A comprehensive overview of ventilative cooling and its role in the standardisation

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SUMMARY

Ventilative cooling is a free cooling methodology, harnessing the cooling potential of the outdoor air to remove excess heat, without the use of thermodynamic process, thereby saving valuable cooling energy in buildings. In future zero energy buildings it is essential to lower the energy consumption for cooling and here ventilative cooling is one good option. Further, for airflows beyond the basic ventilation requirements to provide cooling can be considered part of the renewable energy calculation as indicated by EU 2022/759 Directive, hence underlining the sustainability aspects of ventilative cooling using outside air for cooling.

Further, in order for ventilative cooling to become an increasingly used technology it is essential to ensure integration into standards, legislation and compliance tools. In standards, this is further complicated by the fact that there are both performance, design and operation standards and here ventilative cooling is not yet present in "design standard". There are specifically projects ongoing in CEN/TC 156 and ISO/TC 205, to make new "design standards", ensuring a design methodology to design ventilative cooling systems in buildings. A new methodology for estimating the ventilative cooling potential in the early feasibility phase with 4 different Ventilative cooling modes (0-3), in order to estimate if the outdoor air can be used for cooling, which is presented in the forthcoming European Technical specification called "Ventilative cooling systems - design".

For legislation and compliance tools there is lacking better integration of air flow predictions and the adaptive comfort approach supporting variable comfort temperatures, depending on the mean running outside temperature.

Ventilative cooling being a free cooling methodology needs to be better supported in standards, legislation and compliance tools and this is done with new standardisation projects and better awareness raising.

KEYWORDS

Ventilative cooling, standards, legislation, compliance tools, sustainability, renewable energy

1 INTRODUCTION

Ventilative cooling is a sustainable and energy-efficient method of cooling buildings that utilizes natural, mechanical or hybrid means to remove excess heat. This process harnesses the cooling potential of outdoor air to reduce indoor temperatures, thereby decreasing the reliance on active cooling systems like air conditioning.

Ventilative cooling can be achieved through various techniques, such as natural means e.g. using cross ventilation, stack ventilation, and night-time cooling, each leveraging different natural forces and building designs to optimize airflow and temperature control. Also mechanical means can be used for ventilative cooling, e.g. through fans driving the air inside through ducts without thermodynamic processes and using the outside air at its current temperature.

Finally, the airflow that is increased beyond the basic ventilation requirements to provide cooling is considered part of the renewable energy calculation, as indicated by the Commission Delegated Regulation (EU) 2022/759 of 14 December 2021 amending Annex VII to Directive (EU) 2018/2001 as regards a methodology for calculating the amount of renewable energy used for cooling and district cooling. This information clearly underlines the sustainability aspects of ventilative cooling.

2 THE ROLE OF VENTILATIVE COOLING IN STANDARDS

2.1 General

Setting relevant KPI's for overheating targets and having calculation tools are essential for the assessment of ventilative cooling systems. Overheating refers to high indoor temperatures and can affect occupants' health, well-being and productivity. The calculation tools are in this case, tools used to assess the performance of the thermal comfort (overheating) in the building, where it is essential to both have a good early design stage design assessment, as well as a more detailed later on, to not waste time on a detailed concept design that has not been properly evaluated early on.

Standardisation plays a crucial role in promoting the adoption and effectiveness of ventilative cooling. By establishing clear guidelines and best practices, standardization helps ensure that ventilative cooling systems are designed, installed, and operated effectively. Further, standards can be the platform for setting criteria and assessment methods, if referred to in national legislations.

Below are listed some key areas of standardization, which could be split into performance, design and operational standards, as well as regulatory frameworks. Key standardisation types include:

- **Performance standards**: Standards establishing input parameters by setting key performance indicators for thermal comfort to be used for design and assessment of overheating in buildings. This is used to evaluate the performance of ventilative cooling systems and helps in assessing their effectiveness.
    - Example: Draft revision of **EN 16798-1:2019**, which currently is undergoing a revision into 5 parts (e.g. one part on thermal comfort) setting IEQ criteria
- **Design Standards/guidelines**: Standards for building design can incorporate guidelines for optimizing ventilative cooling systems, such as recommendations for design and how to estimate the potential.
    - Example 1: New Work Item (**Ventilative cooling systems – Design:2024**, **CEN/TS**); focusing on the design process of ventilative cooling systems for acceptable thermal comfort and among other things includes a method to estimate the ventilative cooling potential of the outdoor air in early feasibility phase
    - Example 2: Draft revision of **EN 15665:2024**; focusing on making a design framework for ventilation systems in residential buildings for acceptable IAQ
- **Operational Standards**: Standards for the operation and maintenance of ventilative cooling systems to ensure that they continue to perform efficiently over time. This includes protocols for managing indoor air quality and controlling ventilation based on outdoor conditions.
- **Regulatory Frameworks**: Governments and regulatory bodies can incorporate ventilative cooling standards into building codes and regulations, driving wider adoption and ensuring compliance.

The above shows differences in the types of standards, and the importance is the link and dependencies among each other, where one does not work, without the other. In CEN/TC 156 new Design standards are under development, to guide the designers using a design framework including approaches for design of ventilative cooling systems. The design framework also includes reference to performance standards, such as EN 16798-1 for thermal comfort criteria, e.g. using the categories of the adaptive comfort model for evaluation of ventilative cooling systems during the cooling season.

2.2 Identification and impact of missing elements in ventilative cooling systems (in standards and legislation)

The situation of overheating calculations methods is very complex in Europe. There is a huge disparity between countries and almost no common approach to addressing overheating in residential buildings rigorously.

One of the areas of interest are how to predict the expected "thermal comfort and cooling requirements" when using ventilative cooling in buildings. These may be predicted by using "indicators", which may be based on either static models (e.g. Fanger PMV/PPD model) or adaptive models (e.g. Adaptive comfort model) as e.g. found in EN 16798-1 and others don't [2].

In a broad overheating study on legislations across Europe it was found that most countries heavily rely on the PMV/PPD model that requires active cooling systems, and this should be changed to also support the Adaptive comfort model. Further many countries models households as single zone and doesn't make a distinction between living and sleeping rooms [1].

A background report on status and recommendations to ventilative cooling in standards and legislation concludes that ventilative cooling is not sufficiently integrated in standards, legislation and compliance tools. It also shows that there is a broad field of evaluation methods for ventilative cooling, ranging from simple to detailed that can support a stronger integration of ventilative cooling in the near future [2].

There are many benefits associated with ventilative cooling that are acknowledged, but that still needs to be further implemented into standards, legislation and compliance tools [2]:

- The adequate modelling of natural ventilation and especially of air flows
- The share of the energy used for cooling to provide summer comfort and avoid the overheating risk tends to become equivalent to the energy consumption for heating in winter, depending on the climate
- The adequate prediction of the expected "thermal comfort and cooling requirements", as well as the "energy performance" when using ventilative cooling in buildings (this could be based on Static models e.g. Fanger PMV/PPD model using mechanical cooling or on Adaptive models e.g. adaptive comfort model using ventilative cooling

2.3 Status and developments of ventilative cooling (in standards)

There has generally been missing good ventilative cooling design integration for "system design" and "performance" aspects in existing European standards and legislation and therefore new projects have started up in working groups under CEN/TC 156 and ISO/TC 205. These projects have the aim of developing new documents on ventilative cooling systems to foster motivation and raise awareness.

A new European technical specification (CEN/TS) called **"Ventilative cooling systems – design"** is under development and should be published in 2026 under CEN/TC 156/WG21 with the goal to be the go-to European technical document for how to design natural, mechanical and hybrid ventilative cooling systems. The aim of the new standard is to see how far the designer can get with using ventilative cooling, before going into other cooling solutions by following the eight design steps. In design step #3 the ventilative cooling potential shall be found in the early feasibility phase and here the Ventilative cooling potential method can estimate the cooling potential in 4 different Ventilative cooling modes (#0-3), where VC mode #1 uses Ventilative cooling at low air flow rates and mode #2 at high air flow rates. This method can be used prior to going into the detailed design phase.

When the standard is published it will be complimentary and hopefully become a relevant reference for ventilative cooling in the forthcoming revision of EN 16798-1, named EN 16798-1-3 (for thermal comfort).

3 CONCLUSION

Free cooling solutions like ventilative cooling play a crucial role to address the challenge of increasing energy use in buildings, i.e. a projected 3 fold increase in the global energy consumption for space cooling towards 2030, leading to a 2 fold increase in CO_2 emissions related to cooling [3]. Ventilative cooling is further one of many cooling solutions and relies on the actual outdoor air temperature aiming at mitigating overheating, using natural, mechanical or hybrid means. Further ventilative cooling enhances thermal comfort, reduces cooling loads in buildings and doesn't use thermodynamic process like mechanical cooling.

Ventilative cooling represents a promising approach to enhance indoor environmental quality in buildings. Through effective standardisation, the implementation and optimisation of ventilative cooling systems can be facilitated, ensuring their benefits are realized across diverse building types and climates. As the push for sustainable building practices continues to grow, ventilative cooling will play an increasingly important role in creating energy-efficient and healthy indoor environments.

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