Issues to Consider

Moisture & Exacerbated Heat Loss / Gain

The measure of the rate at which heat flows through an insulant is known as its thermal conductivity or k–value. The lower the k–value, the better the insulant is at restricting heat flow. *Kingspan* **Kool**Duct® rigid phenolic insulation panels have a k–value of 0.021 W/m·K at 10ºC mean / 0.146 Btu·in/ft²·hr·ºF at 50ºF mean, which offers the best performance of all commonly utilised insulating materials.

The k–value for an insulant is measured with the material under laboratory conditions. In–service applications rarely if ever replicate these conditions and it is therefore important to consider physical factors which may alter this state and lead to an increase in the k–value of the material and thus increased primary energy usage.

The k–values of commonly used insulants typically lie in the range of 0.021 to 0.046 W/m·K at 10ºC / 0.146 Btu·in/ft²·hr·ºF to 0.319 Btu·in/ft²·hr·ºF at 50ºF mean. These measurements relate to the material at a specific temperature and in a dry state. If moisture is introduced into the insulant, the measured conductivity will increase very significantly. If moisture is able to penetrate to the point of saturation or near saturation, the thermal efficiency of the insulant can be destroyed. This is due to three main mechanisms:

- the k–value of water is 0.58 W/m·K at 10ºC / 4.03 Btu·in/ft²·hr·ºF at 50ºF, which is significantly higher than that of all commonly used insulants – thus if moisture is present the overall thermal conductivity of the material will increase significantly depending on the quantity of water absorbed;
- moisture moving through or within an insulant can effectively absorb heat from the warm side and then dissipate it on the cold side of the assembly; and
- a closed assembly in which moisture is trapped within the insulant between impermeable layers (such as with aluminium foil faced duct insulation) can be subject to additional ‘phase change’ heat losses.

These heat losses occur when heat from the warm side of the insulant vapourises the trapped moisture which then diffuses through the insulant to the cold side. When it reaches the cold side the heat is dissipated, the vapour condenses back into liquid form and flows back to the warm side of the insulation. This is a closed cycle which could theoretically continue indefinitely if acceptable environmental conditions prevail and leads to significant additional heat losses through the insulant.

Moisture can be present in insulation due to:

- penetration through the weather protection; and
- vapour penetration through the vapour barrier jacket leading to interstitial condensation on below ambient ductwork, particularly in tropical climates where conditions are warm and wet on the outside and cold and dry on the inside of the ductwork.

Mineral fibre has little resistance to water vapour penetration which may occur if it is installed with an imperfectly sealed vapour barrier jacket or if the vapour barrier jacket is damaged in use. This can result in:

- condensation formation on below ambient temperature ductwork;
- corroded ductwork;
- dripping services and spoiled ceilings;
- mould growth and bad odour;
- building fabric damage;
- increased energy consumption; and
- expensive repair works causing disruption to business.

Different types of insulant absorb differing levels of moisture. The level of moisture absorbed also affects varying types of insulants in different ways. Whilst closed cell materials, e.g. *Kingspan* **Kool**Duct® rigid phenolic insulation panels, may have low water vapour permeability characteristics, fibrous insulating materials can absorb considerable quantities of water which, whilst present can adversely affect the thermal conductivity and the effectiveness of the insulation.

Since rigid phenolic insulation has a 90% (or greater) closed cell content, moisture is not readily absorbed as it must penetrate through the cell walls to enter the material. This does not readily occur unless the cell walls have been damaged. If it does occur, the amount of moisture absorption is generally very low and is effectively eliminated if the insulant is faced with an impervious material such as aluminium foil.

If moisture is able to penetrate the outer damaged cells of rigid phenolic insulation where there is no impervious facing material, it will increase the overall thermal conductivity of the product slightly. However, it will not lead to any long term degradation of the product and will fully dry out once favourable environmental conditions exist.

Kingspan **Kool**Duct® rigid phenolic insulation panels have an aluminium foil facing on both sides which makes them highly resistant to moisture penetration.

The risk of moisture penetration from damage to the aluminium foil vapour barrier jacket is considerably reduced as the rigid phenolic insulation core of the *Kingspan* **Kool**Duct® panels is of 'closed cell' construction.

Vapour seal tape can be easier to apply to *Kingspan* **Kool**Duct® rigid phenolic insulation panels with a more secure and efficient seal.

Mineral fibre insulants are open structured materials which rely largely on entrapped still air for much of their insulating power. They can have little long term resistance to water and may have no resistance to vapour flow. Thus, the potential for moisture absorption can be very high if the factory applied vapour barrier jacket is either damaged or inadequately sealed.

Research has been undertaken into the effect of moisture of mineral fibre insulants by Achtziger and Cammerer of FIW in Germany. Their research concluded that 1% moisture content by volume within mineral fibre can increase the thermal conductivity of the material by 36–107% with 4 of the 5 samples tested falling within the 95–107% increase range (Forschungsvorhaben Nr.815–80.01.83–4 contained within CEN TC 88 WG 4–N484). Such increases in the thermal conductivity of the material could have a very significant impact on the level of heat loss or gain on a building services installation.