Research & Development

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Ventilation Systems for New and Existing Houses with Electric Baseboard Heating

Introduction

It is generally acknowledged that mechanical ventilation can improve the indoor air quality within both new and existing houses. Ventilation systems must be able to efficiently and effectively exchange, condition, distribute and circulate fresh air throughout all rooms of a house. Many ventilation strategies have been developed and successfully adopted in houses with forced air heating systems. Most of these systems take advantage of the existing forced air ductwork system to distribute and circulate ventilation air. In houses without forced air systems, knowledge of effective ventilation strategies is limited. Although fully ducted supply and exhaust air systems are effective, they are also relatively expensive to purchase and difficult to install, particularly in existing houses. Consequently, there is a need to develop alternative ventilation strategies that can not only meet the intent of current ventilation codes and standards but that are also simple and inexpensive to purchase, install and operate.

This project investigates the effectiveness of five *(5)* conceptual ventilation systems that would be potentially appropriate for houses with electric or hydronic baseboard or radiant panel heating systems. The five systems were assembled and installed in a full scale test house and the performance of each system was characterized using tracer gas techniques. The test protocol evaluated the ability of each system to exchange and distribute fresh air throughout all rooms of the house.

Project Objectives:

The objective of this project was to identify simple and effective ventilation system strategies that are suitable for new and existing homes with baseboard or radiant heating systems. The intended result of this research was to contribute to the development of appropriate design strategies which can meet the ventilation performance requirements of the Canadian Standards Association standard *CAN/CSA-F326-M91* "Residential Mechanical Ventilation Systems".

Research Program:

Five simple ventilation systems were developed that were inexpensive, easily installed and potentially effective. The systems can be described as follows:

- an exhaust-only system comprised of local exhaust fans in the bathroom and kitchen areas,
- an exhaust-only system comprised of local exhaust fans in the bathroom and kitchen areas supplemented with fresh air intake vents in all habitable rooms,

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- a partially distributed exhaust-only system that draws air from the second floor bedroom areas and operates in conjunction with local exhaust fans in the kitchen and first storey bathroom areas,

- a partially distributed exhaust only system that draws air from the second floor bedroom areas and operates in conjunction with local exhaust fans in the kitchen and first storey bathroom areas, supplemented by a central fresh air intake vent, and,

- a fully ducted supply air system operating in conjunction with local exhaust fans in the kitchen and bathroom areas.

The five systems were designed to meet the ventilation performance requirements of the CAN/CSA F326-M91 ventilation standard. In order to assess the ventilation effectiveness of the proposed systems, each of the systems were systematically installed and tested in a full scale test house facility. The test protocols included the monitoring of the system air flow rates, air change rates in each of the habitable rooms of the house and interior/exterior environmental conditions. The ventilation systems were tested during late fall, winter and early spring weather conditions.

The air change rate performance of each system was assessed using tracer gas decay protocols. Single tracer gas decay tests were performed to assess the room by room air change rates. Multiple tracer gas tests were also performed to assess the degree to which interzonal air movement affected the air change rate of a selected room.

The air changes rates achieved by each of the systems were compared to the natural air change rates of the house and the air change rates that could be achieved in an identical house equipped with a forced air heating system.

Findings:

Local exhaust fans in the kitchen and bathroom areas alone could not induce a sufficient air change rate in the house or in the individual rooms, despite the fact that the fans had been sized and commissioned to develop a total air flow equal to the whole house ventilation requirement.

The provision of passive fresh air intake vents in all habitable areas to supplement the exhaust-only systems improved the ventilation effectiveness of the system, but the natural stack effect of the house tended to predominate causing excessive ventilation in some areas and rooms and poor ventilation in others. Overall, the house was over-ventilated by this system.

The partially ducted exhaust-only system slightly under-ventilated the house. Although the ventilation rates in the closed bedroom areas were substantially improved over the local exhaust strategy, most of this air was drawn from other habitable areas. This would tend to make the quality of this air somewhat suspect in actual practice. When a single, central passive air intake was added to this system, the ventilation rates were sufficient in the bedrooms of the upper floor and in the basement while the ground floor area was slightly over-ventilated.

The fully ducted supply air system balanced with the local exhausts in the kitchen and bathroom areas was found to be capable of providing adequate fresh air supply throughout all rooms of the house.

The test protocol also showed that natural air leakage will not provide adequate ventilation in moderately air tight houses under all circumstances.

Implications for the Housing Industry:

The results of this research tend to confirm mechanical ventilation is necessary to ensure adequate air exchange and distribution in new houses. While ventilation strategies consisting of local kitchen and exhaust fans can increase whole house ventilation rates to acceptable levels, they are unable to provide adequate distribution of ventilation air. The addition of passive intake vents can help improve the performance of local exhaust-only systems, however, the presence of stack and wind pressures make the performance of the combined system difficult to predict and control. Such complications will tend to discourage the adoption of such strategies by the residential HVAC and construction industries.

Ventilation systems for houses without forced air systems must utilize some form of distribution system whether it is on the supply air side, the exhaust air side, or both. This is necessary to ensure that the ventilation air supplied, or induced, into a house will be adequately distributed through all rooms. Accordingly, builders, designers and mechanical contractors must make adequate provision for ventilation air distribution ductwork in new house construction and large renovation activities where mechanical ventilation is necessary.

Although distribution is a significant consideration in the design and installation of ventilation systems, other important factors such as energy efficiency, occupant comfort, ease of operation must also be considered.

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A full report on this research project is available on loan from the Canadian Housing Information Centre at the address below.

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