Ventilation Effectiveness and Outdoor Air from CO_2

Contaminant removal effectiveness from supply, exhaust and breathing-zone CO_2, and the outdoor air flow and rate per person from a steady-state CO_2 balance.

Method: Steady-state tracer balance and contaminant removal effectiveness

Input parameters

Unit system: SI

Parameter	Value	Unit
Supply air CO_2	420.00	ppm
Exhaust (return) air CO_2	900.00	ppm
Breathing-zone CO_2	1,000.0	ppm
Number of occupants	30.000	
CO_2 generation per person	0.005200	L/s

Calculated results

Parameter	Value	Unit
Contaminant removal effectiveness	0.82759	
Outdoor air flow from the exhaust balance	325.00	L/s
Outdoor air per person	10.833	L/s
Flow that would give the breathing-zone level with perfect mixing	268.97	L/s

Notes for this case

• At steady state the CO_2 exhaled by occupants leaves in the exhaust: Q = NG/(C_e − C_s). The contaminant removal effectiveness ε = (C_e − C_s)/(C_b − C_s) compares the exhaust with the breathing zone: 1 for perfect mixing, above 1 for displacement ventilation and below 1 when supply air short-circuits to the exhaust (warm air supplied from the ceiling in heating mode). An adult at office activity exhales about 0.005 L/s of CO_2. CO_2 is a tracer for occupant pollutants, not a toxic hazard at these levels.

Formula and method

$$Q_o = \frac{NG}{C_e - C_s}, \quad \varepsilon_c = \frac{C_e - C_s}{C_b - C_s}$$

Variables

C_s	Supply air CO_2	-
C_e	Exhaust (return) air CO_2	-
C_b	Breathing-zone CO_2	-
N	Number of occupants	-
G	CO_2 generation per person	m³/s
ε_c	Contaminant removal effectiveness	-
Q_o	Outdoor air flow from the exhaust balance	m³/s
q_p	Outdoor air per person	m³/s
$Q_{o,b}$	Flow that would give the breathing-zone level with perfect mixing	m³/s

Method and standards

CO_2 ventilation.

Assumptions and limits

- Steady state; constant occupancy; CO_2 only from occupants.

References

Steady-state tracer balance and contaminant removal effectiveness

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/hvac/loads/ventilation-effectiveness-co2

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.