Technical Research Paper 04

The Ventilation System in the CH_2 Building

Study Outline

This study outline summaries key points raised in one of the 10 technical papers in the pre-occupancy study series that investigates the City of Melbourne's world leading Council House 2 (CH_2) office building. Each technical paper has been developed by independent authors from Australian universities as part of the CH_2 Commercial Green Building Technology Demonstration Project. To obtain copies of the full technical papers visit www.ch2.com.au

This project forms a major part of the CH_2 Study and Outreach Program – a coordinated effort to consolidate the various opportunities for study, research, documentation and promotion generated by the CH_2 office building. The primary aim of this program is to raise awareness of sustainable design and technology throughout the commercial property sector and related industries.

The target audience for these papers is professionals involved in the design, engineering, construction and delivery of office buildings, which explains the technical detail, length and complexity of the studies. Although these papers may be of interest to a wider audience, readers who possess a limited knowledge of the subjects covered should obtain further information to ensure they understand the context, relevance and limitations of what they are reading.

Significant funding for the technical papers was provided through an AusIndustry Innovation Access Program grant and supported by cash and in-kind contributions from the City of Melbourne, Sustainable Energy Authority Victoria, the Building Commission of Victoria, the Green Building Council of Australia and the CH_2 Project, Design and Consulting Team. The Innovation Access Program is an initiative of the Commonwealth Government's Backing Australia's Ability action plan.

An Australian Government Initiative

AusIndustry

6 star rating

green star Office Design v1

This rating represents World Leadership

Technical Research Paper 04

Study Outline – The Ventilation System in the CH_2 Building

The following is a summary of the principles of ventilation explored in paper 4, addressing the relationship between air handling in Council House Two (CH_2) and air pollutants in a city environment. In the last 10-15 years, our understanding of ventilation requirements in commercial buildings has been significantly revised. Studies of office buildings fitted with conventional HVAC systems have shown that energy-intensive space conditioning equipment and sophisticated control systems do not necessarily provide healthy working environments. Studies of buildings with higher ventilation rates, however, have shown reductions in short-term absence of staff. Links between health, productivity and increased fresh air use have been established by certain research projects, and this underpins the ventilation philosophy adopted for CH_2. CH_2 also aims to demonstrate how natural forces can assist to ventilate a building. The result should be a substantial reduction in energy requirements, and an improvement in occupant health and productivity.

Mixed air distribution in a VAV (dilution) system.

Air layering effect in a displacement ventilation (separation) system.

Figures 1: Representation of two air introduction systems (AEC).

Natural and Mechanical Ventilation

Fresh air may be delivered by a mechanical or natural ventilation system. Both these methods are employed in the CH_2 building. The ventilation system for the CH_2 offices will be mechanically driven during the day, using an under-floor air supply technique to distribute filtered air. All introduced air will be drawn from outside, and no recycling of air will occur. Natural ventilation will be employed at night using the stack effect, enhanced by turbine ventilators. Some parts of the CH_2 building, such as the toilets, will rely on direct natural ventilation through vents and windows.

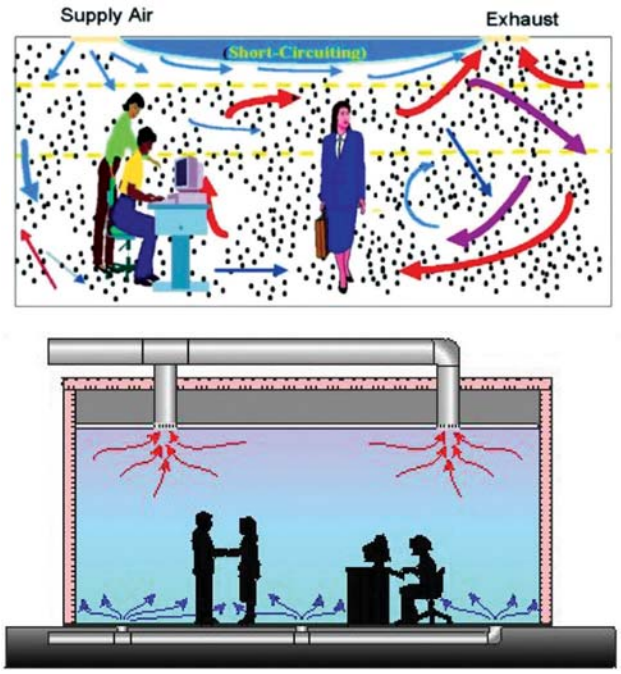

Figure 2: The difference between a dilution-based mixing ventilation system and a separation based under-floor supplied ventilation system (AEC).

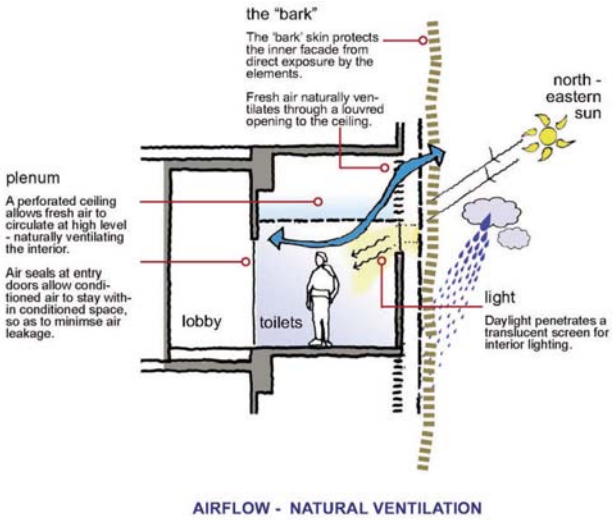

Figure 3: Airflow natural ventilation.

The CH_2 Ventilation System

The main design objective of the CH_2 ventilation system is to avoid recycling any air into the offices. The air entering the offices is to be both 100 per cent fresh and filtered. In addition, the quantity of introduced fresh air will be substantially higher than required by the Australian Standard. Another goal of the system is to avoid the mixing of fresh and stale air within the occupied spaces. At night, purging with natural ventilation will cool the internal fabric of the building in summer. In this process, the windows will be automatically opened at night, when outside air temperatures are below the temperature of the concrete ceiling of the office.

Figure 4: Manufacturing automated timber windows.

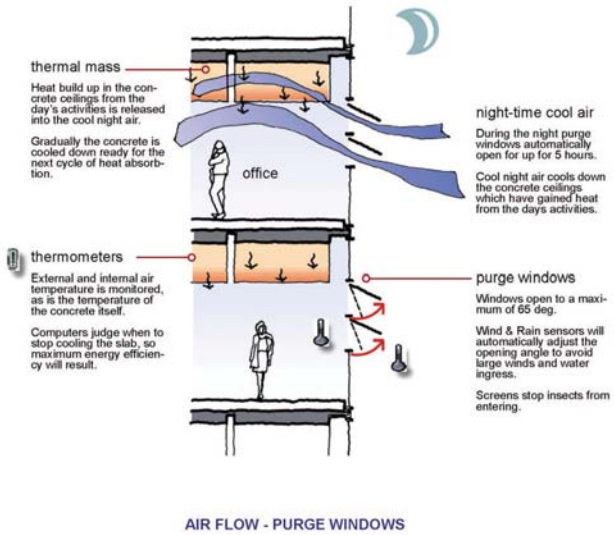

Figure 5: Air flow – purge windows.

Since large quantities of outside air are to be introduced into the building, the quality of the air in central Melbourne is an important factor. The study reviews the night purge aspect of the system in relation to existing standards and strategies for good ventilation practice, and in relation to the performance of completely naturally ventilated buildings. The review suggests that minimisation of indoor pollutants, adequate filtration and high levels of ventilation should ensure satisfactory air quality during occupied hours.

It's all about creating a sustainable work environment… that's been the focus… the great thing about this project and the way the City of Melbourne has done it – is that it's a building for the people. … That has been the prime driver, no matter what the idea is.

Stephen Webb, DesignInc.

System Components

The various components of the ventilation system, including air intakes, air filters, wind-driven ventilators, and materials section, have been designed in order to achieve the objectives described above.

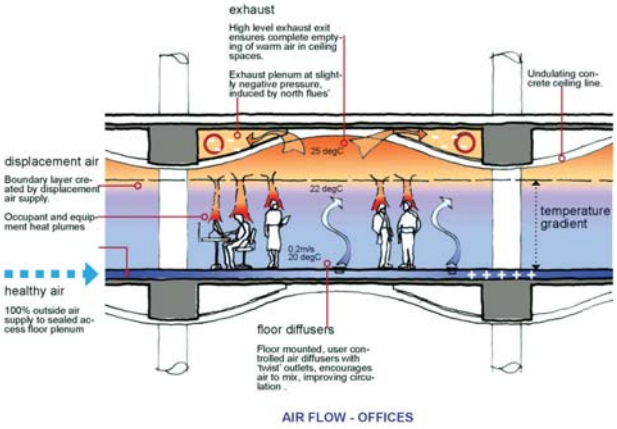

Figure 6: Air flow in CH2 offices. Air is supplied through an under-floor plenum and released through occupant controlled swirl diffusers. Air is primarily supplied to satisfy occupants' breathing requirements, to moderate humidity levels, and to remove internally generated pollutants, such as carbon dioxide. The ventilation system is not designed to satisfy primary heating and cooling demands.

The air intakes have been located away from areas where a high concentration of polluted air may occur. All the air entering the CH_2 building to satisfy occupants breathing requirements will be passed through primary and secondary filters in order to reduce the concentrations of outside air particulates. Six wind-assisted extraction turbines will be mounted on top of the north façade to assist in drawing stale air out of the office spaces during night purge operations. The construction materials, furnishings and fittings used in the CH_2 building have been selected to reduce the emissions, and potted plants will be used to reduce contaminants in the indoor air.

Our findings support the view that the potted-plant system represents a potentially self sustaining, flexible and attractive bio-filtration system, that can be used in any indoor space (provided the plants are well maintained):

- *The pot-plant system reduces or eliminates volatile organic compounds (VOCs) from indoor air within 24 hours.*
- *The system gets better on exposure to VOCs, and maintains performance with repeated doses.*
- *From three to 10 times the maximum permitted Australian occupational indoor air concentrations of each compound can be removed within about 24 hours, under light or dark conditions without saturating the system.*
- *The pot plant system can also remove very low residual concentrations.*
- *The system works at the same rates day and night, and over weekends (when air-conditioning may be turned off).*

Ron Wood

Figure 7: Rendering of north façade showing six wind-assisted extraction turbines.

Clean, fresh air in adequate quantities is required for human health and perceived wellbeing. Higher ventilation rates can reduce the prevalence of 'sick building syndrome' symptoms and improve perceived air quality, and are now often advocated to improve health and productivity. Given its inner-city location and the possibility of excess particulate levels in the outdoor air, the efficacy of the filtering system will be a major determinant of indoor air quality, as is common to most buildings using mechanical ventilation systems. The effect of the ventilation rate on workers' performance is therefore not independent of other factors such as temperature and the filter system's condition. Productivity increases will be achieved indirectly if there is less sickness-related absence. The current evidence suggests this is likely to be the major benefit of the ventilation system proposed for the CH_2 building.

Figure 8: Vents for natural ventilation and windows for natural lighting of toilets located on the eastern façade, prior to installation of architectural cladding.

1 Improving the indoor environment for health, well-being and productivity, www.tropicalplantrentals.com.au/ron wood.pdf, last accessed 5 October 2004.

Other Studies in this Series:

1. **Nature and Aesthetics in the Sustainable City** – form, function, flora, fauna and art;
2. **Workplace Environment** – people, the built environment, technology, and processes;
3. **Lighting and Physiology** – artificial and natural lighting and its relation to the human body;
4. **Air and Physiology** – internal air quality in relation to what the human body needs;
5. **Cooling, Heating and Physiology** – radiant, convective and conductive heating and cooling in relation to the human body;
6. **Energy Harvesting** – economic use and efficiency;
7. **Water** – reducing consumption and increasing harvesting;
8. **The Building Structure and the Process of Building** – engineering, transport, construction and structural elements;
9. **Materials** – selection based on an eco-audit that factors in embodied energy, process toxicity and off-gassing considerations;
10. **The Business Case for Sustainable Design** – economics, payback, productivity and efficiency.

For more information and access to a complete set of studies, visit the CH_2 Web site at:
www.CH2.com.au

Or contact:
City of Melbourne
PO Box 1603
Melbourne, Victoria, 3001
Australia

(03) 9658 9658
ch2research@melbourne.vic.gov.au
www.melbourne.vic.gov.au

The is a publication of Melbourne City Council

An Australian Government Initiative
AusIndustry

6 star rating
green star Office Design v1
This rating represents World Leadership

CH_2