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An Ideal Mechanical Ventilation System for Houses

By John Haysom

Houses require an indoor/outdoor exchange of air to replenish oxygen used by occupants and to remove pollutants generated by breathing, household activities and by building materials and furnishings. For many years, natural air leakage provided this air exchange during winter. Houses built before the 1960s tended to be quite leaky and pressure differences between the inside and outside, caused by wind or temperature difference, were sufficient to provide significant air exchange most of the time. However, even a leaky building envelope does not always guarantee adequate air exchange.

The movement of air requires both a pathway (e.g., a leak) and a pressure difference; thus a leaky house will experience no indoor/outdoor air exchange when there is no pressure difference. This is most likely to occur in spring or fall, when winds are light and there is little or no indoor/outdoor temperature difference that can create a stack effect. However, the leakier the house, the less frequent the periods of inadequate air exchange.

Recently Built Houses Are Fairly Airtight

Based on a 1989 IRC study of the airtightness of recently constructed houses across Canada, it was concluded that most houses built using normal construction practices are sufficiently airtight that air leakage cannot be relied on to provide the accepted air change rate of 0.3 air changes per hour (ach). This is the rate considered necessary to maintain adequate indoor air quality and to avoid high humidity, surface moulds and interstitial condensation. Thus, to ensure a satisfactory rate of air change at all times throughout the heating season, (that is, to provide a rate that most authorities deem necessary to maintain adequate indoor air quality in normal households), houses today need mechanical ventilation systems.

An Ideal Mechanical Ventilation System

An ideal mechanical ventilation system is currently not achievable because of technology limitations. However, the characteristics of an "ideal" system can be listed as follows:

Operate when needed. The system would operate whenever additional indoor/outdoor air exchange is needed and would do so without occupant intervention.

Operate only when needed. Because a mechanical ventilation system has costs associated with it (cost of electricity and cost of heating outdoor air brought in), it should not operate when air exchange is not required. This occurs when there are no occupants in the house, and when there are no activities or processes underway that generate pollutants, and there is sufficient air exchange due to wind or stack effect.

Provide the needed amount of air exchange. The ideal system would be able to deliver enough outdoor air to meet the probable maximum needs of the household. It would also be capable of modulating delivery so that it did not deliver more air than required at times of reduced need. A system without this capability is likely to provide excess air most of the time it is operating, resulting in higher energy costs and low humidity. As well, a system that is unresponsive can be annoying, possibly causing occupants to stop using it.

Distribute outdoor air where needed. It is not enough that the system change the air in the house as a whole to meet the standard of 0.3 ach. It must also be able to deliver the outdoor air to those rooms where occupants spend most of their time.

Be quiet. The system would be quiet enough that occupants would not be tempted to turn it off.

Not interfere with other systems. A mechanical ventilation system that interferes with a fuel-fired heating system can create a high negative pressure in the house, spilling the harmful products of combustion into the house rather than sending them up the chimney.

Not interfere with the building envelope. The system would not create significant positive pressure in the house since this could drive humid indoor air through the building envelope, resulting in interstitial condensation.

Demand-Controlled Ventilation

A mechanical ventilation system that embodies the first two characteristics described above is known as a "demand-controlled" system." Such a system would ideally be controlled by an array of sensors — one for humidity and one for every pollutant that the system would have to respond to, including carbon monoxide, carbon dioxide, formaldehyde and volatile organic compounds. The system would bring in outdoor air and/or extract indoor air until the sensors determined that specific pollutants were at, or below, predetermined safe levels. Whenever a sensor detected a pollutant concentration above its safe level, the ventilation system would operate.

An ideal system with a full array of sensors is not attainable because there is insufficient knowledge and information to determine which pollutants need to have sensors that should be monitored, and what the acceptable levels for a particular pollutant are. As well, practical, reliable and economical detectors for all pollutants of concern are not available. ☼

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