Joseph Lstiburek, Ph.D, P.Eng, ASHRAE Fellow

Building Science

Covid Construction Changes
Comming
Mechanical Systems
Mechanical Systems
Cooling System To Make It Cold
Mechanical Systems
Cooling System To Make It Cold
Dehumidification System To Make It Dry
Mechanical Systems
Cooling System To Make It Cold
Dehumidification System To Make It Dry
Heating System To Make It Warm
Mechanical Systems
Cooling System To Make It Cold
Dehumidification System To Make It Dry
Heating System To Make It Warm
Energy Recovery System To Keep It Cold and Dry and Warm and Comfortable
Mechanical Systems
Cooling System To Make It Cold
Dehumidification System To Make It Dry
Heating System To Make It Warm
Energy Recovery System To Keep It Cold and Dry and Warm and Comfortable
Distribution System To Make It Uniform
Mechanical Systems
Cooling System To Make It Cold
Dehumidification System To Make It Dry
Heating System To Make It Warm
Energy Recovery System To Keep It Cold and Dry and Warm and Comfortable
Distribution System To Make It Uniform
Range Hoods Are A Special Kind of Hell
Don’t Try to Combine Them......
Cooling System makes it cold
Dehumidification System makes it dry
Heating System makes it warm
ERV keeps it cold and dry and warm and comfortable
Distribution System makes it uniform
Build Tight - Ventilate Right
Build Tight - Ventilate Right
How Tight?
What’s Right?
Air Barrier Metrics

Material  \(0.02 \text{ l/(s-m2)} \) @ 75 Pa
Assembly  \(0.20 \text{ l/(s-m2)} \) @ 75 Pa
Enclosure \(2.00 \text{ l/(s-m2)} \) @ 75 Pa

\[0.25 \text{ cfm/ft2} \] @ 50 Pa
<table>
<thead>
<tr>
<th>Task</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting rid of big holes</td>
<td>3 ach@50</td>
</tr>
<tr>
<td>Getting rid of smaller holes</td>
<td>1.5 ach@50</td>
</tr>
<tr>
<td>Getting German</td>
<td>0.6 ach@50</td>
</tr>
</tbody>
</table>
Best

As T tight as Possible - with -
Balanced Ventilation
Energy Recovery
Distribution and Mixing
Source Control - Spot exhaust ventilation
Filtration
Material selection
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\(^3\)

.35 ach     93 cfm
.30 ach     80 cfm
.25 ach     67 cfm
.20 ach     53 cfm
.15 ach     40 cfm

Building Science Corporation
## House

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

### Ventilation Rates

| .35 ach | 93 cfm | 62 - 73 | 5 cfm/person | 20 cfm |
| .30 ach | 80 cfm | 62 - 89 | 15 cfm/person | 60 cfm |
| .25 ach | 67 cfm | 62.2 - 2010 | 7.5 cfm/person | 50 cfm |
| .20 ach | 53 cfm | + 0.01 | |
| .15 ach | 40 cfm | 62.2 - 2013 | 7.5 cfm/person | 90 cfm |
|         |       | + 0.03 | | |
**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 ft$^3$ → 20 cfm/person
300 ft$^3$ → 12 cfm/person
C.P. Yaglou
Harvard School of Public Health
1936
1955

150 ft³ → 20 cfm/person 18.75 ft² 106 occupants

300 ft³ → 12 cfm/person 37.5 ft² 53 occupants

Experiment

470 ft³ → 59 ft²

200 ft³ → 25 ft²

100 ft³ → 12 ft²
Aubin, D., Won, D.Y., Schleibinger, H., 2010
Formaldehyde sample concentration versus
PFT measured outside air exchange rate over the test day

Formaldehyde concentration (µg/m³)

Outside air exchange rate over 24 h test day (ach)

- DOA w/fc
- DOA w/o/nc
- DOA non-oper
- HRV
- 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.
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

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
IRC 2021 and IMC 2021 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

Plus a 30 percent credit for balanced ventilation and distribution
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
3 Bedroom House – 2,500 ft²
30 cfm plus 25 cfm
55 cfm
55 cfm x 0.7 = 38.5 cfm
Dilution For People
Source Control For The Building
Recommended Range of Relative Humidity
Above 25 percent during winter
Below 70 percent during summer
Pressure relief grille to "bleed" pressure field from floor cavity

Motorized damper

Flexible connection for vibration and sound control

Expandable filter slot

Full height louvered closet door for access and to supply air for dehumidification

Air handler

Dehumidifier

Condensate overflow pan
Kitchen Exhaust Hoods
Move cabinets farther apart

Hood wider than cook top and extended outboard past head space

Move hood up to provide headroom

Interlocked make-up air
Clothes Dryers
Fireplaces
Approaches
Return air → Dehumidifier → Supply air → Bath → Kitchen → Outside air

Exhaust air

Interlocked kitchen hood

make-up air
Diagram showing air flow through different rooms and systems:

- Bedroom
- Bedroom
- Bath
- Bath
- Heat exchange ventilator
- Kitchen
- PTHP
- Dehumidifier

Air flow directions:

- Exhaust air
- Outside air
- Exhaust air
- Interlocked kitchen hood make-up air