Ventilative cooling in the Belgian regulation

dr Geoffrey Van Moeseke
Architecture et Climat, UCLouvain, Belgium

QUALICHeCK webinar
in cooperation with IEA Annex 62, venticool, and AIVC

Context

- Belgian epbd based on ISO 13790 monthly balances
- Authorities straigthened cooling demand requierement for offices and schools (<15kWh/m²a)
- Field worried about feasibility and cooling need calculation method

Actual method

$$Q_{cool,net,\text{sec } i,m} = 1.1\, p_{cool,\text{sec } i}\left(Q_{g,cool,\text{sec } i,m} - \eta_{util,cool,\text{sec } i,m} Q_{L,net,\text{sec } i,m}\right)$$

$$Q_{L,cool,\text{sec } i,m} = Q_{T,cool,\text{sec } i,m} + Q_{V,cool,\text{sec } i,m}$$

Air quality and uncontroled infiltrations only

Probabiblity that active cooling will be used determined based on « excess energy » estimation

Conventional factor : cooling device surface condensation

Questions

- No intermittence ?
- Conventional 1.1 factor ?
- Active cooling probability factor ?
- Temperature hypothesis ?
- Ventilative cooling ?

Modified method

$$Q_{\text{cool, gross, fct f,m}} = a_{lat,cool} \cdot \frac{Q_{\text{cool, net, fct f,m}}}{\eta_{\text{sys,cool}}}$$

Conventional factor : cooling device surface condensation

$$Q_{cool,net,\text{fctf},m} = a_{cool,int,fctf,m}(Q_{g,cool,fctf,m} - \eta_{util,cool,fctf,m} \cdot Q_{L,cool,fctf,m})$$

No more cooling probability : a cooling need is calculated for all offices and schools… but ventilative cooling is now considered

EN ISO 13790 intermittence factor

$$a_{cool,int,fctf,m} = max\left[f_{cool,fctf}; 1 - 3\frac{\tau_{0,cool}}{\tau_{cool,fctf}} \cdot \gamma_{cool,fctf,m}(1 - f_{cool,fctf})\right]$$

Modified method

$$Q_{V,cool,fctf,m} = \begin{bmatrix} H_{V,hyg,cool,fctf,m} \cdot (\theta_{i,cool} - \theta_{e,V,cool,day,m}) \\ +H_{V,add,cool,day,fctf,m} \cdot (\theta_{i,cool} - \theta_{e,V,cool,day,m}) \\ +H_{V,add,cool,night,fctf,m} \cdot (\theta_{i,cool} - \theta_{e,V,cool,night,m}) \\ +H_{V,in-exfiltr,cool,fctf,m} \cdot \left(\theta_{i,cool} - (\theta_{e,m} + \Delta\theta_{e,m})\right) \\ +H_{V,nat,cool,day,fctf,m} \cdot \left(\theta_{i,cool} - (\theta_{e,m} + \Delta\theta_{e,m} + \Delta\theta_{e,day,m})\right) \\ +H_{V,nat,cool,night,fctf,m} \cdot \left(\theta_{i,cool} - (\theta_{e,m} + \Delta\theta_{e,m} + \Delta\theta_{e,night,m})\right) \end{bmatrix} \cdot t_m$$

Distinction between IAQ, infiltration, natural ventilative cooling and mechanical ventilative cooling

Modified method

$$Q_{V,cool,fctf,m} = \begin{bmatrix} H_{V,hyg,cool,fctf,m}.\left(\theta_{i,cool} - \theta_{e,V,cool,day,m}\right) \\ +H_{V,add,cool,day,fctf,m}.\left(\theta_{i,cool} - \theta_{e,V,cool,day,m}\right) \\ +H_{V,add,cool,night,fctf,m}.\left(\theta_{i,cool} - \theta_{e,V,cool,night,m}\right) \\ +H_{V,in-exfiltr,cool,fctf,m}.\left(\theta_{i,cool} - \left(\theta_{e,m} + \Delta\theta_{e,m}\right)\right) \\ +H_{V,nat,cool,day,fctf,m}.\left(\theta_{i,cool} - \left(\theta_{e,m} + \Delta\theta_{e,m} + \Delta\theta_{e,day,m}\right)\right) \\ +H_{V,nat,cool,night,fctf,m}.\left(\theta_{i,cool} - \left(\theta_{e,m} + \Delta\theta_{e,m} + \Delta\theta_{e,night,m}\right)\right) \end{bmatrix} . t_m$$

Monthly mean value corrected to match last decade warming climate

Modified method

$$Q_{V,cool,fctf,m} = \begin{bmatrix} H_{V,hyg,cool,fctf,m}.\left(\theta_{i,cool} - \theta_{e,V,cool,day,m}\right) \\ +H_{V,add,cool,day,fctf,m}.\left(\theta_{i,cool} - \theta_{e,V,cool,day,m}\right) \\ +H_{V,add,cool,night,fctf,m}.\left(\theta_{i,cool} - \theta_{e,V,cool,night,m}\right) \\ +H_{V,in-exfiltr,cool,fctf,m}.\left(\theta_{i,cool} - \left(\theta_{e,m} + \Delta\theta_{e,m}\right)\right) \\ +H_{V,nat,cool,day,fctf,m}.\left(\theta_{i,cool} - \left(\theta_{e,m} + \Delta\theta_{e,m} + \Delta\theta_{e,day,m}\right)\right) \\ +H_{V,nat,cool,night,fctf,m}.\left(\theta_{i,cool} - \left(\theta_{e,m} + \Delta\theta_{e,m} + \Delta\theta_{e,night,m}\right)\right) \end{bmatrix} . t_m$$

Monthly mean value corrected for day only and night only ventilative cooling

Modified method – t° correction

Mois	External mean temperature		
	$\theta_{e,cool,m}$ (°C)	$\theta_{e,cool,day,m}$ (°C)	$\theta_{e,cool,night,m}$ (°C)
Jan	3,9	4,2	3,4
Feb	4,8	5,3	4,0
Mar	6,1	7,0	4,7
Apr	9,8	11,2	7,8
Mei	13,8	15,4	11,2
Jun	17,1	18,8	14,4
Jul	17,8	19,3	15,4
Aug	18,1	19,7	15,6
Sep	16,3	17,5	14,6
Oct	11,9	12,8	10,6
Nov	6,7	7,2	6,0
Dec	3,5	3,8	3,1

Modified method – indoor t°

- Cooling need of unconditioned places includes adaptive comfort t° limits (based on EN 15251-A1)

Month	With active cooling $\theta_{i,cool,fct\ f,m}$ (°C)	Without active cooling $\theta_{i,cool,fct\ f,m}$ (°C)
Jan	25,0	25,0
Feb	25,0	25,0
Mar	25,0	25,0
Apr	25,0	25,0
Mei	25,0	25,2
Jun	25,0	26,1
Jul	25,0	26,6
Aug	25,0	26,6
Sep	25,0	25,8
Oct	25,0	25,0
Nov	25,0	25,0
Dec	25,0	25,0

Modified method – natural airflows*

Correction of t° hypothesis variations between methods

Fraction of time = f(gain/loss coefficient) Based on sets of dynamic simulations

$$H_{V,nat,day,cool,fct\ f,m} = \max\left\{\begin{array}{l} 0;0,34 \cdot b_{V,nat,day,cool,fctf} \cdot f_{V,nat,day,cool,fctf,m} \cdot \dot{V}_{V,nat,day,cool,fct\ f,m} \\ - f_{V,nat,day,cool,fctf,m} \cdot H_{V,in\text{-}exfiltr,cool,fct\ f,m} \end{array}\right\}$$

Infiltrations not considered when windows are opened

Conventional single sided ventilation ~73m³/hm²

*day ventilation is considered only when there is a balanced IAQ ventilation and no active cooling

Modified method – forced airflows

Pre-heating coefficient

Pre-cooling coefficient

T° hypothesys correction

$$H_{V,add,day,cool,fct\ f,m} = 0,34 \cdot r_{preh,cool,fct\ f} \cdot r_{precool,fct\ f,m} \cdot b_{V,add,day,cool,fctf,m} \cdot$$
$$\cdot f_{V,add,day,cool,fctf,m} \cdot (\dot{V}_{add,fct\ f} - \dot{V}_{hyg,fct\ f} \cdot f_{reduc,vent,cool,fct\ f})$$

measured air flow capacity

Fraction of time = f(gain/loss coefficient) Based on sets of dynamic simulations

Modified method – fans

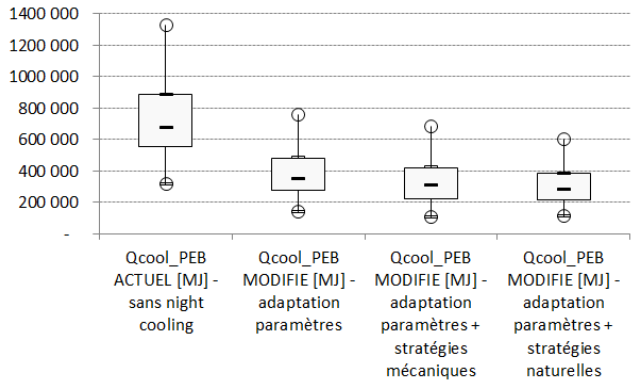
$$W_{fan,fctf,m} = \sum_j \left(W_{fan,fctf,hyg,m,j} + W_{fan,fctf,add,cool,day,m,j} + W_{fan,fctf,add,cool,night,m,j}\right)$$

$$W_{fans,hyg,fct\,f,m} = \sum_j 0{,}8 \cdot f_{ctrl,j} \cdot f_{fan,mod} \cdot P_{instal,j} \cdot \frac{\dot{V}_{hyg,fct\,f,j}}{\dot{V}_{hyg,j}} \cdot f_{fans,hyg,fct\,f,m} \cdot \frac{t_m}{3{,}6}$$

$$W_{fans,add,day,cool,fct\,f,m} = \sum_j 0{,}8 \cdot \left(1 - f_{ctrl,j} \cdot f_{fan,mod}\right) \cdot P_{instal,j} \cdot \frac{\dot{V}_{add,fct\,f,j}}{\dot{V}_{add,j}} \cdot f_{V,add,day,cool,fct\,f,m} \cdot \frac{t_m}{3{,}6}$$

$$W_{fans,add,night,cool,fct\,f,m} = \sum_j 0{,}8 \cdot P_{instal,j} \cdot \frac{\dot{V}_{add,fct\,f,j}}{\dot{V}_{add,j}} \cdot f_{V,add,night,cool,fct\,f,m} \cdot \frac{t_m}{3{,}6}$$

Impact



Conclusion

- Ventilative cooling is now (2016) considered
- In a comprehensive framework
- But with a limited impact due to conservative hypothesys
- Other cooling need adaptations are more sensible
- Further studies (including large scale field studies) may help reconsider these hypothesis
- But first answer the question of monthly VS hourly calculation