insulation

what is it?

It's any material that slows down the rate at which heat is lost through the fabric of your building. Air is actually the insulator - the material is a way of trapping air. For example, you may sleep under a duvet containing eider (duck) feathers. The feathers trap air, which retains your body heat and keeps you warm (the feathers do exactly the same job on the duck too). Insulation can be in your loft; on interior/exterior walls or in the cavity between walls; under floors; or around pipes and hot water cylinders. It can be made from a range of materials, some natural and some synthetic, that will come in different thicknesses, and with different methods of installation.

Houses had solid walls until the 1920s, when they started to be built with two walls with a cavity in between. This cavity started to be insulated in the 1970s, and it became compulsory for new buildings in the 90s. Throughout most of the 20th century, a thin layer of mineral wool insulation was added in the loft as an afterthought, or was absent altogether. It's only recently, with rising fuel prices, that people have started to calculate the amount of insulation they need, as it's now cheaper to insulate than to waste heat.

k-values, R-values and U-values: the insulation properties of a material can be expressed by its k-value - its thermal conductivity (see resources), so obviously, for insulation, the lower the value the better. The U-value is the important one for building regs - it's a measure of heat flow per m², and so for an area of wall or roof, the U-value is a combination of the k-values of all the materials in it, and again, the lower the U-value the better for insulation. (NB: in the US they use R-value, which is based on the inverse of the k-value, and so a higher R-value is better). The k-value is a constant for any material, but the U-value depends on the thickness of the wall / roof etc, as well as the materials involved.

what are the benefits?

It will reduce the amount of heat you need to generate, and therefore save energy, along with the associated pollutants and emissions.

You can save even more energy in a well-insulated house by turning down thermostats. Temperatures will be more even, and so you'll be more comfortable at lower temperatures than in an uninsulated house.

It will also save money - and more so in future, as energy prices rise. However, if you spend a lot on wall insulation, say, then it might turn out to be quite a long payback time. But the benefits in terms of comfort will be immediate.

Natural, local or recycled products have a lower embodied energy (the energy used to make them) than mineral wool, and avoid the toxins and greenhouse gas emissions involved in the production of expanded foams. Mineral wool (the most common insulation) has a huge embodied energy, which reduces the amount of energy saved. However, it's not usually advisable to use unprocessed materials for insulation, e.g. sheep's wool insulation has modern fire retardants and insect repellent to meet building regs, otherwise it would be eaten by the larvae of clothes moths, and the lanolin would be a fire risk.

Some building materials have good insulation properties in themselves, and therefore don't require extra insulation - straw-bales and hempcrete, for example.

how to calculate the U-value of a modern external wall

L = thickness in metres

k-value - see product spec or resources (overleaf) for the k-values (thermal conductivity) of lots of common materials

R-value = L/k

r = surface resistance (0.18, added to R value)

U-value = 1/R-value

material	L	k	R
brick	0.1	0.8	0.125
insulation	0.1	0.03	3.333
breeze block	0.1	0.2	0.5
plasterboard	0.012	0.17	0.07
r (surfaces)			0.18
total R			4.21

U-value = 1/R = 1/4.21 = **0.238** (meets building regs; 2010 building regs require a U-value of 0.25 for a new-build wall)

what can I do?

Start by making sure you have adequate loft insulation, for the simple reason that heat rises. If wall insulation is too expensive, you can achieve a lot with loft insulation, underfloor insulation if possible, and draughtproofing. In your loft, insulate between the joists of the floor if the loft isn't used, and between the roof rafters if it is. You can add batts (slabs) or rolls of synthetic or natural insulation, or you can pour in loose-fill material between the joists. Don't remove any mineral wool insulation already there - put extra insulation over the top of it. And don't forget to attach some insulation to the loft hatch too.

With walls, if you have an uninsulated cavity, that's the first thing to do. You can insulate solid walls internally or externally, but remember that you only need to insulate perimeter walls.

Internal and external wall insulation have their pros and cons. With internal, there's no external disruption, and it can be easier to do a DIY job - but the extra thickness will be inside your room, reducing personal space, and the insulation will be between sources of heat and the thermal mass of the walls (which can absorb heat and help maintain stable temperatures). External insulation means you keep the benefits of thermal mass, but you may have to extend eaves and move gutters, downpipes etc, which can be expensive. In conservation areas, you may not be able to change your frontage, and so you could insulate the front of your house internally and the back externally. External insulation can be breathable - there are various types of wood-fibre boards available, and renders can be lime or hempcrete.

Warmcel - recycled newspaper, loose-fill insulation - poured into a loft.

Don't use synthetic, non-breathable materials on a house made of natural, breathable materials. Breathable materials keep moisture moving, but synthetic materials trap water, which will then damage natural materials. It's important to work out where the dew point is in your walls. The dew point is where water vapour condenses when there is a large temperature difference inside and outside, and is often inside your walls. Adding insulation to an inside wall can move the dew point to the surface of the internal wall, which will cause natural insulation to get wet, removing its insulating properties and potentially causing it to rot. You may need an air gap between the wall and the insulation. Do some research or ask a professional about dew points. Hempcrete is a good internal insulation material that can deal with moisture, as it doesn't lose its insulating properties when wet.

If you're doing work yourself, check books or DIY guides online for instructions, and if you're having your home retrofitted by a builder, especially with solid wall insulation, don't assume that s/he will understand the issues outlined here. Do your own research, and contact product manufacturers for advice. It's best to exceed building regs if you can (they're not great by European standards).

Don't forget to lag hot water cylinders and pipes properly too - get pipe and cylinder lagging from DIY shops. Thick curtains provide good insulation for windows, and don't forget to tuck them behind radiators. Contact your local authority - they should be able to tell you about local or national grants. Also check the energysavingtrust.org.uk and government-grants.co.uk websites.

resources

- lowimpact.org/insulation for info, products, courses, links & books, including:
- Andy McCrea, *Insulating Your House*
- *Bruce Harley, Insulate & Weatherise*
- engineeringtoolbox.com/thermal-conductivity-d_429.html - for the k-values of materials
- nationalinsulationassociation.org.uk - find a local installer
- theyellowhouse.org.uk - useful information
- oldhouse.info/ohenergy.htm – old houses