Concentration versus m3 air per hour

CONCENTRATION VERSUS M^3 AIR PER HOUR – THE BATTLE OF THE ASSESSORS?

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1 ABSTRACT

The opposite of the performance approach is the prescriptive approach. If we refer to an amount of air changes per hour (ACH) or a flow rate in m^3 air per hour (q_v) we assume a certain performance of the ventilation as with these parameters we now prescribe the ventilation. But, with focus on the indoor environment, a certain 'x' m^3 air per hour is not the targeted outcome of ventilation. What is desired of ventilation are performances such as health and (local) comfort; for example the sleep quality in a sleeping room. Instead of air change per hour we should be talking about air quality and thermal comfort or maybe even physiological indicators that directly relate to health and comfort.

While a link with physiological indicators may yet be a bridge too far in most cases, the advantage of a prescribed ACH or q_v is clear. It is much simpler to assess. But the assessment is at system level, not at room level! The latter is much more complex and is an integrated outcome. ACH or q_v may not be sufficient if we look for example at the ventilation efficiency of different diffusers in a living room (Figure 1 [left]). Another example, in this case for school ventilation with underfloor air distribution, may see a transition from displacement to mixing ventilation if the air flow rate is increased (ref. Archimedes number; Figure 1 [right]). For the latter, guideline requirements on q_v (> 90 m^3/h per supply grille) would result in a less efficient mixing situation.

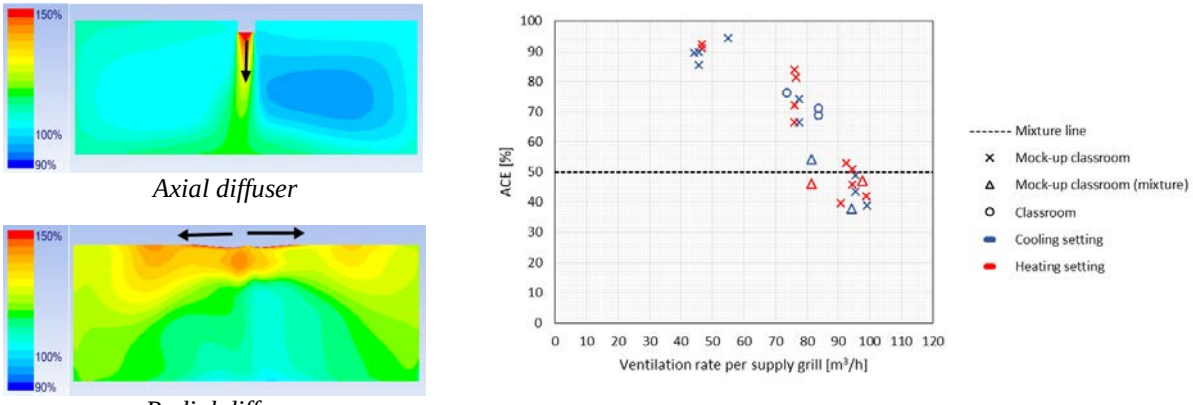

Figure 1: Local air change index in a living room with the same air flow rate but different diffusers (higher value is better; ±100% is mixing) [left]; air change efficiency (ACE) as function of the air supply rate [right].

As another example, available design guidelines (rules of thumb) for cleanrooms are not optimized to actual operation. Focussing on the air quality, apart from local contaminant removal efficiency, detailed knowledge about sources and use time could easily reduce fan energy use in clean rooms by about 60%. Adherence to the required air quality (ISO class) when in use would still be ensured. The prescribed approach therefore limits optimization possibilities and indoor species pollutant concentration is a better performance indicator.

Another example refers to operating theatre ventilation. Prescribed unidirectional flow systems with a set supply velocity have been the standard in the Netherlands. New guidelines focus on air quality performance requirements at the wound area (particle concentration). This can result in a design solution where approximately only 10% of the earlier prescribed air flow rate is required to arrive at the same air quality level (Figure 2). An additional advantage in this case stems from optimizing the room climate system to, e.g., comfort purposes.

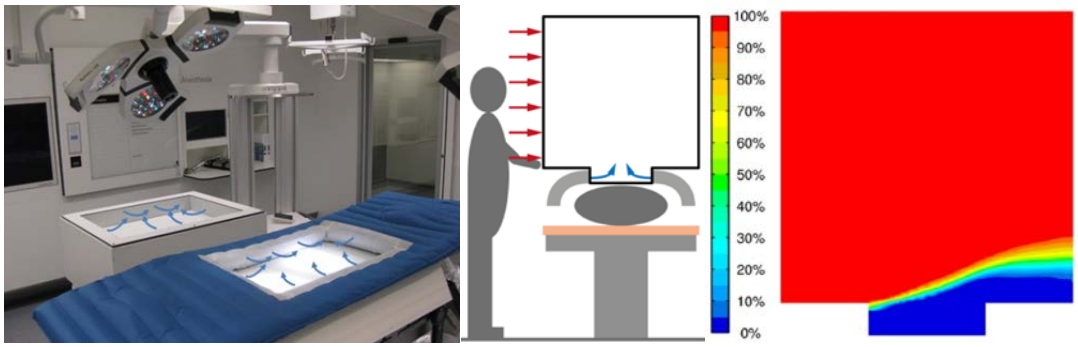

Figure 2: Local ventilation solution at wound area and instrument table [left]; CFD assessment of the relative particle concentration (0% is optimal) [right].

So, several examples show that ACH and q_v do not provide the answer to an optimally performing ventilation system in a design. Functional requirements and related performance indicators are required to come to a suitable, integrated design solution. However, when these design solutions are tested according to specific use scenarios, and sensitivity and uncertainty are identified and quantified, it is possible to refer back to ACH and q_v as performance indicators for testing the performance in practice. They now however represent more than just the system performance; they represent a design parameter for the optimal functioning at room level.

However, buildings and their designs are unique, certainly in combination with their usage. Therefore, it will not be easy to assure that the ventilation performance is assessed in detail before reference can again be made to ACH and q_v. Usually they will still indicate system performance. It is the complexity of assessing the ventilation effectiveness that will keep the battle between concentration versus ACH/q_v alive for some years to come.

2 ACKNOWLEDGEMENTS

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