A vapor retarder's success is dependent on where it is placed

Vapor retarders play a crucial part of pre-engineered metal buildings. Vapor retarders control moisture movement and try to prevent condensation. However, many may not realize the importance of location of the vapor retarder indirectly referenced in the energy codes. The new energy codes have increased energy efficiency stringency (lowers the assembly U-factor) thus featuring different prescriptive R-value assemblies. The 2012 International Energy Conservation Code and ANSI/ASHRAE/ES Standard 90.1-2013 both feature a Liner system (LS) roof assembly and are heavily listed in each of the prescriptive tables. Standard 90.1-2013 lists liner systems in climate zones 4 through 8, while the 2012 IEC lists liner systems in all eight climate zones throughout the country. The newly published 2015 IEC also lists liner systems in all eight climate zones.

Two primary factors

A liner’s system’s high performance can be contributed to two primary factors: 1) uncompressed insulation in the purlin cavities and 2) the vapor retarder is properly placed entirely below the purlin, which isolates them from the inside conditioned space. The vapor retarder for a liner system is typically continuous and is essentially a large, single-piece tarp made to fit the width and length of a bay without erection-applied field seams. The vapor retarder is typically held in place with steel straps and fastened into the bottom side purlin-flange. This creates the depth space for the unfaced, uncompressed fiberglass insulation to be installed from the topside of the building in new construction. The vapor retarder is sealed around perimeter of top rafters and below sideward eave struts. The other newly listed prescriptive method is filled cavity (FC) assembly, also known as a long tab banded system. This method is prescriptively listed in only climate zones through Standard 90.1-2013. The IEC voted not to include this assembly in their prescriptive tables in its 2012 or 2015 IEC.

Similar to liner systems, the filled cavity method includes steel strap bottom side installation to the lower purlin flange so the uncompressed insulation can rest upon it. However, there are crucial differences in the length, width and most importantly, location, of the vapor retarder. Unlike the liner systems, filled cavity method utilizes insulation in which the vapor retarder is glued/filmfaced onto the fiberglass. Thus, each roll of fiberglass has its own vapor retarder that must be field seams during the installation process.

Continuously sealed facings

Installed high-performance claims are based on the two adjoining vapor retarder facings sealed continuously on top of each purlin flame, no gaps along the purlin webs and without insulation compression of purlin brackets/tenon within the cavities. Long vapor retarder tabs of full ins width on each side of the fiberglass roll is needed to allow the full thickness of insulation in the cavity. For example, an 8-inch purlin depth with purlin spaced 60-inch on-center would require each long tab extending beyond the insulation width to be at least 14 inches to allow the vapor retarder to travel up the vertical purlin web (8 inches), extend from the purlin web to the edge of the top purlin flange (3 inches) and sealed horizontally over the top purlin flange (3 inches). Considering this must be done on both sides, each 60-inch purlin spacing would require at least 88 inches of vapor retarder (14 inches + 60 inches + 14 inches). This type of sealing is required for every linear foot stop each purlin flange, essentially twice considering the overlap field seam. The long tabs of the filled cavity method exceed the depth within the cavity, and the objective is that it’s long enough to rest on the support strips. Industry instructions state not to pull the tabs so tight that they pull away from the purlins. This disclaimer or warning is apparently stated to help prevent any gaps along each vertical purlin web where the inside conditioned air can easily circulate around the purlin and hit the exposed roof (standing seam clip) faster. This is a caution area where condensation may be likely to first occur with the slightest percent of humidity inside the building. The thermal performance claims for these assemblies assume no air is allowed to circulate around the purlin and will degrade substantially when exposed to conditioned air.

Considering the new energy codes, the demand for high-insulated/sheathed and the overall finish interior appearance, choosing a proper vapor retarder may be dependent on where you place it in the metal building roof and walls to get the success and acceptance desired. If you want to be certain that you cover all your bases, first start by covering your purlins and girts. By Brad Rowe is national marketing manager of Thermal Design Inc., based in Stoughton, Wis., and Madison, Neb. For more information, visit www.thermaldesign.com.

By Daniel Tempas is temperature manager at Dow Chemical Co., Midland, Mich. To learn more, visit www.dow.com.

Examine the wall system’s temperature profile

Designers have been concerned about condensation in wall assemblies for decades. Since the mid-1970s, the greater amounts of insulation specified in the building envelope has increased the likelihood for condensation somewhere in the assembly. Many articles have been written over the years that describe the physics of this problem. And for the vast majority of the time there has been a laser-like focus on one method for controlling condensation, permeability.

The rule of thumb has been to place low permeability materials/retarders on the warm side of the wall and high permeability materials on the cold side of the wall. In this fashion, the designer strives to make it difficult for water vapor to enter the wall (making it difficult for much water to condense in the wall) and easy for water vapor to leave the wall (drying out any water that managed to get into the assembly). And to answer this siren call, manufacturers began to introduce high-permeability air barriers, water barriers, and sheathing along with “smart” vapor retarders for the warm side of the wall.

Temperature

Unbeknownst to many designers, there is another, far more significant method for controlling condensation in wall systems: temperature. Or more precisely, the temperature profile of the wall system. Why should designers care about wall temperature? Because temperature plays a huge role in the condensation process. Condensation does not occur unless the temperature is low enough. And since a wall is not equally water sensitive in each layer, we can manage the temperature of the wall at any given location by placing insulation in the appropriate locations. By doing this, we can force condensation to only occur (if it occurs at all) in the wall location that can tolerate the condensate. Here’s how:

Place as much of the wall insulation as possible on the outside of the wall. The dotted line temperature profile occurs when insulation is in the stud cavity. The solid line temperature profile occurs when the insulation is moved to the exterior side of the wall. Changing the temperature profile in this manner has far-reaching consequences. Consider a standard rainscreen veneer wall assembly. Certainly the veneer is not sensitive to water, it is exposed to the environment. And quite a bit of water reaches that space. And the insulation layer on which the supports rest has to be moisture resistant as well: for the same reason as the supports. If condensation can be forced to only happen (if at all somewhere in or around these components, which are essentially immune to water, then the wall design is completely robust in its resistance to condensation.

Alter the profile

Designing wall assemblies by adding or altering the permeabilities of the wall components gains only modest improvements in condensation resistance. To create a truly robust wall system with the greatest condensation resistance, designers need to look at altering the temperature profile of the wall assembly by moving insulation as far as possible to the exterior of the wall.

Does all this mean that we no longer think about or design with the permeability of materials in mind? No, not at all. It means that we relegate the water permeability part of our design efforts to the proper place in the design consideration hierarchy. That would be the second place, behind the wall temperature profile design effort.

Figure 1: Place the insulation as far to the exterior as possible.

Figure 2: Changing a wall’s temperature profile has far-reaching consequences.