How to get the ventilation you need in your house

Canadians are coming to value the importance of airtight homes that have proper ventilation. Houses built generations ago tended to be drafty, uncomfortable and very dry in winter because of high air leakage. In contrast, because of improvements in building codes and construction practices, new houses incorporate good air barriers and meet requirements for minimum ventilation. However, most existing houses fall somewhere between these two scenarios.

What does this mean to you?

If your house is stuffy, has lingering odours or has high humidity levels in fall and winter, it is likely the house does not receive adequate ventilation. If the occupants have respiratory conditions such as asthma, bronchitis or chronic colds, getting the proper amount of fresh air is even more important.

Windows can provide fresh air if there is a wind or driving force, but open windows can cause comfort problems, increase heating and cooling costs, and may be a security risk. Using a mechanical ventilation system, such as an exhaust fan or a heat or energy recovery ventilator (HRV, ERV), can be more effective. The key point is that proper ventilation is important for your health and for your home.

Ventilation

Ventilation is often defined as a means of providing fresh air while removing or diluting stale air. However, the word “ventilation” can describe several types of air movement.

Natural infiltration

Houses get some outdoor air from natural infiltration. This is the air that comes into the house through leaks and intentional openings (see Figure 1) and is commonly measured in air changes per hour (ACH). An ACH rate of 0.5 means half of the house air is changed every hour or all the house air is changed every two hours.

Exfiltration is the amount of air that exits the house. It is always offset by infiltration as the house attempts to reach equilibrium. Without this balancing, the house would become depressurized or (very rarely) pressurized. Note that infiltration is uncontrolled ventilation and, as such, is influenced by such

things as wind, outdoor temperature and the height of the building. These factors make it impossible to know exactly how much and from where air enters or exits the house. Consequently, infiltration can cause comfort problems and exfiltration can lead to structural problems.

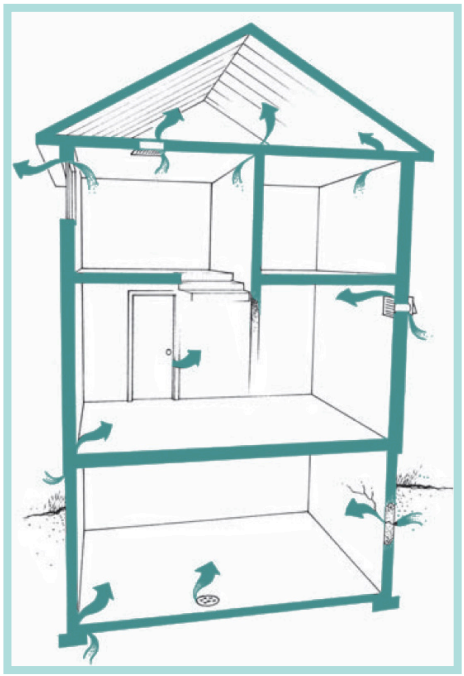

Figure 1. Infiltration and exfiltration of air in a house

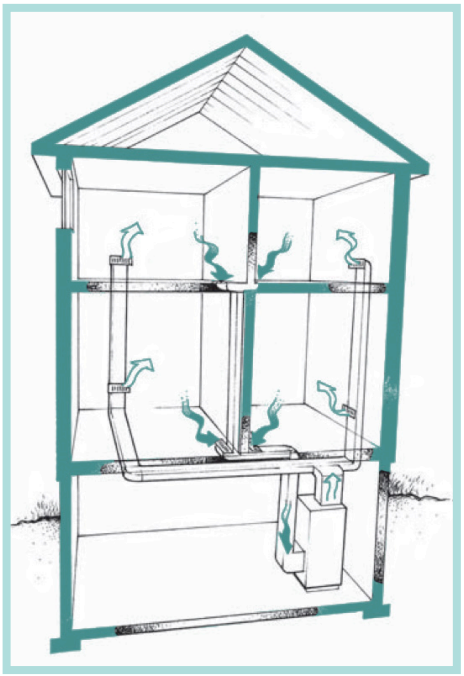

Figure 2. Distribution of air throughout a house

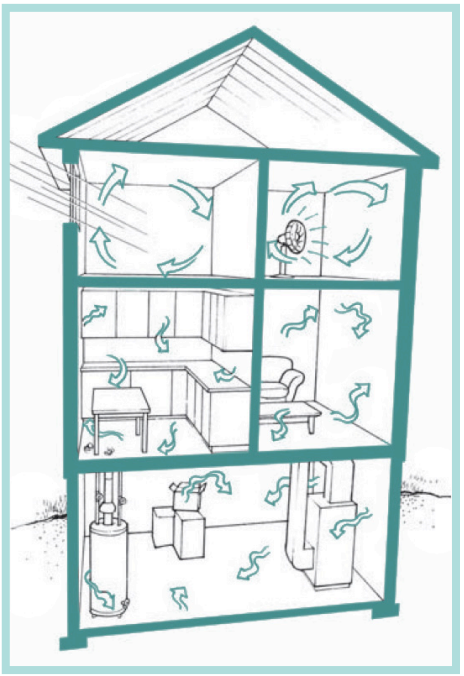

Figure 3. Circulation of air in a house

Distribution and circulation

Fresh air needs to be moved around the house, particularly to rooms with closed doors, such as bedrooms (see Figure 2). Without distribution, fresh air might not reach all the rooms in a house and could cause pockets of stale or moist air. Distribution of air throughout a house usually requires fans and ducting systems.

Circulating fresh air within a room is necessary to reduce under-ventilation, such as in large spaces or rooms with a lot of furniture or stored items (see Figure 3). Fans, or better yet, an upgraded distribution system can help here too.

Is ventilation necessary?

Ventilation and good air quality are sometimes under-appreciated. If the furnace breaks down in the winter and the house starts getting cold, you will notice that problem within a couple of hours. However, insufficient ventilation will generally not be noticed as quickly because it takes time for symptoms such as stuffy air, moisture accumulation or mould to develop.

A good time to get a sense of the indoor air quality is when you enter a house, before you get accustomed to the indoor air. Do you notice residual cooking odours, smelly garbage or even a musty smell from mould? It should smell fresh and neutral.

People need fresh air at all times but the need for additional ventilation will vary by the season. In the middle of winter, when it is very cold or windy outside, the natural ACH rate of the house will be higher, and you may not require additional mechanical ventilation. This high winter ACH rate is stack effect, which is caused by the force of rising warm air: the greater the difference between the interior and exterior temperatures, the stronger the force of the stack effect. The stronger force causes more warm air to leak out the upper portions of the house while cold air is sucked in to replace it in the lower areas of the house – hence a higher ACH rate.

Often mechanical ventilation makes sense in the fall, winter and spring. Mechanical ventilation is even beneficial for mid-summer if you are using air conditioning and do not open windows for extended periods. In fact, summer is when houses have the lowest natural ACH rate. The rate is low because the stack effect is considerably less. This is due to the difference between the interior and exterior temperature being much smaller at this time of year.

Providing good ventilation

Good ventilation can be added to any house, usually at a reasonable cost. The following advice is for a variety of houses.

Older houses that have no ducts or fans

Owners of older homes usually rely on opening windows in bathrooms and kitchens to get a cross breeze to meet their ventilation needs. However, bedrooms are often under ventilated so some type of mechanical ventilation system may be needed. This is especially important if these houses are to be or have been made airtight through renovations and energy retrofits.

Bathroom and kitchen exhaust fans that vent to the outside are recommended as a minimum to remove odours and moisture produced in those rooms. However, a whole-house ventilation system is more effective at providing adequate ventilation.

Caution: Exhaust-only ventilation can promote high levels of depressurization, especially if powerful exhaust fans are used. High levels of depressurization can reverse the flow of exhaust gases in the chimney from many types of fuel-burning appliances such as wood stoves and gas-fired water heaters and spill the gases back into the home. This dangerous situation must be avoided. For more information, see *Combustion gases in your home: What you should know about combustion spillage*.

Homeowners can have the benefits of an HRV or ERV because dedicated ventilation ducting in smaller dimensions is available for regular, low velocity systems. Furthermore, high velocity systems offer even smaller ductwork. Note that systems must be designed and installed properly to prevent noise from the air flows.

Ductwork can be installed between existing floors, in wall cavities, corner spaces, closets, in or on basement ceilings, and in drop ceilings but not in an attic when it is exposed to extreme temperatures that can cause moisture damage and energy losses.

Houses that have bathroom fans and forced-air furnaces

Relying on a bathroom exhaust fan alone is not an effective ventilation strategy. This system depends on outdoor air to leak in through various gaps in the house to replace the air being exhausted by the bathroom fan. The furnace fan and ducting system then mix this infiltrating fresh air with house air and distribute that in the house but only when the furnance fan is operating.

Ventilation fan combined with a furnace fan

Another ventilation strategy is to install an additional high-quality, energy-efficient fan that is centrally located and electrically interconnected to the forced air heating system. This "ventilation fan" is commonly installed in the main floor hallway ceiling or located near the bedrooms, with its controller located beside the furnace control. The fan must be vented to the outside. Although adding an additional ventilation fan that is interconnected with the furnace fan is not the best way to run a ventilation system, it can be made to work.

For some houses that are very airtight, a small duct may also run from the exterior of the building to the return trunk duct of the furnace to introduce fresh air directly into the furnace. This small duct reduces how much air is drawn through wall leaks and promotes tempering of the outdoor air before it reaches the rooms. However, the addition of the small intake duct should be discussed with a heating contractor to avoid possible damage to the furnace heat exchanger.

Installation and operation instructions

1. Install a ceiling-mounted exhaust fan designed for continuous operation that is highly energy-efficient (less than 25 watts) and quiet (1.0 sone or less) so you will not get annoyed by the sound. A small-sized fan that has an airflow rate of 25 litres/second (50 cubic feet/minute) is adequate. Fans that have higher airflow rates should include a speed controller to reduce airflow and power consumption.
2. Link the ventilation fan control to the furnace's operating control (e.g. programmable thermostat). The furnace fan is then being used to help distribute fresh air throughout the house when the ventilation fan operates.

HRV or ERV connected to the furnace ducting system

Heat and energy recovery ventilators are mechanical devices that provide good ventilation without incurring high energy costs to heat the incoming outside air. Both these ventilators first use the air being exhausted to heat the incoming air. They recover 60 to 90 percent of the heat from the exhausted air. Consequently, the incoming air in winter will be much warmer than the untreated outside air (but still cooler than the house air).

The balanced ventilation provided by these devices should not create house depressurization that could affect the proper and safe functioning of fuel-fired appliances in the home.

In addition, an ERV transfers a portion of the moisture from the more humid air flow (the indoor air in winter and the outdoor air in summer) to the drier air flow, which helps to regulate the humidity level in the house. During the heating season, this moisture transfer can reduce drying out the interior of some airtight homes, which might occur when HRVs are used, especially in cold, dry climates. Also, an ERV can improve indoor humidity control and reduce air conditioning energy consumption on warm humid days.

Due to the HRV or ERV using the furnace ductwork in this arrangement, the furnace fan has to be on or at least cycling on and off, for the fresh air to get distributed around the house. The HRV or ERV control can turn on the furnace fan (known as interlocking).

To improve the energy efficiency of a furnace fan, install or retrofit a furnace with a direct-current fan motor or install a fan-cycling controller or a programmable thermostat that has a fan-cycling feature. As with furnaces, HRVs and ERVs need regular maintenance and cleaning.

See Natural Resources Canada's publication *Heat Recovery Ventilators* for additional information and advice.

HRV or ERV that has separate ducts

Installing an HRV or ERV system that has its own ducts can be the most efficient way to ventilate a house, especially if no ductwork exists. The HRV or ERV heats the incoming air, and its internal fan distributes the now tempered fresh air and draws the stale air through its own dedicated ducting. This system does not require a furnace fan to run as part of the ventilation distribution system, which can reduce energy costs significantly.

Although sealing the ducts is always recommended to ensure that conditioned or fresh air gets to its intended location, this is particularly important with dedicated duct systems. Sealed ducts help ensure that the small blower fans in an HRV or ERV can deliver the volume of air required.

The HRV or ERV should be used anytime the house is normally occupied. Run the ventilator continuously or intermittently at low or medium speed, and switch to high speed when you want more ventilation.

When choosing an HRV or ERV, select one that has been independently certified (e.g. has a Home Ventilating Institute (HVI) certification sticker) or an ENERGY STAR® certified model. For an ERV, ensure that it is tested at low temperature in the HVI directory; ENERGY STAR certified models are all tested at low temperature. Choosing a ventilator that has a high "sensible recovery efficiency" and a fan motor with low energy consumption will ensure the lowest operating costs.

Rated HRVs and ERVs are listed on Natural Resources Canada's website and on the HVI website at www.hvi.org. Also ensure that the contractor installing and balancing the HRV or ERV has been trained to do so through an organization such as the Heating, Refrigeration and Air Conditioning Institute of Canada or through La Corporation des maîtres mécaniciens en tuyauterie du Québec.

As mentioned in the previous section, make sure the HRV or ERV is maintained regularly.

Running the ventilation system

Ventilation is not as critical when the house is unoccupied, although some houses require ongoing mechanical ventilation to control moisture and its potential to damage the home (e.g. reduce condensation forming on windows in winter, which can cause damage to window frames, trim and walls). To help control the amount of ventilation required and to prevent over ventilation, which wastes energy and tends to dry out a home, simple to sophisticated controls, from timers to electronic programmable controllers, are available.

However, there are times when high ventilation rates are needed such as:

- the first fall and winter for a new or substantially renovated house, to get rid of construction-related moisture
- houses with high numbers of occupants, either temporary or permanent
- houses in which renovation activities (drywalling, painting, floor re-finishing, etc.) or new furniture are creating high concentrations of pollutants
- houses whose residents have respiratory problems. People allergic to outdoor pollutants require filtered outdoor air supply.

Summary

Most Canadian houses will benefit from the fresh air supplied by mechanical ventilation. In new houses, fresh air is most efficiently delivered by an HRV or ERV. In existing houses, quiet and efficient bathroom and kitchen fans, or HRVs when practical, linked to proper controls, can improve air quality. Using furnace fan motors that are energy-efficient and furnace fan controls that can cycle helps to distribute fresh air to all rooms of the house at a reasonable cost. Sealing the ducts is a good idea to reduce air flow loss.

Mechanical ventilation gives control of the quality of household indoor air to the homeowner rather than having the weather dictate the ACH rate in various parts of the house. Using mechanical ventilation also allows for the house to be built or renovated to high airtightness levels to reduce heating bills and improve comfort while ensuring good indoor air quality.

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