Moisture Control and Roofing

By: John L. Pierson, Jr., P.E.

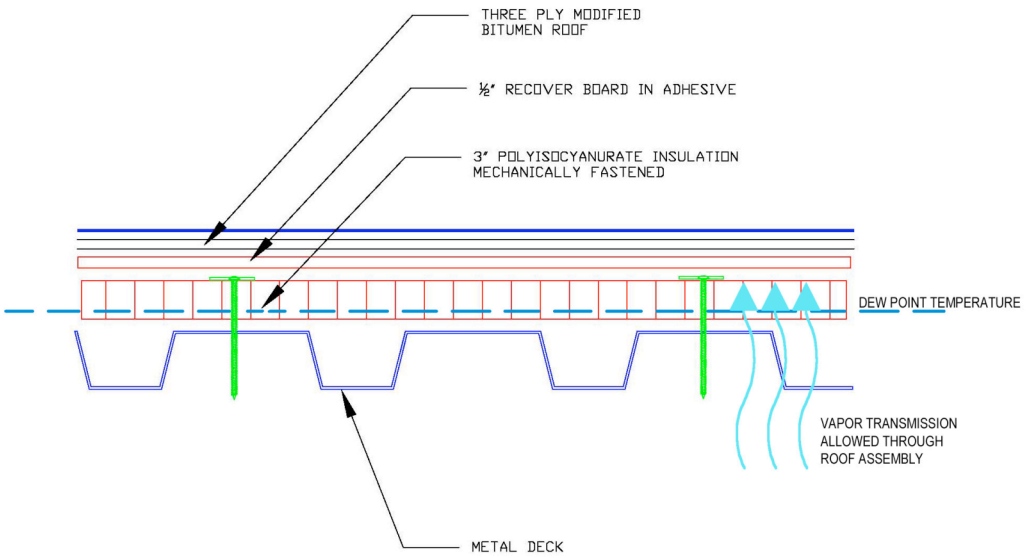
When do you need to use a vapor retarder? Can you cause more damage by using a vapor retarder when it is not necessary? What kind of vapor retarder should be used? Such questions are common when specifying roof systems. To answer these and similar questions, we should first explore the root of the issue: Why do we get condensation in roof construction in the first place? The purpose of this paper is to identify the causes of condensation and to offer some solutions.

Condensation and Vapor Transmission

Condensation may occur when there is a temperature difference between warm humid air and a cold dry surface. If warm humid air reaches a cooler surface at the right temperature, the air will condense into vapor. The right temperature for this condensation to occur is called the dew point temperature, or simply, the dew point. We call the movement of warm, humid air towards the dew point, vapor transmission.

Vapor transmission, also referred to as vapor drive, can move in both directions depending on climate. For example, consider the warm humid air inside a high school swimming pool complex in a northern climate. During the winter months, this warm, humid air wants to move towards the cold exterior air. Therefore the vapor drive is from the interior to the exterior.

Illustration 1, below, shows a typical modified bitumen (mod bit) or built up roof (BUR) construction.



COMMON BUR/MODIFIED BITUMEN
ROOF CONSTRUCTION

The downfall of any mechanically attached roof system is that the insulation screws allow for vapor transmission into the insulation. The screws provide a path for moisture to reach the dew point temperature and condense in the roof assembly.

Now consider an example of a small office building located in a southern climate. During the late summer, the outdoor temperature and humidity will be very high, while the air conditioning will keep the offices at a comfortable 70° F, and not so humid. In this case the warm, humid air will drive towards the cool, air conditioned surfaces inside the building. Therefore the vapor drive is from the exterior to the interior, exactly the opposite of our previous example.

Avoiding Condensation Problems

Condensation can occur for a variety of reasons; therefore, it is difficult to state exactly where condensation prevention should be addressed. However, it is generally recommended that some form of preventive measures be taken if any of the following conditions exist.

1. The January mean temperature is 40° F (4° C) or less.

2. The structures are humidified, or where a facility's operations generate humidity in excess of 45% relative humidity.

3. The structures are enclosed and heated, with interior conditions that generate large quantities of humidity.

4. Any other situation in which a designer has stipulated that a vapor retarder is required.

Some examples of high-humidity environments that typically require a moisture barrier are:

- Pools
- Freezers
- Paper and Textile Mills
- Laundries
- Bakeries
- Gymnasiums and Locker Rooms
- Commercial Kitchens

The International Building Code (IBC) directs us on how to design a building without condensation. The IBC's 2006 International Energy Conservation Code requires the use of ASHRAE Standard 90.1 for minimum standards on controlling interior environments. These minimum standards lead to the use of three typical design elements to control condensation:

- Insulation (with R-value determined from ASHRAE 90.1)
- Vapor Retarder
- Ventilation

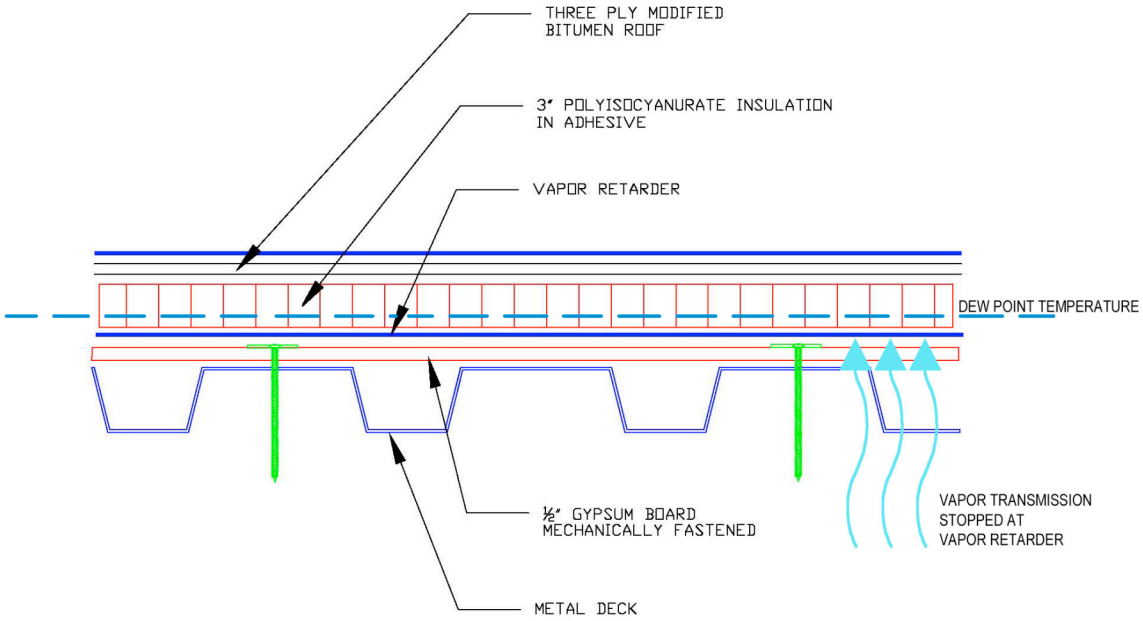
These design elements can be used independently, but the most efficient designs combine all three.

Using Vapor Retarders

To clarify, the purpose of a vapor retarder is to stop condensation from occurring in roof or wall assemblies. Although sometimes referred to as vapor barriers, such descriptions are inaccurate. No material can completely stop vapor transmission, so the use of the word barrier is incorrect. A vapor retarder is used to separate the warm humid air from the surface at the dew point temperature, thereby preventing the warm humid air from condensing.

Two of the most popular products used as vapor retarders in the roofing industry are polyethylene plastic sheets and two-ply fiberglass felts adhered in hot asphalt. But any material that has a permeability rating of 1.0 or less, in accordance with ASTM E 1745, is acceptable as a vapor retarder.

When installing a vapor retarder to a mechanically attached roof system, it is necessary that the fastening screws remain below the vapor retarder, as shown in Illustration 2. The objective is to prevent any moisture near the fasteners from reaching the dew point temperature, where it would otherwise channel along the screws until it eventually penetrates the insulation.



BUR/MODIFIED BITUMEN DESIGN
WITH CORRECT PLACEMENT OF
VAPOR BARRIER

Remember that in warm weather environments, where vapor transmission may occur from the exterior to the interior, the vapor retarder design should be reversed. The vapor retarder is always located at the exterior of the roof construction. BUR roofs work well in this situation, as the asphalt adhesive and multi-ply construction provide a natural vapor retarder.

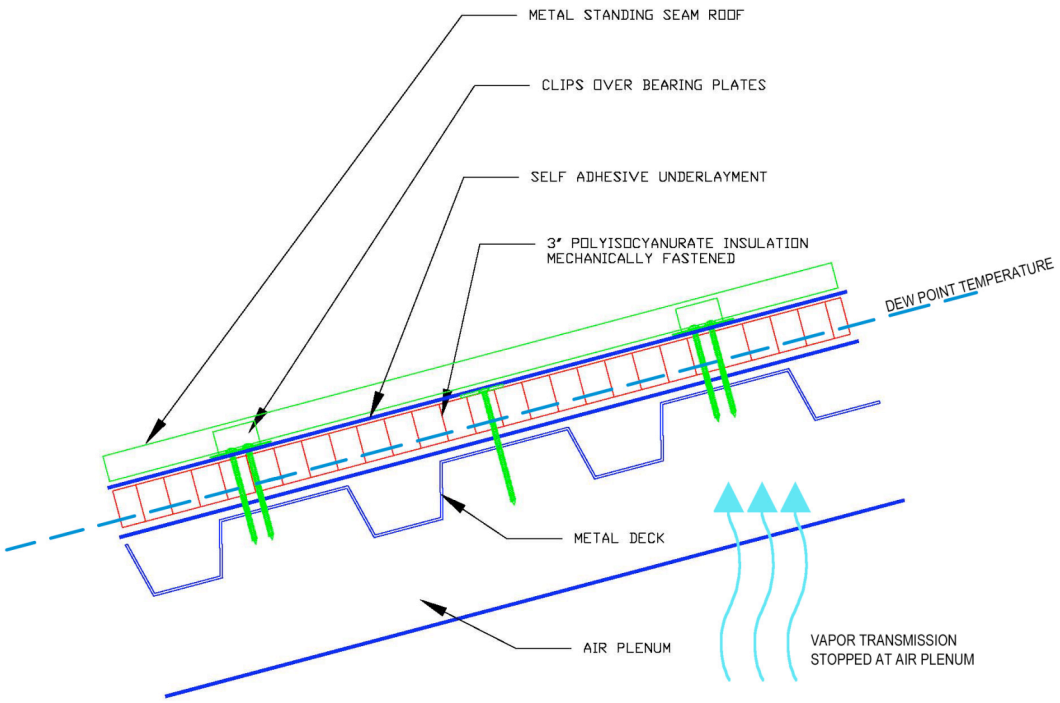
Using Ventilation

Ventilation is too often over looked when designing a roof. Frequently, proper ventilation of humid air is the best way to ensure success. If you remove the humidity from the interior air, there will be no vapor transmission to begin with. Ventilation can be handled by simply removing the air with a roof- or wall-mounted fan. Economically, however, it is really not practical to use a vent that simply blows heated interior air out of the building. Typically, dehumidifying equipment is recommended, which combines a dehumidifier with a powered vent to remove the humidity without removing heat from the building. There are many such dehumidification systems available today. While this equipment can be initially expensive, the payoff is realized quickly in reduced heating costs.

Special Considerations for Metal Roofing

Metal roofs, by design, require fasteners to attach to the building structure. This poses a problem in installing a vapor retarder where necessary. The interior surface of metal roof panels is prone to collecting condensation when the conditions are right. Therefore, a different approach is necessary to prevent condensation in these assemblies.

In metal roof assemblies where condensation is a concern, proper insulation, combined with the use of a vapor retarder, is necessary. As shown in Illustration 3, an air plenum can be used to ventilate the space between the interior finish and the roof deck where the screws are penetrating. In this way, the chance of vapor drive up the fasteners is eliminated. In higher sloped metal roofs, this air plenum would be the unheated attic space above the ceiling and insulation. In lower sloped metal roof constructions, an air plenum may be created with a drop ceiling.



METAL ROOF DESIGN

Special Considerations for Cold Storage Environments

Most cold storage freezers may be designed using a combination of a vapor retarder and proper insulation, as previously discussed. However, blast cell freezers that maintain -40° F temperatures are a special consideration. The construction of these freezers typically includes very thick insulation and heating of the ground below them to avoid damaging the foundations. Retrofitting this machinery with new roofs and/or walls is a complicated task, and beyond the scope of this writing. However, by no means should a through-fastened system be used to attach a new cladding system, as thermal conduction issues will result. Always consult a professional when designing such systems.

Conclusion

There are many design options that will prevent condensation collection in roof and wall systems. A professional should always be consulted in any roof project. In new construction, proper designs are easily documented and followed; however, a reroof project is more complicated, as knowledge of how the existing assembly will react to new changes is of utmost importance. Hopefully this paper has delivered some key insights into moisture control in roof construction. Good luck with your next roofing project.

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