

# Issues to Consider

## 6 Moisture and Exacerbated Heat Loss / Gain

- 6.1 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 Kooltherm*<sup>®</sup> rigid phenolic insulation has a k-value of 0.021 W/m·K at 10°C, which offers the best performance of all commonly utilised insulating materials. This allows specified insulation standards to be achieved with the minimum thickness of insulant.
- 6.2 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.
- 6.3 The k-values of commonly used insulants typically lie in the range of 0.021 to 0.046 W/m·K at 10°C. 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 10°C, 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 pipe 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.

- 6.4 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.
- 6.5 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;
  - 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.

### Mineral fibre has little resistance to water vapour penetration

- 6.6 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 Kooltherm*<sup>®</sup> Duct Insulation, 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.

- 6.7 High performance closed cell insulants such as *Kingspan Kooltherm*<sup>®</sup> Duct Insulation obtain much of their insulating power from the blowing gases which are trapped within their cellular structure. As such insulants have in excess of a 90% 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.
- 6.8 *Kingspan Kooltherm*<sup>®</sup> Duct Insulation has a lightweight closed cell structure which makes it more resistant to moisture penetration.

*Kingspan Kooltherm*<sup>®</sup> Duct Insulation is highly resistant to moisture penetration.

- 6.9 The risk of moisture penetration from damage to the vapour barrier jacket is considerably reduced as *Kingspan Kooltherm*<sup>®</sup> Duct Insulation is of 'closed cell' construction.

*Kingspan Kooltherm*<sup>®</sup> Duct Insulation reduces the risk from damage to vapour barrier jackets.

- 6.10 Vapour seal tape can be easier to apply to *Kingspan Kooltherm*<sup>®</sup> Duct Insulation with a more secure and efficient seal.
- 6.11 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.

- 6.12 Research has been undertaken into the effect of moisture on 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.

Only **1%** moisture content by volume within mineral fibre can increase its thermal conductivity by up to **107%**.

