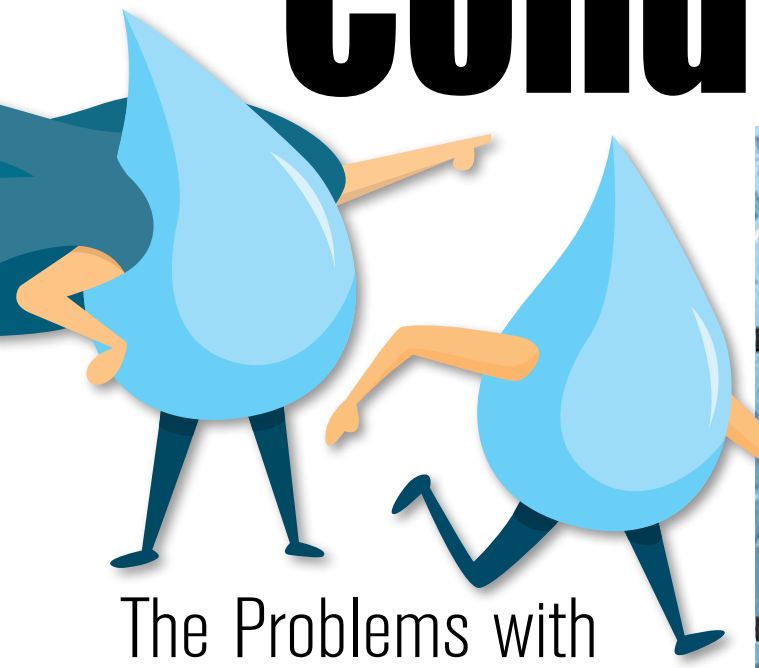
Condensation



The Problems with Condensation and Why Installation Matters

by Ellen Rogers

Nobody wants water on the inside of their windows. Besides the aesthetic distraction, there are a host of other issues that can occur, such as water damage and mold—which can lead to even more problems. While the windows and glazing are often the first to get the blame, condensation usually is not a fenestration problem exclusively. The glazing industry, and contract glaziers in particular, should be aware of a number of contributing factors.

According to John Bendt, vice president building retrofit strategy team for Apogee Enterprises Inc., performance of the fenestration system, indoor relative humidity level and outdoor temperature are the main factors that determine whether or not condensation will occur.

"Fenestration condensation is simply the result of excess humidity and the glazing system providing a visible cool surface on which humidity can condense," says Bendt. "Condensation can lead to damage of interior finishes and wall cavities. When moisture is introduced to these areas it can lead to mold, unhealthy work environments, damaged material and expensive repairs."

Helen Sanders, who works in strategic business development for Technoform North America Inc., agrees that mold is a major concern. "Condensation can create breeding grounds for mold and bacteria. Mold, which can become airborne, has a significant negative impact on indoor air quality and on occupant health in buildings. Water can collect on window and curtainwall elements and on the edge of glass, and then flow onto walls where mold can grow," she says. "Water can also condense inside walls next to the window interface where it cannot be seen, and where it cannot dry out well. In this case, the generated mold can go undetected for years, increasingly affecting the quality of air in the building."

Fortunately, the glazing industry has made great strides in offering products that can help avoid condensation. These include high-performance framing materials, thermal breaks and insulating glass systems, as well as air barrier ma-

Condemnation

Windows are often blamed for condensation, but a number of factors come into play. The indoor relative humidity level and outdoor temperature are two of the main factors that determine whether or not condensation will occur.

terials. But there's more involved than just the system components. Installation is critical, given that uncontrolled air infiltration can lead to an inability to balance the HVAC system, which also can lead to condensation.

What You Need to Know

"Poor installation techniques are often related to improper sealing around the perimeter of a fenestration product (frame to the building structure) or component (glass into the frame).Either may increase the risk of air infiltration," says Chad Ricker, market team manager with Technoform North America Inc. "Additional air infiltration increases the likelihood of condensation by producing additional cold areas on the inside of the building near the interface. The presence of these cold areas and the cold air drafts also reduce occupant thermal comfort."

Bendt agrees.

"Air infiltration is a significant contributor to condensation because the outside cold air will cool the components of the fenestration system, causing the humidity in the air to condensate," he says. "It's extremely important that the installer seal the fenestration system where it connects to the outside structure so the cold air stays at the exterior of this system," he says. "Today's fenestration systems have a thermal break to separate the outside of the window framing from the inside. This thermal break greatly reduces the transfer of cold from the outside window surface to the inside. If sealing is not properly done, and cold air enters the wall cavity, this thermal break is bridged. The cold air will cool the inside framing and increase the risk of condensation."

Since window-to-wall interfaces, as well as material compatibility, are both critical to ensuring air-tight performance, awareness and focus on air barriers is also increasing. Tony Cinnamon, associate principal in the Chicago office of architectural consultants Wiss, Janney, Elstner Associates, says air barriers are now standard on new construction.

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Quality Checks

There are many items that should be considered to evaluate, model and diagnose potential condensation issues. John Bendt, vice president building retrofit strategy team for Apogee Enterprises Inc. suggests a few considerations:

- ☑ Complete a THERM model of fenestration components, anchors and surrounding conditions;
- ☑ Review shop drawings to ensure components and proposed installation match the model;
- ☑ Ensure vapor barrier connection is per fenestration manufacturer's recommendation;
- ☑ Complete adhesion test from sealant manufacturer;
- ☑ Inspect installation to ensure installation is per approved shop drawings; and
- ☑ Inspect sealant work and fenestration craftsmanship to ensure the quality of work.

"Some designers, though, are still playing catch-up a little bit on how to integrate the fenestration with the air barrier," he adds. "Another thing we're now seeing is that the air barrier is also the weather barrier and vapor retarder all in one. So, if that's the case, it's even more important that it be integrated with the fenestration."

Issues and Concerns

Errors ultimately can lead to condensation issues. Cinnamon says his firm has seen instances where the thermal plane (break) of the window isn't in line with the thermal plane of the wall.

"If the insulation in the wall is on plane and the thermal break of the window [doesn't align] then you can get cold temperatures that bypass the thermal break," he says. "In a perfect world it would all be completely lined up. We've found that in a lot of cases, especially in precast construction, condensation can form on the precast and the windows, depending on how deep the return at the windows. That can affect condensation as well. So it's a push-and-pull, based on where the window is in relation to the wall and how thick the wall is."

Cinnamon says the placement of the insulation layer also matters.

"If you're integrating with air barriers, for example, what the window is sealed to can have an impact [on condensation]. So make sure whatever you're installing is integrated with the air barrier, because if not you can get a short circuit in your air control later, which can also impact condensation," he says.

Thermal heat transfer is also a challenge. "One of the challenges we're seeing in the architectural community is how to manage the thermal heat transfer at the top of curtainwall systems when they're extended up above the roofline to create a parapet to contain, say, a roof garden," Sanders says. "Since the room-side part of the curtainwall is extended up past the roofline, it will be in thermal contact with the outside of the building. As a result, if the thermal heat transfer is not stopped from flowing vertically upward to the elements above the roofline, the thermal performance of the whole wall will be compromised significantly and the condensation risk on the interior of the frame will be elevated substantially."

Avoiding Potential Pitfalls

According to Bendt, condensation prevention is a coordinated effort that involves selecting the proper framing material, glass, anchoring method, surround material, sealing and vapor barrier for the installation of fenestration systems.

"Manufacturers of fenestration systems test their products in a laboratory setting using a guarded hot box per AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections," he says, explaining that fenestration systems can also be compared using the condensation resistance factor (CRF).

"CRF is a relative performance rating that is specified to get manufacturers to meet a certain performance level, but does not guarantee that condensation will not happen," he says. "Since this test method is done in a laboratory, a typical jobsite is different than these test conditions. It is important that the glazing industry model the actual jobsite conditions to forecast the dew point of the fenestration components to prevent condensation. Some specifications today ask the fenestration manufacturer and installer to guarantee there will be no visible condensation on their products. Failure to model the actual jobsite conditions properly can open up the glazing industry to liability and damage claims."

Bendt suggests conducting a THERM analysis for determining the risk of condensation.

"THERM is a computer program developed at Lawrence Berkeley National Laboratory for use by building component manufacturers interested in heat transfer. THERM models two-dimensional heat-transfer effects in building components such as windows, walls,

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foundations, roofs and doors, and other products where thermal bridges are of concern," he says. "THERM's heat-transfer analysis allows you to evaluate a product's energy efficiency and local temperature patterns, which may relate directly to problems with condensation, moisture damage and structural integrity."

Speaking of other tests, Sanders says air leakage testing is the most common form of envelope testing according to the ASTM E783 test method for field measurement of air leakage through installed exterior windows and doors. She adds that a number of other air leakage tests can be done using, as examples, a blower door (ASTM E1827) or fan pressurization (ASTM E779) method.

"Water infiltration testing is also relatively common, involving the application of high-pressure water on the façade to simulate wind-driven rain," she says. "Less common, but growing, is the use of infrared cameras to create a heat image of the façade and use it to identify areas of thermal shorting or poor thermal insulation."

Checks and Balances

There are a number of quality checks and other measures that can help ensure proper installation.

"It is becoming more frequent that products are field-tested for air and water infiltration to ensure performance as-installed and to catch issues before the building is completed," says Ricker. "Building enclosure commissioning is becoming a more common practice and, in some projects, is a specified requirement for quality control. The goal of the commissioning process is to ensure that the enclosure of a building meets the requirements of the project, and involves pre-construction design and detail review, as well as performance testing after installation."

He adds that additional field quality assurance involves checking the quality and continuity of caulk beads in wet-sealed systems; and looking for gaps in gasket continuity around the perimeter of the glass edge in dry systems. These and other issues may have occurred during the installation of the IGU.

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Cinnamon says his company has been heavily involved with building enclosure commissioning over the past few years, and agrees that it's becoming more and more common.

"Initially, it was limited to unique buildings ... or those that had a particular interior condition or specific enclosure performance requirement (such as a hospital)," says Cinnamon. "Now we're seeing that expand to other structures where [the owner] is still looking for higher performance of the enclosure; the process can flesh out [potential] issues early on during the design portion. Doing these reviews ... allows you to catch those things that can increase the risk for condensation. By the time the contractor is on board, those issues have been worked out."

Why Does This Matter?

When condensation issues occur, windows and a poor installation are often blamed. But neither is necessarily the case.

"I think condensation is, unfortunately, one of those misunderstood things where the finger is pointed at the window first—but it's rarely a window issue," says Cinnamon.

Instead, condensation often is an issue resulting from interior conditions or the placement of the window within the wall "... and that's not up to the glazier, unless they recognize it and make an issue of it," he says. "I think it's one of those things the glazier is blamed for, but rarely, if ever, is it really their fault."

So, how can condensation be avoided and what steps, if any, can the contract glazier take to help keep such issues from occurring?

"It starts with the design," says Cinnamon. "Unfortunately, the glaziers aren't always involved until it's finished. So their first opportunity to review the design is often in the shop drawings." He suggests checking to see where the thermal break lines up with the insulation in the wall. If they're close to the same plane it's probably okay, he says, but he also suggests identifying the air source.

"What's the HVAC look like? That can have a heavy impact on condensation, and that's something the glazier has no control over. There are a lot of things for them to consider that don't fall into their area of expertise," says Cinnamon.

Ricker adds that it's also important that all systems be installed per the manufacturer's instructions and that specified materials, including anchoring and sealing components, be used.

"Changes can negatively impact the performance of the product and result in additional air and water infiltration, and condensation issues," he says.

Condensation certainly isn't a new problem, and fortunately, the industry has continued to advance and develop products that can help eliminate the issue. For contract glaziers, it's important to stay informed and aware of these developments, and, whenever possible, to have as much involvement with the project design early on to help avoid potential issues that could occur. ■

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