UNIVERSITY OF CAMBRIDGE

World Ventil8 Day

The Well-mixed Model

The *well-mixed model* assumes a uniform distribution of parameters in the room (e.g. Temperature & CO_2). This is often the starting point for thinking about ventilation.

Carbon dioxide conservation

$$V\frac{dC}{dt} = Q(C_o - C) + NG$$

Ventilation: $Q(C_o - C)$

CO_2 from breath: NG

Energy conservation

$$(\rho_a c_p V + I)\frac{dT}{dt} = \rho_a c_p Q(T_o - T) + \lambda A_s(T_o - T) + NW_p + W_h$$

Thermal inertia of room air: $\rho_a c_p V$

Thermal inertia of walls & objects: I

Heat loss to ventilation: $\rho_a c_p Q(T_o - T)$

Heat loss through walls: $\lambda A_s(T_o - T)$

Body heat: NW_p

Heat input £££: W_h

Ventilation

$$Q = \sum \mathrm{k_w A_w}(\theta)\sqrt{|T - T_o|} + k_l A_s\sqrt{|T - T_o|}$$

Flow through windows: $\sum \mathrm{k_w A_w}(\theta)\sqrt{|T - T_o|}$

Natural leak rate: $k_l A_s\sqrt{|T - T_o|}$

C: CO_2 concentration
T: room temperature
Q: ventilation rate
C_o: outdoor CO_2 concentration
T_o: outside temperature
V: room volume
A_s: room surface area
N: number of people (occupancy)
G: per person CO2 generation rate

ρ_a: air density
c_p: air specific heat capacity
I: thermal inertia of room objects
λ: effective conductivity of walls
W_p: per person heat output
W_h: heating input
k_w: window flow constant
A_w: window area (function of opening angle)
k_l: leak rate constant