From the Foundation

Water Vapor and EIFS

by Robert Thomas, Jr.

Introduction
Exterior Insulation and Finish Systems (EIFS) came to the U.S. from Europe where buildings usually have masonry or concrete walls and EIFS are bonded directly to the wall. Because most EIFS in the U.S. are bonded to wall assemblies of gypsum sheathing and metal studs, an American EIFS wall behaves differently from its European counterpart in many ways. One of the most significant differences involves moisture vapor travel through the wall assembly.

The issue of moisture vapor relates to the concern that condensation should not occur in a wall assembly. The heavy, dense wall structure that supports a European EIFS tends to lessen the problems associated with water vapor, compared to lightweight U.S.-style wall structures. This article explores various common U.S. ways of using EIFS from the perspective of their water vapor behavior, and points out wall designs that need attention.

Background

Water exists in three forms: solid (ice), liquid (water), and gas (water vapor). Water vapor is an invisible gas that exists in the air around us all the time. It exists in various concentrations. The weight of water per unit volume of air is called the absolute humidity. The amount of moisture in the air as a percentage of the maximum amount it can hold at that temperature is the relative humidity. If the relative humidity exceeds 100%, then the amount of vapor in the air is more than it can hold, and the vapor is released from the air as condensation. The temperature at which the relative humidity is 100% is known as the dew point.

The amount of vapor that can be held by a given amount of air is a function of its temperature. Warm air can hold much more vapor than cold air. The vapor in the air exerts a pressure on the surrounding air called vapor pressure. Hot humid air has a higher vapor pressure than cold dry air; thus, the vapor pressure tries to move from the high vapor pressure area (i.e., the hot, humid side of the wall) to the low vapor pressure area (i.e., the cold and dry side). In practical terms this means that in winter the vapor tries to move from indoors to the outdoors.

Vapor can move through a wall in a number of ways. Two of the most common are diffusion and direct transfer. Direct transfer is when the moisture is transported by the movement of the air itself. Diffusion is when the vapor tries to force its way through the various layers in the wall due to the vapor pressure differential between the inside and outside of the wall. The degree to which a material resists the passage of water vapor is called its vapor resistance. For example, window glass is totally vapor resistant, while glass fiber insulation has very little vapor resistance.

EIFS and Water Vapor

EIFS are integrated composite systems. They consist of a layer of insulation to which is bonded a multi-layer exterior coating system. Several types of insulation are used in EIFS, each of which has different water vapor transmission properties. The vapor resistance properties of the insulation layer affects the overall vapor flow of the EIFS. Thus, different types of EIFS may perform differently under the same climate and wall design conditions. The outermost layer of an EIFS is seamless and prevents water vapor from getting to the outside by direct transfer. Thus, vapor flow through an EIFS tends to occur by diffusion since there are no direct paths through the EIFS. When an EIFS is properly functioning, vapor flows through the wall continuously and does not condense.

The stud/sheathing wall structures to which EIFS are normally attached have limited resistance to prolonged water attack. Unlike their masonry and concrete counterparts in Europe that have high inherent water resistance, stud/sheathing walls must be protected from water intrusion from all sources. This includes not only liquid water from leaks in the exterior skin, but also from condensation within the wall assembly.
POSSIBLE LOCATIONS FOR
CONDENSATION IN EIFS
Fig. 1

Figure 1 shows the various places where condensation can occur in an EIFS.

Condensation Sensitive Assemblies
There are a number of types of EIFS wall assemblies that are sensitive to condensation related problems. They include:

--Exterior coatings with a high resistance to vapor flow
--Fibrous insulation in the stud cavity
--Reverse vapor flow in the winter versus summer
--Sealant joints

Each of these assemblies is described in more detail below.

Exterior Coatings with a High Vapor Resistance
Problem: If the vapor resistance of the exterior surface of an EIFS is too high, condensation can be introduced into the wall assembly. If the situation is bad enough, sufficient condensation can be deposited in the EIFS to damage the exterior coatings, leading to blistering and/or delamination.

High vapor resistance can occur in the exterior coatings of an EIFS for a number of reasons:

--Vapor resistance is too high for the design conditions;
--Coatings added to the EIFS have increased its vapor resistance. (This can occur as a result of maintenance, by refinishing an EIFS or by applying a coating with a high vapor resistance.)

Solution: A common solution to this problem is to add a vapor retarder material (such as a polyethylene film) to
the inside of the wall assembly. This reduces the amount of vapor that can get into the wall assembly. Another solution is to reduce the relative humidity of the interior space. This can be done using HVAC equipment to condition the indoor air, or by allowing vapor to pass directly to the outside via vents, windows, etc. The reduction in relative humidity decreases the vapor pressure on the warm, humid side of the wall. This, in turn, lessens the amount of vapor trying to get out through the wall, and in some cases can eliminate the need for a vapor retarder.

Fibrous Insulation in the Stud Cavity

Sometimes the EIFS wall design has fibrous insulation in the stud cavity. This is often in lieu of extra-thick expanded polystyrene (EPS) on the outside. Placing fibrous insulation in the wall cavity changes the way vapor flows through the wall.

**Problem:** Because the fibrous insulation allows moisture to pass through it with little restriction, the vapor passes farther out in the wall, where it is colder. The result can be condensation in the stud cavity. This can wet the insulation and render it ineffective.

**Solution:** One solution to this problem is to put a vapor retarder on the warm side of the wall. The use of foil-faced insulation is one way to do this. Another solution is to get the fibrous insulation out of the cavity and put it on the outside as EPS. This does more than reduce the condensation potential, since external insulation is more effective than in-cavity insulation. It also eliminates the labor and material costs of installing the fibrous insulation and may be a separate vapor retarder.

**Reverse Vapor Flow**

EIFS condensation problems are not limited to cold climate areas. In the southern U.S. there are many areas that are hot and humid in the summer which experience cold, dry winters.

**Problem:** Typically, in the summer the vapor will try to flow from the outdoors toward the air conditioned interior. In the winter, the same wall may have moisture flowing toward the outside.

**Solution:** To stop condensation problems in the winter (and also to give an attractive finish) a heavy interior finish may be used, such as vinyl wall covering. Such a material would serve as a vapor barrier as well as the wall’s inside surface.

**Problem:** In the summer, however, that same wall covering may act as a vapor retarder, but on the wrong side of the wall. It can trap moisture in the wall, causing mildew and degradation of the stud cavity.

**Solution:** Solving this problem is not easy. Putting vapor barriers on both sides of the wall can be dangerous since it can trap moisture inside the wall. This type of wall design requires individual engineering attention in order to function properly under all climate conditions.

**EIFS Sealant Joints**

The joints between adjacent EIFS wall areas are normally sealed using a caulking-type joint. This is especially
true with EIFS panels. These joints are open to the stud cavity on their back side.

**Problem:** The moisture in the stud cavity may come into contact with the sealant, which is essentially at the outdoor temperature. Thus, warm moist air coming into contact with the cold sealant can cause condensation to occur.

The problem with this situation is not simply that water may be deposited. Most EIFS use water-based coating chemistry. If the coatings become wet enough, they can soften. If they soften, they lose some of their strength which can result in the delamination of the finish from the base coat, making the weather seal ineffective.

**Solution:** This is a recognized problem and can be handled in a number of ways:

1. Reinforce the sealant-to-EIFS bond area so that the water does not affect the sealant bond. This can be done by using sealant primers which toughen the surface and make it less water sensitive.

2. Another solution is to insulate the joint cavity so that moisture-laden air cannot get to the back side of the sealant. This can be accomplished by placing insulation in the joint cavity.

3. Use two rows of sealant with a gap in between. This keeps moisture from getting to the primary seal and also provides a back-up weather seal.
should the primary seal fail.

It is important to design the sealant joint properly to reduce this problem. This includes using sealants with enough movement capacity, making the joint wide enough, and insuring compatibility of the sealant with the EIFS, especially under moist conditions.

Dealing with the Water Vapor Issue

EIFS manufacturers are knowledgeable about the water vapor behavior of their products and can help designers and contractors use them properly. The key is communication.

During the design phase, the architect needs to consider the issue of water vapor, especially if the building’s location and/or climate conditions are extreme. Many EIFS manufacturers use computer programs (like the one shown in Figure 2 below) to develop cost-effective solutions to water vapor problems.

Contractors need to communicate with the EIFS manufacturers, too. This is especially true on retrofit projects where often there is no design professional involved. Also, seemingly innocent maintenance activities such as painting the exterior surface of an EIFS with a high performance coating can seal the surface too much, causing condensation problems.

The following list is offered to help you identify situations that warrant checking for water vapor problems:

--Projects with high humidity on the inside: swimming pools, saunas, industrial processes, laundries, etc.;
--EIFS with thin EPS on the outside and fibrous insulation in the stud cavity;
--Extremely cold outside climate conditions;
--Hot, humid outdoor climate with an air-conditioned building, e.g. on the Gulf Coast, refrigerated buildings, cold storage buildings, etc.

Several basic strategies are available to resolve moisture vapor problems with EIFS. These include:

--Reducing the relative humidity of the interior space using HVAC equipment;
--Ventilating the interior space and/or wall cavity to the outside to reduce the vapor pressure;
--Installing a vapor retarder on the warm side of the wall;
--Using an EIFS with greater vapor flow capacity.

Conclusions

Water vapor is a complex subject, and this article has just scratched the surface, but recognizing that such an issue exists is half the solution. Armed with the information in this article, you may look at your next EIFS project and ask yourself, “I wonder if this one should be checked for water vapor problems?” If you do, this article will have been a success.

About the Author

Bob Thomas is an architectural consultant at his own firm, CMD Associates, which specializes in technical aspects of marketing wall systems. Bob was Manager of Technical Services at Dryvit Systems, Inc. for many years where he led technical work in Dryvit’s international business expansion. He is secretary of ASTM’s EIFS Steering Committee.