Evaluation of the applicability of the quasi-steady-state overheating indicator for offices and schools

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KEEP COOL AT WORK

SUGGESTIONS FOUND ON THE WEB

USE A HINT OF MINT

FIND A COOL PLACE

COOL FEET

KEEP THE AIR FLOWING

COOL AS A CUCUMBER

EAT SPICY

COOL AS A CUCUMBER

ABR to open first of 25 schools in December

GERMANTOWN, Md.—The Association for Biblical Research (ABR), operated by Art Carpenter of Escondido, Calif., Art Mokernow of Conroe, Texas, and others, announced in November plans to open 25 schools affiliated with the American Institute for Biblical Studies. The first school will open in Brooklyn, N.Y., on Dec. 7.

CGBS offers Bible MP3 CDs in Spanish

GLADEWATER, Texas—A local Church of God Book Club of the Church of God Book Distribution Service (CGBS) is now making available through CGBS (CGBS) numerous titles available through the Church of God Book Distribution Service on CD.

David Barrett

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Consitutive stimulus of alternative cooling methods badly needed

EU set the EPBD

Common calculation method (EN 13790): preferably quasi-steady-state (instead of BES)
Minimum requirements on energy performance

Summer comfort and cooling underrepresented

Focus on heating vs increasing cooling demand:
e.g. 5 out of 9 EU countries have a (limited) summer analysis

Additional requirement(s) to limit the overheating risk
promote passive cooling
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such as an overheating indicator
Quasi-steady-state calculation in a nutshell

Heat balance over long time (month)
Quasi-steady-state calculation in a nutshell

Heat balance over long time (month)

Utilization factor for dynamic effects

$\eta \sim \frac{Q_{ht}}{Q_{gn}} = \frac{1}{\gamma_c}$

$\sim$ thermal mass
Summer analysis:
original overheating indicator

Deutscher et al. (2000)

In line with method for heating demand
(EN 832, predecessor of EN 13790)

\[ Q_{NN} = \sum_{i=1}^{12} \left( 1 - \eta_{H, gn} \right) \cdot \frac{Q_{H, gn}}{H_{tr, adj} + H_{ve, adj}} \]
Summer analysis: original overheating indicator

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In line with method for heating demand (EN 832, predecessor of EN 13790)

\[ Q_{NN} = \sum_{i=1}^{12} \left[ (1 - \eta_{H,gn}) \cdot Q_{H,gn} \right] \cdot \left( H_{tr,adj} + H_{ve,adj} \right) \]
Summer analysis: Flanders’ adoption

Flanders (Belgium)

\[ I_{\text{overh}} = \sum_{i=1}^{12} \frac{(1 - \eta_{H,gn}) \cdot Q_{H,gn}}{(H_{tr,adj} + H_{ve,adj})} \]

Input and calculation parameters of heating

\[ \theta_{\text{int}} = 18^\circ C \text{ (instead of } 20^\circ C) \]

\[ n = 1.0 h^{-1} \text{ (instead of } 0.7 h^{-1} \text{ or } 3.0 h^{-1}) \]

Limited applicability

Dwellings

Fictitious cooling

Penalizes the instalment of mechanical cooling afterwards

\[ P_{\text{cool}}(\cdot) \]

\[ I_{\text{overh}}(Kh) \]

loverh,tresh \quad loverh,max
Summer analysis: revised overheating indicator

Proposal

\[ I_{overh} = \sum_{i=1}^{12} \frac{(1 - \eta_{C,gn}) \cdot Q_{C,gn}}{H_{tr,adj} + H_{ve,adj,ext} + H_{ve,adj,hyg}} \]

Input and calculation parameters of cooling

e.g. \( \theta_{int} = 23^\circ C \)

Additional heat transfer coefficients

Passive cooling techniques
(e.g. windows, increased mechanical ventilation during daytime, night cooling)

Upper and lower bounds

Reusing fictitious cooling

Extended applicability

Dwellings + offices, schools
Summer analysis: revised overheating indicator

Proposal

$$I_{overh} = \sum_{i=1}^{12} \left( 1 - \eta_{c,gn} \right) \cdot \frac{Q_{c,gn}}{H_{tr,adj} + (H_{ve,adj,ext} + H_{ve,adj,hyg})}$$

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e.g. $\theta_{int} = 23 ^\circ C$

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Dynamic simulations of three non-residential buildings

>1 building zone (concurring in EPB and TRNSYS)

3 quality levels (ACCeptable, GOOd, VERy good)

8 x 2 levels of internal loads (real, mean)
## Comfort assessment based on dynamic simulations

<table>
<thead>
<tr>
<th>Discomfort when...</th>
<th>Number of hours for which a PMV-value larger than 0.5 applies, exceeds 100h/year or $\text{TE(PMV&gt;0.5)}&gt;100\text{h/year}$ (ISSO, 2004)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASIEPI suggests adaptive comfort</td>
<td>Higher tolerance when users are allowed to adapt to the building’s environment</td>
</tr>
<tr>
<td>EPBD for compliance control</td>
<td>Safe approximation: PMV only takes into account a varying clothing resistance</td>
</tr>
</tbody>
</table>
Input and calculation parameters used for cooling as a reference
Input and calculation parameters used for cooling as a reference

Higher losses to gains ratio
More varying heat load profile
Input and calculation parameters used for cooling as a reference

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Graph showing the relationship between $TE(\text{PMV}>0.5)$ (h/year) and $Q_{c,sens,net,a}/A_f$ (kWh/m²/year) for various areas and profiles:

- SOB_cafeteria
- SOB_lobby
- SOB_offices
- SOB_meeting rooms
- LOB_NW offices
- LOB_NE offices
- LOB_SE offices
- SC_NW rooms
- SC_SE rooms

Profiles:
- real occupation profile
- mean occupation profile
- ACC
- GOO
- VER
Impact of occupation profiles

SOB cafeteria

SOB offices

θ_{op} (°C)

Heat load (kWh/m²)

August 1  August 2  August 3  August 4

θ_{op} (°C)

Heat load (kWh/m²)

August 1  August 2  August 3  August 4

θ(PMV>0.5) θ_{int,C,set} ACC GOO VER
Overheating indicator applicable to offices and schools ...
... but shows differing relations

Heat load profiles

Period of excess gains ◁ occupation period

Fixed indoor temperature ◁ thermal mass
Lower and upper bounds useful to implement fictitious cooling

![Cumulative frequency of overheated energy sectors (%)](chart)

- Cumulative frequency of overheated energy sectors (%)
- $I_{overh} \ (K_h)$

0 1000 10000
Revised overheating indicator is suited

**Calculation parameters used for cooling**

More logic

**Large spread**

Introduction of fictitious cooling

**Promote passive cooling techniques**

Opening windows during daytime (Goethals and Janssens, 2010a)

Increased mechanical ventilation during daytime (Goethals and Janssens, 2010b)

Night ventilation (Breesch et al., 2011)
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