
Building Science

Building Ventilation and Air Quality

History of Construction Issues

For years, changes in North American housing construction requirements have been introduced with the intent to help reduce energy consumption. Many older buildings with hollow exterior walls were not built with dedicated air barrier, vapor barrier or insulation materials and thus experience serious air-leakage. Blower Door depressurization tests on older homes have recorded 10 complete air-changes per hour (ACH) or more @ -50 Pa (- 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. Wind also creates pressure differentials between exterior surfaces that cause air leakage. Finally, mechanical systems and other fans inside the building lead to air pressure differentials that also cause air leakage. All three pressures cause conditioned air to leak out of (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 creation of microenvironments 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.

Today's Standards

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 good 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 to improve energy efficiency and comfort. Savings from reduced heating and air conditioning equipment requirements are realized.

Under Ventilated Buildings

Virtually any building is likely to experience under-ventilated periods unless controlled ventilation is employed. Until recently, little attention 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 and so, with few exceptions, they do not address under-ventilated conditions in residential buildings.

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Add to this an indoor environment that is a chemical and biological soup. Many building materials such as carpets, furniture, plywood, particle board and flooring 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 create microenvironments suitable for biological growth. Mold and mildew feed 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). Dust mite digestion processes also produce gasses such as aldehydes, alcohols and ketones (perceived as 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.

Ventilation - Doing it Right

The solution is to build buildings as tight as possible and take full control of fresh air requirements with controlled 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.

A Healthy Home with BioBased 501 Insulation™

A *BioBased 501*™ insulated thermal envelope coupled with minimal caulking typically tests for peak air-leakage at 1.5 ACH @50 Pa or less.

Into this tightly controlled indoor environment, a properly designed controlled mechanical ventilation system is installed. The choice of system (exhaust, supply, or balanced) depends on the type of building, and cost. Extra ventilation may be needed to compensate for large point source exhaust fans (i.e. kitchen cook top fans, clothes dryer fans). Ventilation systems that are installed with *BioBased 501*™ operate much more efficiently 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.