Building America *Technical Highlight*

Evaluation of Humidity Control Options in Hot-Humid Climate Homes

As the Building America program researches construction of homes that achieve greater source energy savings over typical mid-1990s construction, proper modeling of whole-house latent loads and operation of humidity control equipment has become a high priority. Long-term high relative humidity can cause health and durability problems in homes, particularly in a hot-humid climate.

In this study, researchers at the National Renewable Energy Laboratory (NREL) used the latest EnergyPlus tool equipped with the moisture capacitance model to analyze the indoor relative humidity in three home types: a Building America high-performance home; a mid-1990s reference home; and a 2006 International Energy Conservation Code (IECC)-compliant home in hot-humid climate zones. They examined the impacts of various dehumidification equipment and controls on the high-performance home where the dehumidification equipment energy use can become a much larger portion of whole-house energy consumption.

The research included a number of simulated cases: thermostat reset, A/C with energy recovery ventilator, heat exchanger assisted A/C, A/C with condenser reheat, A/C with desiccant wheel dehumidifier, A/C with DX dehumidifier, A/C with energy recovery ventilator, and DX dehumidifier. Space relative humidity, thermal comfort, and whole-house source energy consumption were compared for indoor relative humidity set points of 50%, 55%, and 60%.

The study revealed why similar trends of high humidity were observed in all three homes regardless of energy efficiency, and why humidity problems are not necessarily unique in the high-performance home. Thermal comfort analysis indicated that occupants are unlikely to notice indoor humidity problems.

The study confirmed that supplemental dehumidification is needed to maintain space relative humidity (RH) below 60% in a hot-humid climate home. Researchers also concluded that while all the active dehumidification options included in the study successfully controlled space relative humidity excursions, the increase in whole-house energy consumption was much more sensitive to the humidity set point than the chosen technology option. In the high-performance home, supplemental dehumidification equipment results in a significant source energy consumption penalty at 50% RH set point (12.6%–22.4%) compared to the consumption at 60% RH set point (1.5%–2.7%). At 50% and 55% RH set points, A/C with desiccant wheel dehumidifier and A/C with ERV and high-efficiency DX dehumidifier stand out as the two cases resulting in the smallest increase of source energy consumption. At an RH set point of 60%, all explicit dehumidification technologies result in similar insignificant increases in source energy consumption and thus are equally competitive.

Key Research Results

Achievement

Researchers worked with EnergyPlus developers to add in moisture capacitance model to analyze the moisture buffering effect. Combined effect of mechanical ventilation (per ASHRAE 62.2) and infiltration is one of the major culprits of high indoor RH excursions in hot-humid climate homes. For the first time, this effect was analyzed accurately to predict humidity level in homes. Whole-house dehumidification equipment energy penalty was evaluated and summarized at different space RH control points.

Result

Confirmed that supplemental dehumidification must be provided in a high-performance home in the hot-humid climate to maintain space conditions below 60% relative humidity. Energy penalty introduced by the various supplemental dehumidification equipment is sensitive on the indoor RH control levels: at an RH set point of 60%, all explicit dehumidification technologies result in similar insignificant increases in source energy consumption and thus are equally competitive.

Benefit

This research informs homeowners and home builders of house humidity issues with and without whole-house dehumidification in the hot-humid climate, and source energy penalty introduced by dehumidifiers at different space humidity set points.

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For more information

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