CTB - 11
Technical Bulletin

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Roof Condensation and Insulation

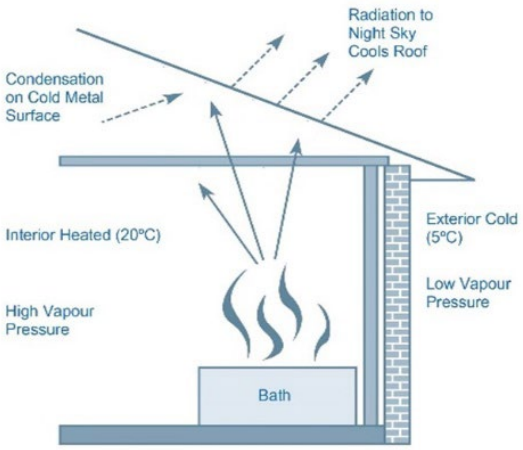
Introduction

Air contains water vapour in varying quantities. Condensation can occur when moist air contacts a surface that is at a lower temperature. As cool air is unable to retain the same amount of moisture as warm air, excess moisture is released to form condensation. Once relative humidity reaches 100% (also known as the 'dew point') the air is said to be saturated, and water will begin to condense as fog.

As the internal climate of many buildings is artificially heated or cooled, cladding materials (roofing and walling) may be exposed to temperatures on the exterior side that are considerably different to temperatures on the interior side. In such circumstances, condensation becomes quite an important consideration in building design.

Certain activities within a building can increase air temperature and add substantially to the amount of water vapour in the air. In a house, these activities include bathing (particularly showering), cooking, the use of washing machines, clothes dryers, dishwashers and even the presence of people. Non-flued combustion heaters can also increase atmospheric humidity to unusually high levels within the home.

Figure 1: Diagram of Condensation Cycle – Uninsulated Metal Roof



Whilst condensation within the interior of a building under these circumstances is not altogether unexpected, little consideration is given to condensation in less visible areas. Such an area is inside the roof cavity, which can be susceptible to condensation.

In a condensation scenario (refer Figure 1), the roof cools at night via thermal radiation and the warm, moist air from within the building interior enters the roof cavity, where water vapour carried in the air may condense on the underside of the roof sheet.

In rare situations, significant levels of condensation and moisture accumulation can lead to consequential damage to building materials and occupant health.

The severity and effect of condensation will vary with environmental / climatic and building conditions. It is recommended that precautionary measures be taken to mitigate condensation and moisture accumulation, including restricting moisture ingress, and allowing for its escape in the design and construction phase of a structure. Significant condensation within a building may be both difficult and costly to eradicate subsequent to its erection.

NOTE: Low pitch roof systems that require drainage as part of their design to remove condensation need special consideration of any restrictions that pond water or hinder the drainage function, such as battens, membrane sag, penetrations and fasteners.

Ventilation

Ventilation will assist in allowing moisture to escape from within a building. While a roof cavity should be sealed, as practicable, from the interior, builders should avoid practices that may seal the cavity against ventilation from outdoor air. For pitched metal roofs, sufficient ventilation may be achieved by passive 'trickle' ventilation through open profile gaps at roof sheet ends. Exhausts such as

range hoods or bathroom fans that vent humidity from within the living areas of a building into the roof cavity can significantly increase humidity. Exhaust fans and range hoods should be flued to the building exterior, refer to National Construction Code (NCC 2022).

Membrane beneath roofing

Reflective membranes, commonly used to provide thermal control under roof sheeting, should be draped between battens to provide at least 20 mm air space above, and below, and can serve a dual function as a vapour control membrane if installed appropriately.

A membrane draped between battens with properties that restrict the passage of water vapour and air can help limit roof sheet condensation and the subsequent risk of corrosion under roof sheeting. In cooler climates the membrane should be installed as a vapour control membrane by sealing at overlap joins with appropriate tape, increasing the effectiveness of the system.

For reflective membranes used beneath metal roofing it is recommended that the membrane:

- Has a vapour barrier classification in accordance with Australian/New Zealand Standard AS/NZS 4200.1:2017,
- Is not susceptible to degradation or shrinkage from high temperatures associated with dark coloured roofing,
- Has double sided reflective properties (includes low emissivity on the anti-glare side).

Reflective membrane installation for a pitched metal roof with flat ceiling is shown in Figure 2a.

Most paper based reflective foil membranes meet these recommendations and have been used successfully over many years as insulation directly beneath metal roofing.

Alternative membrane and installation details are often required for architectural or non-structural roofing. The manufacturer's advice should be followed.

Alternative water control installation details are required for membranes classified as vapour permeable in accordance with AS/NZS 4200.1:2017 to ensure that any condensate or moisture can drain and dry, see Figure 2c. The manufacturer's advice should be followed.

Insulation blanket beneath roofing

The inclusion of a blanket insulation layer between the reflective membrane and the roof sheeting (blanket and foil) will insulate the membrane from the cold roof sheeting, further reducing the risk of condensation. The membrane keeps the blanket dry by providing a barrier to the passage of water vapour from the roof space. By sealing the overlaps of membrane with appropriate tape, the effectiveness of the system may be increased. This is important for high risk environments where there are large differences in temperature and humidity between internal and external surfaces.

Care should be taken when installing blanket and foil, to avoid significantly overhanging the last batten adjacent to any rainwater channeling components, such as gutters and valleys. If the insulation blanket protrudes into the gutter, it is likely to become wet and could function as a 'wick', drawing water throughout a significant area of the insulation blanket.

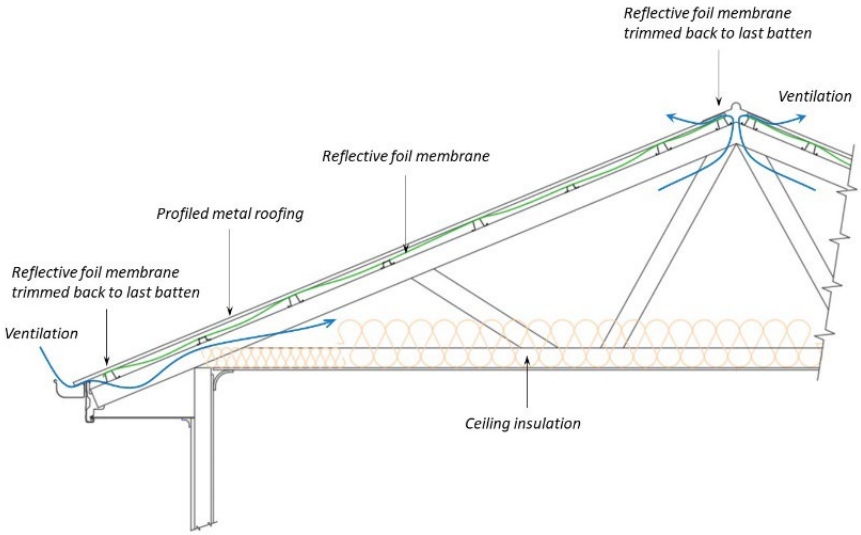
If the insulation blanket becomes wet, moisture may be held in direct contact with the underside of steel roof sheets for significant lengths of time. In such a situation, accelerated corrosion of the roof sheets may occur, initiating from the underside of the sheet. Under these circumstances, corrosion of the roof sheets is generally not detectable until perforation of the material has occurred. To avoid this, insulation material should be trimmed back well clear of the drip edge of the roof sheet to avoid overhang into the gutter.

Blanket and foil installation for a pitched metal roof with flat ceiling is shown in Figure 2b.

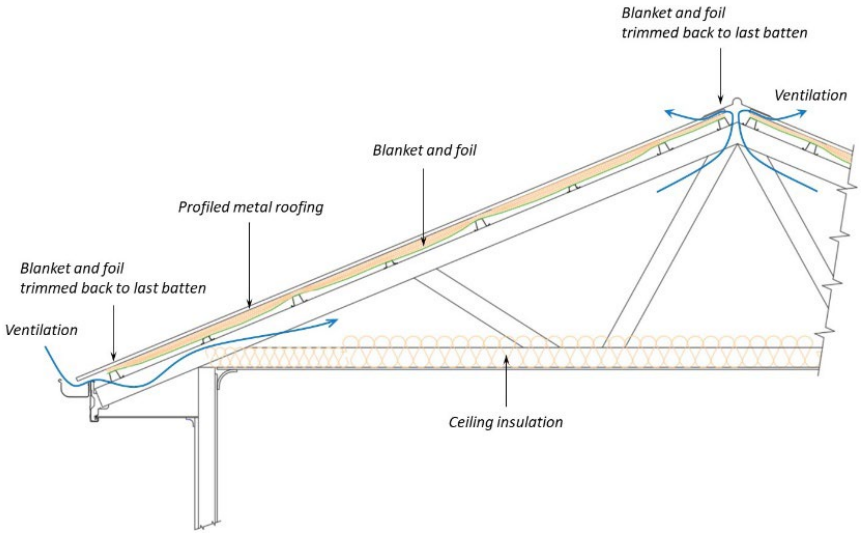
In tropical environments, including Darwin, Cairns, South-East Asian countries or similar, the air outside is typically warm and moist compared to cooler, air-conditioned interior spaces within the building. To avoid condensation problems under these 'tropical' conditions the membrane may be placed with the reflective surface facing towards the roof sheeting. This will typically require the use of a supplementary membrane resulting in a membrane both above and beneath the blanket insulation layer.

The method of installation of insulation may vary depending on the climate and building. The manufacturer's installation guidelines and advice should be followed.

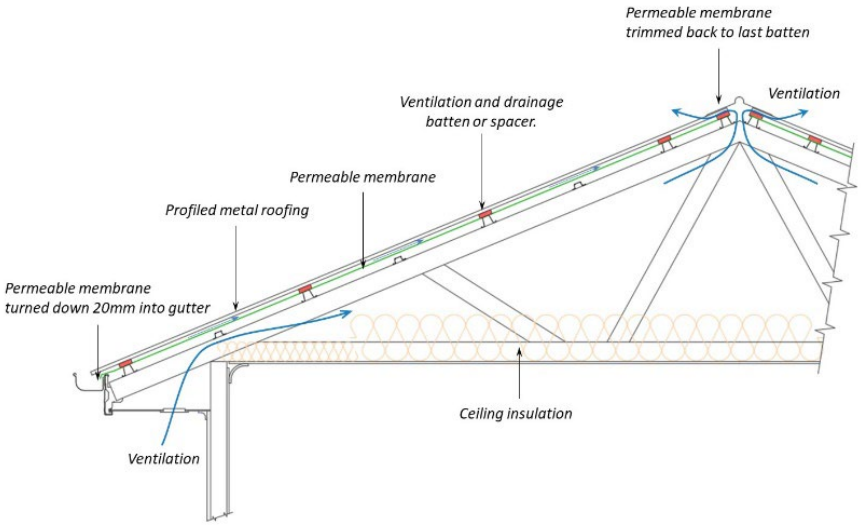
Further information regarding membrane and insulation requirements are available in Australian/New Zealand Standard AS/NZS 4200.1:2017, Australian Standard AS 4200.2:2017 and the NCC 2022.



(a) Thermal control – reflective membrane with vapour barrier classification to AS/NZS 4200.1:2017.



(b) Thermal control – blanket and foil.



(c) Water control – with vapour permeable membrane classification to AS/NZS 4200.1:2017.

Figure 2: Membrane or blanket and foil installation details for a pitched metal roof with flat ceiling

Noise

Installation of membranes or blanket and foil beneath roof sheeting offer further benefit in terms of reducing the noise that can be generated by metal roofs during daily heating and cooling cycles. As the sun warms metal roof sheets during the day the sheets expand, which creates movement of the metal over the roof battens. Where the roof sheets are installed on timber battens, the high friction present between the two surfaces can result in energy being built up. This energy can be released suddenly, resulting in an audible ‘popping’ noise. A similar process can occur as the roof cools at night as the sheets contract.

The presence of a membrane or blanket and foil. installed between the battens and the roof sheet can assist in eliminating this noise by reducing friction and preventing the build-up of energy. This results in a relatively smooth and quiet expansion and contraction cycle.

Summary

- Moisture control and mitigation of condensation should be considered in the design and construct phase of any building project.
- Ventilation and the presence of a membrane or blanket and foil can assist in moisture control and condensation reduction.
- Refer to your insulation supplier for specific recommendations for your membrane and insulation requirements.
- Local or State Government authorities may impose further requirements regarding the use of insulation materials.

Referenced Australian Standards and Codes

AS/NZS 4200.1:2017 *Pliable building membranes and underlays – Materials*

AS 4200.2:2017 *Pliable building membranes and underlays – Installation requirements*

NCC 2022 *National Construction Code 2022*