EDITORIAL

Celebrating differences of opinion

THE management committee of the CIBSE natural ventilation group have been very busy recently, and its efforts culminated in the seminar entitled “Passive Building Technology in Practice” held at UCL in June. And, judging by your responses and attendance you are interested in hearing what we’ve got the group has to say. This makes it all worthwhile. We are very grateful to Dejan Mumovic and David Veitch at UCL for all their help with arranging the facilities and comestibles and to Nyree Hughes at the CIBSE HQ for coordinating the marketing and tickets.

The management committee of the group is a collection of interested individuals; some sell products and services that utilize the principals of natural ventilation, others consultant on or design natural ventilation strategies, some represent government organisations, and others are from the world of academia. As you can imagine, we don’t always agree on the best possible solution to a problem. Recently, the Priority School Building Programme has sparked debate amongst the group. In particular, section 2.7.18 of its specification document, which states that “in naturally ventilation spaces, the Contractor shall provide mixing of ventilation air with room air to avoid cold draughts in the occupied zone during winter time”.

Novelist Charles Kingsley wrote that “there are more ways of killing a cat than choking it with cream.” In this edition of the CIBSE NVG newsletter, Shaun Fitzgerald, managing director of Breathing Buildings, presents his thoughts on the avoidance of draughts in schools classrooms. Others will offer their opinions in future editions.

This newsletter is reviewed by the group management committee before it is published and so there is a modicum of consensus when we agree to disagree. It is worth emphasising that the views and opinions that this newsletter shares do not necessarily represent those of the group or the CIBSE. However, the group is united in its opposition to felicide. Please feel free to share your opinions with us, and thus prove that Charles Kingsley was correct, metaphorically.

Dr Benjamin Jones, editor
The Camel’s Nose

Emeritus Professor Derek Clements Croome, University of Reading

A Camel’s nose is not much to behold, but the survival of the animal depends upon it.

Camels exhale drier cooler air thus conserving water in their bodies. In 1979 Schmidt-Nielsen of Duke University linked up with Zoologist Amiram Shkolnik of Tel Aviv University and discovered the secret of the camels air-cooling ability. The camel makes use of two principles of physics: cooler air holds less moisture; and the greater the surface area the faster the rate of evaporation or condensation. Evaporation results in cooling.

They found an intricate labyrinth of narrow highly scrolled air passageways in the camel’s nose which greatly increases its surface area available for heat and moisture transfer. Typically a human nose has only about 160 cm² of interior surface area, while the camel has about 1000 cm² of mucous membrane on the nasal interior.

The camel's nose acts as both a humidifier and a dehumidifier with every breathing cycle. The hot, dry air that is inhaled passes over the large area of moist membrane. This air is immediately humidified by picking up moisture from the nose and cooled in the process. This cooler air passes to the lungs and remains at approximately body temperature. When it is exhaled, it is cooled even further by passing over the same nasal membranes, this time by a process of dehumidifying instead of humidifying. The nasal membranes are coated with a special water-absorbing substance that extracts the moisture from the air like the cooling coils of a dehumidifier. A net savings of 68% in the water usually lost through respiration occurs just between the cooling and drying phases of the breathing cycle.

According to a report from the United Nations Environment Programme, severe water shortages will affect 4 billion people by 2050. Looking to the dromedary camel's water conservation strategies for inspiration, we could design solutions to limit evaporation from water storage ponds, design more efficient irrigation systems, and learn how to best minimize loss and recapture water used in industrial processes.

About the Author

Professor Derek Clements-Croome worked in the building design and contracting industry before entering university life. He has founded and directed courses at Loughborough, Reading, and Bath Universities.

He researches, writes and lectures on managing healthy and sustainable environments in buildings of all types. Some of his books have been published in Chinese and Russian. He founded and edits the Intelligent Buildings International journal, first published by Earthscan in 2008.
We are often told by consultants, clients and engineers that there are two main problems with natural ventilation in winter - cold draughts or high heating bills which result from incoming cold fresh air being passed over a heating element to warm it up before it reaches the occupants. This method of overcoming cold draughts is nonsensical in terms of energy use when the heat gains in most non-domestic buildings far outweigh the heat required to maintain an average space temperature of around 21°C in winter when external temperatures are in excess of approximately 6°C.

Alternatively, a concept which is being discussed by some in the industry is the use of high level opening vents or windows for winter ventilation. The concept is that cold air enters the building via the vents or windows and is mixed with the internal warm air. A good idea, but how much mixing can you actually get? Not enough would be our assertion in most classroom situations.

In many rooms the floor to ceiling height is around 2.8m. Any high level vent will have a certain depth to it, so the distance from the floor to the bottom of the high level vent is at most 2.3m. Cold air will enter through the bottom of the high level vent when the vent is opened in winter and, if you are sat underneath the window, given typical desk and chair arrangements, the distance from the floor to the top of your head is 1.3m. This is a long way of saying, the distance between the top of your head and the bottom of the vent is very small.

During winter months fresh air rates in many UK classrooms are too low to create an environment conducive for proper concentration, research suggests. The problem lies in the fact most schools rely on windows being open to allow fresh air in; however, cold drafa often see them closed for months on end.

It goes without saying that learning environments need a generous supply of fresh air to keep students alert and able to concentrate for long periods of time. It is surprising then that many of our children sit for hours on end in classrooms that aren’t fit for purpose.

Following an assessment in 2005 of 8 primary schools which were using opening windows for ventilation, Building Research Establishment (BRE) findings revealed that in winter more than half the fresh air rates were below the minimum required.

There are inevitably consequences for those residing in such closed spaces, particularly densely populated ones. Breathing stale air will not supply enough oxygen to keep young minds functioning properly. Furthermore, occupied but inadequately ventilated spaces create a playground for bacteria and viruses.

The challenge is, how do you ensure a steady flow of fresh air into a room in winter without the ensuing cold draught? To answer this question we need to delve a little deeper into the physics and rather than just rely on assertions, see what the experts have to say.

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What do we know about infiltration and exfiltration? 1 — An introduction.

Bejamin Jones and Edward Cooper, University of Nottingham

THE investigation of how air enters and leaves a building is the study of Ventilation. Ventilation can be intentional or unintentional. Intentional ventilation is known as purpose provided ventilation and occurs through purpose provided elements and openings, such as windows and vents. Purpose provided ventilation is driven by mechanical systems or by natural driving forces. There are many excellent texts that discuss ventilation from the highly technical, such as David Etheridge’s Natural Ventilation of Buildings or Ventilation Theory and Measurement, to those that give a clear

References


About the Author

Shaun is a co-founder of Breathing Buildings. He completed his PhD in Geothermal Reservoirs at Cambridge University before moving to Stanford University, CA and later spending five years at Bain and Company. He returned to Cambridge carrying out research into natural ventilation at the BP Institute before turning his hand to energy reduction using his expertise in natural ventilation to found Breathing Buildings in 2006.

Shaun on the BBC

Shaun Fitzgerald recently featured on Radio 4’s programme World Tonight (27th May 2013). He was interviewed by entrepreneur Margaret Heffernan as part of an audio article that asked “What’s holding the UK back from long term sustainable growth” and investigated the potential of high-tech, and often green, companies to lead the towards this aim. The interview can be found on the BBC iPlayer (from 23 minutes):

http://www.bbc.co.uk/iplayer/episode/b01sm2g2/The_World_Tonight_27_05_2013/

Following the audio article, Margaret Heffernan put her thoughts into writing to ask “Vince Cable Has a Policy; Does the Government?”

http://www.huffingtonpost.co.uk/margaret-heffernan/-vince-cable-has-a-policy-_b_3335526.html

probably about 1m. So, the killer question is ‘does the incoming cold fresh air mix with enough of the room air so it falls 1m for the temperature to be above 16°C?’

Fortunately, the fluid mechanics experts have provided us with the tools to assess the risk. A window configuration suggested by some designers involves two 0.9m wide high level windows in winter. If one of these is the inflow and one is the outflow in winter with a minimum fresh air rate of 150 l/s, we can use the plume model calculations of Turner and the principle of a virtual origin (Kaye and Hunt) to determine the degree of mixing which can be achieved. The over-riding conclusion is that if you want to ensure fresh air reaches occupants no colder than 16°C when the classroom is at 21°C, opening windows are fine but only when the exterior temperature is above 13-14°C. Alas, as we spend so much of the time in the UK with external temperatures below this level, the opening window strategy won’t work unless the windows are extremely wide — you will get cold draughts. If you locate a radiator under the window, this can overcome the cold draught problem, but given that the room itself doesn’t need heating until the exterior temperature falls to 6°C this is extremely wasteful in terms of energy and the resulting heating bills will be much, much higher than anticipated.

Controlled mixing is a critical feature of a ventilation strategy. A ventilation system should really be designed to overcome the additional challenges of gusty cold days. By their very nature, opening windows do not cope well with this problem, so hence there is a general move in the industry towards a more controlled approach for winter ventilation.

The first-ever joint conference of the International Society for Environmental Epidemiology (ISEE), the International Society of Exposure Science (ISES), and the International Society of Indoor Air Quality and Climate (ISIAQ) hosted by the Swiss Tropical and Public Health Institute (Swiss TPH) offers scientists, researchers and health professionals from all over the world an excellent platform from which to discuss the latest scientific achievements at the interface of health, disease prevention, the environment, and policy-making.

Some 1,500 international experts, junior scientists and doctoral students are expected to participate. The conference will offer a diverse programme of symposia, oral presentations, poster sessions and lively round table discussions, as well as plenary sessions featuring keynote speakers from around the world.
Unintentional ventilation is known as adventitious ventilation and is a tricky subject. To most practitioners adventitious ventilation is known as infiltration, but this title only covers airflow into the building. Airflow out of a building is known as exfiltration and so adventitious ventilation is actually the combination of infiltration and exfiltration. When considered over a whole building, the rates of infiltration and exfiltration are identical because mass is conserved. However, when considered in a single zone of a building, the rates of infiltration and exfiltration may not be identical.

Adventitious ventilation is important to practitioners because it is not designed for and is, to all intents and purposes, uncontrollable in real-time. This makes it dangerous for two key reasons. Firstly, exfiltration is the loss of heated air, energy, and money. Conversely, infiltration is the ingress of cold air that requires heating, energy, and money. Adventitious ventilation increases carbon emissions when the energy required to heat cold air comes from non-renewable sources. Secondly, adventitious ventilation can affect the performance of purpose provided ventilation systems or distort intended air flow patterns in a room.

Although uncontrollable in real-time, adventitious ventilation can be minimized during the construction of a building and when its services are fitted. This requires knowledge of adventitious airflow paths. Infiltration and exfiltration airflow occur through cracks located in the envelope of a building, known as air leakage paths (ALPs). ALPs are commonly located around windows and doors, through and around permanent vents and service ducts, around pipework (sewage flow-away, or water supply), hatches (such as loft hatches), around joist penetrations of external walls, in suspended timber floors, in the area below skirting boards, in electrical conduits, in areas of bare masonry wall, and through some unfilled wall cavities. This list of specific ALPs is by no means exhaustive and is complicated further by general areas of ALPs, such as the naturally porous walls. This highlights just how difficult it is to determine the location of ALPs.

Buildings with a high rate of adventitious ventilation are known and leaky buildings. Future articles will explore how one might determine the location of specific ALPs in the field, how current regulations require the overall leakiness of a building to be determined, and whether this measurement is good and useful. The leakiness of various stocks of buildings will be investigated and we will ask: what do we know really about infiltration and exfiltration?
### Colin’s Useful Documents

**Colin Ashford, ConsultEco**

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<th>Item Number</th>
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| Building    | Ventilation: Theory and Measurement                                  | This book sets down the fundamentals of the theory and measurement of building ventilation and describes the various techniques for predicting and measuring ventilation. It addresses both envelope flows and internal air motion.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Author: David Etheridge  
Publisher: Wiley |
| Natural     | Ventilation of Buildings: Theory, Measurement and Design             | The book also describes the theoretical and experimental techniques to the practical problems faced by designers of naturally ventilated buildings. Particular attention is given to the limitations of the various techniques and the associated uncertainties.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Author: David Etheridge  
Publisher: Wiley |
| A Guide to  | Energy Efficient Ventilation                                        | This guide is aimed at the non specialist who need to acquire a broad background knowledge of the topic. It is presented in a descriptive format with calculations and equations restricted to the final chapter. This enables the reader to obtain guidance and make basic calculations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Author: Martin Liddament  
Publisher: AIVC  
See: www.veetech.co.uk |
|             | Virtual origin correction for lazy turbulent plumes.                | A platform on developments in buildings and ductwork airtightness. Includes policy issues, publications, events, research findings etc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Journal of Fluid Mechanics, 435; 377-396. |
|             | Buoyancy effects in fluids.                                          | This book gives a connected account of the various motions which can be driven or influenced by buoyancy forces in a stratified fluid, including internal waves, turbulent shear flows and buoyant convection.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Author: J.S. Turner  
Publisher: Cambridge University Press |

### About The Useful Documents

These documents are specific to ventilation but are a small part of a larger list of over 385 references that concentrate on low-carbon and sustainability economics, specification, design, and operation of buildings. The list concentrates on documents that have been peer reviewed and have minimal or zero commercial bias. All have the option of nil-cost download, but some charge for more advanced facilities. Visit [http://www.consulteco.ie/#](http://www.consulteco.ie/#) to access the full set of documents at no cost.

It is hoped that this knowledge will be of use when talking to Clients or when considering design options. This information can also be used to explore the extent of bidder’s knowledge when interviewing. Items are given alphabetically.

To add useful documents to the list or to report errors, please notify Colin.

### About Colin

Colin Ashford was originally a process systems and developer, but moved into energy management in the 1980s when he was responsible for estates totalling almost 3,000 buildings. He was technical lead consultant on Carbon Trust Northern Ireland’s major programme ‘Low Carbon Design Initiative’. Colin has been a member of CIBSE council for 11 out of the last 14 years. Colin was a member of the Carbon Trust’s Consultant Accreditation Panel from 2009 to 2012. He has also contributed to the training of more than 40% of the total 12,500 British Institute of Facilities Management membership.

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