



NATURAL VERSUS MECHANICAL VENTILATION

It may come as no surprise that most homeowners still think they get all the fresh air they need through natural leakage. However, the number of contractors in the building industry who still think that natural infiltration can be relied upon to provide adequate ventilation is

disappointing. “Just open a window,” or “You live in a leaky old house, you do not need mechanical ventilation,” are still common refrains from HVAC and other trade contractors.

The reality is that the natural infiltration of air is not a reliable source of adequate amounts of air to maintain good air quality. This article will explore the reasons for this and then outline the benefits of controlled mechanical ventilation.

DRIVING FORCES


There are essentially three problems with natural infiltration. First, the driving forces causing infiltration are highly variable. Infiltration of air can only occur when there are at least two holes in the building envelope and when there is a driving force. Finding holes, even in very tight houses, is relatively easy. That is, all houses leak air to some extent, although tighter houses do have lower natural infil-

tration rates than loose homes most days. This is the most consistent, persistent airflow mechanism. Whenever the inside temperature is greater than the outside temperature there will be air infiltration at the bottom of the building and air exfiltration through holes near the top of the building. The amount of flow is dependent on the size and location of holes, the temperature difference between inside and outside, and the height of the building. The taller the building, the colder the air is outside and the greater the flow.

One can imagine the problems with stack effect in high-rise buildings. Design elements such as revolving doors and make up air systems that force air into the building, combined with careful attention to air sealing of exterior walls helps to manage flows. Stack pressure measurements of 50 Pa on cold, yet calm days would not be uncommon in a 30-storey building. This would be the equivalent to a very strong wind.

So, while a house with lots of leakage may get adequate ventilation – too much ventilation perhaps – on cold or windy days, there will still be many days in the spring, summer and fall when there is no driving force and therefore limited airflow. HVAC contractors should recall that with the dramatic rise in market penetration of air conditioners people are even less inclined to open windows and thus there is little guarantee of adequate ventilation much of the year.

A Health Canada study done in 400 houses in Wallaceburg, ON, found that houses with the largest leakage areas, coincidentally also had the worst indoor air quality. This is an important finding for those hanging onto the idea that houses with substantial air leakage are healthier than tighter homes. While this is not to say the air leakage resulted in poor air quality, it does indicate natural infiltration cannot be relied upon to maintain good air quality. Typically houses with air leakage problems are



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The fundamental changes that exclude natural infiltration as a viable alternative include:

- The lifestyle changes that result in people spending far more time indoors. On average, nine of every 10 breaths we take is indoor air.
- The reluctance of occupants to open windows in response to privacy, security, noise, dust and energy concerns.
- The profusion of chemicals and other pollutants now present in indoor living environments.
- The design and construction of modern houses, including the issue of house envelopes being tighter, the types of materials used, the size and complexity of the design and even usage patterns. For example, there is a continued trend to want to use the basement as living space.

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There are only three driving forces:

Wind Effect – Air enters holes on the windward side; air exits from the leeward side.

Mechanical Effect – Exhaust fans and appliances induce air entry into houses. Chimney draft also induces fresh air entry. Forced air fans distribute air throughout houses but may also cause slight positive or negative pressures across exterior walls and thereby induce ventilation. For example, a room with a supply vent but no return air grille may be pressurized by furnace operation if the room has a tight fitting door that was closed.

Stack Effect – Otherwise known as temperature or convection effect, this is the principle that warm air rises and cold air falls. In a Canadian winter, and in the

older and/or poorly constructed. This could mean water leakage or other defects resulting in air quality problems.

CONTROLLING AIR FLOW

The second problem with natural infiltration is that it is difficult to control where air enters a building and how it gets distributed. Since the driving forces change constantly, any individual hole in the envelope will, at times, be an air entry point. At other times it will be an air exhaust point. It should come as no sur-

prisingly consistently delivered to the room. When there is no control over where fresh air comes in, alternatives such as a constantly operating furnace fan to encourage proper mixing of air would be required.

IMPACT ON BUILDING ENVELOPE

Lastly, natural infiltration and exfiltration can compromise the durability of the building envelope. In the winter, the combination of warm moist air rising and existing holes in the upper wall

accomplish when there is control over where the fresh air enters the building. Ventilation effectiveness into bedrooms is often compromised if exhaust-only ventilation systems are used. Furnace fan operation is very helpful but typically exhaust-only ventilation capacity needs to be 50 per cent more to achieve the same overall effectiveness as a system that includes fresh air supply. In addition, balanced ventilation systems such as heat recovery ventilation (HRV) units avoid the issues of infiltrating and exfiltrating air causing moisture problems in exterior wall or attic assemblies.



“The elements of good mechanical ventilation overcome the shortfalls of natural infiltration.”

prise that vents labelled as combustion air inlets will, if located on the leeward side of a building, be predominantly air exhaust vents. Similarly, chimneys located on the exterior of a building will be cold. Although we hope and pray air will go up a chimney, the natural inclination of cold chimneys is for air to come down, especially if the chimney is connected to a house with lots of air leakage near the top of the building. Air leakage patterns may result in what we believe to be fresh air being air that has entered through old wall cavities. These cavities may be full of mould or other potential contaminants.

Ensuring fresh air gets to bedrooms where we want it most is difficult when relying on natural leakage. Again studies done by Canada Mortgage and Housing Corporation suggest that if bedroom doors are closed, air quality is compromised in bedrooms unless fresh air is

assembly results in attic moisture problems. Similarly, hot, humid summer air leaking into an air conditioned building will also result in condensation within wall cavities. With current building practices it is vital to remember to “build tight and ventilate right.” The elements of good mechanical ventilation overcome the shortfalls of natural infiltration.

The key concepts are:

- The right amount of ventilation on a constant basis. This has been a code requirement for at least 15 years. Refer to local codes for exact calculations but simply put continuous ventilation is approximately 15 CFM per bedroom, with the master bedroom at 30 CFM;
- Exhaust from wet areas such as bathrooms and kitchens; and
- Provide fresh air distribution to bedrooms and main living areas.

Fresh air distribution is much easier to

GREAT MARKET

It has been my experience in doing air quality audits that all houses, new or old, tight or loose need mechanical ventilation. This requirement is supported by all current literature on indoor air quality and creates a great market for all HVAC contractors who are looking for the next big opportunity now that anybody who can afford air conditioning has it.

In fact, to a large extent, as discussed above, air conditioning is perhaps one of the most important reasons why mechanical ventilation should be installed in all houses. HVAC contractors should survey the existing ventilation capacity of each house and building they work in and start offering alternatives to their clients. At the very least, good quiet bathroom fans, continuously operating furnace fans (ECM motors for example), central exhaust fans and HRVs and energy recovery ventilators (ERVs) should be mentioned on every call. **HPAC**

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