Build Tight - Ventilate Right
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How Tight?
What’s Right?
Air Barrier Metrics

Material  \(0.02 \text{ l/(s-m2)} \@ 75 \text{ Pa}\)
Assembly \(0.20 \text{ l/(s-m2)} \@ 75 \text{ Pa}\)
Enclosure \(2.00 \text{ l/(s-m2)} \@ 75 \text{ Pa}\)
\[0.25 \text{ cfm/ft2} \@ 50 \text{ Pa}\]
Getting rid of big holes 3 ach@50
Getting rid of smaller holes 1.5 ach@50
Getting German 0.6 ach@50
Best

As Tight as Possible - with -
Balanced Ventilation
Energy Recovery
Distribution and Mixing
Source Control - Spot exhaust ventilation
   Filtration
Material selection
Worst

Leaky - with – Nothing
Spot Ventilation in Bathroom/Kitchen
Exhaust Ventilation – with – No Distribution and No Mixing
Three Types of Controlled Ventilation Systems

Exhaust Ventilation
Supply Ventilation
Balanced Ventilation
Induced infiltration
Induced exfiltration
Ventilation Rates Are Based on Odor Control
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Health Science Basis for Ventilation Rates is Extremely Limited
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Almost Nothing Cited Applies to Housing
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The Applicable Studies Focus on Dampness
Figure 1: Minimum ventilating rate history.
Figure 2: Odor acceptance.
House

2,000 ft\(^2\)
3 bedrooms
8 ft. ceiling
Volume: 16,000 ft\(^3\)

\begin{align*}
.35 \text{ ach} & \quad 93 \text{ cfm} \\
.30 \text{ ach} & \quad 80 \text{ cfm} \\
.25 \text{ ach} & \quad 67 \text{ cfm} \\
.20 \text{ ach} & \quad 53 \text{ cfm} \\
.15 \text{ ach} & \quad 40 \text{ cfm}
\end{align*}
House

2,000 ft²
3 bedrooms
8 ft. ceiling
Volume: 16,000 ft³

<table>
<thead>
<tr>
<th>Ventilation Rates</th>
<th>.35 ach</th>
<th>93 cfm</th>
<th>62 - 73</th>
<th>5 cfm/person</th>
<th>20 cfm</th>
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<td>.30 ach</td>
<td>80 cfm</td>
<td>62 - 89</td>
<td>10 cfm/person</td>
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Office

Occupant Density

15/1000 ft$^2$ (67 ft$^2$/person)  62 - 89
15 cfm/person

5/1000 ft$^2$ (200 ft$^2$/person)  62.1 - 2007
17 cfm/person

Correctional Facility Cell

Occupant Density

20/1000 ft$^2$ (48 ft$^2$/person)  62.1 – 2007
10 cfm/person
C.P. Yaglou
Harvard School of Public Health
1936
1955

150 ft³  →  20 cfm/person
300 ft³  →  12 cfm/person
C.P. Yaglou
Harvard School of Public Health
1936
1955

150 ft$^3$  ➔  20 cfm/person 18.75 ft$^2$  106 occupants
300 ft$^3$  ➔  12 cfm/person 37.5 ft$^2$  53 occupants

Experiment

470 ft$^3$  ➔  59 ft$^2$
200 ft$^3$  ➔  25 ft$^2$
100 ft$^3$  ➔  12 ft$^2$
Aubin, D., Won, D.Y., Schleibinger, H., 2010
Formaldehyde sample concentration versus PFT measured outside air exchange rate over the test day

![Graph showing the relationship between formaldehyde concentration and outside air exchange rate. The x-axis represents the outside air exchange rate over 24 h test day (ach), while the y-axis represents formaldehyde concentration (ug/m³). Different symbols represent different ventilation conditions: DOA w/lo, DOA wo/lo, DOA non-oper, HRV, and No vent.]
ASHRAE Standard 62.2 calls for 7.5 cfm per person plus 0.03 cfm per square foot of conditioned area

Occupancy is deemed to be the number of bedrooms plus one
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Occupancy is deemed to be the number of bedrooms plus one

Outcome is often bad – part load humidity problems, dryness problems, energy problems
IRC 2015 and 2018 calls for 7.5 cfm per person plus 0.01 cfm per square foot of conditioned area

Occupancy is deemed to be the number of bedrooms plus one
3 Bedroom House – 2,500 ft²
30 cfm plus 75 cfm
105 cfm
3 Bedroom House – 2,500 ft²
30 cfm plus 25 cfm
55 cfm
The Cult of The Blower Door
Blower Door Can’t Get You The True ACH
On A Short Term Basis – Hour, Day, Week
Don’t Know Where The Holes Are
Don’t Know The Type of Holes
Don’t Know The Pressure Across The Holes
Dilution Is Not The Solution To Indoor Pollution
Source Control
Dilution For People
Source Control For The Building
Recommended Range of Relative Humidity
Above 25 percent during winter
Below 70 percent during summer
Kitchen Exhaust Hoods
Unconditioned make-up air 60 - 70% of hood exhaust
Clothes Dryers
Fireplaces
Approaches
Return air

Supply air

Bath

Kitchen

Outside air

Exhaust air

Exhaust air

Interlocked kitchen hood make-up air