NSG GROUP

Technical Information

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Condensation on the Exterior Surface of High Performance Glazing

Most people are very familiar with the dew that forms on grass overnight, and with the condensation often seen on the outer surface of a car windshield when it is parked in the open after a clear cloudless night. This latter condensation is more of an issue when the air temperature is close to freezing and the condensation turns to ice, requiring scraping before the car can be safely driven. The key factor in the above examples is that a clear night sky at high altitude has an effective temperature far below the air temperature at the earth's surface. This causes objects at ground level to become cooler than the air around them by radiant heat transfer to the extreme cold of outer space.

First surface condensation on three high performance North elevation, river facing, windows. Ohio, 7:30 a.m. in June. Still air, 70 °F inside and outside, 85% Relative Humidity, 65 °F Dew Point.

Pilkington North America, Inc.
811 Madison Avenue, Toledo, Ohio 43604-5684
Telephone 800 221 0444 Fax 419 247 4517

Any object exposed to the colder night sky will radiate heat skyward (heat flows from hot to cold). When radiation heat loss causes the object's temperature to fall below that of the surrounding air, heat will then start to flow, by convection, from the air into the object. If the air is still, then this convective heat transfer is less effective than the radiant heat loss and so the object's temperature falls further until an equilibrium point is reached where the inward convection heat flow balances the outward radiation heat flow.

It is easy for an object with a high emissivity value such as glass (Eh = 0.84) to become about 4 or 5 °F (2 or 3°C) cooler than the exterior still air. As nighttime air cools from its higher daytime temperature, the relative humidity (RH) increases. The nighttime temperature of air is often only a few degrees above its dew point temperature (at which the RH is 100%) especially in humid areas such as near rivers (see photo above) or lakes. If the temperature of an object falls below the dew point temperature of the surrounding air, then condensation will form on it.

The temperature of a typical double glazed window is usually above that of the exterior nighttime air because of the heat flow from the warm interior of the building. But if insulating, tight fitting, drapes are fitted, or if the unit has a very low U-Factor (thermal conductivity) from the use of a low emissivity coating or coatings and Argon or other insulating gas, and if the glass has a direct line of sight view to a cloudless sky, then on a still air night, the temperature of the outer glass surface can easily fall below the exterior air temperature or even its dew point temperature. When the glass temperature falls below the dew point temperature condensation occurs. This happens often in humid areas. This condensation will not evaporate until the glass is heated by wind, sunlight or heat transfer from the building interior.

In commercial curtain wall construction, this condensation can occasionally be seen in the early morning on the outer surface of glazed spandrel panels because there is usually very effective insulation behind the glass and its temperature can fall below the exterior air temperature. It is seldom seen on the vision panels because those U-Factors are usually not as low.

This nighttime condensation on the exterior surface is seldom an issue of importance because it soon dissipates as the day progresses. If the condensation must be removed quickly then one could consider adjusting HVAC vents to direct warm air towards the window if the building air temperature is above the exterior dew point temperature (excessive temperature differentials in the glass must be avoided, especially in winter, or breakage will occur from thermal stresses).

This condensation could also be prevented by shielding the windows from direct, line of sight, radiant heat transfer with the sky by the use of appropriately placed trees or awnings. While this solution may be unrealistic for many buildings, it can be easily adopted, and is very effective, for winter night time parking of cars. If a car is parked so that the windshield directly faces the wall of a house or building, condensation and frost will be far less likely to occur.

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In very hot and humid conditions, exterior surface condensation can also be seen with air conditioned, single glazed, lobby areas of office towers, when the temperature of poorly insulating, single, clear, glass falls below the exterior dew point temperature. Then the opposite treatment is needed to prevent condensation: HVAC ducts should not blow cold air at the glass; they should be directed away from the glass allowing the exterior, warmer air to heat the glass, hopefully to a temperature above the dew point of the outside air.

The optimum solution is to use Pilkington **Activ**™ Self-Cleaning Glass. This will allow clearer vision through any first surface condensation by the sheeting action of the hydrophilic coating. An ideal window would combine a Pilkington **Activ**™ coating on the #1 surface of an IG unit with Pilkington **Energy Advantage**™ Low-E Glass on the #3 surface for energy efficiency and comfort. If a low solar heat gain is required Pilkington **Activ**™ Blue can be used for the outer light of an IG unit.

Questions or comments should be directed to Pilkington North America, Inc. Architectural Technical Services, (419) 247-4448.

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