

# UC Berkeley

## HVAC Systems

### Title

Adventitious ventilation: a new definition for an old mode?

### Permalink

<https://escholarship.org/uc/item/8hm7w0bk>

### Journal

Indoor Air, 24(6)

### ISSN

09056947

### Author

Schiavon, Stefano

### Publication Date

2014-12-01

### DOI

10.1111/ina.12155

## **Adventitious ventilation: A new definition for an old mode?**

Does your home have a mechanical ventilation system? If not, does this mean that your home is naturally ventilated? Probably not.

Several studies have compared the effects of naturally versus mechanically ventilated buildings on indoor air quality. However, these comparisons may be unfair to some naturally ventilated buildings. Let's discover why.

Ventilation is the process of supplying air to and/or removing air from a space for the purpose of controlling air contaminant concentrations, humidity, or temperature within the space (ASHRAE, 2013a). Buildings are usually classified according to their ventilation system as mechanically, naturally or mixed (hybrid) ventilated.

In a mechanically ventilated building, ventilation is provided by powered equipment, such as motor-driven fans and blowers. In a naturally ventilated building, ventilation is provided by natural forces such as wind-induced pressure differences or temperature-induced differences in air density. In natural ventilation, air is introduced to the ventilated space through *intentional* openings in the building envelope. In the third mode, mixed or hybrid ventilation (Heiselberg, 2002) the two strategies are alternated spatially or temporally.

ASHRAE Standard 62.1-2013 (ASHRAE, 2013a) specifies that a natural ventilation system should be “designed.” This specification implies that there should be a professional who takes responsibility for designing openings and methods for their control according to standards or best practices, e.g. CIBSE AM 10 (CIBSE, 2010). The designer may take into consideration parameters that affect the performance of the natural ventilation system, like wind speed and direction, indoor and outdoor temperatures, and location and size of the designed and controlled openings.

So, here is a key question to consider. Should buildings without a mechanical ventilation system automatically be classified as *naturally ventilated*? In my view, the proper answer is “no.” It is reasonable to assume that — for a significant part of the world's building stock — no one *designed* a ventilation system according to pertinent best practices. In the absence of appropriate design, it seems wrong for the default building classification to be “naturally ventilated.” If buildings without designed ventilation should not be classified as “naturally ventilated,” then how should we classify them? How should we refer to this case?

One option would be “noncompliant ventilation.” However, this name may be too ambiguous. The ventilation system may not comply with a specific standard or a version of a standard but it may comply with other guidelines or standards. This name does not shed light on the fact that the no one deliberately designed the system.

Another name might be “unknown ventilation” or, to draw on a classical Greek root, we might refer to such circumstances as possessing “agnostic ventilation” (from “agnōstos” in classical Greek: “ἀγνώστος”, “not –(to be) known”). This nomenclature, too, presents problems. One could argue that even for designed mechanical or natural ventilation systems, the actual or

average outdoor airflow rate is uncertain in operation. Moreover, in English usage, the term *agnostic* is commonly associated with people who believe that the existence or nature of God is not known or cannot be known.

In reflecting about this problem, I found myself stuck on these terms, when Bill Nazaroff happened to stop by my desk and suggested the term “adventitious ventilation.” It took me some minutes to learn how to spell it, and it is not yet easy to pronounce, but regardless of these difficulties, this was exactly the term I was looking for. In fact, the Oxford English Dictionary defines adventitious as: “...occurring as a result of an external factor or of chance, rather than by design...”

Interestingly, the term “adventitious ventilation” is not new. It has been used, mainly in the seventies and for residential buildings, as synonymous of infiltration and natural ventilation (Harris-Bass et al., 1974). This interchangeable use of the terms “natural” and “adventitious” ventilation underlines the negative prejudice about the unpredictability and randomness of natural ventilation. Since then, we have learned a lot about natural ventilation and it now seems worthwhile to distinguish natural ventilation from adventitious ventilation.

Now that we have a name, let’s try to develop a definition. In an adventitiously ventilated building, ventilation is incidental and the ventilation system has not been taken into account and designed to achieve any particular code, standard or best practice. This definition does not exclude that sufficient or abundant outdoor airflow rate could occur or that adventitiously ventilated buildings have higher, equal or lower performance compared to naturally ventilated buildings (i.e. buildings provided with a designed system). There are examples of vernacular architecture that are proven to work well. Those buildings have embedded centuries of empirical design that can be considered a best practice. This definition does not guarantee that the natural ventilation performs well either. In order to do that an assessment should be carried out. The definition underlines the point that, for an adventitiously ventilated building, the issue of ventilation was not considered by the designers and builders. If a researcher, engineer or architect does not find reasonable evidence to show that a natural ventilation system was designed, then she should classify the building as adventitiously ventilated.

Is this new classification needed? In an ideal world we would not need to distinguish naturally and adventitiously ventilated buildings because we would classify ventilation systems based on their measured performance (e.g., outdoor air flow rate, ventilation effectiveness, pollutant concentrations, etc.). Until then, it seems manifestly unfair for well-designed naturally ventilated buildings to be included in the same group of buildings for which ventilation occurs incidentally, rather than intentionally. For the same wind conditions and air temperature differences between indoors and outdoors, it is possible that the outdoor airflow rate, where air enters the indoor space and how air is distributed throughout the building could be substantially different between superficially clustered naturally and adventitiously ventilated buildings.

Seppänen and Fisk (2002) published a literature review on the associations of ventilation and air-conditioning system types in office buildings with sick building syndrome (SBS) symptoms. They classified buildings in five main categories (natural ventilation, mechanical exhaust, mechanical ventilation, and air conditioned with and without humidification). They followed a

similar classification used by Mendell and Smith (1990). They concluded that: “relative to natural ventilation, air conditioning, with or without humidification, was consistently associated with a statistically significant increase in the prevalence of one or more SBS symptoms, by approximately 30 to 200%.” We do not know exactly what proportions of the buildings they studied were naturally or adventitiously ventilated. How different would the prevalence of SBS symptoms be in air-conditioned buildings compared to naturally or adventitiously ventilated buildings? Finding an answer would be interesting and potentially important for ongoing efforts to improve ventilation design and practice.

Why has this category not been introduced before? A possible answer comes from the introduction of natural ventilation design methods into code and standards. Decades ago, it was unlikely to find buildings in which natural ventilation was explicitly designed. Today, the absence of design may still be common, but an increasing number of buildings have been designed for natural ventilation according to appropriate guidelines. This effort and the potential for improved performance should be acknowledged in our studies when we compare different ventilation systems.

So, are your home and workspace mechanically, naturally, or adventitiously ventilated? Let me know the answer at <http://bit.ly/Adventitious>

*Stefano Schiavon*  
*University of California, Berkeley*

## References

- ASHRAE (2013a) *Ventilation for Acceptable Indoor Air Quality*, Atlanta GA, American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE Standard 62.1-2013).
- ASHRAE (2013b) *Thermal Environmental Conditions for Human Occupancy*, Atlanta GA, American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE Standard 55-2013).
- CIBSE (2010) *Application Manual 10: Natural Ventilation in Non-Domestic Buildings*, London, UK, The Chartered Institution of Building Services Engineers (CIBSE AM10-2005)
- Harris-Bass, J., Kavarana, B. and Lawrence, P. (1974) Adventitious ventilation of houses, *Build. Serv. Eng. Res. T.*, **42**, 106-111.
- Heisenberg, P. (2002) *Principles of Hybrid Ventilation*, Aalborg, Denmark, Aalborg University.
- Mendell, M.J. and Smith, A.H. (1990) Consistent pattern of elevated symptoms in air-conditioned office buildings: a reanalysis of epidemiologic studies, *Am. J. Public Health*, **80**, 1193–1199.
- Lomas, K. (2007) Architectural design of an advanced naturally ventilated building form, *Energ. Buildings*, **39**, 166-181.
- Seppänen, O. and Fisk, W. (2002) Association of ventilation system type with SBS symptoms in office workers, *Indoor Air*, **12**, 98-112.

## Acknowledgments

This work was supported by SinBerBEST (Singapore-Berkeley Building Efficiency and Sustainability in the Tropics) Research Program. The idea described here was inspired by the

discussions on residential ventilation systems with Prof. Roberto Zecchin and Dr. Valentina Raisa.