HVAC Guide to Solving Condensation Problems in Buildings

An Online Continuing Education Course for Engineers

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HVAC Guide to Solving Condensation Problems in Buildings

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Introduction

Condensation is the formation of water or frost on a surface. Condensation occurs when warm, moisture-laden air comes into contact with a colder surface such as glass. The air temperature in contact with the colder surface suddenly drops, releasing some of the moisture onto the surface as water droplets.

There are several reasons that condensation forms. These include (but are not necessarily limited to) the following:

- Indoor surface temperatures of windows, doors, and skylights are lower than the dew point of the surrounding air
- High indoor humidity
- Cold outdoor temperatures

You can see examples of this in your everyday life. Humidity levels increase when you shower, cook, or even breathe. Another example is a cold beverage in a warm room when you can see the water droplets form on the glass. This is condensation in its simplest form.

Window Condensation with High Indoor Humidity

Mold and Microbial Growth with High Humidity

Condensation can form on any surface such as glass, mirror, ductwork, pipes, and other fixtures, or it can go undetected when it penetrates your carpets, fabrics, and any other absorbent surfaces such as wall plaster. While a bit of moisture might sound harmless enough; if this issue isn't addressed, it can lead to numerous problems, including:

a. Dampness, corrosion, deterioration of the building fabric (e.g., wet and stained ceilings, warping of wood, cracking of paint, spoilt furnishings or appliances).

b. Condensate water and damp surfaces are favorable to the growth of bacteria, fungus, mold, etc., which present a health hazard

c. Damage to inventory, as the water drips onto the merchandise below

d. Growth of mold on the building materials where condensed water drips and presents a health hazard

e. Increased heating costs (as additional energy is required to convert condensation back into vapor, which is taken up by the air as the temperature rises).

Because of these potential problems, preventing condensation or, more accurately, avoiding damp surfaces that support the growth of microorganisms, especially molds, is critical and fundamental to avoiding health and air quality problems in buildings.

Factors Influencing Condensation

Condensation is most common in winter, but it can occur whenever water vapor in the air comes in contact with a surface temperature lower than the dew point (the temperature at which air becomes saturated and produces dew). In rare instances, during the spring and fall (and occasionally, during hot, humid summer days), exterior condensation can also form on windows. Condensation is more likely to form:

a. When indoor relative humidity is high. That's why it's more common to see condensation on a bathroom window than a bedroom window.

b. On cold surfaces rather than warm surfaces. That's why it's more common to see condensation on a single-glazed window than a double-glazed window, which is more insulated.

What is fundamental in preventing condensation is the accurate knowledge of the dew point temperature. This course will discuss the causes of surface condensation, the factors influencing it, and how to best identify design conditions and select system components to prevent surface condensation.

This course starts at the very beginning of delivering a full understanding of why condensation occurs. The second part of the course covers the HVAC solutions for how to avoid condensation.

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Chapter 1: Formation of Condensation

All air contains water vapor to a greater or lesser degree. The amount of moisture contained in the air varies depending on the temperature of the air. Warmer air can hold more water than cold air, which leads to humidity. When this warm moisture-rich air comes into contact with a cold surface or cold air, the warm air cools and, in doing so, is unable to retain all the water vapor in the air. This excess moisture is then released as water, which becomes condensation. The fundamental to condensation is the dew point temperature.

It is typical that many cases of condensation are only observed in the winter-time. This is when most home activities are carried out inside the property with extra reliance on the heating system but without extra ventilation. The condensation will also occur in summers in air-conditioned buildings whenever water vapor in the air comes in contact with a surface temperature lower than the dew point. We will learn these principles in this chapter.

1.1 Types of Condensation

There are two types of condensation to be considered:

a. Surface condensation
b. Interstitial condensation

1.1.1. Surface Condensation

Surface condensation occurs when water vapor in the air condenses on a surface that is below the dew point temperature of the surrounding air.

Dew point is a meaningful way to anticipate condensation. You must know two things:

a. The temperature of surfaces or object that is prone to condensation. This surface may be the glazing, ductwork, pipes, carpet, building structure, walls, or any other object.
b. The amount of water vapor present in the air. The degree of dryness/wetness is very often expressed in terms of Dew Point or Relative Humidity.

The condensation will occur if the dew point of air is ABOVE the temperature of the surface. As the dew point temperature of air reaches the surface or object's temperature, condensation on the surface or object is imminent. For example, outside air at 75°F and 75% RH has a DP of 66°F. Cooling the air below 66°F will cause water vapor to condense out of the air.

Dew point instruments available in the market today are very compact, user-friendly, and maintenance-free. This can be a simple portable indicator or a fixed transmitter used to track dew point temperature full-time. These devices come in wall mount and duct mount designs. Alternatively, the dew point can be determined by measuring any of the two parameters viz. the dry-bulb temperature, wet-bulb temperature, or relative humidity (RH) with a portable indicator or a fixed transmitter and estimating dew point temperatures from the psychrometric chart or table above.

1.1.2. Interstitial Condensation

Interstitial condensation occurs internal to the building element. It occurs mainly because of the hygroscopic nature of construction materials and construction gaps. Depending on the water vapor pressures, water vapor can be moving inward or outward through any building element. If the temperature gradient through the element is [illegible] at any point the temperature falls below the dew [illegible] cannot be held as vapor will condense within t[illegible] evaporates into vapor and continues to move[illegible] undesirable as it can cause deterioration of [illegible]

To minimize interstitial [illegible] the following:

a. Obtain low vapo[illegible] input to the building
b. Use materials of l[illegible] construction
c. Use material of lo[illegible] near the colder side of the constructio[illegible]
d. Use materials of lo[illegible] construction
e. Use materials of hi[illegible] the construction

In this course, we will focus[illegible] condensation.