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Hybrid Heating Research for Houses

by James Reardon

The majority of new houses built in Canada are equipped with combustion-fired, forced-air heating systems. The energy-efficiency of Canadian housing has been dramatically improved over the past three decades due to improvements to forced air heating systems and to the construction of housing envelopes. With the participation of other federal government department partners and several manufacturers, the National Research Council's Institute for Research in Construction (IRC) is seeking further energy-efficiency improvements by examining hybrid-heating schemes suitable for houses that can provide thermal comfort, acceptable indoor air quality and further improve energy-efficiency. This research is examining whether heating efficiency can be improved by combining the best features of hydronic heating and forced-air heating and may have a significant impact on Canada's energy consumption and greenhouse gas emissions.

The advent of electronically commutated motors to drive the blower and exhaust fans in high-efficiency, fuel-fired, forced-air furnaces has substantially improved the energy efficiency of delivering thermal comfort via forced-air. However, forced-air heating may not be the most energy-efficient way to deliver thermal comfort to occupants.

Hydronic-based, radiant floor heating is becoming more popular due to the comfort advantages of a warm floor. In addition to comfort, hydronic radiant heating may offer a more energy-efficient means of delivering thermal comfort to the occupants due to the economies of the comparative heat capacities of water and air. By delivering part of that comfort radiantly, they may allow indoor air temperatures to be reduced without compromising comfort, thereby also reducing conduction heat loss through walls and windows.

Previous IRC research confirmed that central forced-air heating systems mix the air well in a house, thereby helping to ensure that infiltration and natural ventilation supply air can reach all occupants of the house, regardless of whether adequate distribution of thermal comfort is always achieved.

A completely hydronic approach to home heating does not provide this indoor air distribution, so supplementary ventilation schemes are needed for houses without forced-air heating, and their performance and operation will add to the total energy consumption in the house. Therefore, the hydronic radiant floor heating system and its supplementary ventilation system must be considered together for a comparison with forced-air heating systems.

Hybrid heating systems combining radiant floor and forced-air heating may provide improved thermal comfort and greater energy efficiency for the house overall. This project is taking place in parallel with a project investigating residential hybrid ventilation systems to take advantage of the overlaps in considerations for acceptable indoor air quality and thermal comfort.

The objective of the IRC research is to evaluate the relative performances of a forced-air heating system and a hydronic, radiant floor heating system, in terms of heating energy consumption, thermal comfort delivered and the energy required to deliver that thermal comfort, in the same house. Hybrid combinations of forced-air and radiant floor heating will also be examined.

This experimental research is being carried out in the newly renovated and upgraded NRC Two-Storey Research House located on the Montreal Road campus of NRC in Ottawa. The research house has been upgraded to current building technology. It has been provided with a modern forced-air heating system and hydronic heating for all areas of the floors (except the basement).

Both heating systems are fully zoned which means that researchers can assess the efficiency of various combinations of forced-air and hydronic heating to provide the necessary level of heating comfort. Automated data acquisition and control systems have been upgraded, envelope pressure distribution measurement coverage has been expanded, and an extensive network of surface temperature and relative humidity monitoring has been implemented. In two identical rooms, robotic 3-D traversing systems have been assembled to allow automated, round-the-clock monitoring of indoor environmental parameters and thermographic surveys of surface temperature distributions. The automated multi-tracer gas dosing and sampling system has also been upgraded. Occupancy simulation, via computer controlled electrical appliances and humidity generators, is also present.

To account for the fact that heating requirements may vary during the course of experiments, the Reference House of the Canadian Centre for Housing Technologies, located on the same NRC campus in Ottawa, will serve as an experimental control reference, to ensure that the performance monitoring periods are challenged by equivalent heating demands.

Experiments with various approaches to ventilation and measurements of the air exchange rates and indoor air distribution will be included in the test schedule to evaluate the impact on energy consumption and indoor air quality of the different heating strategies tested. These experiments are to take place during the 2006/2007 heating and shoulder seasons.

In addition to this planned hybrid heating research, Natural Resources Canada is conducting research to improve the aerodynamic efficiency of forced-air system fans. This could further boost the energy efficiency of hybrid heating systems.

The outcome from this hybrid heating research is expected to provide a comprehensive evaluation of the comparative energy and comfort benefits of each approach to home heating. This quantitative information will provide valuable input to national energy policies aimed at reducing Canada's energy consumption and greenhouse gas emissions. The project's results will also help the industry and consumers make better-informed, objective choices about the heating systems for renovations and new house construction.

Readers can obtain more information from these websites:
Hybrid heating research: http://irc.nrc-cnrc.gc.ca/ie/iaq/factsheet12_e.html

Research house facility: http://irc.nrc-cnrc.gc.ca/ie/facilities/testhouse3_e.html

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