Ventilative Cooling and Summer Comfort: The FREEVENT project

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Programme (Brussels time)

10:30 INTRODUCTION
Peter Wouters, INIVE, Belgium

10:40 ASSESSMENT OF THERMAL AND COMFORT PERFORMANCE
André Livoti, Apebau, France

10:55 Questions and answers

11:05 ON SITE MEASUREMENTS AND FEEDBACK
Anne Marie Bernard, Allie’Air, France

11:20 Questions and answers

11:30 GUIDELINES TO ACHIEVE AN EFFECTIVE VENTILATIVE COOLING
Nicolas Piot, EGE, France

11:45 Questions and answers

12:00 End of the webinar
Ventilative Cooling major issues

• Heat wave periods are more and more frequent. The associated increase of mortality is a real issue in terms of public health
• Non air-conditionned new or refurbished buildings show summer overheating issues (loads containment)
• Energy Transition, bioclimatic architecture and passive house buildings : how to guaranty summer comfort without air-conditionning

FREEEVENT Guide : published and online

Downloadable on Construction21.fr :
https://www.construction21.org/france/community/pg/groups/19939/
Ventilative Cooling Performance

- Thermal Energy Evacuation

Evening 18:00
28°C

Morning 8:00
26°C
22°C
18°C

Thermal energy evacuation:

Ventilative Cooling period

Thermal Potential and Evacuation

- ΔT: Night evacuation
- Potential maximum
- Potential

Graph showing thermal potential and evacuation over time.
Energy Performance

• EER: Energy Efficiency Ratio
  \[ EER = \frac{\text{kWh cooling}}{\text{kWh electric}} \]

• Natural Ventilation
  \[ \text{kWh élec} \sim 0 \]
  \[ EER = \infty \]

• Mechanical Ventilation
  EER usually between 4 and 10

The EER optimization depends on evacuation potential. A performant EER doesn’t mean necessarily an efficient ventilative cooling.

OPTIMIZATION OF THERMAL PERFORMANCE AND COMFORT

• To characterize the ventilative cooling performance: evacuation and EER

• Accounting for all the comfort issues related to ventilative cooling:
  – Temperature (over-heating, too cold in the morning)
  – Acoustics (inside, outside)
  – Air velocity

• Bioclimatic Architecture and Ventilative cooling
Thermal Comfort

• Definition of discomfort threshold
  – According to activity, clothing, adaptative comfort. Generally between 27 and 28°C.
  – Acceptable number of hours beyond the discomfort threshold
  – Caution for discomfort in the morning
  – Caution for residual air velocities, if ventilation occurs during building occupancy hours

Acoustics Comfort

• Premises occupied during ventilative cooling period:
  – Natural ventilation: noise exposure zone, as regarding to doorway openings
  – Mechanical ventilation: equipment noise, air velocity

• Unoccupied premises during ventilative cooling period:
  – Mechanical ventilation: equipment noise towards neighbours

• In all cases: install interphone systems if transfer grille are necessary to maintain adequate airflow pathways through the whole premises
Indoor Air Quality

• Ventilative Cooling impacts IAQ, through increased air change rates
  – Positive impact in the majority of cases in non polluted environments (increased dilution of indoor pollutants)
  – Caution for preventing outdoor pollutants penetration from outside (industrial zone, road traffic routier, airport, etc...). The necessity of filtration enforces mechanical ventilation equipments and has an impact on EER.

Available Public Ressources

• Noise exposure
  Maps provided by local authorities

• Air Quality
  In France, maps provided by Prevair.org
  • PM_{10}
  • PM_{2.5}
  • NO_{2}
  • O_{3}

Example of 24/02/2018
Bioclimatic Architecture

• The challenge of ventilative cooling:
  – Unload in a brief summer sparsely cold night all the accumulated heat during a hot long day, then preserve coolness as long as possible.

• Action-levers:
  – Solar shadings
  – Thermal inertia and insulation,
  – Height of premises (stack effect) and warm air stratification
  – Limitation of internal loads

Energy Approach

Impact of glazing and solar shadings > 50%

- rafrachissement surventilation
- latent
- occupants et équipement sensible
- éclairement
- apport dt & ensoleillement

Internal loadings
Thermal Inertia / Insulation

- Thermal shift and damping

**Outside Peak Temperature**
- Temperature = 33 °C at 16:00

**Inside Peak Temperature**
- at 22:00 = 29 °C
- Damping = 4 °C
- Shift = 6h
- T° at 2:00 am = 25°C

**Inside Peak Temperature**
- at 18:00 = 32 °C
- Damping = 1°C
- Shift = 2h
- T° at 2:00 am = 23°C

In all cases: external envelop with high inertia

3. Building Analysis

Thermal Inertia

![Graph with lines and markers for thermal inertia analysis]
Stack Effect Height

- Tall height promotes:
  - Stack effect for natural ventilation
  - Warm air stratification, then comfort in occupied zones in all cases

Ventilative Cooling Air Flowrates

- The air flowrate depends mainly on the cooling potential of the site.
- Modelling on identical buildings in Mâcon and Montpellier show better results of 1 ACH in Mâcon, and 4 ACH in Montpellier.
- Usually, one should aim at 2 to 6 ACH
Comparison of outside $T^\circ$

**ORDERS OF MAGNITUDE**

Ventilation air flowrates

*Comparison of 2 sites: better results in Mâcon (1 vol/h) than in Montpellier (4 vol/h)!*
Assessing ACH in an office building in Toulouse Détermination du taux de brassage sur un bâtiment tertiaire à Toulouse

Regular Hygienic Ventilation (0,3 à 0,5 vol/h) : 722 h average discomfort hour/year
Ventilative Cooling 3 vol/h : 266 h average discomfort hour/year
Ventilative Cooling 6 vol/h : 83 h average discomfort hour/year

KEY POINTS FOR SUCCESS

• Upstream bioclimatic design :
  – Ventilative cooling will not compensate a poor design of internal and external loadings.
• Adapted dimensionning that accounts for all comfort criterias
• Involvement of owners / maintener and occupants in the first years for fine-tuning operation.
Questions?

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Ventilative cooling and summer comfort: Freevent project in France