed to falls solutions and does not suffer from lengthy drying times.

Floors

One area that can bring significant benefits in terms of reducing energy consumption, but one that is often overlooked, is floor insulation. Although the greatest heat loss through an un-insulated floor is from the edges, the thermal performance of an un-insulated domestic floor slab as a whole is fairly poor, so complete floor insulation has a big advantage over perimeter insulation if you're looking at the floor dimensions of a typical house.

So what is the best way to insulate a floor? For example, the only realistic way to insulate a suspended timber floor is to install the insulation between the joists, which if you are using a fibrous material would mean supporting it underneath with netting. The risk of sagging, and possible deterioration of performance because of air movement or moisture makes this an uncertain solution. Rigid PU

[1] European Commission, Energy Efficiency Plan 2011, March 2011

insulation is not affected by any of these problems, and works equally well fastened beneath a suspended timber floor or used beneath a solid concrete floor.

PU insulation above bearing floor is a must when using under floor heating. It prevents storage of warmth in the floor and the space can be heated more quickly.

Insulation boards and block in non-residential buildings

It isn't just housing that can benefit from PU insulation: everywhere we look, from hospitals and schools, offices and shops, to convents and sports stadia, it can be found in every type of building providing long lasting thermal performance.

PU insulation boards are extremely suited for the insulation of steel deck membrane roofs. The boards are easy to install, dimensionally stable and withstand foot traffic required during installation and for maintenance purposes.

Features and benefits of insulation boards

Features	Benefits
Low thermal conductivity	<ul style="list-style-type: none">• Space and resource saving eg. for timber frame buildings, no need for increased studs
Dimensional stability	<ul style="list-style-type: none">• No danger of slumping and sagging
Walkability	<ul style="list-style-type: none">• Withstands foot traffic on flat roofs
Closed cell structure	<ul style="list-style-type: none">• Unaffected by air movement or moisture• Longevity, majority of installations will retain thermal qualities for at least 50 years• Eliminates risk of water penetration
Non hazardous and non fibrous	<ul style="list-style-type: none">• No need for personal protective equipment• Non irritant





Insulated panels

In today's demanding world we ask more and more of the construction industry. We want our buildings to be energy efficient and aesthetically pleasing; we also want them to be built rapidly and to come in on time and on budget, but without loss of quality. PU insulated panel systems are a very effective way of meeting all of these demands.

What are insulated panels?

Insulated panels, also sometimes called sandwich panels or composite panels, are made from two rigid metal facings (usually steel or aluminium), with a PU insulating core in between. During the manufacturing process the PU core expands, auto adhesively bonding and laminating completely to the metal facings, forming a single strong semi-structural unit. These panels are able to provide excellent thermal performance, with guaranteed continuity of insulation and factory engineered airtight joints.

Benefits and applications

One of the key advantages to using PU insulated panels as opposed to systems assembled on site is that panels are factory engineered one-piece units, delivered to site and simply fixed. This is less labour intensive, reduces construction time, and makes project completion more predictable. The pre-engineered panels help to reduce on site waste, and to ensure the quality of the installation, greatly reducing the risk of air leakage, cold bridging and inconsistent insulation.

There are also health and safety benefits: using PU insulated panels on a roof reduces the installation time and therefore minimises the risks of working at height



when fixed insulated panels can provide a safe, walkable platform to work from compared with the common practice of installing fragile roof liners first followed by the multiple parts of a site assembled system.

Long length PU panels are increasingly available, and speed up the construction process even more. With the advent of longer and thicker (heavier) panels mechanical handling systems are increasingly being used. This means that the work can be done with fewer people in a shorter time and with increased safety.

PU insulated panels are also extremely durable, and are particularly useful for upgrading the appearance of buildings in need of refurbishment as well as improving their thermal performance.

Now add to all of this the wide range of colours and finishes that are available – from ridged profiles to completely smooth, flat panels, wood or metal to ceramic tiles, all offering excellent thermal performance – the design possibilities are endless.

You will find PU insulated panel systems used on warehouses, offices, retail outlets and industrial units, flats, schools and hospitals. Also the housing sector has discovered the benefits of using insulated panels.

Cold stores and clean rooms

PU insulated panels can also be found in cold stores and other chilled facilities, where their excellent thermal properties can offer temperature controlled environments. PU is unaffected by low temperatures and the closed cell nature of the core means there is no ingress or absorption of moisture. The demand for frozen and chilled foods is increasing and, whether the application is for food processing, chill or cold storage, there are PU cored insulated panel solutions to meet these needs.

Panels are available in a wide range of thicknesses, depending on the kind of temperatures that need to be maintained, for example 200 mm thick panels can provide a U-value as low as $0.11 \text{ W/m}^2\cdot\text{K}$. Low air leakage of around $0.5/\text{m}^3/\text{hr}/\text{m}^2$ or better also helps to keep energy usage and running costs down, whether the temperature to be maintained is high or low.



Apart from excellent thermal performance, PU insulation can offer key benefits for food, pharmaceutical or other industries where health and hygiene are paramount. Because the closed cell structure of PU is resistant to water or vapour ingress it does not support mould and bacterial growth, and since it is also fibre-free there is no risk of loose fibres leading to contamination in a clean room situation.

This kind of application can be found in many different sectors: retail, food supply chain, confectionery, distribution and logistics, pharmaceuticals, even hotels and large leisure facilities.

Features and benefits of insulated panels

Features	Benefits
Single manufactured unit	<ul style="list-style-type: none">• Fast on-site erection• Allows early project completion• Minimises on-site impact on product quality
Low thermal conductivity	<ul style="list-style-type: none">• Space saving (smaller panel thickness at same thermal performance)
Joints	<ul style="list-style-type: none">• Factory engineered joints give a high degree of air-tightness reducing energy costs
Large range of facings, colours, profiles, accessories, curved panels	<ul style="list-style-type: none">• Design flexibility
High strength at low density	<ul style="list-style-type: none">• Light weight panels easy to handle• Long spans





Structural insulated panels

Traditional construction methods rely on bricks and blocks, or a conventional timber frame. Structural Insulated Panels (SIPs) typically comprise PU insulation sandwiched between two sheets of wood-based Oriented Strand Board (OSB).

The panels are joined together using an insulated jointing system that minimises air leakage through the joints in comparison to a building constructed with traditional timber frame. In addition, the design of the joints yields a more continuous layer of insulation in walls and roof. SIPs are a perfect high performance building fabric solution for extremely low energy buildings which require little or no heating at all, such as those designed to Passivhaus standard, or to the upper levels of the Code for Sustainable Homes.

A SIP building can also be very quick to build, particularly if you are also constructing the roof from SIPs.

Features and benefits of structural insulated panels

Features	Benefits
Single manufactured unit	<ul style="list-style-type: none">• Fast on-site erection• Allows fast project completion• Minimises on-site impact on product quality
Low thermal conductivity	<ul style="list-style-type: none">• Space saving (smaller panel thickness at same thermal performance)
Joints	<ul style="list-style-type: none">• High air-tightness reducing energy costs
More continuous insulation layer	<ul style="list-style-type: none">• Reduction of thermal bridges





Spray insulation

Spray PU insulation foam is a cost effective and versatile way to insulate all kinds of areas, including awkward and hard to reach spaces. The polyurethane system is produced directly on the substrate to be insulated using a spray process. The material forms a continuous, even layer with no joints or gaps, eliminating any thermal bridges. Spray insulation is the ideal solution for a very wide variety of surfaces and shapes because the material adapts to any profile without gaps.

The field of applications covers virtually all areas of flat and pitched roofs, ceilings, walls and floors.

For example, it is often used to seal a roof space, providing insulation, draught proofing, weather proofing and

sometimes structural stability in one. Like all PU insulation, the sprayed version has a lower thermal conductivity than many other commonly used insulation products, so does not need to be as deep to achieve the same level of roof insulation.





Another example is spray insulation on top of ground floors with underfloor heating. The foam is simply sprayed on to a dry, dust-free base, covering the pipes for water, heating and electrical installations. After a brief curing time, the heating pipes and screed are laid, the screed layer being separated from the insulation by a sheet. The high compressive strength of the PU foam guarantees a secure substrate with excellent insulating performance even when subjected to permanent stress.

Other advantages include the fact that before application it is a very low volume product, requiring little space and therefore reducing transportation costs. It is simple to apply and needs no fixing devices, helping to keep costs down.

Installation of spray insulation should always be performed by qualified contractors.

Features and benefits of spray insulation

Features	Benefits
Adhesion during application	<ul style="list-style-type: none"> • Bonding to any type of surface • No fixings required • Bonds tiles together increasing resistance to wind and storms
Continuous layer of insulating foam and gap filling	<ul style="list-style-type: none"> • Eliminates cold bridges and increases air-tightness
Low thermal conductivity	<ul style="list-style-type: none"> • Space saving
Qualified people from certified installation companies	<ul style="list-style-type: none"> • Safe, professional installation
Foamed as liquid mixture on site	<ul style="list-style-type: none"> • Rapid transport and space-saving storage on the site





Cavity injected insulation

Injected PIR/PUR insulation not only provides highly efficient thermal performance but expands to bond the outer leaves together (thus stabilising the building and eliminating the problem of wall tie failure) but also seals all gaps to provide air-tightness. It is ideal for narrow cavities which are deemed to be “Hard to Treat”, where traditional insulation materials cannot be used.

Buildings with traditional cavity wall construction have great potential to have their thermal performance improved by filling the cavity with an insulating product. In some cases where the cavity already contains an insulant but it has failed due to settling or moisture ingress, it may be possible to remove the failed product and replace it with a more suitable alternative.

A PIR or PUR system can be injected into the cavity via holes in the outer leaf producing insulation with excellent adhesive and structural properties. The product bonds the inner and outer leaves together thus eliminating the problem of wall tie failure.

Installation of injected insulation is carried out by specialist installers.

Features and benefits of cavity injected insulation

Features	Benefits
Low thermal conductivity	<ul style="list-style-type: none"> Prevents heat loss
Does not settle or sag in cavities	<ul style="list-style-type: none"> Provides constant thermal performance in excess of 50 years
Adhesion to both surfaces	<ul style="list-style-type: none"> Provides wall stabilisation, especially useful with failing wall ties
Flood resilient (more resistant to moisture ingress)	<ul style="list-style-type: none"> Recommended by Environment Agency as a measure to reduce flood damage in walls
Installed via the external wall	<ul style="list-style-type: none"> No disruption to building occupants



Pipe insulation

PU foam is commonly used for the insulation of pipelines where hot or cold liquids are being carried through, because they minimise the exchange of heat within the pipe and surrounding environment. The main applications of PU insulated pipes are district heating and cooling, oil and gas pipelines, and chemical plants.

Over the past 30 years PU insulated pipes have established a proven track record for reliability, durability and efficiency. Thanks to their unmatched performance and ease of application, they are progressively replacing other insulation media. Its outstanding insulation properties, which prevent heat loss, or alternatively maintain temperatures in cold environments, conserve energy and improve the overall cost efficiency of the pipeline systems. PU insulated pipes have the ability to insulate over an extremely wide range of temperatures, from the extreme cold of $-196\text{ }^{\circ}\text{C}$ to the intense heat of more than $+150\text{ }^{\circ}\text{C}$.

There are two main types of pipe: straight and flexible – and two main forms of pipe production techniques: discontinuous and continuous. Flexible pipes are being

used more and more frequently because of ease of handling and cost saving potential during pipe laying. Applications range from small plumbing pipes, 10 mm in diameter, up to the largest heating pipes with 2.000 mm diameters and 250 mm of insulation thickness.

Features and benefits of pipe insulation

Features	Benefits
Low thermal conductivity	<ul style="list-style-type: none"> Prevents heat loss/insulates against freezing
Suited to wide temperature range	<ul style="list-style-type: none"> $-196\text{ }^{\circ}\text{C}$ to $+150\text{ }^{\circ}\text{C}$
Flexible pipes	<ul style="list-style-type: none"> Ease of handling/installation Reduces pipe laying costs
Factory manufactured or in-situ	<ul style="list-style-type: none"> Production versatility to suit application
Compatibility with pipe materials	<ul style="list-style-type: none"> Works with steel, PE, PP, PVC or HDPE
Longevity	<ul style="list-style-type: none"> Low maintenance/long replacement cycle



Conclusion: PU the versatile insulation

- > From pipes to panels, floors to roofs, PU insulation can provide excellent thermal performance and durability.
- > It is used in every kind of building, old or new.
- > It can help us to find a sustainable solution to the problem of climate change.

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For more details on the benefits of polyurethane insulation, see www.excellence-in-insulation.eu

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