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Heating and Ventilating Research at NRC-IRC

By Luc Saint-Martin

This article outlines two NRC-IRC housing research projects. One is evaluating the energy efficiency of a hydronic radiant floor heating system to verify industry claims of fuel savings over forced-air systems. The other is investigating means of improving the energy efficiency of ventilation using a hybrid approach.

In a bid to improve energy efficiency, comfort and air circulation in houses, researchers at NRC-IRC have re-designed a key facility to assess technologies for heating, cooling and ventilating. The two-storey 160-m^2 building, called the ventilation and wall research house, can be fitted with different heating, cooling and ventilating systems to study and compare their performance in terms of energy consumption, comfort and indoor air quality. The information provided by the research will be useful to builders and homeowners when deciding on mechanical systems for new construction or for retrofits to existing homes.

The first series of experiments, which will run during the coming winter months, will investigate ways of improving the energy efficiency of fans in forced-air heating systems. One approach is to replace conventional fan motors with a new generation of products called electronically commutated motors or ECM. These are brushless DC motors with a built-in inverter that typically use about one-third as much power as regular motors. An experiment carried out at the Canadian Centre for Housing Technology (CCHT) in 2002 showed that an ECM motor could save as much as $180 a year in a typical air-conditioned R-2000 house in the Toronto area. In their experiments in the research house, researchers will also try to find ways to improve the aerodynamic efficiency of the fan itself.

Another key project now underway is evaluating the energy efficiency of a hydronic radiant floor heating system to verify industry claims of fuel savings of 15-20% over forced-air systems. Since a hydronic system can transport a given amount of heating energy using less than 5% of the energy used by a conventional motor and fan in a forced-air system, scientists think that combining a hydronic system with a more efficient forced-air system could improve comfort and save energy. One of the advantages of having both hydronic and forced-air systems is that a fresh air supply can be made available through all rooms from a heat recovery ventilator that is ducted to the furnace plenum. The project will look at means of ensuring that any such improvements can be scaled down to the range of airflow rates appropriate for other residential ventilation devices such as range hoods, bathroom exhaust fans and heat recovery ventilators.

A ventilation project that is also under way in the research house is investigating means of improving the energy efficiency of ventilation for houses using a hybrid approach. Hybrid ventilation systems can be described as two-mode systems using different features of both passive and mechanical systems at different

times of the day or season. Generally, they take advantage of natural ventilation when it is available and supplement it as necessary with mechanical ventilation. The challenge is to do this in an energy-efficient way while avoiding the typical disadvantages of natural ventilation – cold drafts and excessive ventilation in winter and inadequate ventilation in summer and shoulder seasons. Under different ventilation strategies, the research house will be monitored in terms of air distribution, air change rate, temperature, humidity and indoor air quality.

The system that is currently operating uses a zoned forced-air system with opening vents in the basement and three stacks equipped with variable speed fans for mechanical-assisted ventilation. A high-efficiency propane furnace is used for heating and a high efficiency air-conditioning system for cooling.

Results will be available by early summer of 2008 for the hybrid heating project and by the fall of 2008 for the hybrid ventilation project, so stay tuned.

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NRC-IRC Ventilation and Wall Research House – front view