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Relative Humidity – How it Impacts Our Comfort and Our Buildings

We have probably all experienced a humid summer afternoon when it feels like you are swimming through the air. This is a case where the relative humidity would fall at the top end of the range. When it comes to the interior of our buildings, the changes in relative humidity can be much more subtle but no less impactful to our comfort.

Relative Humidity and Condensation Basics

For a quick crash course in moisture physics, relative humidity (RH) is typically expressed as a percentage and is determined by dividing the of amount of moisture within the air by the maximum amount of moisture that air could possibly contain at a specific temperature. The "specific temperature" is an important qualifier because if the amount of moisture in the air remains constant but the temperature drops, then the RH will increase until a limit is reached where condensation will occur. Condensation occurs at the dew point, the point where RH reaches 100%.

Equipped with a basic understanding of RH and how it is impacted by both temperature and moisture in the air, we can dig into the delicate balancing act of the interior RH range that is comfortable for humans and good for our buildings. Our discussion will be focussed on the

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cold-dominated climate found in the Golden Horseshoe of Southwestern Ontario.

Impact of RH on People

Interior relative humidity, along with temperature, are key aspects of indoor air quality. The human comfort range for RH is generally between 25% to 60% but depends on the individual (RDH Blog post). One clarification when discussing the comfort range is that it also varies by season. What may be comfortable in the summer is not the same as what we feel to be comfortable in the winter. The top of the comfort range is typically set to minimize the potential for mould, bacteria, and disease growth; while the bottom of the range is set to maintain respiratory health.

Impact of RH on Buildings

Interior RH can impact our buildings in numerous ways, but we will be focussing on one of the most common: condensation within walls and on windows. As discussed above, condensation occurs when warm moist air is cooled to the dew point where it can no longer hold moisture. When warm moist air reaches the dew point, water droplets (condensation) will form on relatively colder surfaces –just like when warm, humid air from your morning shower hits a colder bathroom mirror. On a cold winter day it is fairly common to see some minor condensation along the bottom of an exterior window. In this example, the interior air warmed by the HVAC system comes into contact with the window surface that is much colder due to low exterior temperatures. The condensation may dissipate throughout the course of the day as the window's surface temperature heats up.

What would happen if we changed the example slightly, and had the warm interior air leaking into a wall cavity or attic space and contacting a cold surface such as the exterior wall sheathing or underside of the roof? Condensation would very likely form in the same way on colder surfaces, but now it would be forming on an organic material (wood or drywall) which is problematic because these surfaces are concealed.

This hypothetical example is one we come across quite frequently in our work as building science consultants. The specific pathways that allow warm interior air into these concealed spaces often vary. The cold surfaces where condensation forms also vary from case to case. The root cause of the issue, however, remains fairly consistent. During the winter, our building interiors are heated and may even be humidified by the HVAC system or unit-specific humidifiers. This warm air can hold more moisture and is at a higher vapour pressure relative to cold exterior conditions. This creates a pressure differential across the enclosure that can cause the warm interior air to move towards the lower pressure, cold exterior condition. This is a natural phenomenon and one we can attribute to mother nature's never-ending pursuit of balance. If the warm, humid interior air hits a cold surface as it diffuses or leaks through wall or roof assemblies, concealed con-

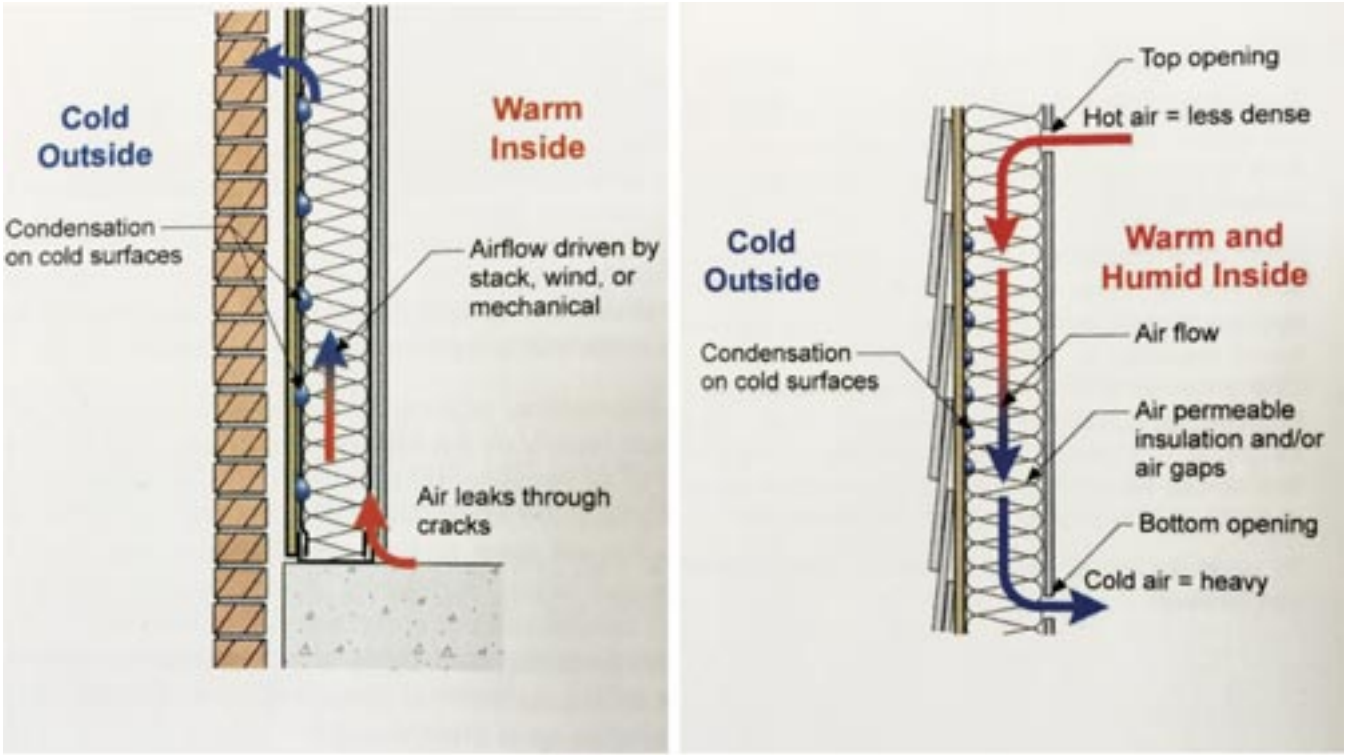

Figure 1 – Two ways in which condensation can form in an exterior wall. Both cases are caused bny warm air contacting the cold exterior sheathing. Image credit: High Performance Building Enclosures.© John Straube and Building Science Corporation.

densation will occur and could start deterioration, corrosion, or mould growth.

Understanding Root Causes of Moisture Issues

RDH has performed investigations in numerous condominium buildings of varying size and construction. Our investigations have led to both large scale repairs to address deterioration from water leaks or condensation; other approaches to managing condensation and moisture issues include minor adjustments to interior RH conditions. Although the investigations are tailored to the unique conditions of each building and suite, they often involve some form of interior temperature and RH measurement, air leakage testing, and exploratory openings into either the interior drywall (walls or ceiling) or the exterior cladding. Air leakage testing is a way of identifying potential paths that bring warm air in contact with cold inner wall/roof surfaces. Exploratory openings help to provide information on the existing construction and extent of deterioration.

Some Solutions for Addressing Condensation

With condensation being a result of interior RH, temperatures of wall/window surfaces, and exterior temperature, it can be challenging to develop a one-size-fits-all approach to reducing moisture issues caused by humidity. Where only a small number of suites in a large condominium building are having condensation issues, these issues could be attributed to a specific HVAC or building envelope issue, or to a high-humidity resident lifestyle. Lifestyle issues that can cause condensation include:

- Presence of a large number of indoor plants that release moisture into the air and can elevate the RH;
- Heavy curtains or drapes that reduce the amount of air movement along walls and windows. This can reduce the window temperature, shield the window from air movement, and lower the potential for drying minor amounts of condensation ; and,
- More people living in a suite will typically raise the RH as breathing, cooking, and cleaning all release moisture into the air.

Figure 2 – Air leakage testing in progress at condominium building in Toronto. The blower door (red) is used to either pressurize or de-pressurize the building interior. Photo credit: RDH Building Science Inc.

If you think that condensation may be an issue in your home or building, here are a few things to consider:

- Know your mechanical system (HVAC) set points for temperature and relative humidity. It may be possible to adjust these set points to maintain indoor air quality and comfort while also reducing the potential for condensation to form.
- Dehumidify the interior air during the winter months to reduce the amount of moisture in the air. Consider keeping the RH closer to the lower end of the comfort range in the winter and the middle of the range in the summer.
- Reduce air leakage where possible to prevent warm air from flowing into the concealed spaces of the walls and attics. This can include sealing around outlets and switches, sealing HVAC ducts within the walls and ceiling, installing weatherstripping around attic hatches, and patching holes within the walls and ceiling.

If condensation issues are widespread throughout most suites of your building, or if problems persist after implementing some lifestyle changes, consider having the issue investigated to identify the specific problems and implement well-planned solutions.

REFERENCES

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