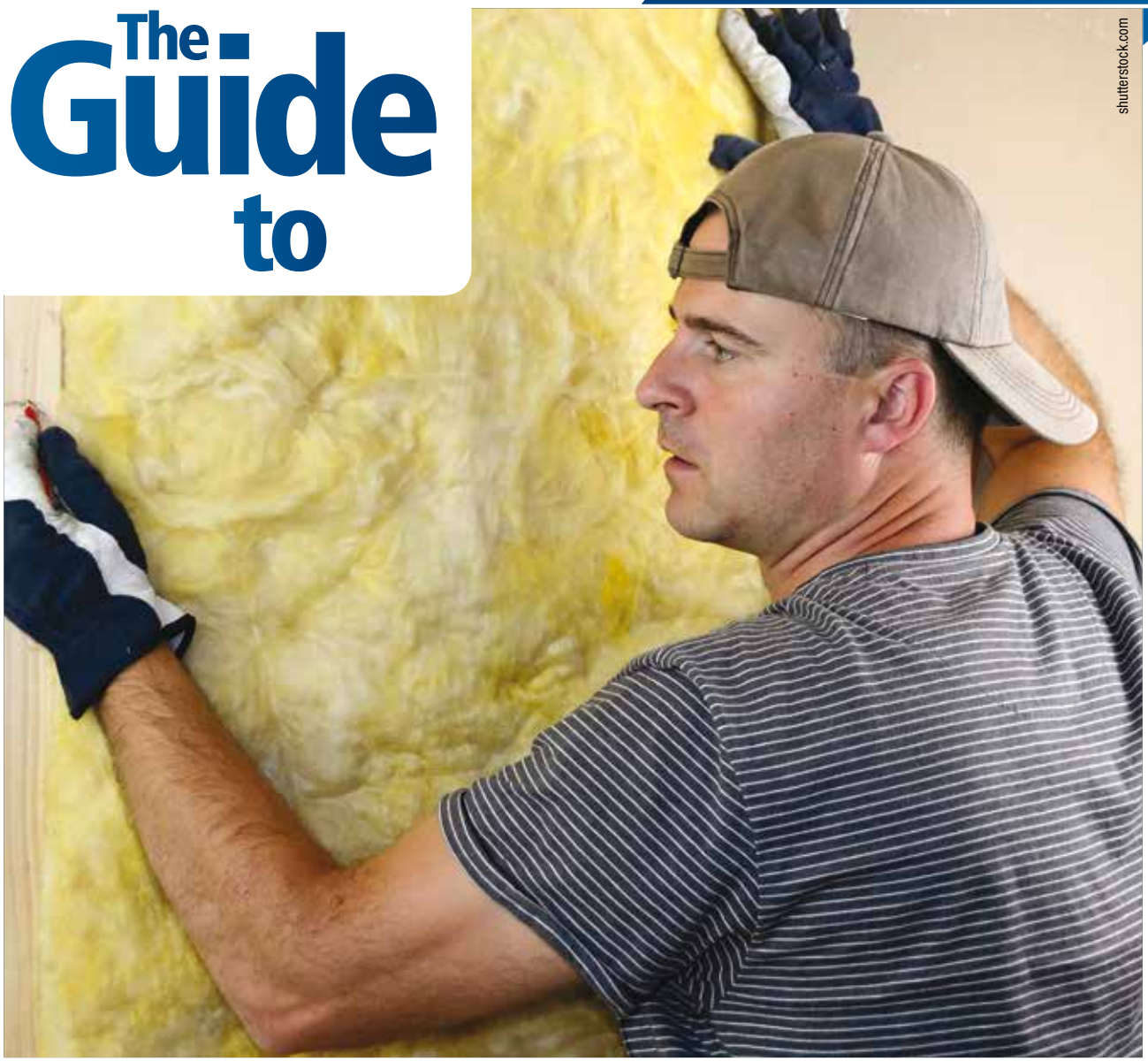
The Guide to



Thermal INSULATION

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Thermal insulation is the material or combination of materials that are used to provide the heat flow resistance. The more heat flow resistant is the building, the lower heating and cooling costs.

The low cost insulation retrofits can dramatically reduce the heat loss and improve the energy efficiency of building. Insulation of buildings in UK is crucial for sustainable environment making homes more economically and environmentally friendly. Buildings in the UK hold Energy Performance Certificate (EPC) rating system which shows their energy efficiency. The insulating materials have to meet the requirements of current legislation including Part L, BREEAM and the Code for Sustainable Homes.

Why is insulation required?

To insulate the home with the most appropriate material it is essential to understand how heat flows. Heat flows in three different ways- conduction, convection and radiation. Conduction is when heat moves through materials. Convection is the heat transfer by the motion of the fluid - it is the way heat circulates through liquids and gases. Warmer air rises while cooler falls. Radiation is the emission or transmission of the energy in the form of waves that passes through materials which absorb it.

Regardless of the heat flow mechanism, heat always flows from warmer to cooler until there is no temperature difference. Insulation material slows the conductive heat flow and to some extent the convective heat flow. Radiation can be limited with radiant barriers and reflective insulation systems. Heat flows directly from radiators, fireplaces, UFH, etc. to the spaces and from heated spaces to adjacent unheated spaces like garages, attics, basements and outdoors. Moreover, heat flows indirectly through ceilings, walls and floors. Also, heat can flow from outdoors to indoors.

Insulation provides effective resistance to heat flow. Proper insulation will remove the heat flows, reduce energy loss, cut energy bills and add comfort.

Thermal conductivity, R-Values, U-Values

Thermal conductivity (LAMBDA) is the measurement of how fast heat flows through the particular type of material, not taking into account material thickness. The lower the thermal conductivity of insulating material the better its thermal performance. It is measured in Watts per Metre Kelvin (W/mK). For instance wool and fibre, insulation has a thermal conductivity of approximately 0.034 W/mK while insulated panels about 0.008 W/mK.

The resistance of heat flow through a given thickness of insulation material is measured as R-Values. The higher the R-value, the better heat insulation is achieved. The R-value depends on the type of insulation, its thickness, and its density. For multilayered insulation system, all the R-values of each layer are added to calculate the R-value of the whole system. The more insulating material is installed in the building, the higher the R-values and the resistance to heat flow. The total thermal insulation of the cavity wall is calculated by adding the heat resistance of each separate layer. That is why the R-value is a relatively simple way

to compare two insulating materials given the heat conductivity of each material. Moreover, it enables to see the difference when adding thicker layers of the same material. However, R-Values take into account only heat conduction. The amount of insulation or the R-value required to effectively insulate the home depends on the standard of existing insulation, the type of heating and cooling system, the part of the house which will be insulated. It is important to remember about the thermal bridging so to prevent the heat loss at the junctions. Heat flows more easily through joists, studs or other building materials so the effectiveness of an insulation depends on where it will be installed.

U-Values take into account all three ways for heat flow and measure the heat loss through a given thickness of the particular insulating material. With U-Value the rule is the lower, the better. The best insulating materials have U-Value close to zero. According to Building Regulations, the following elements should have the maximum- wall- 0.3 W/m2k, roof- 0.15 W/m2k, windows 1.6 W/m2k.

The uninsulated 225mm thick solid brick wall will have the U-Value of 2.70 W/m2K. To achieve better U-value, there is an option to insulate externally or internally with the 100mm of EPS insulation what should bring the U-value in line with the Building Regulations. In the case of 100mm of Rockwool insulation, same result can be achieved when both internal and external walls are insulated. To improve the cavity wall U-value for a new build, the 150mm of wool is enough, and it is the cheapest solution. The maximum U-value to achieve in the retrofitted cavity walls built before 1975 or between 1970-1995 is 0.5 W/m2K as there are limits connected with the cavity thickness. After 1995 all cavities should have the U-values in accordance with the Building Regulations.

TYPES OF INSULATION

1. ***Fibreglass*** - is an excellent non-flammable insulation material, with R-values ranging from R-2.9 to R-3.8 per inch. It is a cheap insulation option, but it has to be installed with safety precautions. It is made of woven silicon, glass powder or glass particles. It is cheap but requires careful handling.
2. ***Mineral wool*** - it has R-values ranging from R-2.8 to R-3.5 per inch. Mineral wool is not fire resistant, but it is effective for thermal insulation purposes. It is eco-friendly and most cost effective. It is available in rolls or slabs.
3. ***Cellulose*** - it is an eco-friendly insulating material either loose fill or spray applied. It is highly fire resistant, not expensive and easy to handle. However, it requires skills for installation. It has R-values ranging from R-3.1 to R-3.7 per inch.
4. ***Polyurethane Foam*** - it is rigid foam insulation and has high strength so can be used under the floor or in lofts. It has the R-values of approximately R-6.3 per inch of thickness. It is fire resistant and provides acoustic insulation but less eco-friendly.
5. ***Polystyrene*** - it is a waterproof synthetic polymer, solid or foam, used as an acoustic and thermal insulator. It has a smooth surface and is ideal for wall insulation. It is highly flammable.

Which part of the home should be insulated to achieve the optimal energy efficiency?

Attic insulation

Attic insulation is necessary to achieve the heat resistant home. It can be done with the loose or panels insulation materials. Duct system requires insulation to prevent the heat losses. Ceiling insulation allows for a room temperature to be distributed more evenly and reduce exceptional heat losses. For instance, rigid foam insulation under rafters eliminates thermal bridging.

Roof and Loft Insulation

The heat loss through roof accounts for a 25%. The effective insulation of loft can cut the energy bill by up to 20%. Loft insulation is placed between the joists on the loft floor. The most common materials used for loft insulation include glass wool or rock wool, blown in cellulose or mineral wool. The current regulations imposed by the European Energy Centre imposes the requirement of a minimum 270mm of loft insulation. The recommended depth for loft insulation is:

- 270mm for glass wool,
- 250mm for rock wool,
- 220mm for cellulose

Loft insulation will add to the energy efficiency of the building.

Cavity Wall Insulation

The Cavity is the gap of at least 50mm between the inner and outer leaf of brickwork or blockwork which are tied together with metal ties. The main materials used for insulation of cavity wall are mineral wool or polystyrene panels. Insulation of cavity is through the injection of the insulating material through the holes of 22-25mm, which are drilled before. There are various types of materials available like bonded bead, glass wool, rock wool or urea formaldehyde foam. The proper ventilation has to be secured.

Solid Wall Insulation

Solid Wall Insulation is the most expensive to install and can take the form of external wall insulation, internal wall insulation or hybrid solution. External wall insulation requires boarding and beading, application of base coat and mesh plus top coat. Can be applied when temperatures are above 5 degrees. Internal wall insulation requires laminated insulating plasterboard, insulated studs to minimise cold bridging. The hybrid solution is the combination of both external and internal wall insulation.

Duct Insulation

The duct insulation system should be adequately insulated to avoid the energy losses associated with its operation. All paperwork, extractor ducts or air diffusers should be the insulated.

Floor Insulation

Timber floors can be covered with the insulation panels. Proper ventilation has to provided. Gaps and draughts around skirting boards can be insulated with sealants. Rigid insulation can be installed on top of the solid concrete ground floor. There is no need to insulate the floors above the ground level apart of in garages or other unheated areas. In England and Wales, the U-values for floor should be of 0.25 W/m2K or less. To achieve this at least 70mm of high-performance foam insulation, or 150mm of mineral wool, should be installed, but this will vary depending on floor type, shape and size.

Foundation Insulation

Foundation can loose a lot of heat and uninsulated foundations cause condensation.

Slab and Basement Insulation

Concrete slabs can be a source of heat loss in a home. Installing slab insulation during the construction process is straightforward. The foam board is used either directly on the exterior of the slab and footing before backfilling or under the slab and alongside the stem wall of the foundation.

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	Heat loss	Targeted U-value (EPC Band B)	Possible solutions
Walls	35%	0.15	Cavity, Internal & External wall insulation
Windows and doors openings	15%	1.6	Double, triple, secondary glazing, sealants, shutters and curtains
Roof	25%	0.10	Pitched, warm deck or cold deck roof insulation
Floor	15%	0.15	Floor insulation
Gaps, cracks, joints	10%	n/a	Draughtproofing- ventilation with heat recovery

(source: www.superhomes.org.uk)

The UK's housing market is one of the least energy efficient in Europe. The Government put impact on the reduction of carbon emissions. The retrofits to existing homes are required to meet targets and create the more sustainable build environment. There are various retrofit incentives:

- Energy Company Obligation (ECO) - policy sets standards for energy suppliers to deliver energy saving measures to households, current scheme will expire in March 2017
- Minimum Energy Performance Standards (private rented sector) - landlords will have to improve EPS to E by undertaking improvements to legally rent the property
- Renewable energy Feed-in-Tariff (Fit)- financial incentive to invest in solar electricity, wind turbines, hydroelectricity, anaerobic digesters, and micro combined heat and power (CHP)
- Renewable Heat Incentive (RHI) - advices to invest in new technologies, supports use of biomass boilers, heat pumps, solar thermal collectors, biomethane, biogas
- The Green Deal - scheme which offered upfront loans to fund retrofits, no longer available.

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MOST COMMON MISTAKES in installation of polystyrene sheets

The effective insulation of the building provides the homeowner with lower costs of energy. The quality of the thermal insulation is important for the home energy efficiency. What are the most common mistakes done during installation of thermal insulation with polystyrene?

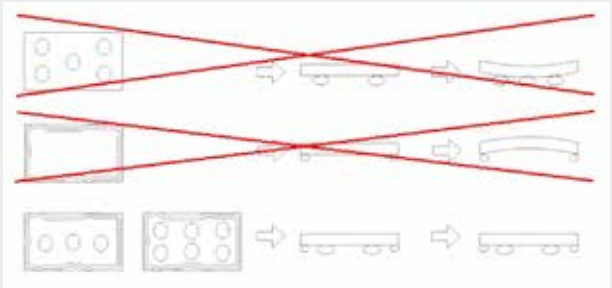
1. Poorly prepared surface

- inaccurate assessment of walls geometry (smoothness of the substrate)
- inaccurate assessment of the ground
- lack of primer

The substrate surface should be stable, even and dry. Dust, oil, efflorescence, biological or chemical contamination reduce adhesion of polystyrene plates. Minor irregularities (up to 2cm) and defects should be made smooth with the mortar levelling. Significant gaps can be eliminated by varying the thickness of the polystyrene.

2. Incorrect application of the adhesive

Application of adhesive should be only in patches and boundaries not on the whole surface. The consequence of wrong adhesive application will be bending of the polystyrene panel, loosening of the panels or visible joints between panels. The adhesive is applied on the panel:



- In strips on the edges of the boards of the width of 46cm. On the remaining surface in 3 to 8 patches. The total area of the adhesive should cover 40% of the whiteboard or 60% of the grey board.
- In the case of very levelled rendered surfaces the adhesive can be applied with the comb trowel on the whole surface of the board.
- Patches of adhesive should be placed symmetrically and have the same volume.
- The adhesive mortar is applied only on the surface of the polystyrene board, never on the substrate surface.

3. Inadequate choice of the adhesive mortar

The adhesive mortar has to be properly selected to avoid the peeling of the entire insulation system due to the weight of successive layers of the system.

4. Installation of the polystyrene sheets should be in "staggered" pattern - on one row install sheets horizontally, on the next one lay them vertically

Sheets should be aligned properly with the edges of the boards aligned to each other. Consequently, the installation should start horizontally from the bottom corner of the wall, using a full sheet, so that in next row should be installed vertically what will give the better strength to the whole system. In the next row, each sheet should be offset by a half length of the previous one. All sheets should be levelled and aligned properly. There should be no gaps between the sheets. To cut smaller piece than a full sheet the saw can be used.

5. Fill the gaps between foamed polystyrene adhesive plaster

Leaving gaps unfilled will result with thermal bridges. To fill gaps with width up to 4mm use System PU foam.

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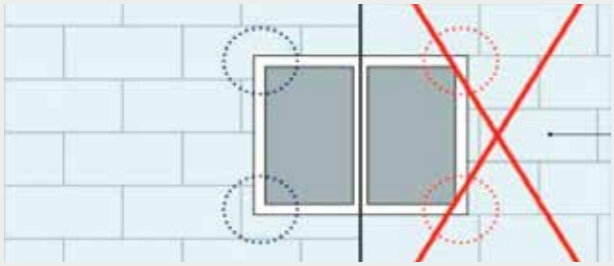
6. Improper drill and installation of dowels

Too deep drilling in the insulation sheets can result in the thermal bridges and destruction of the whole system. Too shallow drill will cause the bulge which will be visible on the facade.

7. Lack of starter strip and overlapping of the mesh onto the polystyrene sheets makes the system more prone to the adverse weather conditions and rodents.

8. No grinding of the substrate layer will result in the inequality on the facade and might lead to sheets peeling or dropping.

9. Improper cutting of sheets for the door and window openings and lack of mesh in this areas. The opening of the window should be in the middle of the sheet.



10. Carrying out works at the conditions below 5 ° C, above 25 ° C should be avoided. The result of installation in such weather conditions will result in too fast drying of the adhesive between the substrate and the sheet, what will lead to weak joints.

11. Failure to use a sunshade for graphite polystyrene panels will result in the loosening of the sheets and sheets falling.

Professional Infrared Thermal Imaging Cameras For The Smartphone

Up until recently, thermal imaging cameras were expensive and mainly used in industrial or utility buildings.They measure the radiated thermal energy and show the heat differences of objects. They have various applications in the construction industry. Professional infrared cameras allow to detect air leaks, find missing insulation or thermally audit home. In addition, thermal imagers allow to spot electrical issues or locate hidden drywall patchworks or uncover clogs and leaks. They enhance accuracy and efficiency and are very useful during site inspections.

- allows non invasive testing
- assess for fire or water damage
- detects areas which need to be repaired
- find the energy loss
- verify the insulation system
- verify the electric system - overload energy circuit, loose wires, safety hazards
- assist with roof inspections- air leaks
- assist with moisture inspections - leakages, clogs
- reveal pest infestation, locate lost pets at night

As technology is getting better infrared thermal imaging devices are available nowadays for smartphones. In 2015 at the IFA Berlin 2015 consumer electronics trade show, Seek Thermal™ introduced on European market first ever compact professional thermal imaging cameras- The Seek Thermal Compact and Compact XR for both iPhone and Android smartphones.

"Seek Thermal wants to make thermal imaging technology simple to use and accessible to all for the benefit of everyone, not just a few," said Mike Muench, CEO of Seek Thermal. "By introducing to

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Mike Muench
CEO of Seek Thermal

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the European market the first consumer-ready thermal imaging technology which is portable, compact and affordable, we are giving millions of people a powerful smart tool and personal safety device at their fingertips."

The Seek Thermal Compact imaging cameras contain an advanced thermal sensor and custom chalcogenide lens to capture, detect, and translate heat into a thermal image that's visible to the human eye. The pocket-size thermal camera operates with a free app that makes it easy for people to get started with thermal imaging, capture or share thermal photos and videos, and select from different temperature measurement modes, and see the unseen. Now, this military-grade technology makes it easier than its ever been to master home energy problems, conquer the outdoors and stay aware of the situations in the day time or complete dark. The camera weighs only 0.5 ounces and creates true thermal images with a resolution of 206 x 156, or over 32,000 thermal pixels and turns your smartphone into a smart tool.

The Seek Thermal Compact costs approximately £224.00 including VAT. The Seek Compact XR with a variable focus lens and extends the distances up to 1,800 feet with a narrower field of view to 20-degrees sells for £259.00 including VAT. Both products are available at Amazon. The free Seek Thermal mobile app can be found on the App Store and Google Play.

This year in June, Seek Thermal™ announced the company's first line of high performance, affordable, infrared thermal imaging cameras for experts and contractors in industrial and commercial building trades. Available soon, the Seek CompactPRO weighs less than 0.5 ounces and plugs directly into an iOS or Android smartphone device for instant connect-and-detect convenience. The CompactPRO is the first thermal imaging camera built for a smartphone to ever feature 76,800 measurement pixels, a thermal sensor array of 320x240. The CompactPRO is also an innovative game-changer in helping to make thermal imaging technology more easily affordable and available to professionals working in the building, electrical, mechanical fields and more.

For more information visit www.thermal.com
(source: Seek Thermal™)