

Building America *Technical Highlight*



NREL Provides Guidance to Improve Thermal Comfort in High-Performance Homes

Researchers at the National Renewable Energy Laboratory (NREL) have developed recommendations to help residential heating, cooling, and ventilation (HVAC) designers select optimal supply inlet size and system operating conditions to maintain good thermal comfort in low heating and cooling load homes. This can be achieved by using high sidewall supply air jets to create proper combinations of air temperature and air motion in the occupied zone of the conditioned space.

The design of air distribution systems for low-load homes is an integral part of residential system research and development in systems integration. As American homes become more energy efficient, space conditioning systems will be downsized. The downsizing will reach the point where the air flow volumes required to meet the remaining heating and cooling loads may be too small to maintain uniform room air mixing, which can affect thermal comfort.

NREL researchers performed a detailed study evaluating the performance of high sidewall

supply air jets over a wide range of parameters including supply air temperature, supply air velocity, and supply inlet size. They found that in heating mode, low and intermediate supply temperatures of 95°F (308 K) and 105°F (314 K) maintained acceptable comfort levels at lower fan powers than can be achieved at 120°F (322 K) supply temperatures. For the high supply temperature of 120°F (322 K), higher fan powers (supply velocities) were required to overcome buoyancy effects and reach a good mixing in the room. In cooling mode, a supply temperature of 55°F (286 K) provided acceptable comfort levels. A small supply inlet of 8-in. (0.2 m) × 1-in. (0.025 m) is recommended in both heating and cooling modes.

Computational fluid dynamics was used to model heat transfer and airflow in the room. The technique consists of using the model output to determine how well the supply air mixes with the room air. Thermal comfort is evaluated by determining the Air Diffusion Performance Index (ADPI). The level of comfort is evaluated by monitoring air temperature and air velocity in more than 600,000 control volumes that make up the occupied zone of a single room. The room has an acceptable comfort level when more than 70% of the control volumes meet the comfort criteria on both air temperature and air velocity.

Key Research Results

Achievement

NREL's Residential Buildings Group provides recommendations on HVAC system design and operating conditions to achieve optimal thermal comfort in high-performance homes.

Result

The study showed that high sidewall supply air jets achieve uniform mixing in the room, which is essential for providing acceptable comfort levels. It also provides information required to optimize overall space conditioning system design in both heating and cooling modes.

Benefit

The findings of this study will help guide HVAC designers to achieve acceptable thermal comfort and increase energy savings in high performance homes.

Funding Support

This research was sponsored by the U.S. Department of Energy's Buildings Program.

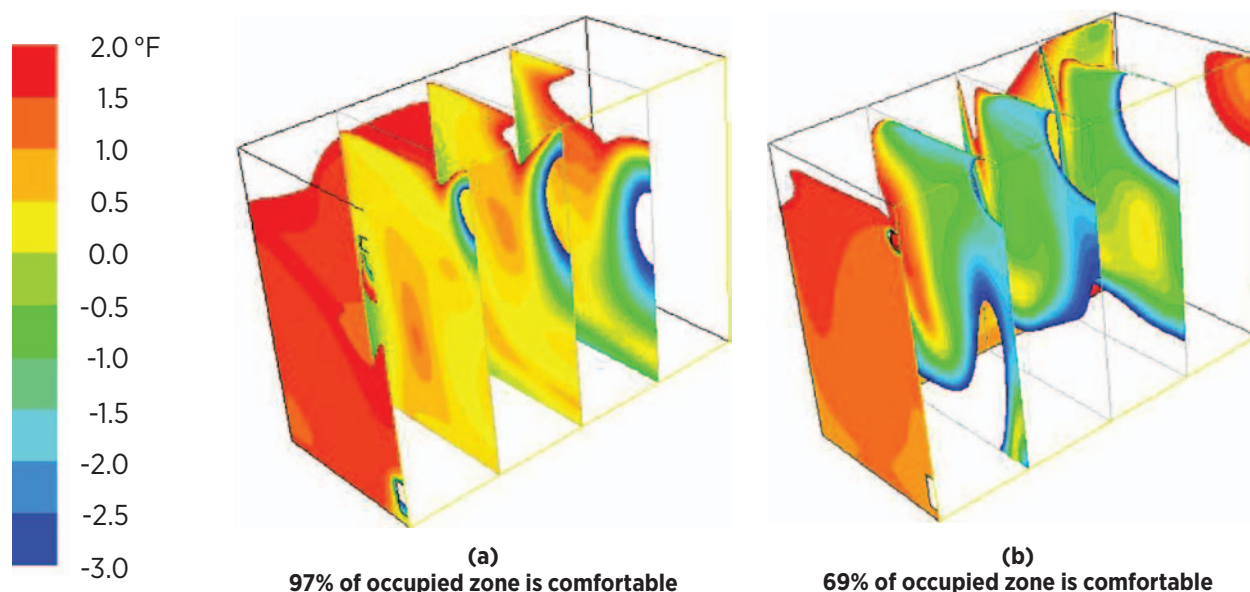


Figure 1. Plots of acceptable draft temperature in cooling mode when the room is supplied by 55°F (286 K) through 8-in. (0.2 m) × 4-in. (0.1 m) supply inlet: (a) supply velocity of 394 fpm (2 m/s) and (b) supply velocity 788 fpm (4 m/s). Figures by El Hassan Ridouane

Figure 1 illustrates the plots of acceptable draft temperature, which is between -3 (-1.7) and 2°F (1.1 K) for two supply velocities of 394 fpm (2 m/s) (a) and 788 fpm (4 m/s) (b) when the room was supplied by 55°F (286 K) air. The plots show the distribution at selected cross-sections along the room. Colored regions on each cross-section are considered comfortable (blue regions are on the cold side and red regions are on the warm side). Regions

of acceptable draft temperature are larger at low velocity and decrease as the velocity increases. As a result, the supply velocity of 394 fpm (2 m/s) provided higher comfort level than the supply velocity of 788 fpm (4 m/s).

Work is in progress at NREL to extend this research to evaluate additional configurations and to integrate this system into a whole-house context.

For more information

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U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

DOE/GO-102012-3492 • January 2012

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 10% post consumer waste.

Prepared by the National Renewable Energy Laboratory (NREL), a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy; NREL is operated by the Alliance for Sustainable Energy, LLC.