



Ventrite International (Pty) Ltd  
Fire Ventilation Specialists  
Established 1998

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## **The Importance of Natural Ventilation**

### **1. Human Performance in a Hot Environment**

In hot stuffy conditions work has little appeal. People need to rest more often and their concentration wanders. Human relations suffer and inevitably performance drops.

Research confirms that uncomfortably high or low temperatures, lack of fresh air movement and high humidity leads to lassitude, more accidents and higher absenteeism.

The actual number of vents required and the air supply necessary makes allowance for flow resistance based on their exhaust and inlet coefficients. The positioning of the vents is also critical in order to exhaust the smoke without mixing and cooling.

### **2. Natural Ventilation**

The term Natural Ventilation is used to describe ventilation systems which make use of existing thermodynamic forces within a building to draw in fresh air and discharge waste air without the assistance of powered components. Properly designed, manufactured and installed, natural ventilation systems are extremely economic, efficient, self-regulating and require only minimum maintenance.

When air in a building is heated by solar effect, product, plant and machinery or other means, it expands, which causes the density to decrease. This results in a reduction in the mass of a given volume. Should this air then be exposed to and in contact with surrounding air that is cooler and heavier, the warmer air will be induced to rise.

The rate at which this air rises depends firstly on the temperature difference between the rising column of warmer air and the surrounding cooler air. The greater the temperature differential, the faster the column rises.

### **3. Stack Height**

The rate at which warm air rises also depends on the height through which the temperature differential is sustained. A tall chimney will “draw” air faster than a shorter one because the warm air in the taller chimney continues to be driven through the full height of the stack.

Because the early theory of ventilation design was related to chimney stack design this factor is called “stack height” and is defined as being the vertical distance between the source of cooler air and the upper exit point. Applying this to a building, the stack height is measured from the fresh air inlet to the throat of the ventilator.

Providing that a temperature differential is maintained through a reasonable stack height, a natural ventilation system can be invoked by making a hole in the wall of a building, say a door through which cool air may enter, and a hole in the roof through which exhaust air may escape. Such natural ventilation systems have been used effectively for centuries.

#### **4. The effect of wind**

Even at low velocity, wind can devastate a ventilation scheme if the shape and position of the ventilation outlets are not properly designed. Perhaps the most common misconception is the view that slope mounted ventilators which have openings that are “offered” to the flow of wind, are reliable. Jack roofs and other exhaust outlet designs that “catch” wind are equally unreliable.

No configuration designed to exhaust unwanted air, including chimney stacks, can work efficiently all of the time if the *outlet is not horizontal on the highest point of the building*. Well designed and correctly located exhaust ventilators will have their discharge capacity significantly improved by maximizing wind forces on a building.

Outlets that are sloped, or fixed on a slope to catch wind, may allow outside air to enter the system from the top, which at best prevents exhaust air leaving, and at worst forces it back down into the building. Using only open throated slope mounted ventilators on a roof it is possible to reverse the intended ventilation flow completely, forcing exhaust air down into the building and out through doors, windows and louvers at ground level.

In addition to exhausting warm air, ventilators must also be designed to preclude the entry of rain and overcome the ill effects of wind. Both these factors impose influences on the design configuration that, to a greater or lesser extent, act to the detriment of exhaust performance.

#### **5. Backdraughting**

Backdraughting is the term to describe wind blowing back through an exhaust outlet. The effect is almost always responsible for inefficient ventilator performance, negative airflow, or airflow reversal. In addition to reversing the airflow, backdraughting often reverses the internal drainage geometry of the ventilator, which in turn results in serious leakage.

#### **6. A Measure of Efficiency**

In order to bring some degree of evaluation to bear on the design of ventilators, a perfect orifice regarded as being 100% efficient is considered to have a coefficient of discharge (Cd) of 1.00. Such a shape is essentially theoretical as it does not incorporate any provisions to combat rain or wind. But it does provide a measure against which the relative performance of fully developed exhaust systems may be measured as a relative Cd.

THE HIGHER THE CO-EFFICIENT OF DISCHARGE (Cd), THE MORE EFFICIENT THE VENTILATOR, AND THE SMALLER THE VENTILATOR NEEDED TO PRODUCE THE SAME EFFECT.

As in almost every form of human endeavour, size alone has little to do with performance, and ventilator size is not an indicator of overall efficiency. Indeed; the Cd rating of a ventilator can be accurately established and certified through appropriate testing in special low velocity wind chambers. Cds cannot be derived from calculation or guess work. They can only be obtained and certified through independent testing.

## **7. Stack Height**

So far we have considered the manner in which warm air leaves a building through roof mounted ventilators. This assumes that there is provision for replacement cool air to enter the building. Natural ventilation systems will not work unless adequate inlet air is provided. You cannot suck air out of a bottle! Although doors and windows can be incorporated into a design they are not a reliable source of air inflow. Air inlet systems, normally louvers, are positioned at or near floor level to maximize the stack height and provide incoming air at the level of the building's occupants.

It is therefore important to control the velocity at which cool air enters to prevent discomfort.

## **8. General Environmental Considerations**

### **a. Natural Ventilation is cheaper than Insulation**

In hot climates such as those experienced in Australia and South East Asia, it is not uncommon for the roofs of large industrial buildings to be insulated in order to minimize the effects of solar transmission and internal heat gain.

Providing the roof height is adequate to avoid radiated transmission, the unwanted heat above the workplace can be used to provide the motive power to control internal temperatures without the application of additional insulation materials.

### **b. A Free source of power**

Because natural ventilation systems are driven by existing thermodynamic forces, they do not require energy consuming motors to condition air or provide extraction. They also provide a constant service, without the danger of breakdown or expensive operating and maintenance costs.

### **c. Natural Ventilation controls Condensation**

Night sky or "Black Sky" radiation can generate serious levels of condensation on the underside of roof surfaces creating a source of corrosion and damage.

The potential for this form of "radiation fallout" exists in all buildings with metal roofs, regardless of whether or not they include ceilings. Well designed natural ventilation systems will control the conditions that encourage condensation at night.

### **d. Additional Natural Light**

Both roof mounted exhaust ventilators and air inlet louvre systems can be designed to provide significant levels of natural lighting through:

- The inclusion of translucent materials
- The diffusion of reflective light entering through the ventilator
- The provision of direct openings to the outside (whilst maintaining weather protection).