Healthy Indoor Air Quality and Ventilation

Design Note

Ventilation is a necessary requirement for the proper operation of any home. Many existing homes rely on natural ventilation to control interior humidity, odors and combustion products. Natural ventilation is wind dependant and therefore unreliable. The quality of construction, however, is improving, and homes are becoming tighter and more energy efficient. These houses cannot rely on natural ventilation and as a result new residential buildings are developing a need for mechanical ventilation.

The Drive to Energy Efficiency

In older buildings, uncontrolled air leakage can be responsible for 50 % to 60 % of the heating and cooling energy consumption and 40% of the overall energy consumption, prompting many energy conscious homebuilders to focus their efforts on reducing air leakage.

The local building code sets the minimum level of ventilation air required to maintain the health of both homeowners and their home itself at approximately 0.35 ACH_{nat}[1]. Typically the average house is sufficiently drafty, that this minimum level of ventilation air can easily be met by air leakage. New energy-efficient homes are able to reduce air leakage rates to a level that are far less than the minimum required for ventilation. A dedicated mechanical ventilation system is therefore a necessary component in any energy-efficient home and is highly recommended for all homes. The mechanical ventilation system assists in control of interior humidity, odors and chemical pollutants, emissions of combustion appliances, and indoor microenvironments.

Interior Humidity

Interior humidity is generated by normal human activities, such as showering, cooking, cleaning and breathing. In fact, any activity where an item or surface has to dry causes an increase in interior humidity levels. Ineffective management of interior humidity leads to complaints of reduced occupant comfort, pollutants and increased potential for both mold and condensation damage particularly in hot/humid climates. In northern climates, excessive air exfiltration and infiltration due to stack effect causes uncomfortably low indoor relative humidity levels, and humidification is needed to compensate. Supplemental humidification, such as from a portable humidifier unit, does not always supply an even distribution of humidity throughout a home. As a result, problems from high humidity can even occur in houses with very low overall humidity conditions.

Interior Odors and Pollutants

It is important to note that anything that has an odor is emitting pollutants. This includes everything from cleaning compounds to food odors, to trash and even the perfumes we use to mask them. In a new house, this also includes many of the building materials, such as plastics, paints, carpets, and furniture. Indeed, every product must meet a strict set of emissions specifications in order to be approved for household use. However, where a single product may not generate a substantial amount of emissions, a whole house full of new paint, furniture, and carpet can be well above the safe limits.

Smells are transmitted through diffusion, and continue to spread until their concentration is uniform throughout an entire house. Although this process may dilute a pollutant sufficiently to eliminate the odor, it does not mean that the chemical has disappeared. With many chemical compounds, even low concentrations can be detrimental to occupant health, especially in cases

[1] International Mechanical Code: Table 403.3

of prolonged exposure, such as in the case of elderly or young occupants. The effect is further increased when the occupant is in poor health or sensitized.

Combustion Appliances

What many homeowners do not realize is that there are some heating appliances that actually rely on the available air within the living space for the supply of combustion air. This includes unvented heaters, kerosene heaters, and other combustion appliances that also vent combustion products into the indoors. Of course, it is typically the most drafty homes that require these supplemental heat sources, creating a fairly good match. However, if the home is insulated and the air tightness increased, then these appliances are polluting the home and should be vented to the outside.

Combustion devices should not only be fitted with a direct exhaust, but also with a dedicated intake, in order to supply the unit with combustion air. The dedicated intake is necessary in order to prevent conditioned air from being continually drawn into the mechanical room. Without a dedicated intake, the house can become negatively pressurized; drawing cold air in through the envelope and increasing heating loads, or even causing the chimney to backdraft.

Microorganisms

Ambient outdoor air presents a significant contribution to indoor air quality. Ambient air contains mold and mildew spores, bacteria, pollens, dust, etc. In addition, air leakage through structures carries water vapor with it, which can condense on colder surfaces. This condensation can cause wood decay and contributes to the set-up of microenvironments that are suitable for the development of mold and mildew. Mold, mildew and dust mites feed on organic materials such as the cellulose in paper and pet or human skin dander. Dust mite life cycles produce dried carcasses and feces that often become airborne and are known to trigger asthmatic attacks.

Ventilation Requirements

Traditionally, building ventilation concentrated on removing combustion products. Ventilation provisions further developed to remove large sources of moisture and odors through the use of fans in kitchens, washrooms, and even closets. The balance of ventilation occurs through either stack effect or wind pressures. Stack effect is the natural tendency for hot air to rise until obstructed. When outdoor temperatures are lower than indoor temperatures, stack effect causes warmer, humid indoor air to rise though joints and penetrations in the ceiling plane and escape through the attic. Cold, dry outdoor air enters at the base of the house to replace the outbound volume of air. Wind pressures act under any climate conditions to replace indoor air with outdoor air.

Although the initial cost is appealing, relying on natural ventilation can lead to a lack of adequate ventilation during the summer (minimal stack effect), and on windless days. In reality, all buildings should have some type of ventilation system so as to provide adequate air exchange during under-ventilated periods. With a few exceptions, building codes do not adequately address the requirement for mechanical ventilation in residential buildings.

With the emergence of energy efficient construction, stack effect and wind pressures can no longer be relied upon to supply adequate levels of ventilation. Indeed, energy efficient construction necessitates the use of a dedicated mechanical ventilation system. In air tight homes, only a dedicated mechanical ventilation system can provide adequate protection from the effect of indoor humidity, odors, pollutants, combustion appliances and microorganisms.

Often the decision to use a dedicated mechanical ventilation system is influenced by cost. In practice, energy efficient construction provides substantially lower heating and cooling loads, resulting in dramatic reductions in the required

equipment capacity and operating costs. The use of lower-capacity HVAC equipment for space conditioning provides a large reduction in first cost. The end result is that the combined capital cost of the entire mechanical system remains roughly the same, but with a substantial increase in energy efficiency, condensation and mold minimization, and occupant comfort.

Icynene®

Icynene® is a combined air barrier and insulation material that is both flexible and durable, thereby ensuring that air-tightness can be achieved for the life of a building. A building envelope that is both insulated and air-sealed with Icynene® typically tests for peak air leakage at 1.5 air changes per hour (ACH) or less, at 50 Pascals (Pa) of pressure. In comparison, blower door depressurization tests on older homes have recorded 10 ACH @50 Pa. With the adoption of air barrier and insulation materials, typical new housing air leakage rates are now 5 to 7 ACH @ 50 Pa during peak leakage tests. Builders who provide extra attention, labor, and many sealing materials provide structures that test for peak air leakage at 3 to 4 ACH @ 50 Pa.

Because of its ability to provide a complete air-seal to the entire building envelope, the difference in performance between a house insulated and air-sealed with Icynene® and even a well built new house is dramatic. Natural air-change rates are typically 0.05 ACH to 0.1 ACH, with 0.1 ACH used as a conservative estimate for the design of the HVAC system.

Any house insulated with Icynene® should be equipped with a mechanical ventilation system that is sized to continuously deliver the full ventilation requirement, with no reliance on natural ventilation.

Emerging residential ventilation standards such as ASHRAE 62.2-2003 provide a comprehensive strategy for taking advantage of high-performance construction techniques, including the use of Icynene®. The end result is a healthier indoor environment, superior energy efficiency and ultimate comfort.

Icynene® is a low-density soft foam insulation, which is sprayed into/onto walls, crawlspaces, underside of roofs, attics and ceilings by Icynene Licensed Dealers. Sprayed as a liquid, it expands to 100 times its volume in seconds to create a superior insulation and air barrier. Every crevice, crack, electrical box, duct and exterior penetration is effortlessly sealed to reduce energy-robbing random air leakage. Icynene® adheres to the construction material and remains flexible so that the integrity of the building envelope seal remains intact over time. Icynene® is ideal for residential, commercial, industrial and institutional indoor applications. **Information about Icynene® can be obtained by visiting Icynene.com or contacting your local Icynene Licensed Dealer.**