COMPARATIVE ANALYSIS OF VENTILATORS PERFORMANCE

Extract from West S.T.K (2008) "Design and Development of Natural Ventilation Products and Associated Improvement of Indoor Environment Quality." **In *World Sustainability Conference -Sustainable Buildings 08*, September 2008, CIB International Conference, Melbourne, Australia, Published in conference proceedings**.

Ventilators tested were those that are sold commonly in the Sydney market and experimental designs aimed at increasing performance. A fair analysis was sought to compare the ventilators performance at Sydney's average wind speed of 12km/hr.

Ventilators on the market had a range of manufacturers performance and options such as fans (refer to figure No 4.) stated as improving exhaust performance. In fact throat restrictions in the case of some fans actually impeded performance.

Figure No 4.380mmm throat vent with fan blade fitted.

Another factor that stands out in the comparative performance is the effect that throat area has on the flow rate. Comparing a 250mm throat diameter to a 300mm throat diameter,($0.049m^2$ and $0.071m^2$ respectively) shows a 30% increase in throat area but there is not a proportional association ie as the throat increases in diameter the flow rate does not increase proportionally, but increases by an extra15% over the 30% throat increase giving a 45% increase in flow rate. Blade separation, shape and bearing drag are other factors that have been shown to contribute to exhaust efficiencies.

WIND DIRECTIONAL SKYLIGHT VENT

Experimentation with new designs resulted in a unique omni directional aerodynamic foil that ventilated by rotating into the wind and at the same time provided light as a vertical light pipe. The Wind Directional Skylight Vent (WDSV) was a product tested under the Australian/New Zealand Standard AS/NZ 4740 2000 Natural ventilators- Classification and performance. The product is a clear dome skylight that ventilates by turning as an omni directional vane into the wind and gives increased air extraction flow rates, (as seen in Figure No 5 below)

Figure No 5. 300mmm throat Wind Directional Skylight Vent.

The WDSV product will be particularly useful in New Zealand, which has condensation problems. The WDSV will ventilate at twice the air changes per hour (ACH) compared to the rotary vent. Another useful feature for local conditions is the purported benefits of daylight discouraging possums and vermin that like to sleep during the day, in the roof space.

Another major benefit of the vent will be locating it to remove hot and moist air at ceiling height via a tube to the outside (please refer to Figure No.6). As inside temperatures rise, the ability for air to hold moisture rises, which is usually exasperated by warm humid sources such as showers, kitchen sink, clothes dryers etc.

Above the point of the moisture source is an ideal location to have a ceiling vent that will via light tube and WDSV, extract the humid air to the outside environment saving potential dew / condensation forming inside the house as would be the case if warm humid air touches cool windows or walls.

The results shown in figure No 5 were all tested at the UTS aerodynamics laboratory, those in yellow by the author on the 20.7.05 and those in red by Matthew Low laboratory manager 28.11.06.

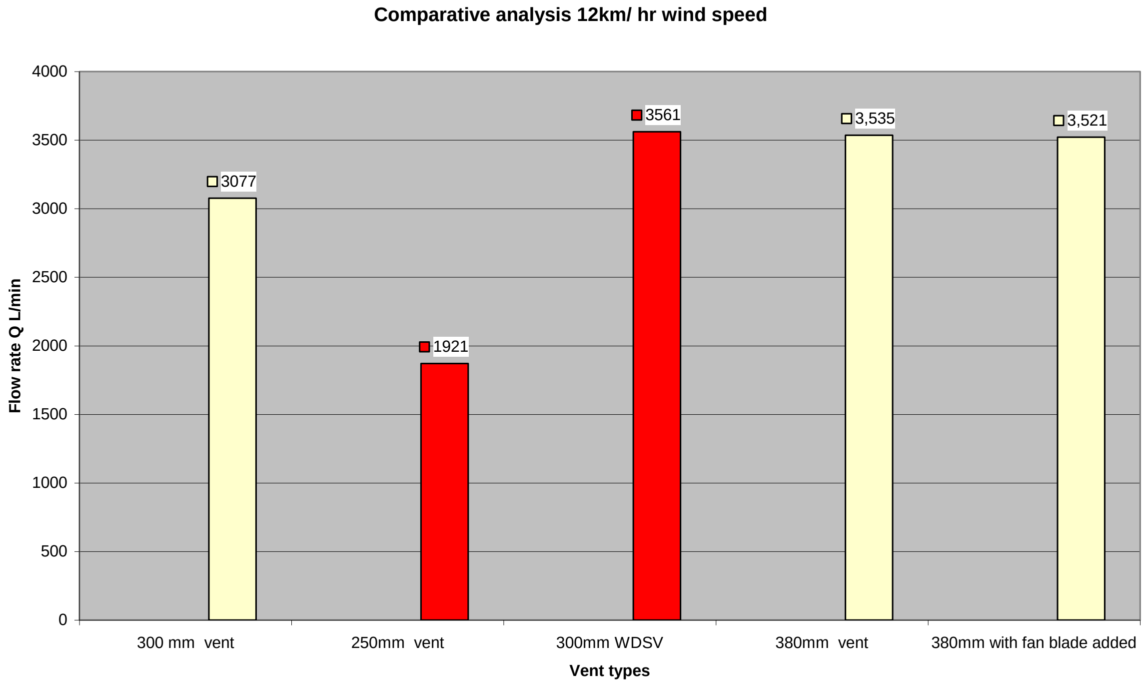


Figure No. 5 Vents tested, 300 mm throat, 250mm throat, WDSV 300mm throat, 380mm throat with and without fan.

The efficiency of the WDSV having the smaller throat size but better performance is notable as is the slight reduction in flow rate caused by blockage to the throat with the 380mmm throat fitted with a fan blade compared to the relative performance of the same vent with the fan removed.

HEALTH

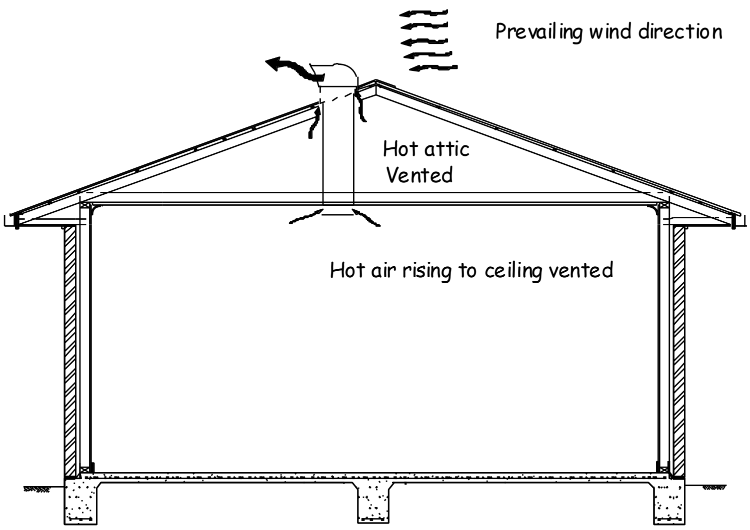
Indoor Air Quality is well known as a concern and reports have consistently shown that indoor air pollution may be twice or up to 5 times worse than outside air (Hess-Kosa, 2002). Breathing trapped polluted air, is one definition that could be used to describe the indoor air quality that occupants may be subjected to in some buildings. Even in airconditioned buildings, contrary to the name "conditioned", implying improved air quality; the internal air may have poor filtration and have less than 15% fresh air intake, (Australian Standard 1668 Pt 2 1991, recommends offices to have a ventilation rate of 10 litres per second per person.) leaving the internal air space full of contaminants.

The value of increased ventilation and desired removal at ceiling levels above sources has been identified in main studies such as (Li & Delsante 1997) where range hoods and direct bathroom exhaust ceiling extractor efficiencies were measured. This study showed the efficiency and ability to reduce the spread of moisture and contaminants were best achieved at source before dispersal throughout the building.

The need to further increase and induce air movement in bathrooms and kitchens of Malaysian houses was expressed by (Zain –Ahmed Et al 2005).

Many mould issues associated with bathrooms and carpets having high moisture content have also been shown to have higher dust mite associations. In New Zealand studies have suggested that higher ventilation rates are required to overcome the situation of tighter houses requiring greater ventilation to reduce moisture content. (Cunningham et al 2001) suggested the need to alter bio climatic conditions and reduce humidity levels to reduce mould growth and associated micro organism proliferation.

The ability of reducing moisture laden air at its source over shower recesses is combined with an energy free operation that allows for ventilation to continue and provide an outlet that is required for tight buildings that operate with roof ventilation supply systems that push dyer air from the roof attic space or outside into the house relying on the moist inside air finding seepage out of the building. By reducing the moisture at the source, providing daylight to further reduce mould growth and the ability to ventilate at ceiling level, the WDSV enhances the anti condensation pressure systems by providing a flow path of air to the outside that is capable of far greater exhaust than a rotating cowl by utilising attic pressure, better wind siphonage, and internal stack pressures as shown in figure No 6.



This system has three way extraction: Stack effect, wind assisted, attic siphonage

This arrangement ventilates the room space and the attic space, whilst providing daylight to both the room and attic space.

Roof Siphon

Figure No 6. The Wind Directional Skylight Vent operating as a ceiling daylight and vent combination.

Figure No 10 Comparative testing of WDSV and rotary vent

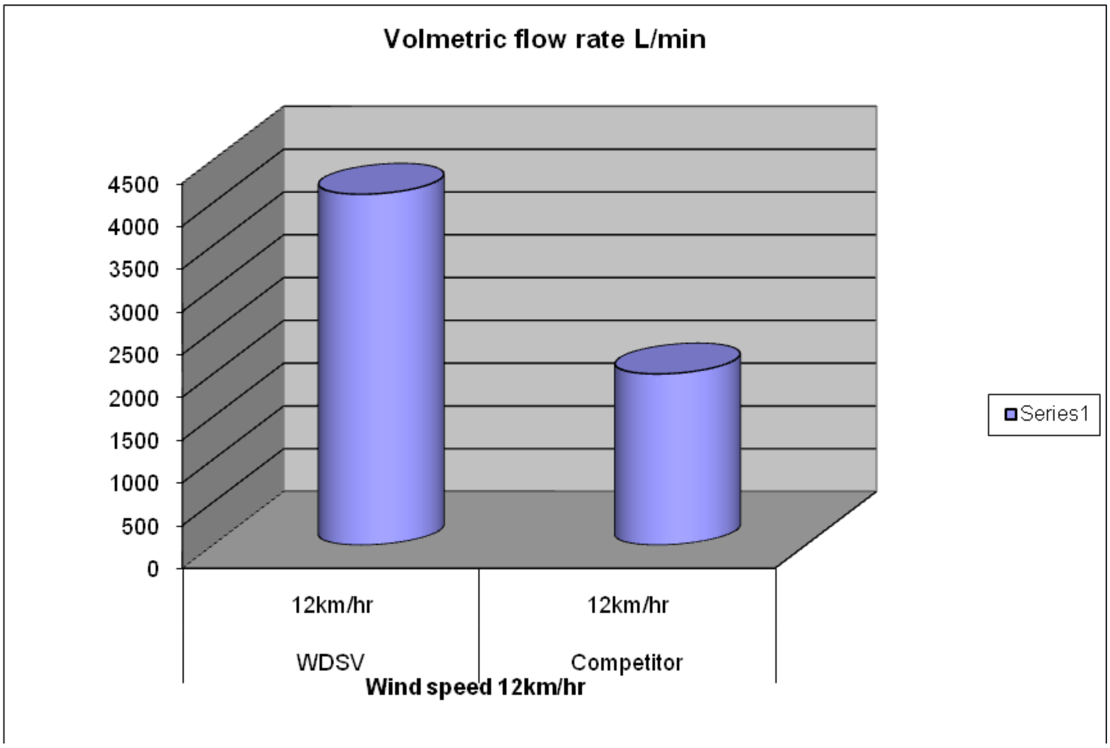


Figure No 11 Comparative volumetric flow rates

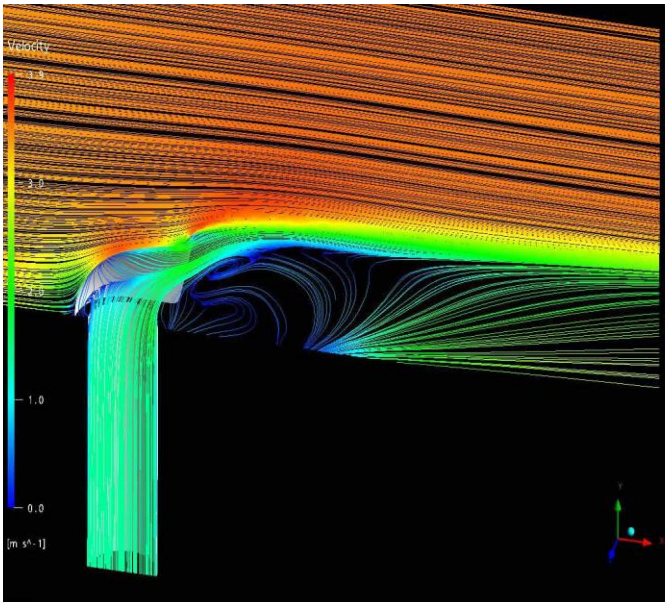


Figure No.13. Computational Fluid Dynamics of the WDSV

The commercialisation of the final product will be based on a combined operational performance and manufacturing efficiency and its benefits to IAQ, daylighting and ventilation will depend on how it is applied in its final configuration.

5.4 CONCLUSION

The testing procedure developed at UTS and incorporated into the Australian / New Zealand Standard 4740 has provided an ideal platform to standardise and make accurate comparative analyse of natural ventilators exhaust flow rates.

The obvious development of technologies and linking of the theme of environmental technologies can be seen with the development of light pipe technology and ventilation technology being synergised in the development of the WDSV.

The need to reduce or dissipate the heat load inside buildings to improve comfort levels and hence productivity is desirable. However, the costs associated with redesign, air conditioning and insulation may be prohibitive. With the on going energy reduction / greenhouse emission campaigns and in line with ESD principles the relevance of stack effect and wind siphonage to reduce internal heat loading is now gaining the attention of building designers around the world.

The results of the author's experiments have shown some surprising results and have achieved significant improvements with new designs combining natural ventilation with daylighting. Natural ventilation has a crucial part to play in the sustainable buildings of the future and these experiments and products are now making inroads into the science behind the myths.

In the experiments conducted, advanced aerodynamic designs have been shown to increase exhaust flow and the products practical application into ceiling fixtures in conjunction with attic exhaust will assist in reducing mould growth conditions associated with bathrooms and laundries helping inturn to improve IAQ.

REFERENCES

AS/NZ 4740(2000) **Natural ventilators- Classification and Performance**. Standards Australia.

Cunningham, M, Roberts, P and Hearfield, M (2001) **" Changes in Indoor Climate and Microclimate of a New Zealand Bungalow after a Two stage Insulation Retro Fit."** CIB World Building Congress, Wellington , New Zealand.

Hess_Kosa K (2002) **"Sampling methodologies"** Indoor Air Quality**:** Boca Raton, Florida CRC.

Low. M (2006). **"Testing of Roof Ventilators"** Report for Alsynite Roofing Products. Faculty of Engineering, University of Technology, Sydney.

Li, Y. Delsante, A and Symons, J. (1997**) "Residential kitchen range hoods- buoyancy-capture efficiency revisited"**. Indoor Air, No7, pp 151-157.

West S.T.K (2005) **"Natural Ventilation Flow Rate Performance and Product Development"** (Ed) Professor Tony Sidwell, QUT Research Week, *July* 2005, Queensland University of Technology, Published in conference proceedings.

Zain-Ahmed A, Abdul Rahman s, Sharani S (2005) **" Natural Cooling and Ventilation of Contemporary Residential Homes in Malaysia: Impact on Indoor Thermal Comfort.",** World Sustainability Conference, Tokyo.