Unvented Combustion Appliances

You don't light a camp stove or barbecue inside the house. Nor do you light a fire in the middle of your living room, unless that's where the fireplace is found. So why are so many people promoting unvented combustion heating appliances?

Combustion appliances without venting may sound like a ridiculous idea, yet hundreds of thousands of unvented appliances for interior use are sold each year in the United States. Some are even manufactured in Canada. Many US states allow unvented combustion appliances, and others are on the verge of approving them, although the Governor of New York state recently vetoed a proposed approval for that state.

The reason for the big push is that compared with vented heaters, unvented units are generally less expensive to purchase and install. However, there is a growing controversy among concerned individuals questioning the whole idea. Meanwhile manufacturers are aggressively promoting these products although vent-free heating products can only represent a step backward in the safety record of the gas industry.

The material used by manufacturers in their lobbying efforts draws on resources that only a well-funded industry with deep pockets can assemble. As is so often the case, they rely on consulting reports favourable to them. Unvented gas heating products are shown to meet standards only by the selective choice of acceptable pollutant levels and by using assumptions for airtightness of houses that do not reflect the construction practices of the 1990's.

The issue is that unvented appliances dump pollutants into the living space.

We thought it appropriate to highlight this issue because it has become such a big industry, and with Free Trade there will be pressures to market the products in Canada. Currently BC allows unvented appliances in single family detached dwellings, with certain restrictions.

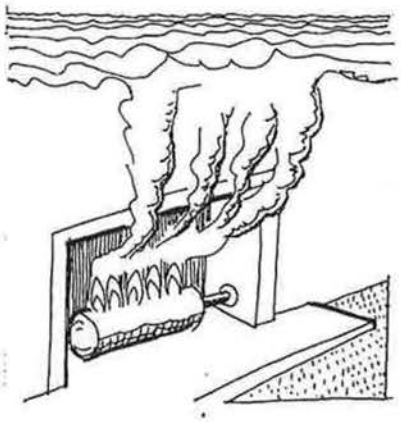
Combustion Venting

Our ancestors long ago learned that you had to remove combustion products from enclosed spaces. Even the most primitive societies at least put holes in the roof of their homes to act as a chimney. Of course, when you burn wood or coal, you can see and smell the combustion by-products, but that is not so with natural gas which burns very clean, giving off primarily moisture.

However, we don't really appreciate the other by products of natural gas combustion and the impact they have on the indoor air quality.

Natural gas combustion produces carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides and water vapour, high concentrations of which are detrimental to indoor air quality. These gasses are colourless, odourless, and tasteless so other indications of inadequate air change rates are needed. CO and NO_2 present health risks even at low concentrations.

The primary industry study (conducted by the American Gas Association's Research Division) that is being used to support unvented appliances with claims that vent-free heaters are safe in houses has serious shortcomings It is based on a typical appliance use time of four hours, obtained from a single survey of fireplace users that showed 96% of all owners operate fireplaces for 4 hours or less per use. The suggestion is that persons with vent-free fireplace units are more likely to use their units for decorative purposes rather than principal heating.



Unfortunately a single study of fireplace users does not provide a reliable database for all vent-free appliances. Persons with vent-free heating appliances could and probably will use their units for heating for longer periods. (A cold winter night lasts much longer than 4 hours.)

The predicted pollutant levels are based on mean values of air change rates that don't consider the variation of air exchange rates that result from weather changes (wind and temperature) and use of other appliances. The assumption made was that if there is enough air leakage, it will take care of the combustion products. No mention was made of a "worst case" or even a less than favourable condition. The concern is not "what are the average pollutant levels?" but rather, "what is the probability of damaging levels being developed?" In other words, what is the risk level at extreme operating conditions?

Medical professionals and references were not consulted for the latest research concerning health risks from pollutants. Without uniformly accepted indoor air quality standards, the authors chose acceptable pollutant levels most favourable to their argument, based on their interpretation of "reasonable" levels. Not surprisingly, the higher acceptable levels were chosen.

Gas Combustion By-products

Carbon monoxide

Carbon monoxide (CO) is a product of incomplete combustion. Amounts of CO produced can vary widely. During complete combustion only small amounts of CO are produced, but when there is incomplete combustion large amounts of CO are produced. Incomplete combustion may be a result of inadequate combustion air, dirt or lint on burners, improper gas orifices, and improper gas pressure.

Carbon monoxide is a deadly poison. Even one time exposure to elevated levels can cause permanent health problems. Symptoms of CO exposure at low concentrations in healthy people include headaches, decreased alertness, dizziness, flu-like symptoms, nausea, fatigue, rapid breathing, confusion, disorientation, impaired judgment, and weakness and also decreased learning ability in school children; lower concentrations in people with chronic heart disease include chest pain; and higher concentrations include coma and death. The effects depend on the concentration, duration of the exposure, the individual's activity level and health status and also sensitivity.

The AGA report shows that CO levels can increase from 0 ppm to 8 ppm in only 4 hours of vent-free heater operation in a loose house. Health Canada's indoor exposure guidelines suggest an upper limit of 11 ppm for eight hours, while ASHRAE uses 9 ppm as the maximum allowable exposure for an 8 hour average (not to be exceeded more than once per year). The World Health Organization (WHO) considers CO levels greater than 4.5 ppm to be of concern.

Oxygen depletion sensors required on these units do not protect consumers from all causes of incomplete combustion. The study does not consider the possibility of increased CO production from aging units.

Preliminary results of research still underway suggests that even a regular gas oven without adequate venting can generate high levels of CO. A potentially dangerous example of this kind of application is the gas oven being left open to provide heat. This would also be similar to the operation of an unvented gas log fireplace.

What is the background concentration of CO?

Outdoor CO levels generally are about 1 to 2 ppm (the lower limit of detectability for many measurement methods).

Nitrogen dioxide

Nitrogen dioxide (NO_2) increased from 0 to 0.6 ppm after only 4 hours of vent-free heater operation. This was in a loose house, with 1.0 air change per hour. Health Canada's indoor exposure guidelines suggest an upper limit of 0.25 ppm for short term exposure, while the maximum recommended by ASHRAE is 0.5 ppm on an 8 hour average. World Health Organization suggests the concentration of concern is 0.16 ppm or greater.

Because NO_2 concentrations exceeded 0.5 ppm, the authors of the AGA report model reduced the modeled NO_2 concentrations by adjusting recommended heater input values downward, so they may not create a totally comfortable temperature but will maintain "acceptable indoor air quality." Unfortunately, instruments to detect NO_2 are not or available to most consumers, dealers, installers, or maintenance staff. It is not likely most dealers/installers or homeowners will understand the need to comply with the requirement to downsize the unit.

Carbon dioxide

Carbon dioxide (CO_2) is produced during normal combustion and human respiration. It is not considered to pose immediate health threats but high levels of CO_2 can lead to drowsiness and headache. ASHRAE uses 1,000 ppm as a limit to satisfy comfort (odour) criteria while Health Canada suggests a limit of 3,500 ppm. CO_2 concentrations exceeded 3,500 ppm in less than 2 hours of continuous operation. This was in a loose house with 1.0 air change per hour. All combinations met or exceeded the ASHRAE limit of 1,000 ppm in 4 hours of operation Since a major component of combustion products is carbon dioxide, the rise of CO_2 from vent-free gas heaters is to be expected.

Water vapour

High humidity levels are a concern as they create unhealthy indoor conditions.

Water vapour is released into a house during animal and plant respiration, cooking, bathing, dish washing, and laundry. It enters structures via water leaks and capillary action (primarily through floors and walls in contact with the ground). Excessive moisture leads to deterioration of structural parts of buildings and to wood window frames, which rot. Excessive moisture also leads to mold and mildew growth, increased mite populations, and higher concentrations of bacteria.

Gas combustion generates large qualities of water vapour. Ned Nisson, editor of Energy Design Update, has calculated that a single 12,000 BTU gas cooking burner can easily humidify a home (and also introduce other unneeded by-products). Thus, anything over that contributes to excessive humidity levels.

Adding an additional moisture source to homes already experiencing moisture problems will further degrade indoor air quality. Removing moisture at the source (i.e., the vent-free heating appliance) is the best way to control moisture.

House airtightness

The basis on which the case for unvented combustion appliances has been built is the assumption that houses are leaky. Three different air tightness levels were modeled: loose, average, and tight. The air change rates were 1.0, 0.5 and 0.35 air changes per hour (ACH). The minimum air change rate of 0.35* per hour was chosen because the authors assumed rates below that value would be uncomfortable from moisture and odours and there are both U.S. and Canadian codes that recommend mechanical ventilation below about 0.35 ACH*.

However, minimum recommended air change rates are partly based on moisture and odour considerations. It does not insure occupants living in homes with odour and moisture problems will increase the air exchange rate to 0.35 ACH* or greater. In fact studies have shown people don't always use their mechanical ventilation. Besides, when combustion pollutants are colourless, odourless, and tasteless, other indications of inadequate air change rates are needed.

Consumers expect heating appliances will operate safely over the entire service life. They assume appliances will not pollute air in their home to a level causing them undue health problems. They expect someone (the manufacturer, the dealer, code authorities, the government) is ensuring the safety of the appliance. Although consumer education can be used to reduce risks, manufacturers, dealers, code authorities and government must ensure heating products do not require unreasonable consumer knowledge or present undue health problems. Regulations have to cover those products that present an undue risk.

Consumer education can't be relied on to avoid problems. These kinds of heaters are likely to be used in less than favourable situations, (e.g. low cost housing) where the occupants have limited resources for alternatives, or may not be able to do anything about it.

Vented heating appliances are readily available. They heat economically, without dumping

**This air change rate is the average natural air change, and is not to be confused with that measured by a blower door air test. 0.35 ACH is roughly equivalent to 5-7 ACH at 50 Pascals.*

BC Unvented Heater Regulations

Unvented gas heaters are permitted in British Columbia. The regulations are outlined in the Gas Safety Branch's directive DC 20.

- only one heater per house is allowed,
- they can be only be used for supplemental heat.
- they cannot be used in bedrooms, mobile homes, trailers and recreation vehicles.
- the maximum size allowed is 25,000 BTU (input), and must not be more than 20 BTU per cubic foot of room.
- the unit must be equipped with an oxygen depletion sensor and be labelled that annual servicing is required (this assumes that people read and act on labels!).

combustion products into living quarters. New, direct-vent sealed-combustion gas fireplaces and heating appliances have been designed and are readily available for tight houses. Vent-free heaters represent a step backward in attempts to improve indoor air quality in homes.

Issues that have to be considered when evaluating these appliances include:

Do we want to live in polluted air?

How serious are health problems caused by polluted air and what are the medical costs of breathing polluted air?

What are costs and benefits of vent-free appliances versus vented heaters?

Health Effects of Carbon Monoxide

Why is it we are concerned about carbon monoxide? It is a colourless, odourless toxic gas that is responsible for several deaths in Canada each year. Recently, during a cold winter spell, a number of deaths in Saskatoon were the direct result of CO poisoning - and they happened in middle class housing, not in some low cost, sub-standard housing.

Indoor concentrations of carbon monoxide vary widely depending on sources and occupant patterns of use. Concentrations of 1 to 2 ppm may be found in houses with a normally operating gas furnace, but can reach more than 1,000 ppm in a house with a faulty furnace.

Four burners on a gas stove can cause concentrations of 35 to 120 ppm after 20 minutes of operation (which is why direct venting to the outside is so important).

Kerosene space heaters can produce more than 20 ppm. An unvented gas heater in a 1,150 square foot test house was found to produce almost 90 ppm.

What are the health effects of CO? For the average healthy non-smoker, the health effects of CO are:

200 ppm over 2 to 3 hours: slight headache, fatigue, dizziness, and nausea.

400 ppm (maximum concentration in flue gas recommended by the U.S. EPA and the American Gas Association) over 1 to 2 hours results in frontal headache, and after 3 hours, this exposure is life-threatening.

800 ppm within 45 minutes results in dizziness, nausea, and convulsions; within 2 hours results in unconsciousness; and within 2 to 3 hours results in death.

1,600 ppm within 20 minutes results in headache, dizziness, and nausea; within 1 hour results in death.

3,200 ppm within 5 to 10 minutes results in headache, dizziness, and nausea; within 25 to 30 minutes results in death.

6,400 ppm within 1 to 2 minutes results in headache, dizziness, and nausea; within 10 to 15 minutes results in death.

Building Code changes

Ontario

Ontario Municipal Affairs has released proposed code changes (more than 650 proposed changes). Many proposed changes are substantial, but the stated aim is to harmonize with the National Building Code.

The deadline for comments is December 20, 1996.

Information: Code Development Unit, Housing Development & Buildings Branch, 777 Bay St., 2nd Fl., Toronto, ON M5G 2E5
Tel.: 416-585-666; Fax 416-585-4029

British Columbia

The BC Building Standards Branch is now reviewing the BC Building Code. The proposed update is not based on the 1995 National Building Code, but on the current BC Building Code (this may mean the BC code will increasingly differ from the National Building Code). Information and proposed changes already on file can be viewed on the Internet, at

http://www.marh.gov.bc.ca

The deadline for proposed changes is November 17, 1996, and the deadline for comments and challenges to changes is January 5, 1997.

Information: Building Standards Branch, 747 Fort St., Victoria, B.C. V8W 3E9
Tel.: 250-387-4010; Fax 1-250-356-9019
(note: the new telephone area code comes into effect on October 19)