Issues to Consider

Embodied Energy

It is often claimed by mineral fibre manufacturers that the embodied energy of their products is lower than that of alternative materials such as the rigid phenolic insulation panels that make up the *Kingspan* **Kool**Duct® System.

Embodied energy is a measure of the total amount of energy consumed by a product during production and installation. It includes the energy used during the extraction of raw materials, transportation, manufacture through to the installation of the product.

The lower the embodied energy of an insulating product, the lower its overall environmental impact and the faster its environmental payback will be. The environmental payback for an insulating product occurs when it has effectively conserved more energy by restricting heat loss or gain, than its initial embodied energy figure.

In the case of insulating products in energy saving applications the environmental payback period is generally extremely short, compared with the lifetime of the application. After the environmental payback is complete, the insulating products can go on saving energy for many years more. Because of this, the energy saved over the lifetime of an application is mostly far greater than the embodied energy of the insulating products saving that energy. Embodied energy is therefore usually irrelevant in the specification of insulating products.

However, even though mineral fibre manufacturers are aware of this, they persist in using embodied energy as a platform to promote their products.

The embodied energy content of mineral fibre and rigid phenolic insulants vary significantly. Some mineral fibre insulants have been quoted as having an embodied energy content of 13–26 MJ/kg whilst rigid phenolic insulation is quoted as having an embodied content of 100 MJ/kg. Whilst these figures would seem to suggest that the mineral fibre insulant is the more environmentally friendly product, as it has the lower energy content per kilogram, this is not the case.

In comparing the embodied energies of materials, the concept of a functional unit must be taken into account. In the case of ductwork insulation, the functional unit depends upon firstly, the density of the insulation and secondly, the thickness of insulation required to achieve a defined heat loss / gain. This thickness will vary depending upon the thermal conductivity of the insulation material.

If a comparison is to be made between the *Kingspan* **Kool**Duct® System and conventional galvanised sheet steel ductwork insulated with different materials, then the functional unit must not only include the insulation as specified above, but also, in the case of conventional ductwork, the sheet metal as it is absent from the *Kingspan* **Kool**Duct® System.

The results of such a comparison between a 1.25 m x 0.8 m / 49" x 32" ductwork section fabricated from the *Kingspan* **Kool**Duct® System and conventional galvanised sheet steel ductwork section insulated with mineral fibre are shown below. The insulation thicknesses in this comparison are taken from:

- the TIMSA Guide (see the Project Specification – Appendix A2 section of this document for details);
- the BCA 2008 Specification J5.2–3 Table 3b (see the Project Specification – Appendix B2 section of this document for details);
- BS 5422: 2001 (see the Project Specification – Appendix C2 section of this document for details); and
- ANSI / ASHRAE / IESNA 90.1: 2007 (see the Project Specification – Appendix D2 section of this document for details).

If both the mineral fibre (embodied energy estimated at 21 MJ/kg) and phenolic (density 60 kg/m³ – embodied energy 100 MJ/kg) products were finished with an aluminium foil facing (embodied energy estimated at 52.5 MJ/m²) the embodied energy content of the insulated ducts would be as shown in the table below. In the cases of mineral fibre, these figures take account of 1.0 mm / 20 Gauge galvanised sheet steel ducting (density 7842 kg/m³ / 490 pcf – embodied energy 32.5 MJ/kg) and assume the above-stated aluminium foil finish for the inside surfaces of the *Kingspan* **Kool**Duct® System. All flanges, gaskets, mastic, rivets, bolts etc. have been assumed insignificant.

Specification	Installed R–value	Thickness: *Kingspan* **Kool**Duct®	Thickness: Mineral Fibre	Assumed Mineral Fibre density	Embodied Energy (MJ/ linear metre): *Kingspan* **Kool**Duct®	Embodied Energy (MJ/ linear metre): Galvanised Sheet Steel with Mineral Fibre
TIMSA Warm Air	–	22 mm	29 mm	45 kg/m³	993	1389
TIMSA Chilled Air & Dual Purpose	–	30 mm	50 mm	45 kg/m³	1203	1485
BS 5422: 2001 Warm Air with 10°C ΔT	–	22 mm	34 mm	45 kg/m³	993	1411
BS 5422: 2001 Warm Air with 15°C ΔT	–	22 mm	37 mm	45 kg/m³	993	1425
BS 5422: 2001 Warm Air with 25°C ΔT	–	30 mm	44 mm	45 kg/m³	1203	1457
BS 5422: 2001 Chilled Air at 15°C	–	22 mm	25 mm	45 kg/m³	993	1371
BS 5422: 2001 Chilled Air at 12°C	–	22 mm	37 mm	45 kg/m³	993	1425
BS 5422: 2001 Chilled Air at 10°C	–	30 mm	45 mm	45 kg/m³	1203	1462
BCA 2008 Spec. J5.2–3 Table 3b	0.9	22 mm	38 mm	22 kg/m³	993	1351
	1.5	30 mm	50 mm	22 kg/m³	1203	1381
	1.8	33 mm	75 mm	22 kg/m³	1282	1445
ANSI / ASHRAE / IESNA 90.1: 2007	3.5	7/8"	1 1/2"	0.75 pcf	993	1317
	6.0	7/8"	2 3/16"	0.75 pcf	993	1345
	8.0	1 3/16"	3"	0.75 pcf	1203	1377

It can be seen from the above that in all circumstances shown, the embodied energy of the *Kingspan* **Kool**Duct® System can be less than that for galvanised sheet steel insulated with mineral fibre (up to 30% less).