#3670

AIVC

Ventilation systems
design, installation and commissioning: how well is it done?

To provide improved indoor air quality in new homes mechanical ventilation is a must. Debate continues over how best to provide it. What types of systems are most appropriate? What will the cost impact be on the price of the home?

To try and provide some answers, the Flair Homes Energy Demo/CHBA Mark XIV Project in Winnipeg undertook to evaluate the performance of several residential mechanical systems, with special emphasis on ventilation systems.

Ventilation Systems

The systems looked at were:

* *Combined Heat Recovery Ventilator (HRV)/forced air heating system*
* *Dedicated HRV ventilation system*
* *Dedicated HRV ventilation system with a heat pump HRV*
* *Prototype exhaust-only heat pump HRV*
* *Integrated heat pump HRV, space and DHW heater*

The mechanical systems were designed by UNIES Ltd. in accordance with standard industry (HRAI) design practices.

Most of the houses had high sidewall supply registers rather than conventional floor registers. This was done to provide better ventilation distribution and to reduce discomfort caused by cool drafts. Standard off-the-shelf HRV's were used.

The houses were completed in the spring of 1986. All system installations were done by a large mechanical contractor with several years of experience on a variety of residential mechanical system installations including HRV's in R-2000 houses. Additional on-site support and inspections were provided by the system designers.

The houses were left in a "contractor-delivered" state. Only the total ventilation supply and exhaust flow rates were measured and adjusted to their design values. One house was also zone-balanced to adjust the internal air distribution.

Tracer gas tests were performed to determine the actual air change rate experienced by the house due to the combined effects of mechanical ventilation and natural infiltration.

Detailed balancing exercises were carried out in seven of the houses. These were performed after the tracer gas testing had been completed. Test procedures varied slightly depending on the type of system, but typically consisted of measuring the branch and main duct flow rates in the system and then making the necessary adjustments to achieve the design flow rates.

In the case of forced air heating systems, only the total supply and exhaust rates were measured and adjusted.

Branch duct air flows were measured at the appropriate supply or exhaust grille.

What was found?

Combined HRV/Forced Air Heating

The most common type of ventilation system in R-2000 houses is the combined HRV/forced air heating system in which an HRV supplies outdoor air to the return air plenum of the furnace which in turn mixes and distributes the air throughout the house. Continuous operation of the furnace blower is required.

Two houses in the project had this type of system. Two features of the systems are: a) return air registers were used in each room to assist air circulation when interior doors were closed and b) all supply registers were mounted high on interior partition walls to minimize occupant discomfort. (This is not the standard practice for forced air systems)

The complete design of the heating and ventilation systems for one house took about 12 hours for an experienced designer. This included the HRV ductwork, supply and return systems and the high-sidewall supply ductwork.

These systems were installed and commissioned in accordance with recommended practice, and were able to achieve the design ventilation rates. Because of the high recirculation rates by the furnace blower, there was good air distribution throughout the house. However, it was noted that exhaust duct leakage in the basement provided a major portion of the basement ventilation.

Dedicated HRV ventilation systems

These are usually used with baseboard or radiant heating systems in R-2000 type housing. In the absence of forced air heating ductwork, the dedicated HRV ventilation system is designed to supply outdoor air to each zone of the house.

The time required for an experienced individual to design the dedicated HRV system was about 6 hours.

These systems did not achieve the desired distribution of ventilation air without zone balancing. Grille location and direction of throw had a strong impact on the mixing of ventilation air with the room air. Short circuiting of ventilation through open interior doors could take place.

Total ventilation rates were unaffected by the position of the interior doors. Dedicated HRV ventilation systems usually rely on under door air transfer, but there are practical limits to the amount of undercut possible due to increased noise transfer.

The balancing reports for three houses showed that too much air was being supplied to the basement while insufficient flows were reaching the main floor. With the basement supply grills closed, the system in one house was able to attain a good distribution.

It was noted that the basement received enough ventilation just by duct leakage, which was substantial in both the supply and exhaust ducts. As most of the ducts are located in the basement, the researchers suggested that duct leakage could provide ventilation air to the basement. (This is not the recommended practice!).

How bad was the leakage? 42% of the total flows in both supply and exhaust runs. In one house, taping an 8 foot section of duct between the HRV and flow measuring station resulted in 32 cfm of leakage being eliminated (20% of the total flow)!

The design of proper design for a low pressure with proper grille design is important.

Exhaust-Only Heat Pump/HRV Ventilation

As these houses did not have fireplaces or other open combustion appliances, 2 were equipped with prototype exhaust only heat pump heat recovery ventilation systems. They use four speed exhaust fans to provide variable ventilation capacity.

They are designed to depressurize the house and provide required ventilation requirements through the envelope leakage (utilizing the dynamic wall approach).

This type of system relies on a 'proper' distribution of envelope leakage to provide balanced and distributed infiltration into each zone.

The test results were not clear, but they do suggest that the system was not able to achieve the desired ventilation rates. The reason for this is because of leakage in ducts, cross leakage in the heat recovery module, and the air handler itself.

From the design and system layout this type of system is substantially different from conventional mechanical systems, and requires careful planning and integration to the overall structure. The location of doors relative to grilles is important, as poor layouts can short circuit air flows.

Another problems noted was with the nature of the equipment. It required considerable amount of homeowner input: the unit had 3 dials and 3 switches.

Good mechanical systems have to be designed to operate as automatically as possible, so that there is a minimum of occupant input required. Not all homeowners are techno freaks!

The equipment in these houses were prototypes, and following the tests the manufacturer replaced the units with updated units which resolved the manufacturing problems.

Observant readers may have guessed that the system desbribed is the Fiberglas Canada Habitair system.

How bad was the duct leakage? In one house, 42% of the total ventilation air flow in both supply and exhaust runs leaked out.

Integrated Heat Pump HRV Space and DHW Heating Systems

These systems combine several different components into one mechanical package. They used 2 speed circulation blower, with extra capacity provided by manually activated exhaust fans in the bathroom, kitchen and laundry.

This system used a Peach heat pump, which is no longer made. However, integrated mechanical systems will become more common, as new equipment is being developed. They offer the potential for efficient, simple systems. The lessons learned can be used in other situations.

Careful planning of the installations was found to be more critical than with conventional systems. The units themselves were large and heavy, requiring planning at the framing stage to manoeuvre them into place. As well, two large duct penetrations (8"x32") were needed, and had to be allowed for at the foundation construction stage.

As with other systems, uncontrolled air leakage from the unit case, and ducts was a major problem.

The blower unit must be isolated from the structure to avoid vibration and noise transmission problems which happened in this installations.

Ventilation rates could not be determined by the installer due to the method used in the HRV unit to introduce outdoor air with the recirculating house air. Installed in accordance with recommended practice, the total ventilation rate was adequate, although a large variation in flow rates was noted between the two houses.

Commentary

This study was done a couple of years ago, so it reflects the state of the art of the industry at the time. In areas where much R-2000 activity has taken place, the findings described are old news, as mechanical trades have become familair with the equipment. However, the observations made and lessons learned are still valid.

By their vary nature, some systems are harder to inspect and verify that they perform as intended. We shouldn't have to design systems just for the convenience of the inspector, but if they can't be inspected (whether by inspector or installer) how can we be sure that they are working the way they are supposed to?

One common item noted in all installations, regardless of mechanical system type, is that there is a lot of duct leakage. Poor installation practices can defeat the intent of the best system design.

This item outlines the findings noted in the Flair Homes Project Report No. 3: "Design, Installation and Commissioning of the Ventilation Systems" prepared by Gary Proskiw and E.G. Phillips of Unies Ltd., D.A. Figley of IRC/NRC, and D.R. Fisher of K.P. Engineering & Design. For information or to obtain a copy, contact: EMR, Residential Energy Management Division, Ottawa, Ont. K1A 0E4