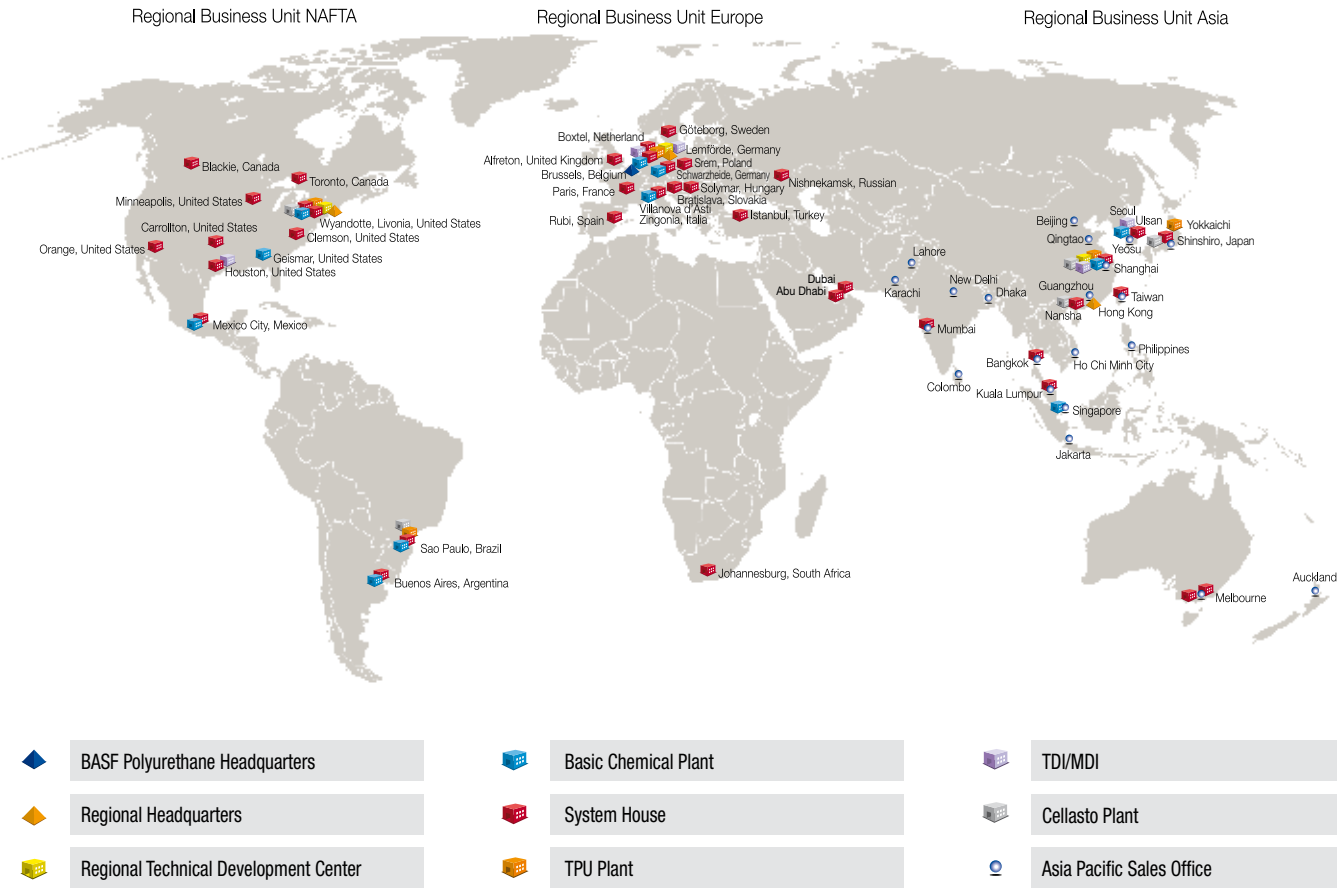


BASF Polyurethane Solutions in Construction

Building a Greener Future

BASF Polyurethanes Worldwide Network



Polyurethane Solutions

BASF is the leading supplier of polyurethane basic products, systems and specialties. The brand “Polyurethane Solutions” stands for the worldwide leading supplier of polyurethane systems and specialty elastomers. We provide excellent problem solving expertise and product quality from a global network of 38 BASF System Houses which offer tailor-made solutions to our customers.

PU Customers all over the world experience first hand customized consulting and development services in polyurethane systems and specialties whenever they do business with BASF’s polyurethanes specialists. Polyurethane Solutions brings BASF close to the customer, providing local support to help customers become even more successful.

For further information, please visit www.polyurethanes.asiapacific.basf.com

Comprehensive Service



The search for energy efficiency is one of the defining characteristics of our age. No matter who we are or where we come from, we are all in some way concerned about pollution, global warming and the kind of world we'll be leaving for our kids. And yet often the most surprising thing about the whole issue of energy conservation is just how safe, easy and cost-effective the solutions can be.

Polyurethane rigid foam is the world's most effective insulation material. It is also extremely light and versatile.

In field test, installing insulated windows and polyurethane rigid foam boards on the walls, roofs, floors and ceilings of existing houses have contributed to reducing the houses' heating energy consumption by more than 50 percent. So it is a clean and cost-effective way of cutting fuel cost and saving precious energy resources.

BASF Polyurethanes is one of the world's largest and most established producers of polyurethane rigid foam systems, and with decades of production application experience, supported by dedicated technicians and customer service team at all times, we provide our customers with a comprehensive mixture of outstanding products, solutions to application requirement and many other advantages.

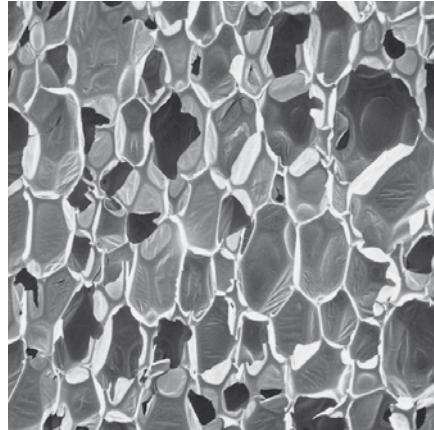
With an Asia Pacific Regional Development Centre and a comprehensive product development program, we have strengthened our local sales and technical teams throughout the region. We understand their needs by speaking their languages.

Outstanding Insulation, Outstanding Service

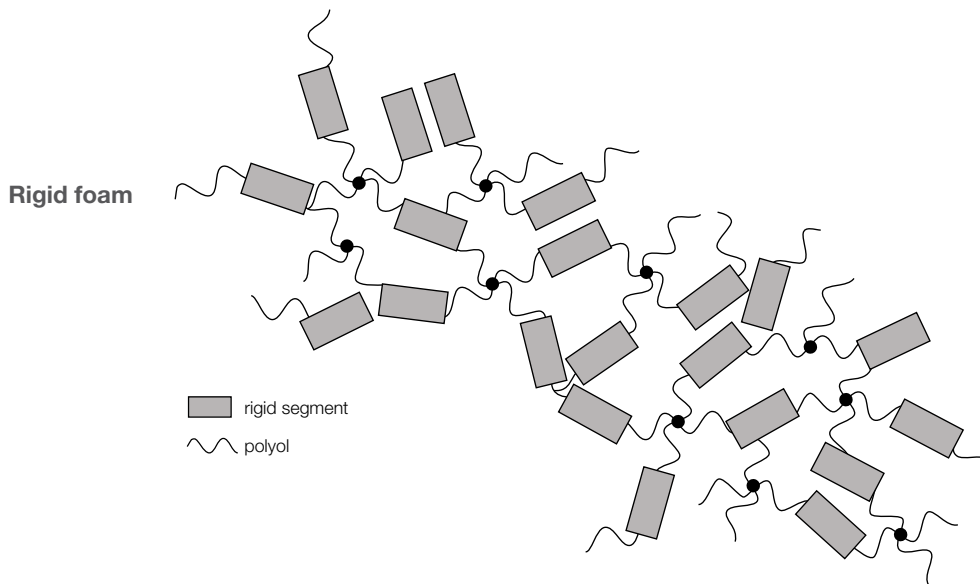
BASF Polyurethanes has two key rigid foam systems, Elastocool™, which is solely used in the insulation of refrigerators and freezers, and Elastopor™, which is used for a whole range of insulation applications and has the most relevance to the construction industry.

BASF Polyurethane's core advantage is to provide our customers with a complete package of tailor made products and application oriented services. This means that a customer can find all of the answers in a single enquiry.

For example, when customers use Elastopor™, they



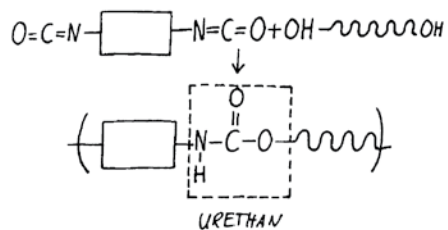
The closed cell structure of PU rigid foam allows superior thermal insulation ability and lower density.



need to apply other chemical products in the process, such as blowing agents and flame retarding additives.

Unlike many other suppliers, BASF Polyurethanes provides customers not only with essential MDI and polyol components, but also advise technically or know how to apply the other additives.

Using BASF Polyurethanes' Elastopor™ brings you many other advantages as described in the next chapters.





Applications

In technical terms, polyurethane is a plastic polymer derived from mixing two components, Isocyanate and Polyol to create a chemical reaction.

BASF Polyurethanes recommends cyclopentane, with its patented blowing agent to turn polyurethane into foam. This is an environmental-friendly product that does not contribute to ozone layer depletion.

The interaction of polyurethane and the blowing agent produces foam that can be expanded into any given shape, making it extremely versatile.





In the construction industry, some of the key applications for Elastopor™ include:

1. Sandwich Panel

Sandwich panel is an invaluable product for all kinds of construction usage including warehouses, factories, supermarkets, car showrooms, stadiums, swimming pools, cold stores, shipping containers and vehicle super-structures.

Panels are made up of polyurethane insulating core and an outer layer of diffusion-resistant metal sheet.

These panels produced with BASF PUR & PIR (polyisocyanurate) rigid foam not only provide very low lamda value in terms of thermal conductivity, they also offer an outstanding combination of excellent flame resistance while sustaining other specified physical properties.

Sandwich panel produced with BASF's PUR & PIR rigid foam conforms to international standards for building material classification and fire prevention including DIN 4102 Part 1 (B1 Class), GB 8624-1997 (B1 Grade), KSF 2271-1998 (Grade 3), FM 4880 (Class 1). Furthermore, BASF innovative products – Elastopir™ rigid foam has passed high level fire test like LPS 1181.

The panels retain their dimensional stability, used long-term over a temperature range of -30°C to $+90^{\circ}\text{C}$. It can withstand temperature up to 250°C for short periods with no adverse effects. Furthermore, special polyurethane products can be used under withstand temperatures of $+200^{\circ}\text{C}$ without additional heat protection, or can be used for cold-temperature applications down to -180°C .

They can be produced quickly and efficiently, and they come with problem-free toggle-joint systems to enable rapid installation. They also come in a wide range of colours, making them easier to match all colour in construction design.



2. Wall and Roof Insulation Board

Elastopor™ can also be applied as insulation board for walls and roofs. These boards are lighter and easier to handle. They are made of tongue-and-groove connection that not only makes them easier to install, but also ensure that the joints are seamless.

The PU boards also have a higher degree of dimensional stability, which is the key characteristic to ensure sustained insulation properties over time.

Other insulation systems, for example, tend to settle over time, causing a gradual reduction in the degree of thermal insulation performance.

The other advantages of the PU boards are that they are thin, resulting in more internal living space, and they are versatile enough to be used both in the construction of new buildings and in retrofits.



More living space with PU insulation board



3. Spray Foam

In construction, Elastospray™ provides a simple, economical and highly effective way of insulating a building and sealing a roof. Since it is sprayed by trained and qualified technicians, the foam formed a seamless layer of insulation that is hard enough to walk on. It has proven to be highly popular in the renovation of old buildings.

BASF spray foam products Elastospray™ could be applied on versatile surfaces with any irregular shapes and penetrations. Horizontally or vertically, BASF spray foam adheres strongly to almost every building material. The high dimension stability of the foam ensures sustainable thermal insulation over the application lifetime.

BASF spray foam boosts smooth surface, which facilitates the external insulation finishing system (EIFS). In addition its low weight due to low density of the foam hardly forms any additional load on a building's structure.

4. Pre-Insulated Pipe Insulation

Used as pipe insulation, Elastopor™ is invaluable as a means of both preserving the low temperature of transported liquids and maintaining efficient heating systems. For example, Elastopor™ insulates the full length of the Trans-Alaskan pipeline.

It is used to make pipe-within-pipe, with a layer of rigid foam binding an inner and an outer pipe. Insulated pipes can be thus prefabricated, which is one of their key advantages, allowing for quick installation.

BASF rigid foam system conformed to all requirements of EN 253. Its high insulation performance, with long-term temperature resistance of $140\pm 30^{\circ}\text{C}$ over 30 years, is of critical importance.

Elastopor™ cyclopentane blown system has high insulation performance, with change and continuity over time (CCOT) at 161°C over 30 years.

The Government Materials Testing Centre in Hannover has officially confirmed the result.



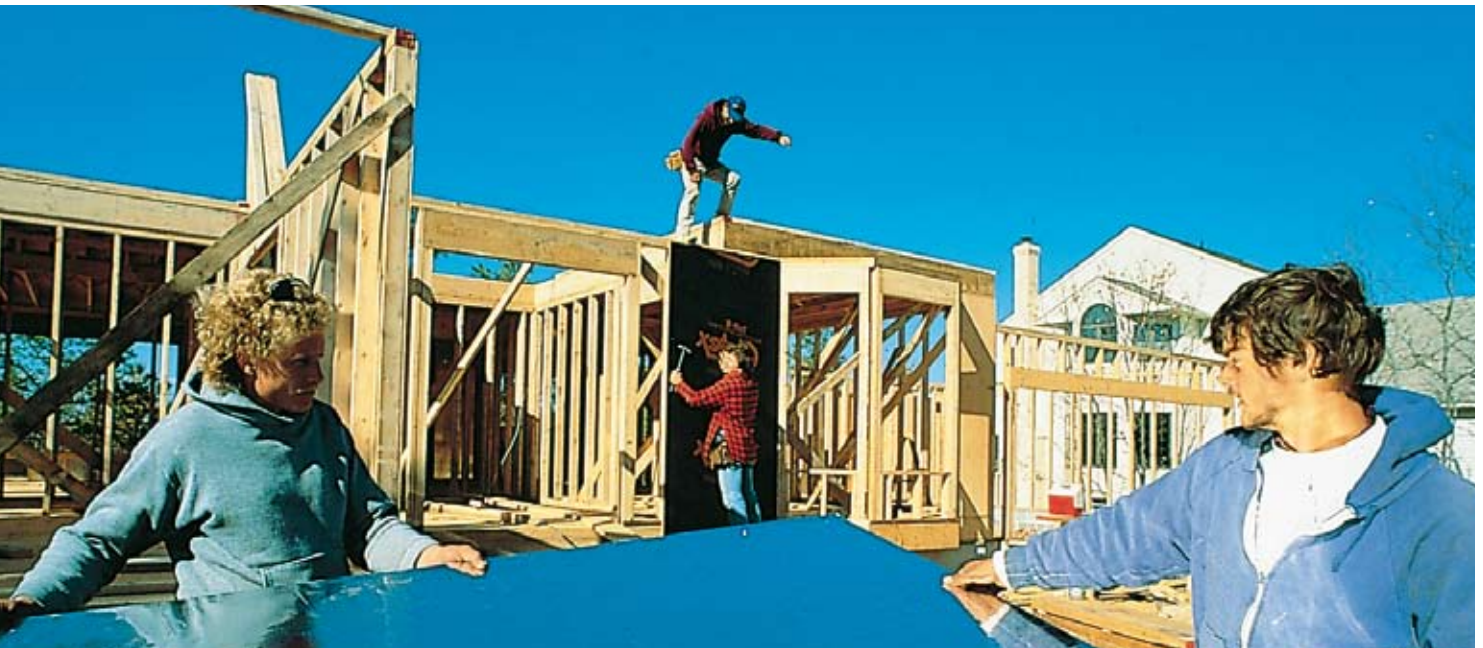


5. Cryogenic Services Industry

Our customers are using Elastopor™ to produce many types of insulation used in the transportation of liquefied gaseous at extremely low temperatures, an application that requires maintaining at low temperatures with the minimum energy consumption.

With demand for liquefied natural/petroleum gas surging, Elastopor™ is an attractive solution for installation in carrier ships, pipelines and receiving tanks.





6. Wood Binder

With Lupranate® isocyanates as binders, Elastopor™ is used in the making of composite wood panels and engineered wood products in construction. Wood composites made in this way have strong internal bonds and excellent water resistance.

For this application, BASF Polyurethanes offers a choice of Lupranate® binders:

Lupranate® M20SB is our standard MDI binder suitable for most composite wood applications, including

oriented strand board, medium density fibreboard, particleboard and engineered wood products.

Lupranate® M20FB is a more sophisticated binder with a faster setting time, allowing manufacturers to increase productivity by reducing their press cycles time. Lupranate® M20FB also generates stronger internal bonds at the same binder dosage as Lupranate® M20SB.



Properties



Fire-Resistance, Environmentally Friendly

Elastopor™ and Elastospray™ is an environmental friendly product because it helps reduce energy consumption. BASF Polyurethanes' barrage of proprietary technologies also includes cyclopentane, a blowing agent that turns polyurethane into foam without causing any depletion of the ozone layer.

Elastopor™ and Elastospray™ also has a long life cycle, retaining its properties for 10-50 years, and is recyclable by various methods including glycolysis, adhesive pressing, pulverisation and incineration to generate heat.

Unlike the others, BASF Polyurethanes also has the technology to increase fire-retarding performance of rigid foam without causing it to lose any of the other key properties.

Therefore, as an environmental-friendly with high-performance, and excellent fire-resistant product, Elastospray™ and Elastospray™ is held in high esteem in the construction industry. It also conforms to the international standards for building material classification.



Better Efficiency

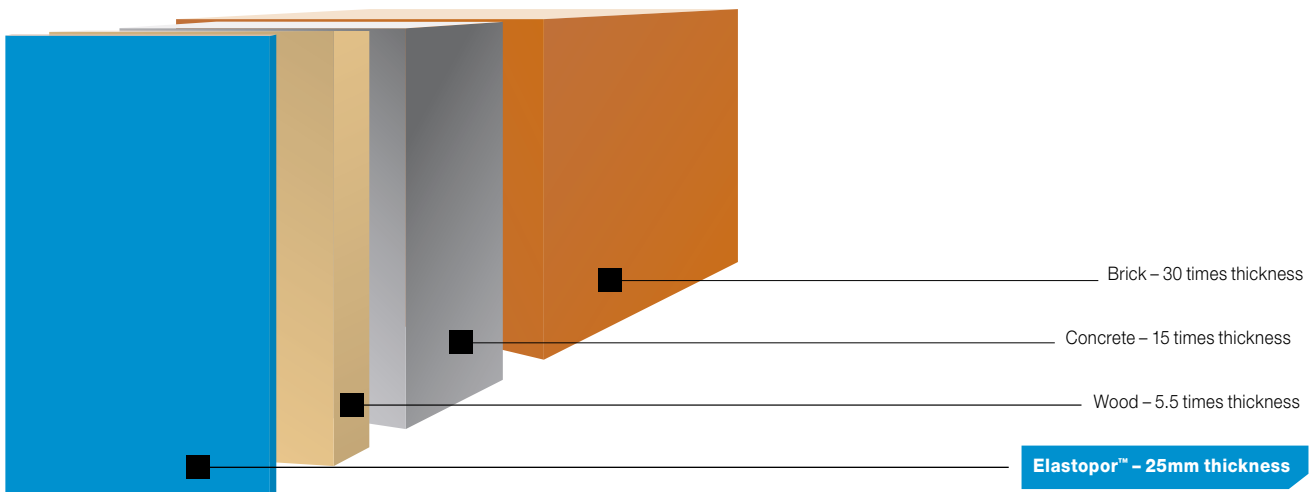
The cost savings offered by Elastopor™ go far beyond the energy consumption reduction.

Its binding properties, for example, are so great that it functions as an adhesive. As sprayed foam, it is hard enough to walk on to be used as roofing. Also, Elastopor™ is simultaneously rust-resistant, fire-resistant and easy to install.

What is even better is a thin layer of Elastopor™ can last a very long life.



As an illustration of below, you can compare the thickness of other building materials required to achieve the same thermal properties.



Boosting Adhesion

Polyurethane can adhere to a wide range of substrates before curing, so it does not require additional adhesive.

Fire Resistance

The fire-retarding rate of polyurethane depends on its shape and chemical composition. A PIR foam formulation can significantly increase the fire resistant, enabling it to meet fire safety standards.

Influence of index on flexibility and flammability of isocyanurate modified PU foam

Test	Index			
	105	150	200	300
ASTM-C 421 *	3.7	9.0	13.1	18.8
Butler Chimney Test ** ASTM-D 3014	22.8	31.0	47.5	69.8

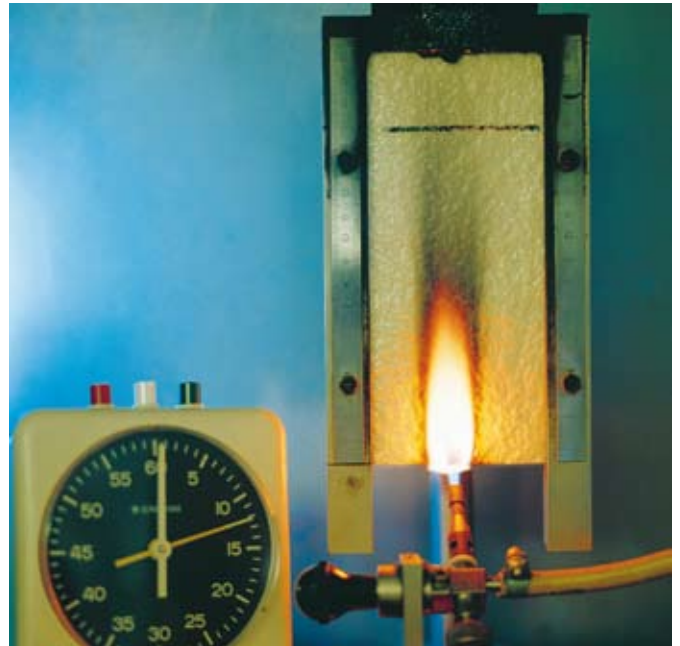
* Weight loss measurement of foam cubes, which are rotated together with wood cubes in a cylinder.

** Under certain test conditions, test samples are burned over a period of 10 sec. The remaining weight is reported in percent

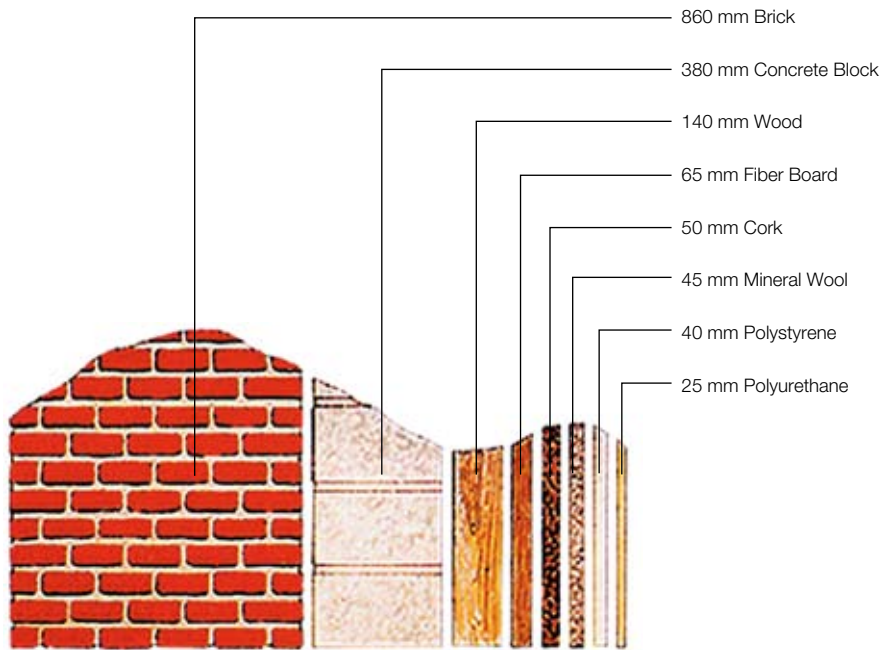


For standard polyurethane, the amount of isocyanate used is usually about 105% to match the chemical equivalent of the polyol. Foam made with that recipe would have an index of 105.

Theoretically, Polyisocyanurates can be produced with no polyol, using only isocyanate, catalysts blowing agents and surfactants. Instead of reacting with the polyol, the isocyanate reacts with itself to form a highly cross-linked thermosetting polymer with a ring-like structure. For commercial foam, the polyurethane foam is modified with Polyisocyanurate structure, creating superior fire resistant while maintaining required physical strength. For example, the index of polyisocyanurate foam insulation product is usually over 250 °c.

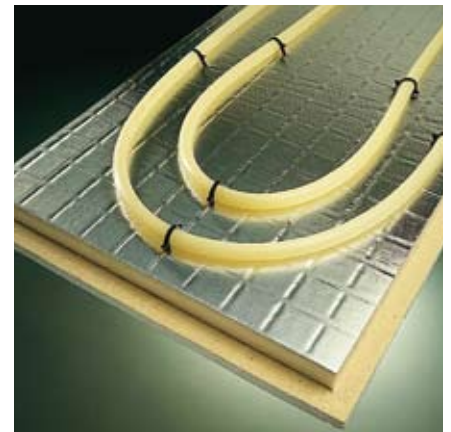


Required thickness with an equivalent thermal insulation



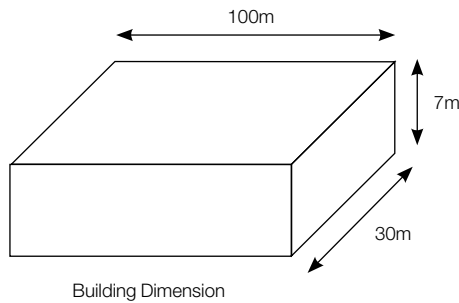
Insulation and Energy Efficiency

About 50% of a building's heat loss occurs through the roof, walls and floor. Insulating these with Elastopor™ can deliver a saving of between 18 to 85 litres of heating oil per square meter per year.



Energy Efficiency Model Calculation

1. Conditions



Outdoor Temperature : -10 °c
Indoor Temperature : 20 °c
Temperature Difference (Δt) : 30 °c
Heating Time : 16hrs / a day
Panel Thickness : 50 mm

2. Formula

Thermal conductive resistance (R) = $1/\alpha_i + \sum d/\lambda + 1/\alpha_o$ (m².hr.°C/Kcal)

Thermal conductive rate (K) = $1/R$ (Kcal/m².hr.°C)

Total energy consumption = $K \times \Delta t \times \text{area} \times \text{time}$

Thermal Conductive Resistance	$1/\alpha_i$, at indoor surface	$1/\alpha_o$, at outdoor surface
Wall (m ² .hr.°C/Kcal)	0.130	0.050
Roof (m ² .hr.°C/Kcal)	0.100	0.050

3. Energy Consumption & Energy Cost

	Glass Wool	PU
Density (kg/m ³)	64	40
Panel Thickness (mm)	50	50
Thermal Conductivity (kcal/mh °C)	0.028	0.018
Energy Consumption (kcal/day)	128,402	82,809
Energy Cost (USD/day)	9.77	6.30
Relative Cost Effect (%)	100%	64% (a saving of 36%)

Thermal conductivity : presented by the panel manufacturers

Heat capacity of diesel oil : 9,200 kcal/ℓ

Price of diesel oil : 0.7 USD/ℓ

Example of the Energy Efficiency



Before renovation



After renovation

Case Study:

Renovation of a Four-Storey Building in Hongkou, Shanghai, with Spray Foam

Following a comprehensive makeover using Elastospray™ CH spray foam system, a four-storey building has achieved about 50% savings in heat energy usage, with a significant reduction of carbon dioxide emissions by 21.6 kg/m² (please see table below).

This makeover project provides an illuminating example of how BASF spray-foam system outperforms traditional building insulation and air barrier combinations.

Equally, it shows that other buildings in Shanghai and in fact, across the whole of China, can achieve a similarly high level of energy efficiency, in line with the state's directives on scaling down energy intensity and CO₂ emissions.

	Before renovation	After renovation	Benefits
Exterior Wall 25mm PU spray foam	K-factor = 1.91 W/m ² a	K-factor = 0.62 W/m ² a	Improvement of 68%
Roof 50mm PU spray foam	K-factor = 3.47 W/m ² a	K-factor = 0.42 W/m ² a	Improvement of 88%
Energy Consumption	60.91 kWh/m ² a	31.82 kWh/m ² a	Heat energy saving ≈ 50%
	6.1 litre oil/m ² a	3.2 litre oil/m ² a	Reduction of CO ₂
	45.1 kgCO ₂ /m ² a	23.5 kgCO ₂ /m ² a	emissions: 21.6 kg/m ² a

BASF Product Advantage

Application	Product	Benefits	
Sandwich Panel	Elastopor™ Panel System	Energy Saving	High thermal insulation with low product weight
		Efficiency	Rapid installation with accurate fitting
		Good Appearance	Various designed and colored panels available
		Durability	Dimensional stability of panel from -30°C to +80°C
		Fire Resistance	Good fire resistance conforming to DIN4102 part 1, B1 class
Wall Insulation Board, Roof Insulation Board	Elastopor™ Panel System	Energy Saving	High thermal insulation with low product weight
		More Space	Panels are thin, allowing for more living space
		Easy Handling	Easy to handle. Their light weight ensures stability
		Versatility	Suitable for all types of tiling. Suitable for new buildings or renovation
Sprayed Foam	Elastospray™ System	Energy Saving	Maximum energy saving by optimal insulation with no joints or thermal bridges
		Durability	Permanent insulation
		Versatility	Can be applied to most horizontal and vertical surfaces as well as surfaces with irregular shapes and penetrations
		Low Weight	Hardly and no additional loading on building structures
		Strong Properties	Chemical and rot resistance
		Easy to handle and process	Easy to renovate on old roof surface

Application	Product	Benefits	
Pipe	Elastopor™ Pipe System	Energy Saving	Useful for a district heating system, and good for thermal insulation
		Outstanding performance	Consistent thermal insulation over 30 years at high temperature
		Cost Saving	Trouble-free laying, dispenses with costly coupling
		Versatility	Can be adhered to most surfaces, steel and Polyethylene, without any additional adhesives
Cryogenic Industry	Elastopor™ Insulation System	Energy Saving	Useful for insulation of liquefied gas transportation and storage
		Structural strength	Good mechanical strength at extremely low temperatures
		Physical Properties	Good adhesion strength to most substrates.
		Environmentally-friendly	Environmentally-friendly blowing agent (water) applicable.
Wood Binder	Lupranate® M20FB	Productivity	Binder sets faster, reducing press cycle
		Physical Properties	Strong internal bond strength
		Strong Properties	Tolerant to moisture and temperature variation
		Versatility	Suitable for most composite wood applications, including OSB, MDF, PB and EWP.

Sustainable Development



For BASF, sustainable development means combining long-term economic success with environmental protection and social responsibility. Sustainability is therefore a crucial aspect when we develop new products and processes.

BASF have decided to focus on four key areas – climate change and energy, renewable raw materials, corporate social responsibility, and Responsible Care®.

High energy prices call for innovative concepts to utilise energy more efficiently. BASF have numerous products that enable more efficient use of energy, these range from fuel additives to insulating materials that are used in construction and appliances like refrigerators.

Furthermore, BASF's Verbund networks enable us to efficiently use energy and raw materials. This concept facilitates the conservation of our natural resources, reduces emissions and waste, and provides economic and environmental advantages.

BASF has globally binding standards for the transportation and storage of chemical products. Our global network of safety distribution officers play an important role in implementing the standards listed in our Transportation and Distribution Safety Guide. These experts ensure that national and international regulations are observed for all shipments irrespective of the mode of transport.

Product stewardship is also important to BASF. We are responsible for ensuring that our products are safe for people and the environment. Safety data sheets inform our customers about the properties and possible risks of the products they buy. These data sheets are the most important means of communicating safety information and are updated when new data becomes available. Product Information can be obtained around the clock by using the emergency hotline system that we have established worldwide.

Our commitment and goals in the area of environmental protection and safety are also aligned with the principles of Responsible Care®, a voluntary global initiative of the chemical industry to which BASF has been committed since 1992. Responsible Care® enables the sharing of information, checklists, performance indicators and verification procedures. This allows the industry to demonstrate how it has improved over the years and to develop policies for further improvement. Responsible Care® helps the industry build trust with the public whilst operating safely, profitably and with due care for future generations.



Example –

BASF's Elastocool™ Plus is an example of an eco-efficient product.

- Elastocool™ Plus consists of vacuum insulation panels (VIP) with polyurethane cores (PU) and the PU hard foam Elastocool™.
- VIPs have a complex construction and are applied to the outer shell of refrigerators and freezers. Heat conduction can be reduced to an absolute minimum. Refrigerator energy consumption can be reduced by roughly 30 percent compared to traditional forms of insulation.
- Insulation thickness can also be reduced with Elastocool™ Plus. This leaves more useable space within the fridge.
- Consisting exclusively of organic material, recycling of VIPs is no problem at all.

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