Insulating paints: literally greenwash

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From time to time one sees advertisements for insulating paint or paint additives. One can see the potential attraction of them for hard-to-treat walls, but isn't it a case of too good to be true? Is there any scientific basis to the claims made for them?

The effectiveness of thermal insulation depends on its thickness and its thermal conductivity, λ, which in SI units is stated as W/mK*. Typical conductivities are

- Dry brick 0.8—1.2 W/mK
- Expanded polystyrene 0.035–0.055 W/mK
- Polyurethane foam 0.017–0.020 W/mK

So for instance because expanded polystyrene is roughly twice as conductive as polyurethane foam, one would need double the thickness of it to achieve the same insulating effect.

Each layer of a building structure has a thermal resistance R proportional to its thickness d and inversely proportional to its thermal conductivity, *i.e.* R = d/λ. The thermal resistance of a complete structural element is the sum of the thermal resistances of each of its constituent layers. For example a cavity wall:

Layer	Thickness d (m)	Thermal conductivity λ (W/mK)	Thermal resistance R (m^2K/W)
Internal surface			0.120
Plaster, Dense	0.012	0.50	0.024
Brick, Inner	0.100	0.62	0.161
Cavity	0.050	-	0.180
Brick, Outer	0.100	0.84	0.119
External surface			0.060
		Total resistance	0.664

Note that the surfaces and cavity have some thermal resistance of their own. The 'U-value' of the wall—the way thermal performance is usually expressed—is the reciprocal of total thermal resistance. In this case U = 1/0.664 ≈ 1.51 W/m^2K

* *this is the rate of heat transmission in watts through one square metre of the material when the temperature gradient through the depth of the material is one kelvin per metre (one kelvin, K, being equivalent to 1ºC)*

If, in the example above, we were to fill the 50mm cavity with fibrous insulation (λ =0.04), we increase the thermal resistance of that layer (shown in bold):

Layer	Thickness d (m)	Thermal conductivity λ (W/mK)	Thermal resistance R (m^2K/W)
Internal surface			0.120
Plaster, Dense	0.012	0.50	0.024
Brick, Inner	0.100	0.62	0.161
Rock fibre	***0.050***	***0.04***	***1.250***
Brick, Outer	0.100	0.84	0.119
External surface			0.060
		Total resistance	1.734

This brings the overall resistance up to 1.734 m^2K/W giving a U-value of 0.58 W/m^2K.

To evaluate the effect of an insulating paint, we will have to make some assumptions, firstly about its thermal conductivity. I will base my estimates on a supposedly insulating paint additive called 'ceramic microspheres' which apparently contain a vacuum. Although, as the advertisers are quick to remind us, heat cannot travel through a vacuum, it can of course travel through the walls of the spheres (which will have high conductivity and represent a substantial fraction of their cross-section) and through the pigment and binder around them. So let us say the paint has λ=0.04 W/mK, which is similar to cork or cellular rubber.

What about the thickness? An advert for one such paint additive states that the product, whose packaging has a volume of 1.3 litres, is added to 2.5 litres of paint to give a coverage of 18 square metres. This works out as an applied thickness *before* drying of 0.21 mm. Let's be generous and say that the finished thickness is 0.20 mm.

Now see what happens when, instead of cavity filling, we *paint* our unfilled cavity wall from the previous example. With a thickness d = 0.0002 m and conductivity λ = 0.04 W/mK, the additional thermal resistance due to the paint layer is 0.0002 / 0.04 = 0.005 m^2K/W. Based on an initial resistance of 0.664 m^2K/W, the improvement is somewhat less than 1%. Hence claims that such treatments can save 'up to 25%' are clearly misleading

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The author publishes free energy advice and information at his web site, VESMA.COM