Simulating the Effects of Temperature Based Smart Ventilation Control on Comfort, Energy Use and Air Exchange

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Research Purpose and Goal:

This research will provide simulation results that may lead to further code specification with respect to requirements for whole-house mechanical ventilation systems. The research will evaluate the impact of automatically disabling all or part of mechanical ventilation systems in new Florida homes during periods of high outdoor temperature and moisture. Resulting air exchange, indoor relative humidity and space conditioning energy use from ventilation systems that utilize outdoor temperature and moisture based whole-house ventilation control will be compared to continuous ventilation levels called for in the 2014 Florida Building Code and ASHRAE 62.2-2016.

Expected Outcome and Impact on The Code:

Currently ASHRAE standards, the IMC and Florida Statutes all vary on when residential whole-house mechanical ventilation systems must be installed and run. A delayed provision of the 2014 Florida Building Code, set to take effect on July 1, 2016, requires natural air change be supplemented through whole house mechanical ventilation for homes with tested air leakage of 3 ACH50 or less. Air infiltration by natural mechanisms is variable according to weather and building based driving forces. Newer mechanical ventilation standards deem the uncertainty and variability of natural air exchange insufficient, and recommend a more consistent and reliable delivery of outdoor air through mechanical means. However, there is concern among Florida builders and contractors about the implications associated with mechanically introducing humid outside air on a consistent basis [Vieira, et. al., 2016]. These implications include the potential impact on comfort, moisture issues, and both first cost and operating costs of the home.

This research may lead to Florida-specific exceptions to the IMC or ASHRAE specifications, that allow for adjustment of outdoor air requirements during periods of high outdoor moisture levels. Results may provide operational parameters for mechanical ventilation systems that will alleviate concern amongst builders and contractors towards implementing air exchange and mechanical ventilation provisions of the provisions of the 5th Edition Florida Building Code. Furthermore, allowances for such exceptions may stop the disabling of systems found in recently funded FBC research (Sonne, et.al., 2015).

Definition of the Problem:

Whole building air exchange is a required element for maintaining healthy indoor air quality (IAQ) in residential buildings. Air exchange dilutes indoor air pollutants with fresh, outdoor air. Other components that make up a comprehensive strategy for IAQ include limiting materials and activities that provide the source of pollutants, and employing local exhaust in dedicated areas where high concentrations of contaminants are likely to occur (e.g., kitchens). However, much of the year, bringing in outside Florida air will increase humidity and that has its own comfort and air quality issues.

Most mechanical ventilation systems deliver a fixed amount of outdoor air either continuously, or intermittently based on a timed schedule. Smart ventilation controls have recently emerged in the marketplace that enable ventilation systems to be controlled based on feedback from various measured variables. Data can either be measured locally, in real time via sensors, or provided over a broadband connection. This enables systems to operate in an optimized fashion by m operation when unnecessary (for example when occupancy sensors determine a home is unoccupied) or modifying operation when risk factors, such as high outdoor moisture levels, are determined to be too high. Examples of currently available systems that incorporate various degrees of control such as outdoor temperature and/or moisture control variables include:

Aprilaire 8126A Ventilation Control System
Aprilaire 8191/8192 Ventilating Dehumidifier
AirKing QuFresh Supply Ventilator
Honeywell Prestige IAQ
AirCycler TempGuard

Such systems either have manufacturer pre-set limits or may allow the user to program outdoor dry bulb temperature and/or moisture conditions (either relative humidity or dew point temperature) above (or below) which the ventilation system will not operate. “Hybrid” systems that incorporate smart controls always allow for ventilation while a home’s cooling system is running, regardless of outdoor conditions since moisture can be removed during cooling operation, and disable ventilation in response to outdoor conditions when the cooling system is not running.

In any case, as a result of the “off” time generated by the smart control, a system designed with an outdoor air flow rate based on continuous operation may not be in compliance with code for every hour of the year. While the system could be designed to operate in compliance by increasing the design airflow to achieve the same effective annual air exchange, such a design is difficult due to unknown weather and the ability of the homeowner to modify cutoff set points.

Work Scope:

The scope of this project is to use EnergyGauge USA to conduct simulations of homes that utilize mechanical ventilation systems with and without temperature and moisture cutoff controls. Temperature controls that suspend operation will be simulated with and without

increases in outdoor air flow that would maintain equivalency. EnergyGauge USA is selected as it already has temperature-based control simulation, and the ability to select the most popular mechanical ventilation systems. These features have already been used to generate research results described in a soon to be published ASHRAE paper [Lubliner, et. al, 2017]. The software team is also planning on expanding those features this summer to include hybrid ventilation system types. The baseline continuous mechanical ventilation systems against which advanced systems will be compared will be designed to be in compliance with the 2014 Florida Building Code. Differences in seasonal and annual air exchange among the control strategies will be tabulated for a range of outdoor dry bulb and dew point temperature combinations, along with differences in hourly space conditioning energy use and indoor relative humidity. TMY3 data for IECC Climate Zones 1 and 2 will be used for simulation.

Deliverable: A report showing results of simulations and possible code changes.

Budget:

$30,000

References:

Lubliner, Michael, Paul Francisco, Eric Martin, Iain Walker, Brennan Less, Robin Vieira, Rick Kunkle, Zachary Merrin, “Practical Applications and Case Study of Temperature Smart Ventilation Controls – DRAFT3,” ASHRAE Transactions *draft*, May 2016 [likely to be published in Jan. 2017]

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Sonne, J.; Withers, C.; Vieira, R. (2015), “Investigation of the Effectiveness and Failure Rates of Whole-House Mechanical Ventilation Systems in Florida,” FSEC-CR-2002-15, June 1, 2015.