Healthy Indoor Air-Quality & Ventilation

Construction History

For years, changes in North American housing construction requirements have been introduced with the intent to reduce energy consumption. Many older buildings with hollow exterior walls did not receive dedicated air-barrier, vapor barrier or insulation materials and thus experienced serious air-leakage. Blower Door depressurization tests on older homes have recorded 10 complete air-changes per hour (ACH) or more at -50 Pascals (- 0.2" w.c. the standard pressure difference to estimate simulated peak building air-leakage conditions).

During the heating season, large temperature differences between indoor-air and ambient-air cause leaky buildings to act like chimneys and this "stack" effect alone causes significant air-leakage to occur. Wind also creates pressure differences on the exterior of the building that cause air leakage. Finally, mechanical systems and other fans inside the building lead to air pressure differences that also cause air leakage. All three pressures cause conditioned air to leak out (exfiltration) or unconditioned air to leak into (infiltration) the building, depending on the climate and season. This leakage occurs through holes in the building envelope where the air barrier is incomplete, improperly installed, or damaged. In northern winters, humidification is needed as excessive air exfiltration causes uncomfortably low indoor relative humidity levels. In humid summer conditions, excess infiltrated moisture must be removed from the interior of the building with air conditioning and/or dehumidifiers.

Other air-quality problems are present as ambient air contains mold and mildew spores, bacteria, pollen, dust, etc. In addition, air leakage through structures carries moisture vapor with it, which condenses on colder surfaces. This condensation causes wood decay and contributes to the set-up of microenvironments that are suitable for the development of mold and mildew.

In older buildings, uncontrolled air leakage can be responsible for 50 to 60 % of the heating and cooling energy consumption, and large capacity heating and air-conditioning equipment is required. During times when even small temperature differences exist between inside and outside and/or no wind is blowing, leaky buildings still experience under-ventilated conditions.

Where We Are Today

With the adoption of air barriers and insulation requirements, 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.

Building Code changes and extra tightening efforts by custom builders have been implemented with the intent of improving energy efficiency and comfort. Savings from reduced heating and air-conditioning equipment requirements are realized, but as energy efficiency is improved more under-ventilated periods will occur.

Ventilation by Accident or by Code

Virtually any building is likely to experience under-ventilated periods often unless continuous ventilation is employed. Until recently, little concern has been devoted to varying weather conditions in relation to indoor air-quality. Although most residential building codes require point-source exhaust fans for spot use, few specify make-up air for combustion appliances. With a few exceptions, building codes do not address under-ventilated conditions in residential buildings.

Add an indoor environment that is a chemical / biological soup

Many building materials such as carpets, furniture, plywood, particle boards, flooring, and so on off-gas VOC's (volatile organic compounds). Cleaning solvents

and solutions vaporize. Smoking and cooking odors are often present. Oxygen is consumed. Human activities and related processes produce moisture vapor that helps to produce microenvironments suitable for biological development. Mold and mildew feeds on organic materials like the cellulose in paper and pet or human skin dander. Dust mite life cycles produce dried carcasses and feces that often become airborne (these allergens are known to trigger asthmatic attacks). Their digestion processes also produce gasses such as aldehydes, alcohols and keytones (moldy odors).

During under ventilated conditions a myriad of pollutants are introduced to the indoor air, building up to unhealthy levels. The U.S. Environmental Protection Agency has performed studies indicating that average indoor air is 10 to 70 times more polluted than outdoor air. The U.S. EPA also estimates that people typically breathe in two tablespoons of particulate-type contaminants and chemicals each day.

Build tight – Ventilate Right

The solution is to build buildings as tight as possible and take full control of fresh air requirements with continuous mechanical ventilation. This minimizes unwanted air and moisture movement through the structure and allows the intake and cleansing of the correct amount of air for the specific building. Buildings are complicated and, when using conventional insulation and air/vapor barrier materials, extremely tight construction is difficult and expensive to achieve.

The Icynene Insulation System® Healthy Home

An Icynene® insulated thermal envelope coupled with minimal caulking typically tests for peak air-leakage at 1.5 ACH @50 Pa or less. Natural air-change rates are typically 0.05 to 0.1 ACH. Due to Icynene's® low air and vapor permeance, additional vapor barrier materials are not required in most instances.

Into this tightly controlled indoor environment, a properly designed continuous mechanical ventilation system is installed. The choice of system (exhaust, supply, or balanced) depends on the type of building, climatic conditions, and cost. Extra ventilation may need to be provided to compensate for large point source exhaust fans (ie. kitchen cook top fans, clothes dryer fans). Ventilation systems that are installed with Icynene® operate much more efficiently than before because of greatly reduced random air leakage through the exterior walls, roof, and floors. The result is a healthy indoor environment, superior energy efficiency and ultimate comfort.