

## **A breath of fresh air (natural ventilation strategies for indoor air quality)**

Stuart Fishman

*Vice President, Titon Incorporated, PO Box 6164, South Bend, IN 46660, USA*

### **ABSTRACT**

Natural controlled ventilation is often ignored when buildings are designed. It is important that architects, property developers both commercial and residential, designers, engineers and the general public be aware of guidelines (readily available) for proper indoor air quality. Mechanical engineers should realize that introducing supplemental fresh air ventilation into heating, ventilating and air conditioning (HVAC) systems aids in improving indoor air quality and often maximizes the efficiency of the HVAC systems. In addition to air leakage present in every building, the supplemental fresh air ventilation mentioned above is maximized through the use of devices either installed in windows or through walls that provide an alternative to merely opening windows and/or doors for natural ventilation.

### **INDEX TERMS**

Natural controlled ventilation; Security; Indoor air quality; Energy consumption; Mould and condensation

### **INTRODUCTION**

It is hard to pick up a newspaper or magazine these days without reading something about the environment, indoor air quality, tight construction, stale air, indoor pollution and now the greater concern of mould and mildew. The concept of additional natural, background or passive ventilation into tightly constructed buildings originated in Scandinavian countries more than 25 years ago. Window manufacturers in these countries developed what have become known as integrated window ventilators, trickle ventilators, individual outdoor air inlets and integral ventilating systems/devices that are manually operated air-inlets fitted to windows and/or doors (preferably at the top) to allow controlled supplemental fresh air to flow. Devices installed through exterior walls to achieve fresh air flow also exist. Building codes in the United States, Canada and in Europe address proper indoor air quality. There is a minimal impact on energy consumption using both window applied and through-the-wall ventilation devices. In summary, the title of this paper could be 'Build Tight, Ventilate Right' that will in essence be the content. However, the title used is preferred.

### **COMMENTARY**

For many years prior to the energy crisis of the early 1970s, natural air infiltration or leakage was not a consideration when designing and constructing buildings. Energy required for heating and air conditioning was plentiful and inexpensive. Needless to say, the situation has changed extensively. Architects, designers, mechanical engineers, property developers and homebuilders can no longer ignore the need for tightly constructed buildings thus conserving energy. However, there now becomes a dilemma—how to construct tight buildings and still address proper indoor air quality. Mechanical engineers claim that 'make-up air' solves the concern for proper ventilation. Once air is introduced into mechanical systems it no longer is considered fresh air. The American Society of Heating and Refrigeration Engineers (ASHRAE) in a number of their publications indicate that fresh air should be introduced by

opening windows and/or doors. An open window or door is uncontrolled natural ventilation causing increased energy consumption.

The Washington State Building Code Council adopted the Washington State Ventilation and Indoor Air Quality Code in 1991. It is a residential code that has been revised over the years and now has a 1999 version. The section entitled 'Whole House Ventilation Systems' reads as follows: 'Each dwelling unit shall be equipped with a whole house ventilation system which shall be capable of providing at least 0.35 air changes per hour, but not less than fifteen cubic feet per minute per bedroom plus an additional fifteen cubic feet per minute. Whole house ventilation systems shall be designed to limit ventilation to a level no greater than 0.5 air changes per hour under normal operation conditions. Whole house ventilation systems shall supply outdoor air to all habitable rooms through individual outdoor air inlets, force-air heating system ducting or equivalent means. Doors and operable lites in windows are deemed not to meet the outdoor air supply intake requirements'. There are similar codes in existence for commercial and multi-family buildings in both Washington State and Oregon in the United States. Other codes that are mechanical system oriented can be found in Canada and in other states in America such as Minnesota and Vermont. Ventilation codes also exist in France and Scandinavian countries. It is unfortunate that similar codes are not in force in many more states in America and in other countries throughout the world.

It is the last sentence of the first paragraph of the Commentary section that supports the concern for energy conservation. Uncontrolled natural ventilation through windows and doors that are opened increases not only energy costs but also the possible requirement to build additional power generating facilities. A 1998 survey conducted by Mr John Devine of the US Department of Energy for the Washington State University Energy Program concluded that lower energy costs were achieved by using low capacity exhaust fans in combination with through-the-wall (or window applied air inlets that are equivalent) devices. It would be well to mention that the Washington State Ventilation and Indoor Air Quality Code was patterned after The Building Regulations 1991 approved document published by the Department of the Environment and the Welsh Office and printed in the United Kingdom for the HMSO. Not only the Building Research Establishment (BRE) but also The Chartered Institution of Building Services Engineers (CIBSE) is referenced in the document.

As mentioned before, opening windows and doors is an often-recommended solution to improved indoor air quality. Not only do open windows and doors effect energy consumption but also violate the security of a building. Law enforcement agencies point out that a window or door merely unlocked compromises the security of a building. Individual outdoor room air inlets such as through-the-wall and trickle ventilators maintain complete security while still allowing fresh air to circulate. These ventilators can be left open even when buildings are unoccupied. In addition, these devices have screening to prevent the entry of insects. Some are designed to react to pressure differentials with an exterior flap that moves according to pressure differences across it in order to control the exact amount of air passing through.

*MOULD*—a word that causes shivers up and down human spines! The discovery of mould in a building is like hearing an emergency vehicle coming down your street; seeing black flags appear in your dreams; and having monsters appear. One of the conditions that contributes to mould growth is condensation both seen and hidden—seen on glass in window openings and

hidden in walls until mould appears. Of course, any source of moisture can cause mould growth. Merely being in a building and performing daily activities such as breathing, bathing, washing clothes and dishes produces moisture in the indoor environment. Excessive humidity, either natural or mechanically produced is a dreaded condition producing harmful effects of condensation. One only has to consult the Old Testament in the book of Leviticus, Chapter 14:33, to learn how long humans have had to contend with mould growth. Ventilation that helps dry up condensation is a positive aid to reducing the possibility of mould growth.

Pardon the repetition but it is important to again point out that a combination of mechanical and natural ventilation will not only improve indoor air quality but also help to reduce unwanted condensation. Newer construction techniques, i.e. 'build tight', typically reduces natural ventilation. In combination with small capacity exhaust fans and integrated window ventilators or through-the-wall devices a small but adequate amount of fresh air circulates around the window and room keeping condensation at a minimum. The small controlled flow of air through an integrated window ventilator is like the defroster in an automobile- a little slower but equally as effective. Having adequate natural ventilation will contribute to reducing the possibility of mould growth.

#### **CASE STUDIES**

##### **Lehigh Valley Hospital—Allentown, Pennsylvania**

After extensive research, the Board of Directors of Lehigh Valley Hospital specified a window-applied ventilator as an alternative to operating windows. In excess of 200 ventilators were furnished for an addition to the hospital in November 1998. An additional 96 window-applied ventilators were furnished for a subsequent project in June, 2000.

##### **Peter Cooper Village—Stuyvesant Town Apartments, New York, New York**

These apartments on the Lower Eastside of New York City were built in the late 1940s after World War Two, using single glazed steel sash windows that were the top of the line models for that era. Nearly 50 years later, it was decided to replace all the windows that had horrible maintenance problems with modern aluminium windows using insulating glass. The concern by management of the apartments is that tight new windows would cause a deterioration of the indoor air quality in each apartment. In addition, because of security on the lower floors of each building, opening windows or doors for ventilation was not practical. In excess of 80 000 windows were replaced. Over 120 000 window-applied ventilators were furnished for this project as some windows were fitted with two window-applied ventilators.

##### **Las Vegas, Nevada**

The city of Las Vegas, Nevada is in Clark County, Nevada. The Clark County Building Code requires fresh air circulation in each guestroom of a hotel. The Code also points out that the fresh air access also serves as a smoke exhaust outlet in case of fire. Window-applied ventilators can be found in most hotels either remodelled or newly constructed since 1991. Hotels that have window-applied ventilators include: Caesar's Palace, The Venetian, MGM Grand, Embassy Suites, Marriott Suites and Treasure Island.

The use of through-the-wall ventilators is restricted to single and multi-family residential construction. There is not a simple way to trace their usage as they are marketed through distributors.

### **DISCUSSION**

Natural ventilation cannot be overemphasized to architects, builders and the general public. How it is achieved other than merely relying on operating windows and doors is irrelevant—just do it.

### **CONCLUSION AND IMPLICATIONS**

- Builders are constructing tighter buildings and houses to reduce energy costs often sacrificing needed controllable natural ventilation.
- Tight construction creates excess moisture inside a building or house causing undesirable condensation to form on glass in windows as well as hidden in walls.
- A family of five can generate as much as 3.5 gallons of moisture per day.
- Ideal humidity levels range from 30 to 45%—any higher may cause condensation.
- Opening windows and doors for natural ventilation causes drafts and increases the need as well as the cost of energy.
- Through-the-wall and window-applied ventilators in combination with low capacity exhaust fans is a proven method of natural ventilation to remove excess moisture, reduce condensation and help alleviate the possibility of mould growth.

### **REFERENCES**

ASHRAE.

US Department of Energy 1998 Survey (John Devine).

Washington State Ventilation and Indoor Air Quality Code—1999.