An Assessment of Energy Efficient Methods of Indoor Humidity Control in Florida Housing for Florida Building Commission Research

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Definition of the Problem: The thermal efficiency of homes has improved in recent decades. Some of those improvements have reduced the amount of sensible heat entering the house (sensible heat is associated with temperature rise while latent heat is associated with water vapor in the air). Wall and attic insulation, improved duct insulation, improved windows, and better shading of windows and houses have reduced sensible heat entry into the home, which have brought about smaller AC systems and will cause the A/C system to operate less. Smaller A/C units and reduced compressor operating time can lead to a reduction in water vapor removal, and the potential for an increase in indoor Humidity.

On the other hand, two other factors tend to counter this. The first is that more electronic devices (computers, TVs, video games, etc.) are operating in our homes producing considerable internal sensible heat. The second is that natural air infiltration has declined dramatically in recent decades as tighter construction has been adopted. Typical new homes have declined in air leakage from about 22 ACH50 (air changes per hour at 50 pascals of pressure; a blower door test result) to about 5 ACH50 in recent years. Since about 85% of the cooling load associated with air entering from outdoors during hot and humid weather is latent heat (water vapor) and only about 15% is sensible heat, the tightening of homes has greatly reduced the amount of water vapor that must be removed by the air conditioning system. Tightening of duct systems has also substantially reduced the amount of water vapor entering the house.

While in the recent versions of the Florida Energy Code most of the issues that contributed to higher Energy use and indoor humidity have been addressed, such as building air leakage, duct leakage and proper AC equipment sizing, the unintended consequences of these, primarily Energy conservation measures, have negatively affected the IAQ in such tightly constructed buildings. Thus the need arose to provide treated OA to homes by means of Mechanical Ventilation, primarily utilizing the ASHRAE 62.2 2007 Standard for Residential ventilation.

The new Florida 5th Edition (2014) Code will require that houses be tested for envelope air leakage that may not exceed 5 ACH in Zones 1 and 2 and 3 ACH on all other zones. At the same time, the new Mechanical Code requires that Mechanical Ventilation be provided for any house that has less than 5 ACH. In order to comply with both requirements the only solution is to require Mechanical Ventilation in all residential buildings.

This re-introduces a considerable portion of the outdoors-to-indoors air exchange that was eliminated by house tightening. In addition, if the new ASHRAE Standard 62.2 (2013 version) is adopted in future Codes the amount of fresh air introduced in homes will need to increase even higher. The net result of the reduction in envelope sensible loads, increased internal sensible loads and increase in ventilation-

induced latent loads is that some A/C systems will not adequately control indoor Humidity and are not currently required by code to have neither a RH sensor nor any other humidity control device.

There is a need, therefore, to identify methods of improved humidity control in homes to prevent moisture-related occupant health problems as well as preservation of building materials. It is of course also essential that humidity control be achieved in ways that are energy efficient and cost-effective. In conclusion, for Code development purposes in our Hot & Humid Florida climate there is a need to determine the role of humidity control and the possible inclusion of some minimal code requirements for new residential buildings.

Scope of Work:

Task 1: Our research team proposes to perform a review of literature, examination of experimental data, and an assessment of the energy efficiency and cost-effectiveness of various approaches to managing the latent load in homes. Humidity control is not just a question of which appliance or technology to choose. It is often an issue of adopting design approaches which improve the chances of effective latent cooling.

Task 2: A second task is also proposed. Experiments will be implemented in a lab building to assess the resulting indoor RH and energy consumption (with measurement of temperature and humidity, and system energy consumption) when various latent load management approaches and equipment types (including a high-efficiency dehumidifier) are implemented and various levels of ventilation air are introduced to the space. It should be pointed out that this research can be performed in a cost-effective manner because lab, equipment, and data collection instrumentation is largely in place and ready to go. The following experiments are proposed to examine energy and RH outcomes using at a minimum the following experimental variations:

- Central ducted fixed capacity system vs high efficiency mini-split
- It may be possible to examine the humidity control performance of a variable capacity central ducted system
- Ventilation air sent directly to the return or mixed in space
- Outcomes when exhaust air is the method of providing ventilation
- A high efficiency dehumidifier will be used as backup to all test configurations
    - Dehumidifier energy will be included in the overall energy budget for each RH control approach
- Outdoor air humidity (Dew Point) measurement methods and determining their maximum set points for potential O.A. sensors that could prevent Mechanical Ventilation operation in periods when O.A. is too humid to be introduced into the home is also part of the study.

- Other RH control approaches may also be examined

Goals, Expected Outcome, and Impact on the Code: This research is proposed in two parts.

1. A report will be prepared that summarizes the pros and cons of various approaches to indoor humidity control, with a focus on the solutions that are most energy and cost-efficient. The report will also address the issue of ventilation and optimized humidity control. Recommendations will be presented on ways of avoiding elevated indoor humidity, approaches to system design, and selection of systems/technologies that can achieve energy efficient humidity control. From the recommendations of this report, it is expected that the Florida codes will be modified or adjusted to take into account the best approaches to energy and cost effective control of humidity in the Florida climate.
2. The data collected from these experiments will be examined to characterize approaches, technologies, and solutions which yield the most energy efficient and cost-effective humidity control. The advantages of the proposed experimental work are that 1) it is now clear that the Codes are pushing buildings toward specific levels of ventilation and 2) there are new approaches to energy-efficient humidity control that have not been closely examined and are now available to address energy, RH control, and indoor air quality.

Budget: Budget total is $54,100; Task 1 $24,500 and Task 2 $29,600.