Ventilating Your Home

CO_2RE Home$avers

Take Action on Climate Change

CO_2RE

Carbon Dioxide Reduction Edmonton

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About CO_2RE

Created *by* Edmontonians *for* Edmontonians...

Carbon Dioxide Reduction Edmonton (CO_2RE) is a developing organization formed to implement Edmonton's Community-Wide Greenhouse Gas Emissions (GHG) Reduction and Energy Strategy. CO_2RE is supported by the City of Edmonton and a group of local organizations dedicated to implementing the strategy and reducing greenhouse gas (GHG) emissions in our city.

The CO_2RE mission is to work with Edmonton residents, businesses, institutions and industry providing services, programs and initiatives to assist in reducing energy use, thereby reducing the levels of the GHG emissions that are responsible for Climate Change.

CO_2RE goals include:

- up to a 6% reduction in GHG emissions (from 1990 levels) by the year 2010 and
- a 20% reduction in GHG emissions (from 1990 levels) by the year 2020.

Do your part...

We can do many things to reduce our emissions – and that includes making our homes and lifestyles more energy efficient. The publications in this series are a first step, providing Edmonton with specific how-to guides on improving home energy efficiency, saving money and reducing GHG emissions.

For more ideas on how to become more energy efficient, log onto our website at **www.co2re.ca!**

Free Membership

Why get a membership? Becoming a $C0_2RE$ member is free and the more people who join us in taking action on climate change, the faster we will achieve our goals. CO_2RE is working with local companies to offer incentives on energy-efficient products and programs to further assist homeowners. You'll also receive a regular newsletter with new ideas and updates. Sign up today at **www.co2re.ca.**

Industrial and commercial/institutional companies can contact our manager at 944-CORE (2673) to find out how they can participate.

Introduction

The information provided in this booklet is designed to increase your understanding of ventilation and help remedy existing or potential problems.

In the past, houses received enough fresh air through natural air leakage in and out of the building shell. In most homes we often get a lot more fresh air than we need, especially on those cold winter days at –35°C.

Starting in the 1970s, increasing fuel prices and the consequent pursuit of energy efficiency through tighter construction has led to some concerns over adequate ventilation.

Better air sealing techniques and special construction methods have reduced heating bills and increased comfort. The concern is that tightly sealed homes may result in unsafe operation of combustion appliances, condensation problems, or concentrations of air contaminants that may cause discomfort or negative health impacts. Householders with air conditioning or security concerns are less likely to open windows in summer to provide ventilation.

Most ventilation problems can be solved by carefully controlling the movement of indoor and outdoor air within the house.

The exchange of indoor and outdoor air is called ventilation.

Natural ventilation is the term used to describe air exchange occurring without the use of mechanical devices or fans. This can be through unintentional openings (air leakages through cracks) or through intentional openings (operable windows or fresh air ducts).

Mechanical ventilation refers to air exchange created by electric exhaust and intake fans.

Understanding Ventilation Terminology

The following explanations describe the various terms used in Figure 1.

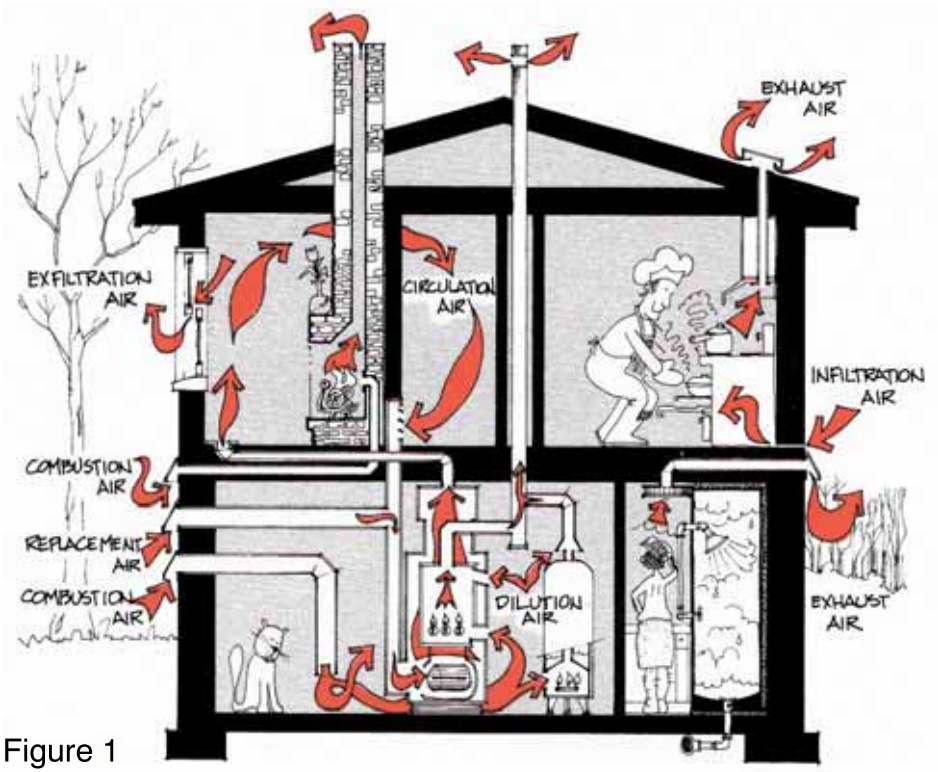


Figure 1

Air Exchange Rate – The rate at which air is replaced inside the house by outside air, through a combination of natural leakage and mechanical ventilation. For example, an air change rate of one-half air change per hour (ACH) means that half the volume of air in the entire house is exhausted and replaced by fresh air every hour.

Circulation Air – Indoor air that is moved around the house by a circulating fan, as in forced air heating or combination systems.

Combustion Air – The air required to allow fuel to be burned efficiently and exhaust the by-products of combustion safely from appliances such as furnaces, water heaters and fireplaces.

Dilution Air – The air required by standard efficiency combustion appliances to maintain an effective chimney draft regardless of atmospheric pressure fluctuations or weather conditions.

Exhaust Air – Air expelled outdoors by bathroom and kitchen fans, clothes dryers, power vacuums, etc.

Exfiltration – The uncontrolled leakage of indoor air out of the house through cracks around windows, doors, electrical outlets and other openings such as the chimney.

Infiltration – The uncontrolled leakage of outdoor air into the house through cracks around windows, doors, electrical outlets and other openings.

Replacement (Make-up) Air – Air from outdoors that replaces the air removed from the house by dilution air, exhaust air and exfiltration.

Ventilation Concerns

Humidity and odours can be annoying and unhealthy when present in excessive amounts. Over time, high indoor relative humidity can cause serious structural problems with wood rot and damage to other building materials as well as respiratory problems from molds and dust mites.

When odours linger or excessive condensation accumulates on windows, it may be an indication that the house is not receiving an adequate supply of fresh air. Solutions to moisture problems are detailed in the *Home$avers – Condensation Concerns* booklet. Try the simple steps in the booklet first to solve condensation problems.

It is important to understand that houses with condensation problems do not necessarily have a ventilation problem. There are causes for condensation other than lack of ventilation, such as inadequate insulation, poor window glazing, excess moisture production or worn weatherstripping (cold air leakage). Conversely, solving the condensation problem does not mean there is no ventilation problem.

Indoor Air Pollutants

Our indoor environment has changed. Questions are now being asked about possible adverse effects of lower air change rates and the health of occupants. A number of factors can cause problems.

- Sources within the house may create high pollutant levels.
- Ventilation may not be sufficient to remove the pollutants.
- Poor air circulation results in localized areas of high pollutant concentrations.

A house can be contaminated in a variety of ways. Some building materials, carpets and furnishings give off formaldehyde gases and a variety of other pollutants. Radon gas can enter from surrounding soil or groundwater and needs to be measured to identify if it is a problem (not often a problem in Edmonton area homes).

Other pollutants are added to indoor air from various sources (Figure 2). Carbon Monoxide from incomplete burning or malfunctioning stoves or furnaces is a serious health hazard.

Figure 2

Long-term health effects of exposure to low levels of home pollutants are not well documented or understood and it is difficult to establish safe concentrations. The wise choice is to ensure that you have adequate ventilation, which will dilute and reduce pollutant levels. Some sources and health effects of pollutants are described in Table 1.

Table 1 - Indoor Air Pollutants

Pollutant + Possible Source	Health Effect
Benzo(a)pyrene - Fireplaces, woodstoves, tobacco smoke	Can cause coughing, headaches, nausea and irritation to eyes, nose and throat. Also known to cause lung cancer.
Carbon dioxide - Humans, animals, improperly operating gas appliances, kerosene heaters, malfunctioning furnaces, fireplaces	High concentrations reduce the flow of blood to the brain and can cause headaches, nausea and dizziness. Exposure to very high concentrations can be lethal.
Carbon monoxide - Tobacco smoke, improperly operating gas appliances, kerosene heaters, malfunctioning furnaces, fireplaces	Symptoms include headaches, mental confusion, dizziness, impaired vision and fainting on exertion. At high levels unconsciousness and death can occur.
Formaldehyde - Particleboard, plywood, carpet backing, furnishings, insulations, tobacco smoke	Can produce eye, nose and throat irritation, coughing, headaches, dizziness, nausea, vomiting and nosebleeds.
Nitrogen oxides - Kerosene heaters, woodstoves and fireplaces, malfunctioning furnaces, tobacco smoke, unvented gas appliances (i.e. stoves)	Causes irritation of mucous membranes of upper respiratory tract. Prolonged exposure can cause lung damage.
Radon - Soil, ground water, (needs to be measured)	Radioactive radon particles attached to dust can become trapped in the lungs and cause cancer.

Use this table carefully. Although the sources produce various pollutants, high concentrations may not necessarily result. If you or your family show signs of the health effects listed, refer to the solutions in the next section. If the health effects persist, seek medical advice.

Solutions to control indoor air pollutants are to stop them at the source or to ventilate. Limit the production of air pollutants using the following methods:

- Selecting chemically stable building materials can reduce formaldehyde levels. Limit the use of glues and interior grade plywood and particleboard (which use ureaformaldehyde resin). If particleboard must be used, such as in cabinets, be sure it is well sealed to prevent the escape of gases.
- Any potential radon infiltration can be kept to a minimum by sealing cracks in the basement, and in new homes by installing a layer of polyethylene plastic under the basement floor before the concrete is poured.

- Nitrogen oxides and carbon monoxide can be kept at safe levels by limiting the use of unvented or improperly operating combustion appliances.
- Fireplaces and woodstoves are possible sources of benzo(a)pyrene, particulates, carbon monoxide, etc. so be sure that they draft properly. If you can see or smell the smoke in the house, these devices are spilling combustion by-products into the home.
- Maintain and adjust all combustion appliances to ensure they are operating safely and efficiently.
- Reduce polluting activities such as tobacco smoking. This helps control levels of benzo(a)pyrene, nitrogen oxides, formaldehyde and carbon monoxide.
- Reduce your reliance on toxic cleaning products and eliminate the use of aerosols.

If attempts to reduce the contaminant at the source are not sufficient to control indoor pollutant levels, it may be necessary to increase ventilation rates. Ventilation options are detailed later in this booklet.

Back Drafting

Identifying the Problem

Many devices require large quantities of indoor air to function properly. On a cold winter day, a home with a conventional furnace and hot water tank would use 760,000 litres per day (27,000 cubic feet per day) of house air for combustion and dilution air.

A large fireplace might exhaust the same volume of air in three hours when burning rapidly. Significant amounts of indoor air can also be vented outdoors by clothes dryers and bathroom and kitchen fans. This means that an entire volume of house air could be removed in less than an hour.

Have you considered how this large amount of air is replaced? In the past, infiltration (air leaking in) usually provided combustion and replacement air to balance the quantity exhausted outdoors. If the home is tight enough to restrict natural infiltration and is not equipped with a proper ventilation system or fresh air supply this can result in a serious problem called **backdrafting.**

Imagine you have put a load of clothes in the dryer and sat down to relax in front of the fireplace on a cold winter night. House air is being drawn up the fireplace chimney creating a lower indoor pressure relative to the outside and air will be drawn into the house through the easiest route.

The furnace chimney may become an air supply route (Figure 3). If the furnace comes on and cannot reverse this backdraft condition, combustion gases that would normally go up the furnace chimney will escape into the house through the draft hood of the furnace or gas fired water heater.

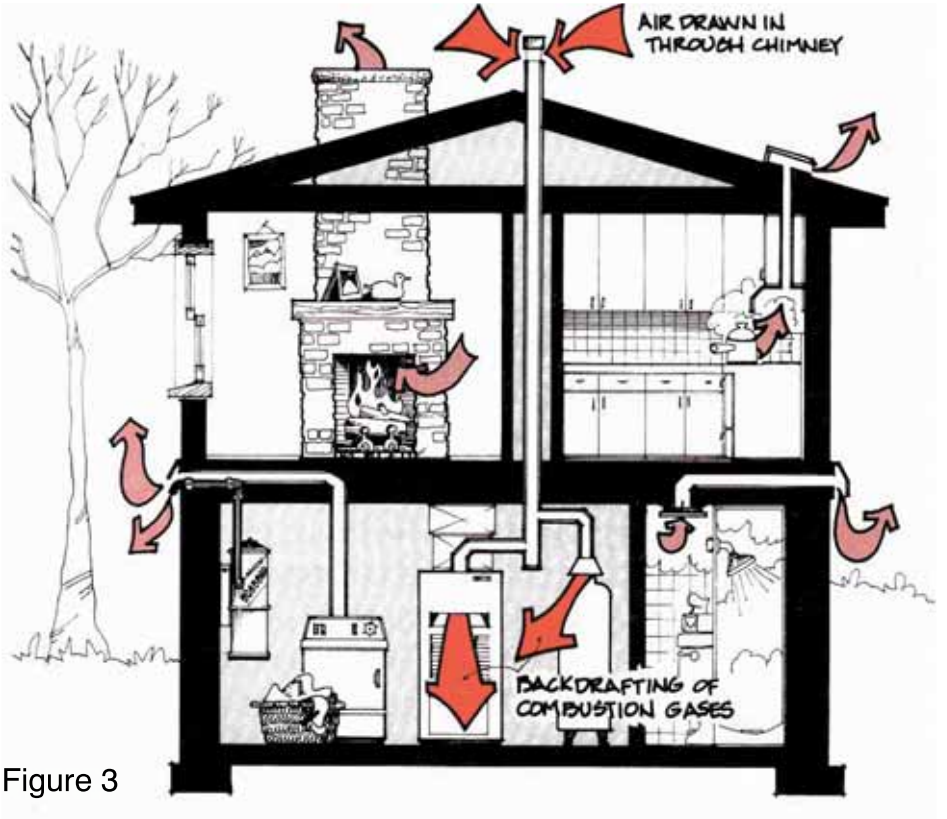


Figure 3

Research indicates that backdrafting can be a common occurrence in many homes and a potential problem in others. Listed are some indicators that will help you determine if backdrafting is occurring:

Inspect your furnace and hot water heater for the following signs (Figure 4):

- Combustion odours near these appliances particularly when they have just started up.
- Heavy sooting, discolouration or burnt areas around the draft hoods.
- Condensation and rust around the vents to the chimney. Check in cold weather when the furnace has not been running for some time.
- Problems such as high humidity and stale indoor air or odours can also be attributed to a malfunctioning chimney.

- Physical ailments caused by combustion products, such as carbon dioxide and carbon monoxide, include headaches, nausea, coughs and stinging eyes.

Serious backdrafting can cause enough combustion gases to be vented into a home to cause unconsciousness and death.

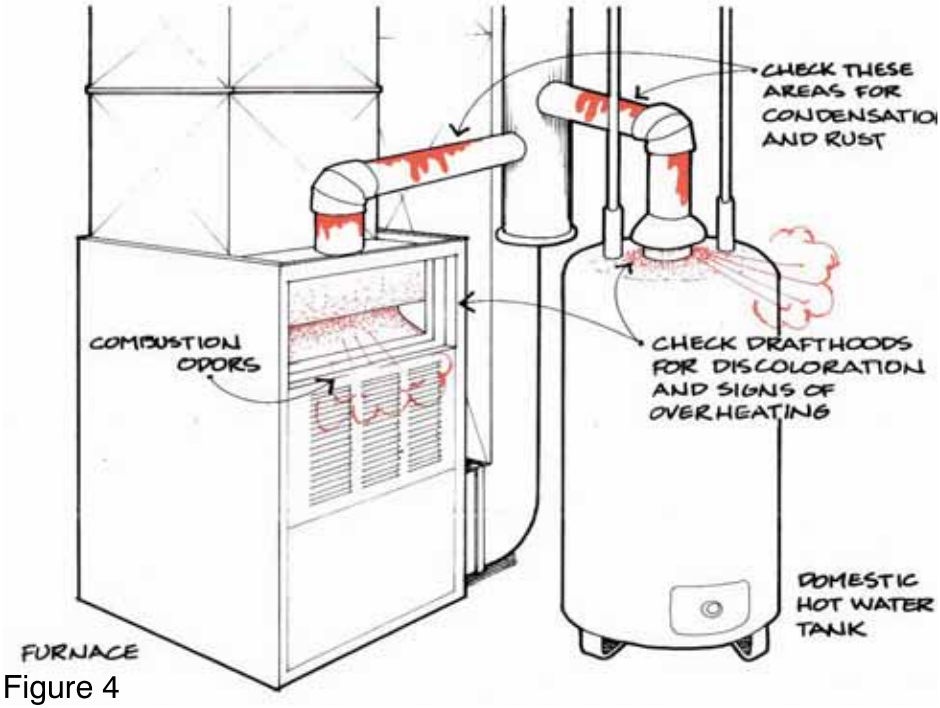


Figure 4

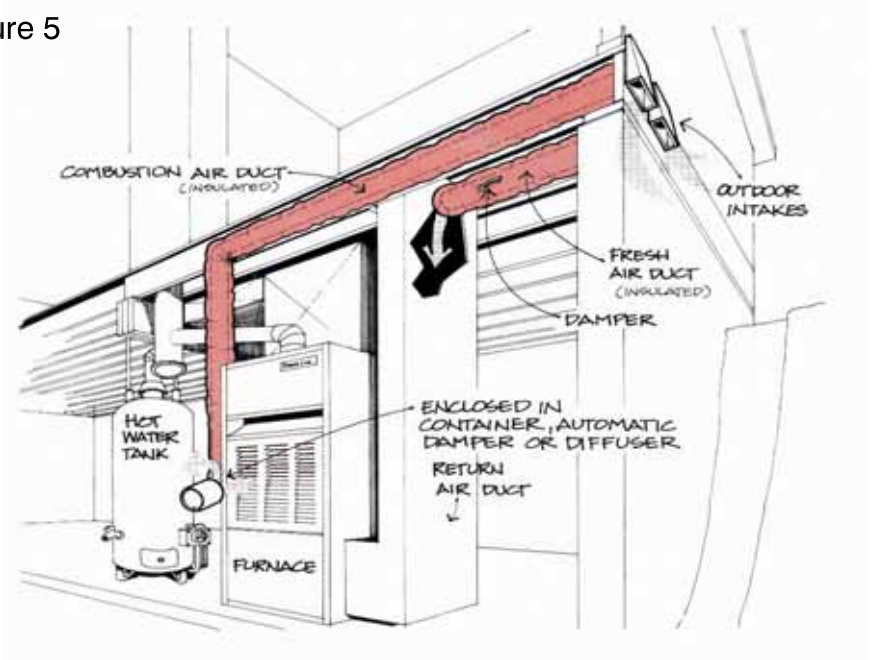
Solutions

If you have detected signs of backdrafting it should be corrected immediately because of the health hazards. Your gas supplier may have an inspection service or can direct you to qualified service personnel or a certified HRAI heating contractor, to inspect the chimney and venting system for damage or blockage and conduct **an appliance backdraft test.**

You should already have a separate insulated combustion (fresh) air duct from outside as shown (Figure 5) to provide combustion air for the furnace and hot water heater. If you do not, you should have one installed immediately. Lack of combustion air in a furnace room could be a contributing factor to backdrafting.

This combustion air duct cannot have a manual damper and must be located within one foot vertically and two feet horizontally of the burners on the largest gas appliance, usually the furnace. To avoid uncontrolled entry of cold air the duct should be fitted with an approved automatic damper.

Figure 5



An insulated fresh air duct from the outdoors to the return air plenum of a forced air heating system is required by building code to provide a ventilation air supply to the home. Fresh air ducts are not designed to prevent backdrafting and have no impact unless the furnace fan is being run continuously.

To avoid the worst consequences of backdrafting, install a carbon monoxide detector near all combustion appliances. If the alarm should sound, leave the house and have your appliances immediately checked by a professional.

If you can detect minor backdrafting try checking around the home when this occurs to determine what is happening to cause backdrafting. Are the furnace and hot water tank both running, is the fireplace going, and are any or all of the exhaust fans, bathroom, kitchen or clothes dryer running? If you know the cause you can sometimes simply change usage habits and reduce the backdrafting.

If backdrafting remains a problem then you need to consider installing new spillage-resistant appliances such as a sealed combustion high efficiency furnace and direct vent hot water tanks. Another possible solution is to reduce exhaust capacity by reducing exhaust fan sizes, installing a control system or installing separate fresh air ducts with two way dampers for dryers or large kitchen fans.

Fireplaces are prone to both causing and experiencing backdrafting themselves. At the least consider installing a combustion air duct directly into the firebox combined with a set of glass doors, it will help reduce some spillage and backdrafting. Consider having a smoke and CO alarm installed near the fireplace, it will give you a warning when fireplace spillage is occurring.

Choosing a Ventilation System

Ventilation standards are established in the Alberta Building Code. The code requires that the entire house have a mechanical ventilation system capable of providing at least one-third an air change per hour. This is equivalent to 42 litres per second (L/s) or 89 cubic feet per minute (cfm) in a 1000 square foot home.

Permits are required for the installation of ventilation systems and related equipment. Contact the City of Edmonton at **www.edmonton.ca** or call (780) 496 3100.

The system should also satisfy the following performance requirements.

- **Supply each room with a continuous supply of fresh air, at a rate of about 5 L/s (10 cfm).** Higher ventilation rates are required for kitchens and bathrooms: 25 L/s (50 cfm) to bathrooms and 50 L/s (100 cfm) to kitchens on an intermittent basis.
- **Distribute fresh air to every room.** In homes with a forced air system, running the furnace fan continuously at a low speed can distribute the fresh air but greatly increases operating costs.
- **Not affect the operation of the combustion appliances.** Exhaust only systems create negative indoor pressure, which can cause backdrafting to occur.
- **Be controllable.** Controls may be manual (such as adjustable dampers) or automatic (such as override switches or humidity controllers like humidifiers and dehumidistats).

A variety of systems and techniques are available for ventilating the home. Some of the system types are examined next.

Passive ventilation systems operate without use of fans. An open window is an example. Open windows, however, are not practical on cold, windy, winter days and they will not provide a constant ventilation rate.

Another method of passive ventilation is to bring fresh air in through an open fresh air duct (Figure 5), as part of the solution to backdrafting. This will be effective only if there is a significant amount of exhaust elsewhere in the home, such as vents that open to positive pressure.

Exhaust-only systems use fans to remove stale air from the house. This creates a negative pressure indoors and causes fresh outdoor air to be drawn into the home through infiltration or intentional inlets such as a make-up air duct. The kitchen and bathroom exhaust fans common in most homes are simple exhaust-only ventilation systems.

In older homes exhaust fans can be installed in high humidity areas bathrooms, kitchens and laundry rooms. It is best to install the fans on interior walls, vented through ducts down the wall cavity and out through the joist space (Figure 6).

This inhibits warm air leaking up the duct and eliminates duct condensation and dripping. Make sure the exhaust fans are powerful enough to move the air the distances required.

If vents must be installed through the attic space, they should be insulated and well sealed for two reasons. First, so that warm, moist exhaust air cannot leak into the attic space and secondly so that the warm moist air will not condensate (ice build-up) inside the vent pipe only to later melt and drip back into the exhaust fan housing.

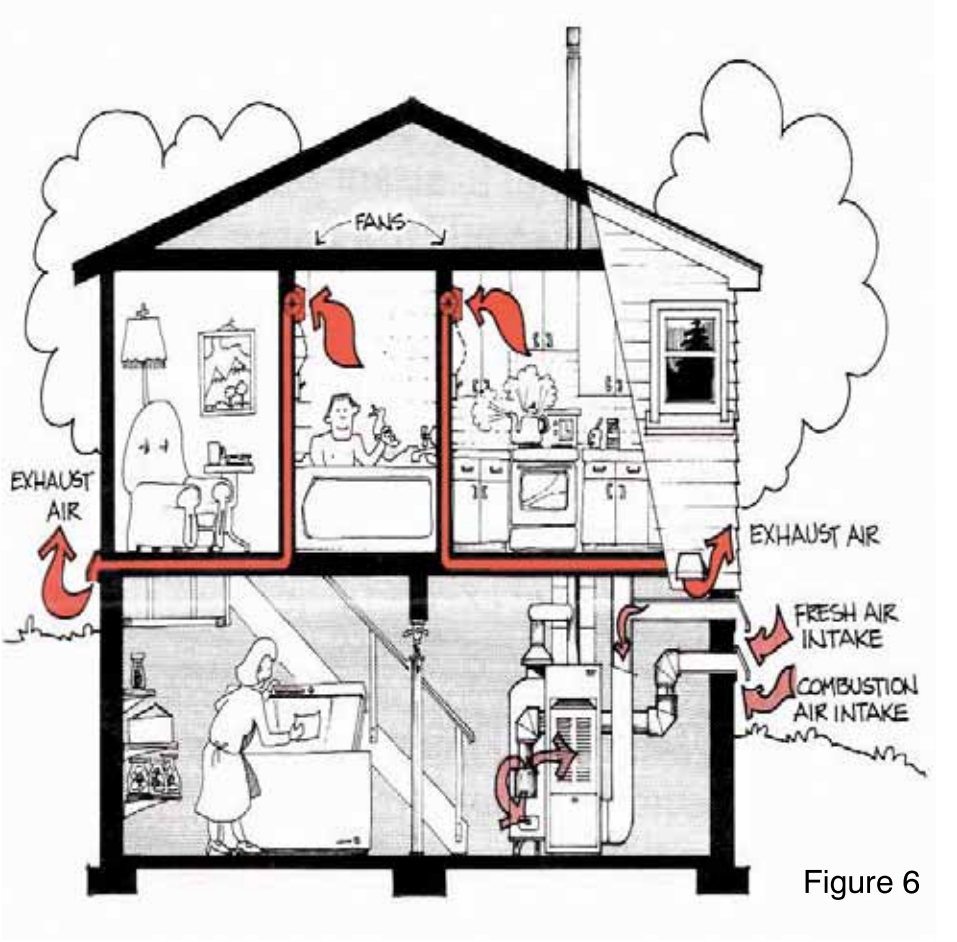


Figure 6

For continuous ventilation, a single, centrally located fan can be installed to draw exhaust air from high moisture areas such as the kitchen or bathroom. The fan should be controlled by a dehumidistat, which will turn the fan on or increase its speed when humidity levels rise above a set limit.

With any exhaust-only ventilation system, the potential for lower indoor pressure increases the risk of backdrafting. You need to include provisions for adequate fresh air (make-up air) must be provided through other openings such as fresh air supply ducts.

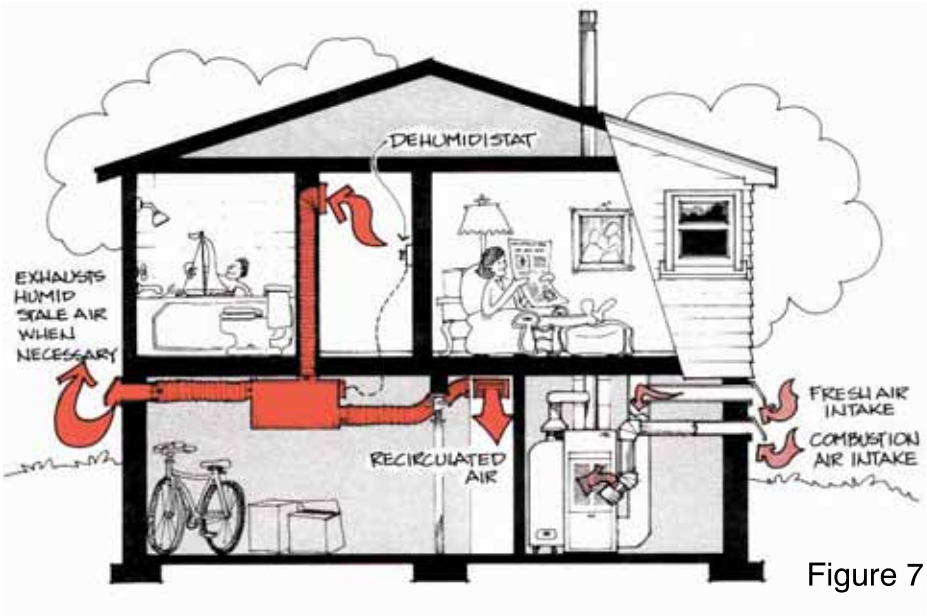


Figure 7

An improvement on this is an exhaust-only ventilation system, which circulates air continually and expels humid air outside only when necessary (Figure 7). Its operation is controlled by a dehumidistat. More elaborate control systems such as those described next under heat recovery ventilators can also be used.

Heat Recovery Ventilators

To reduce heating bills that accompany ventilation in cold weather, attention is being focused on heat recovery ventilators (HRV's), commonly known as air-to-air heat exchangers. Figure 8 shows how a heat recovery ventilator works.

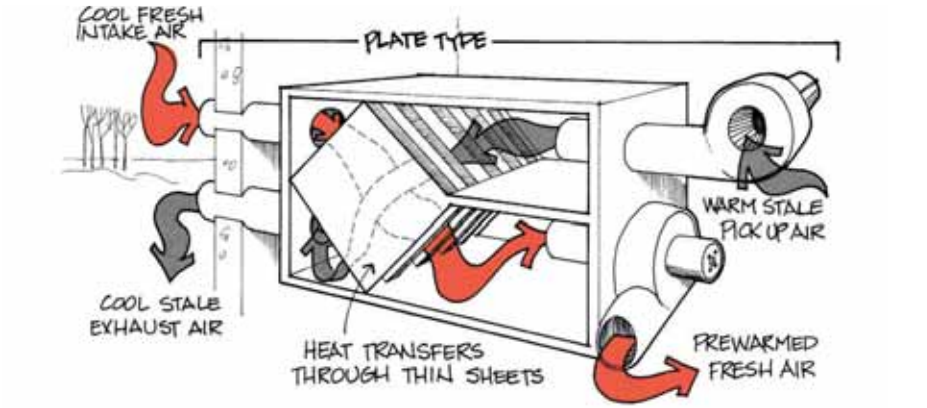


Figure 8

In order to keep outgoing and incoming air streams separated so that the fresh air will not be contaminated by exhaust air, each heat recovery ventilator contains a two-way heat exchange core.

A fan draws warm, humid, stale air from the house and passes it through the core of the unit. Heat from the warm air is transferred through thin sheets or pipes before the air is exhausted outside. At the same time, another fan draws in an equal amount of cool, dry, fresh air from outdoors through the core where it picks up the heat lost from the outgoing air. This pre-warmed incoming air is then distributed throughout the house.

System Design

Most heat recovery ventilators use ductwork to move air. The ducting layout and venting arrangement is essential to attain good air mixing. Ideally, the ventilator should draw stale air from, and distribute fresh incoming air to, all parts of the house. In practice the situation is rarely ideal. If your house is an open design with few partition walls, air mixing will generally be good. Homes with many rooms have poorer circulation and may require extra ductwork to be installed.

In homes with forced air systems, the furnace fan and ducts are commonly used to distribute fresh air (Figure 9). Separate stale air pickup ducts draw air into the ventilator from the kitchen, utility rooms and bathrooms, where most of the moisture, pollutants and odours are produced. The kitchen stale air pickup is separate from the range hood exhaust fan to prevent cooking grease and smoke fouling the heat exchanger core.

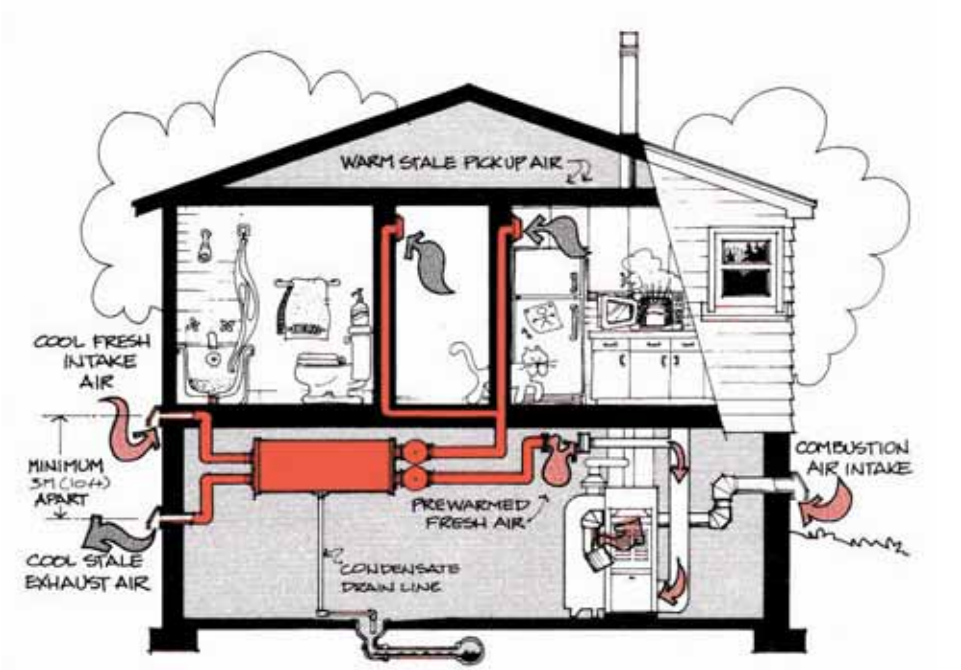


Figure 9

The Canadian Standards Association does not approve venting the clothes dryer or kitchen range hood exhaust directly into the ventilator. All clothes dryers and ranges should be exhausted directly outdoors.

The fresh air intake line from outdoors to the ventilator and the stale air exhaust line from the ventilator to outdoors are run through the floor header joist to exterior hoods, much like dryer vents. The ventilator is placed close to an outside wall when possible, to keep the two ducts short. The ductwork will be cold and should be insulated and wrapped in a vapour barrier to prevent condensation and conduction of heat out of the house.

Outside, it is wise to separate the exhaust port from the intake port by at least 3 m (10 ft) to prevent cross-contamination of the incoming fresh air with pollutants from the exhaust air. The vents must be placed a minimum of 460 mm (18 inches) above snow level to prevent blockage. Try to place the fresh air intake on a side of the house away from traffic exhaust, prevailing winds or road dust.

To distribute pre-warmed air throughout the house using a forced air system, the supply air duct from the ventilator empties into the return air plenum (duct) of the furnace. Two types of connection are possible so check manufacturer's specifications for the recommended type of connection. For indirect connections, ventilation air is supplied between 10 and 30 cm (4 to 12 inches) from an air grille on the return air plenum. For a direct connection the ventilator supply air duct is connected directly to the heating systems return air duct.

For fresh air to be distributed, the furnace fan must run (continually on low speed) whenever the ventilator is on, which will substantially increase your yearly electrical costs. Consider upgrading your furnace motor to an Electronically Commutated Motor (ECM) or purchase a new furnace equipped with an ECM motor. Recent testing of ECM furnace fan motors has shown a reduction in electrical usage of about 70% with savings potentials of about 1,500 kWh a year ($100/ year) over a standard furnace fan motor.

In houses with radiant hot water heating systems, additional ductwork must be installed to distribute the prewarmed fresh air-much like a forced air system. Fresh air is supplied to the living rooms and bedrooms while the exhaust air is drawn from the kitchen, bathroom and laundry areas. It is best to locate supply lines in non-sitting areas or above baseboard heaters because incoming air will be cool. Supply lines may also be placed near the ceiling where cool air will mix with warm air at the ceiling level. The heat recovery ventilator replaces only the stale air it removes and will not provide for any other air requirements.

Controls

Humidity measurement is the most practical method to control the operation of the heat recovery ventilator. An example of how a control system could be connected is shown in Figure 10.

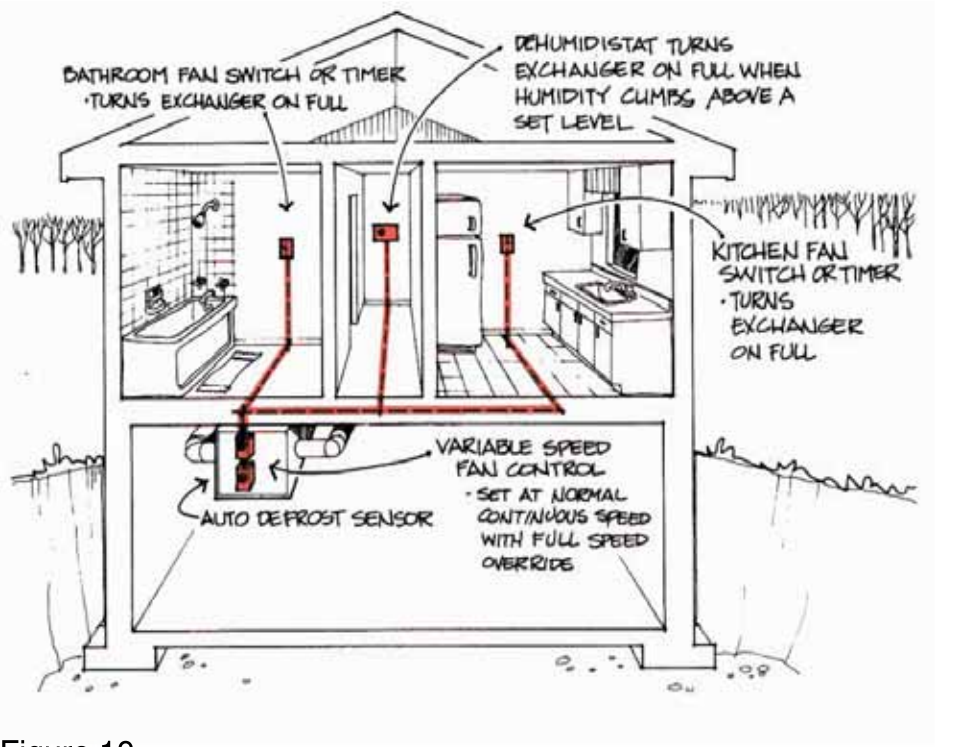


Figure 10

These guidelines should be considered when selecting controls for the ventilation system:

- Install timer switches in the bathrooms and kitchen. When switches are turned on, ventilator fans are boosted to high speed for the period set on the timer. This is an effective method to provide peak ventilation. Manual wall switches will also work but must be conscientiously shut off when high-speed ventilation is no longer necessary.
- Install a dehumidistat control in a central location away from fresh air outlets. Choose an area of average humidity and, if possible, locate it near the thermostat. The ventilator fans operate at low speeds when the humidity is below a set point, say 30% to 40%. The dehumidistat automatically boosts fans to high speed when humidity climbs higher than the setting. When humidity falls below the setting the fan reverts to low operating speed.
- Be sure the ventilator has a variable speed control to regulate normal fan operating speed so that the continuous low speed setting can be adjusted easily to suit your lifestyle.
- A comfortable humidity level to maintain year round should be in the 30% to 35% range year round. During cold spells maintaining a lower humidity level will reduce window condensation.

Selection and installation Guidelines

When choosing a heat recovery ventilator, check the following:

- The ventilator should have the capacity to exchange at least one-third the total volume of air in your house every hour. A 1000 sq ft house is equivalent to 42 L/s (89 cfm). The ventilator capacity will need to be greater than this to overcome resistance of the ductwork.
- It should have a variable speed control with manual override or a dehumidistat to adjust operation to the needs of the house.
- A defrost mechanism to melt frost or ice that may build up inside the heat exchanger core during cold weather is essential.
- It should have easy access to clean the core, which accumulates dust and dirt. Regular cleaning is necessary to maintain heat exchange efficiency and indoor air quality.
- Ductwork must have filters to clean the air. Filters are placed on the incoming fresh air and the stale air pickup lines and they must be cleaned or replaced regularly like furnace filters.

Choosing an installer for your heat recovery ventilator must also get careful consideration. Many problems associated with ventilators can be prevented if installed according to the specifications of the Canadian Standards Association.

Based on these standards, the Heating, Refrigeration and Air Conditioning Institute of Canada provide courses to instruct and certify installers. Check that your installer has received HRV training and is HRAI certified.

Summary

- Become familiar with the ventilation requirements of your home.
- See if you have problems caused by inadequate ventilation. Check for signs such as:
    - Prolonged condensation on your windows in winter.
    - Symptoms of health problems that may be a result of indoor pollutant build-up.
    - Signs of backdrafting.
- Decide on the proper solution:
    - Turn the humidifier off.
    - Install a fan in the kitchen.
    - Eliminate pollutant sources.
    - If necessary, install an appropriate ventilation system.

Providing adequate home ventilation makes sense. You can better control humidity, maintain an adequate fresh air supply and ensure a healthier home environment for your family to live in.

Additional Information Sources

Natural Resources Canada – Office of Energy Efficiency

www.oee.nrcan.gc.ca – The Office of Energy Efficiency offers a wide range of free publications, programs and services to help Canadians save energy and reduce the greenhouse gas emissions that contribute to climate change.

EnerGuide for Houses (EGH) evaluations is a program from Natural Resources Canada. This detailed home assessment provides independent expert advice on the different systems of your home and what can be done to improve comfort, reduce energy bills, and cut down on greenhouse gas emissions that contribute to climate change. Consider having an EGH completed on your home.

Recommended Reading: *Keeping the Heat In* is a comprehensive source of energy efficiency how-to information for homeowners. This free publication is available from Natural Resources Canada. **Call toll free at 1-800-387-2000**.

Canada Mortgage and Housing Corp.

www.cmhc.ca/publications – CMHC is a valuable resource for information. The CMHC Order Desk is a one-stop shop for all free and priced publications, fact sheets, reports, videos and other CMHC resources. You can order online, or through their call centre at **1-800-668-2642.**

EPCOR

www.epcor.ca – The website contains information on energy and water efficiency with calculators, tools and downloadable publications to assist you in reducing your energy and water consumption.

Tools include a ***Home Energy Audit,*** a do-it-yourself home audit with a library of resources; ***EPCOR House,*** an animated tour of a typical home with efficiency information; and calculators for most major appliances, plus a ***simple electricity calculator*** and ***water audit tool.*** Tools are located in the EPCOR-Customer Service drop down menus.

Environment Canada

www.ec.gc.ca - Environment Canada's website "The Green Lane" provides weather and environmental information to help connect Canadians, exchange information and share knowledge for environmental decision-making. The Climate Change section provides a direct link to the One-Tonne Challenge and Project Green information resources.

Notes:

Notes:

Become A CO_2RE Member

We all contribute to the problem of Climate Change — and each of us can contribute to the solutions. Become a CO_2RE Member. Membership is free and you can sign-up on the CO_2RE website at: www.co2re.ca

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