Natural Ventilation
A Strategy for Increased Productivity

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INTRODUCTION

Although the concept of ventilation has been around for several thousand years, the application of ventilation to overcome low productivity in warm to hot climates has been neglected over the last few decades. Since the advent of relatively cheap air conditioning owners have been seduced into installing air conditioning in the belief that the supposed increase in productivity will offset the high capital installation cost as well as the operation and maintenance expense. Local limited research has indicated that this is not the case. In fact, anecdotal evidence suggests the opposite. In a typical situation, it is not unusual to find a decrease in productivity as the workers slow down to prolong their stay in air conditioned comfort. Particularly when there is a threat that they may have to work outside after the workshop fabrication is complete.

Another of the problems encountered with air conditioning is that in an endeavor to save capital costs, the cheapest (and often the nastiest) equipment is selected. The consequential lack of control of the conditions can sometimes be more enervating than if there were no a.c. at all.

Not wishing to dwell on the topic, the other detrimental feature of using a.c. is its energy consumption that could lead to an increase in so called “Greenhouse Gases” Although the topic of globally warming is being hotly debated, unnecessary inefficient consumption of non renewable energy resources is a very poor policy.

WHY VENTILATE?

For any facility in this region, the choice is whether to air condition or ventilate or do nothing. Surprisingly there are a serious number of facilities where the third option was chosen. Having been in a number of these facilities during the peak summer period, one can be well assured that the conditions are intolerable. Temperatures as high as 55 degrees C have been recorded!

As discussed in the introduction, air conditioning can have considerable disadvantages leaving the other option of ventilation. We will address the obvious limitation of ventilation. It is immediately apparent that the dry bulb internal conditions of a ventilated facility can only be around that of the ambient conditions. However, with the affect of thermal storage from free night cooling it is common to find reductions in peak internal dry bulb temperatures of up to five degrees centigrade less than the instantaneous outside temperature.

What proper ventilation can achieve is a significant reduction in humidity, metabolic carbon dioxide levels, body odors and, if present, noxious fumes and pathogenic biological viral and bacteriological levels.

At this point, it is useful to discuss the humidity levels that can build up in the roof space during the course of the day. The solar roof gain elevates the dry bulb temperature in the roof space above the ambient temperatures. This increase in the dry bulb temperature results in an increase in the saturation temperature of the air trapped at high level. Moisture is drawn in and the relative humidity increases. The roof, being water tight, does not allow the moisture laden air to escape. Subsequently, as the night time temperature decreases, condensation forms on the inside of the roof and water droplets appear on the roof structure and then fall to the floor. With continuous roof ventilation, this problem is almost negligible. It should be noted that the same thermal mechanism can occur in air conditioned areas and the same solution is necessary.

GEOGRAPHY & AVERAGE WIND SPEED

Due to the natural features of the Gulf (and of course other littoral areas of the world) there occurs, particularly in summer, adiabatic diurnal winds that are as regular as clock work. The difference between the sea and land temperatures create winds that are commonly known as “land or sea breezes”

Fortunately, the civil aviation authorities in this region have kept excellent records of wind speeds for their own purpose. This data is easily available (usually for a price) and can be used to determine the wind patterns of the area.

Commonly in the UAE and the other Gulf Countries, regular winds prevail with an average wind speed of 12kphr (slightly less in Oman), the most reliable ones occurring during the hot summer months when ventilation is most important.

Map of the Arabian Gulf Region

DEVELOPMENT OF WIND DRIVEN TURBINE VENTILATORS & STANDARDS

Of all the natural ventilation systems, the wind driven turbine ventilator is arguably the most effective. Wind driven ventilators are a development of the basic concept found in the wind towers that can still be seen in the old parts of Dubai. The original turbine ventilators were rather primitive and had a basic “S” shape. As a natural ventilator, they take advantage of the principle of the stack effect that is enhanced by the rotation that causes a low pressure on the up wind side of the wind stream. The dynamic rotation of the ventilators increases the pressure difference between the throat of the ventilator and the outside air. This measurably improves flow rate and performance of the ventilation system.

For nearly halve a century, the round or onion shape wind driven turbine ventilator has dominated the industry. Their simple constructions enable its manufacture as a cheap manual cottage industry.

With the advent of concerns over anthropogenic climate change and increasing energy costs, research on improvement of these ventilators was started in Australia with the assistance of government grants. One of the first steps towards further development was the creation of a standard to allow verifiable testing to compare different configurations. It should be noted that before this standard was published by the Standards Associations of Australia and New Zealand, no other comparable standard existed in the world.

Since 1995, one Australian company has funded research into the development of wind driven turbine ventilations and from this evolved the cylindrical shape that has proved to be measurably more efficient.

By using a flow algorithm that is a function of the aerodynamic area and flow discharge coefficients a nominal performance can be evaluated for different wind speeds and temperature differentials in accordance with the Standard.

Performance variations have shown that ventilators made using vertical vanes have overall higher efficiencies and flow rates than traditional designs.

Additionally the Standard covers rain leakage and wind load resistance testing procedures.

DESIGN CRITERIA

The selection of ventilation rates for facilities in this region using recognized theoretical heat load calculations can be complex and difficult. It is a relatively simple matter to carry out an enthalpy balance by matching solar gains with an increase in the dry bulb conditions of the ventilating air. But, in practice, ventilation is a dynamic system that varies with the daily external ambient conditions and the thermal storage of the building structure.

When an internal heat load is imposed on this system it makes the theoretical estimation even more difficult. Other new methods are currently being trialed and investigated in Australia.

A simpler approach is to use ventilation rates that have been determined by experience of many years. These ventilation rates can be found in the texts of both the ASHRAE and CIBSE manuals. For the high heat loads experienced in the Gulf, these rates have been increased by a safety factor that again has been determined by field experience.

After selecting the appropriate number of ventilators it is essential that adequately sized inlet louvers are included at low level. Many ventilation installations perform badly due to undersized or badly installed inlet systems. In this region, the normal requirement is for sand trap louvers for which there is scant information available on there aerodynamic performance.

INSTALLATION COST

One of the greatest advantages of natural ventilation and in particular wind driven ventilators is their very low installation costs. Intrinsic to their function, wind driven ventilators made from aluminium have a very low mass, no dynamic loading and require no electricity. These types of ventilators are easily fitted after completion of the roof fabric and require no specialized techniques. A simple flashing with a variable pitch neck enables them to be installed on almost any roof. The installation is carried out from above the roof and there is no requirement for internal scaffolding. This feature is particularly useful in existing facilities where activities can not be interrupted.

COST COMPARISON

SUMMARY OF COST OF OWNERSHIP PER YEAR

	Roof Extract Fan	Wind Driven Turbine Ventilator
1. Running Cost	206.00	----
2. Replacement Cost	104.00	87.00
3. Maintenance	13.00	----
TOTAL	**USD. 323.00**	**USD. 87.00**

Note: We have not included for SOUND ATTENUATORS on the fans (the fans produce a sound level over NR50). Wind Ventilator are silent.

Performance Monitoring

Using standard monitoring equipment, including a weather station, the performance of wind driven ventilation can be simply verified. The use of HOBO temperature and humidity data loggers along with wind speed and direction logging has confirmed that wind driven turbine ventilators can maintain inside enclosed facilities conditions that rarely exceed the ambient peak conditions. In some cases, temperatures of up to five degrees centigrade less than the peak ambient have been regularly recorded. These results have been verified and witnessed in studies done around the world, particularly in The Arabian Gulf Countries.

CONCLUSION

Wind driven turbine ventilators are particularly suited to the Arabian Gulf conditions. With its long hot summer, the Gulf can produce arduous working conditions with facilities that are poorly serviced with insufficient ventilation. Since the majority of labour in this region is from the Asian subcontinent it is arguable as to whether or not air conditioning will improve productivity.

More and more, correct ventilation along with the appropriate cladding fabric for enclosed facilities is proving satisfactory. Along with a number of learned bodies, manufacturers are seeking more efficient systems for ventilating not only commercial and industrial facilities but also private dwellings.

Recently a hybrid wind driven turbine ventilator assisted with an electronic commutating low power motor has been trialed in Australia with astounding results. In addition steps are being taken to have the Australian New Zealand standard adopted by the International Standards Organization.

Finally the many installation of wind driven turbine ventilators in the UAE as well as Oman and Bahrain attest to the clients' satisfaction with the benefits of properly design ventilation systems.

Installation of wind driven turbine ventilators

Installation of a typical sand tap louvres