Water, air and vapor Retarders, What Works, What Doesn't

Steve Easley 2008 RESNET Conference

Our Expectations for Building Enclosures

- They keep building components dry
- They maintain a temperate environment
- They are long lasting
- They do not make you sick

Goals for Building

- **Building Durability**
- **Energy Efficiency**
- **Comfort**

How Wall Assemblies Get Wet

- Bulk water intrusion
- Air current induced moisture vapor movement
- Vapor migration by diffusion

Moisture =
Problems

A MITE IN A MILLION

Meet *Xanthodasythyreus toohey*, a recent addition to the world's 50,000 known species of mites. (The actual size of its capitulum —the knob that looks like a head—is just 100 microns across.) Its discoverer, David Walter of Australia's University of Queensland, says there remain some 1 million species still to be revealed. *X. toohey* was found in Brisbane's Toohey Forest. "Some people thought the species name referred to Tooheys Old Black Ale," says Walter. "But I consider that a slur. I'm a wine drinker."

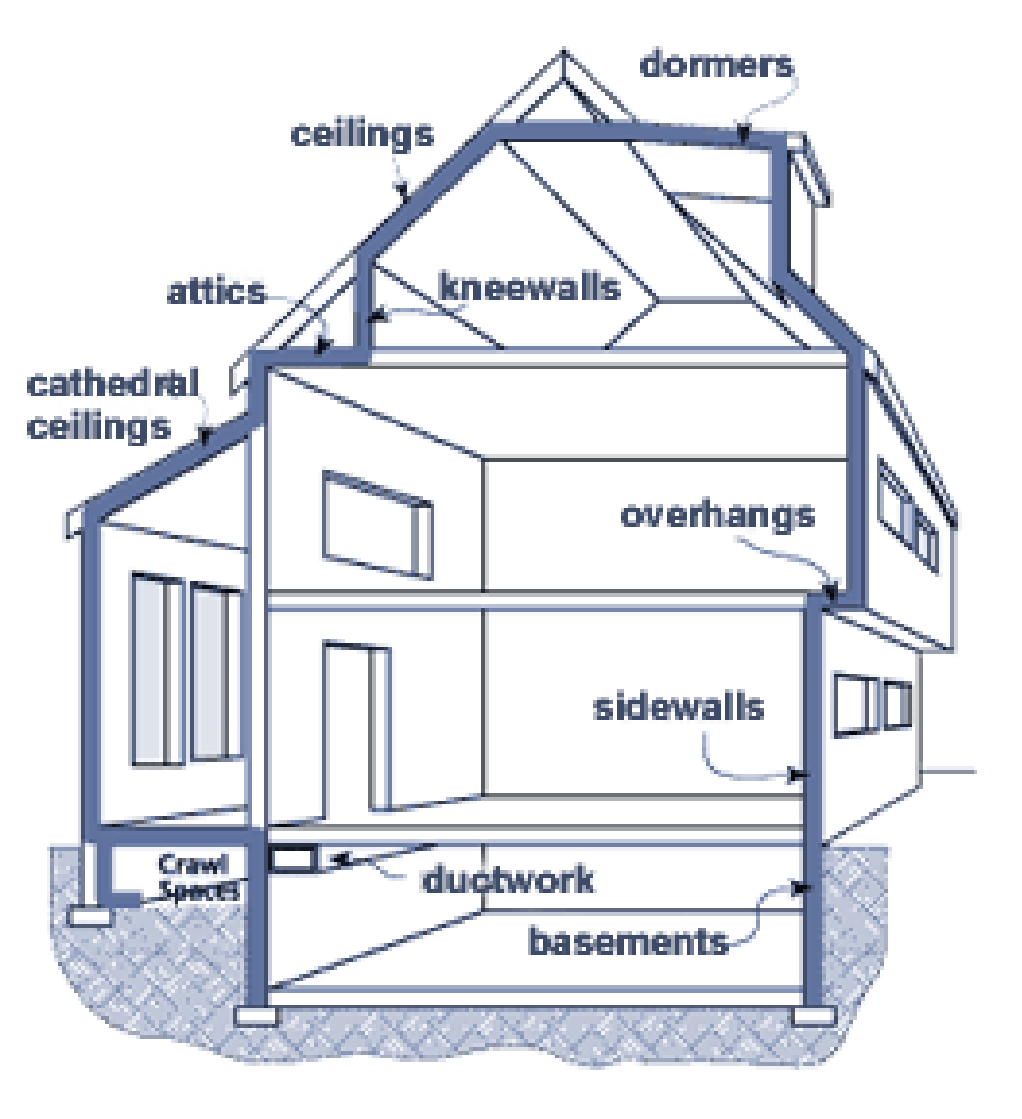
Managing Water & Moisture

- **Job 1 keep out the water**
- **Job 2 Eliminate air in/exfiltration**
- **Job 3 Design so the building can dry**

Water moves as a liquid and a vapor

- Leaks in the building enclosure
- Moisture vapor piggy-backs on air movement

If it were only this easy…



Buildings components get wet by:

- Water Leaks and moisture laden air infiltration or exfiltration
- **They dry by evaporation or diffusion**

Remember

- **It only takes minutes for building components to get wet…**

But it takes days or weeks to dry out.

Building materials dry only by evaporation or diffusion.

OSB VS. Plywood

- Susceptible to mold growth
- Tendency to buckle, ripple, warp and swell
- Combustible material

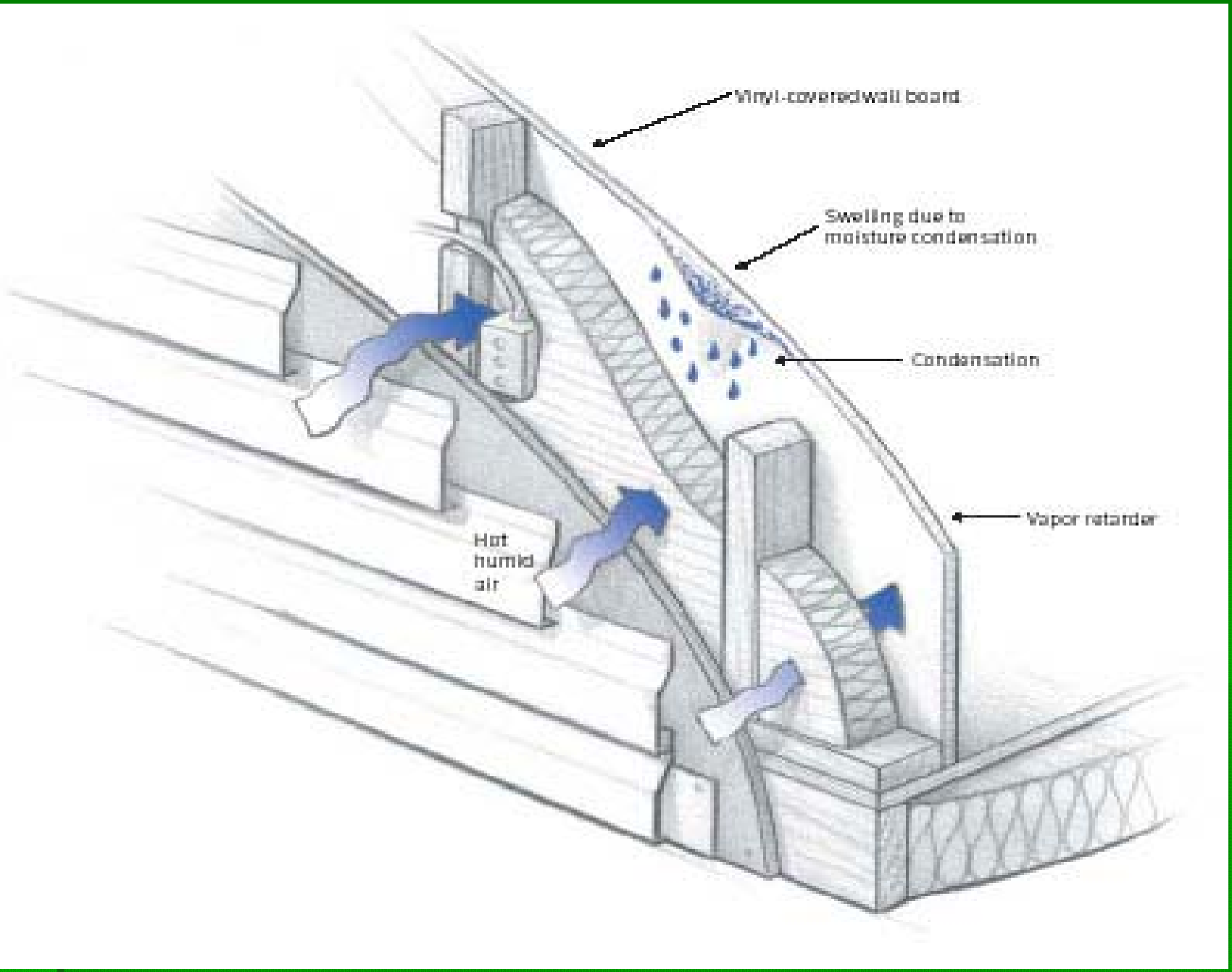
Misconception #1

- **One of the biggest misconceptions in the building industry today is:**

Building a leaky building enclosure and air infiltration leads to better drying of building components

Air is most always warmer and wetter than the air it is driven to. Why??

- Heat moves from warm to cold
- Moisture moves from wetter to dryer areas
- Buildings dry more to the inside during summer
- Building dry more to the outside in cold climates during winter


Vinyl-covered wall board
Swelling due to moisture condensation
Condensation
Vapor retarder
Hot humid air

Summary Moisture Content of Air, 90°F

T = 90°F

Units \ RH, %	90%	85%	80%	70%	65%	50%
lbs/1000cuft	1.920	1.814	1.707	1.493	1.387	1.067
oz/1000cuft	0.120	0.113	0.107	0.093	0.087	0.067
lbs/cuft	1.920E-03	1.814E-03	1.707E-03	1.493E-03	1.387E-03	1.067E-03
oz/cuft	**1.200E-04**	**1.133E-04**	**1.067E-04**	**9.334E-05**	**8.668E-05**	**6.667E-05**
oz/m3	4.238E-03	4.003E-03	3.767E-03	3.296E-03	3.061E-03	2.355E-03
Grains/cuft	13.441	12.695	11.948	10.454	9.708	7.467

Misconception #2

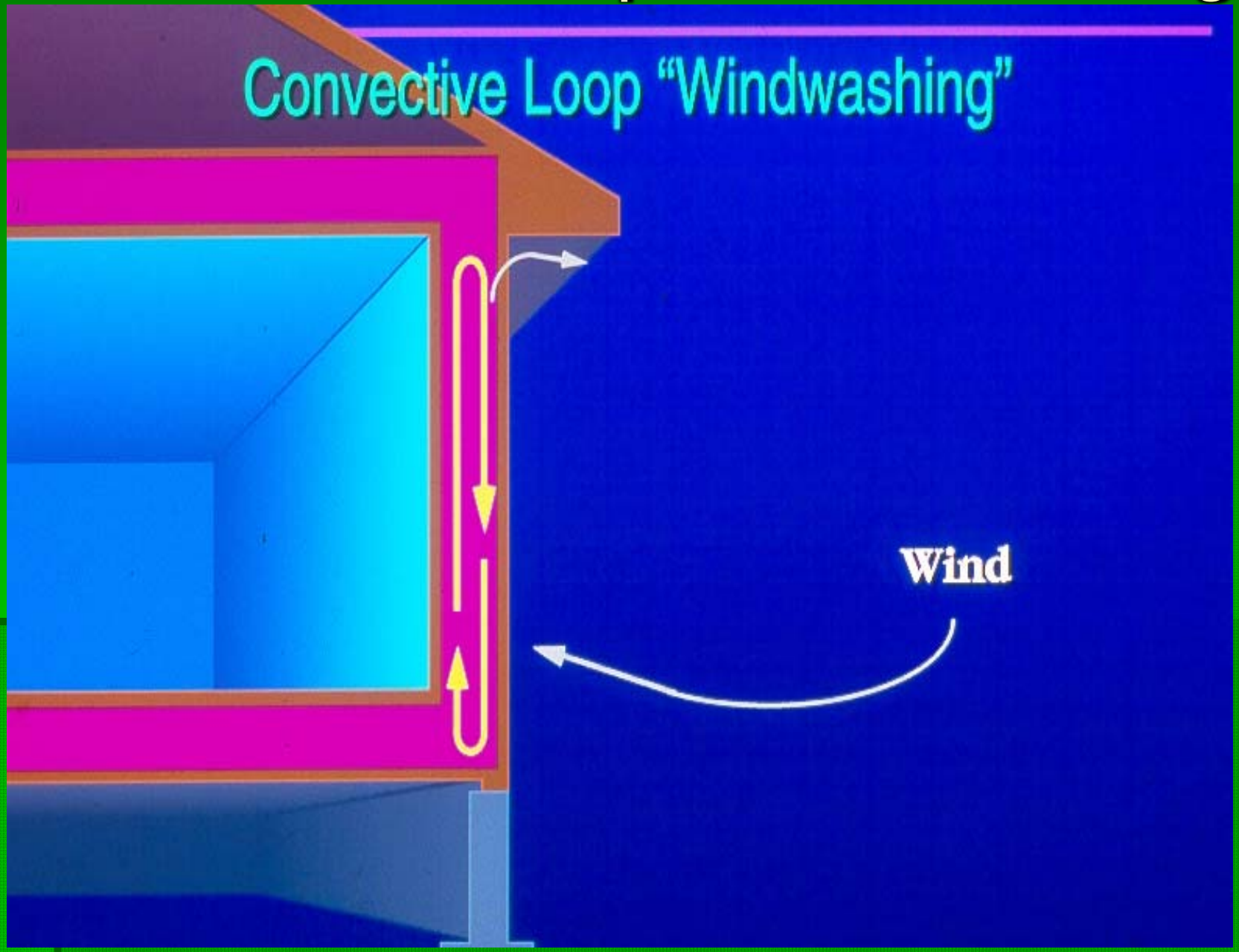
- **One of the biggest misconception in the building industry today is:**

Moisture transport by diffusion is a significant mechanism for the wetting of building components.

Basic thoughts about walls…

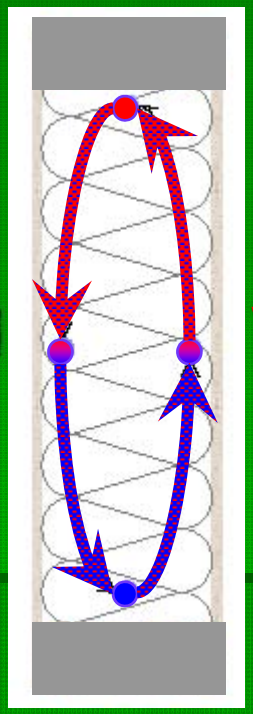
- Colder temps usually contribute to wetter areas and higher surface relative humidity
- Warmer temps usually contribute to dryer surfaces and lower surface relative humidity

Convective Loop “Windwashing”

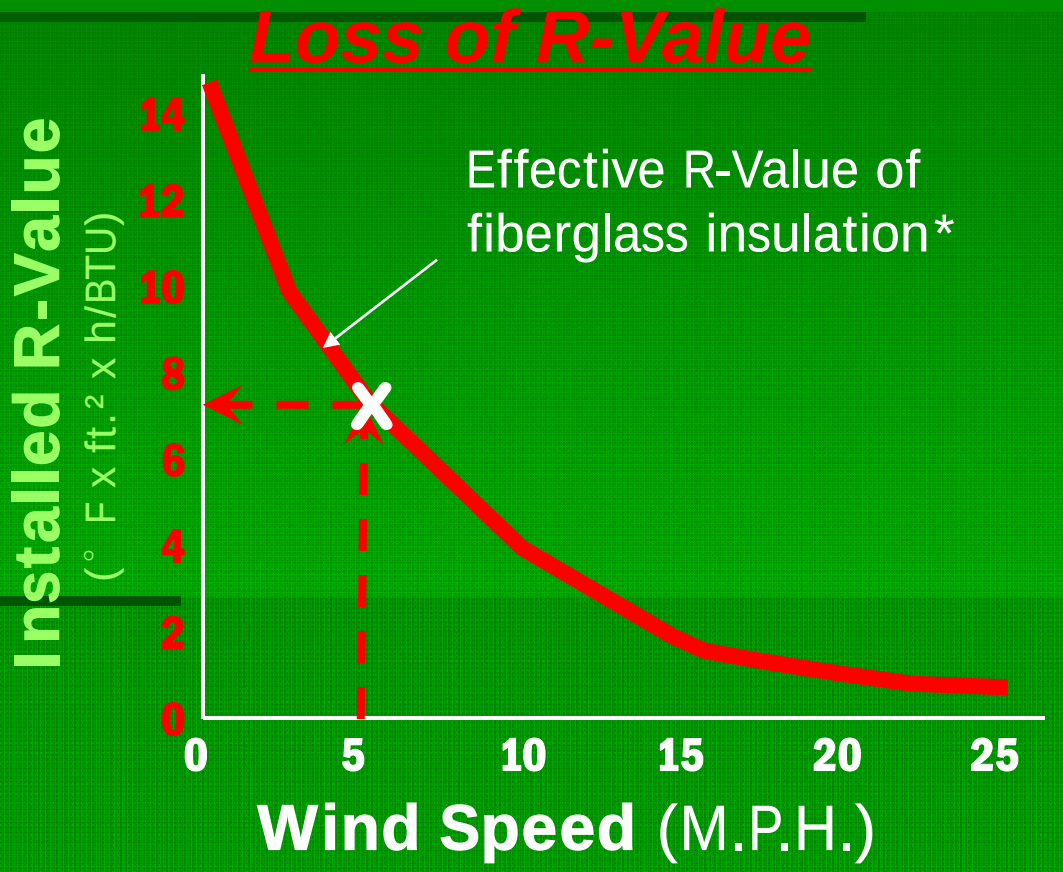


Building Performance – Energy Efficiency

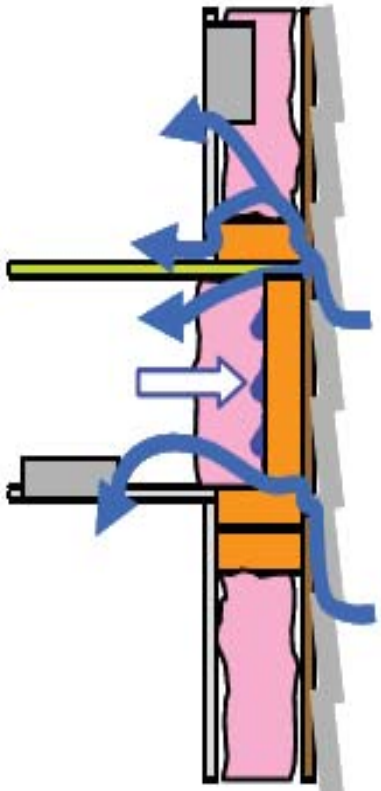
Loss of R-Value due to Air Leakage



Convective loops due to wind washing



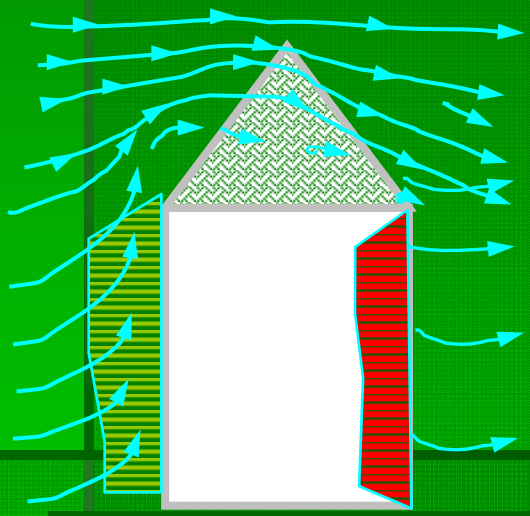
*Test data by Holimetrix



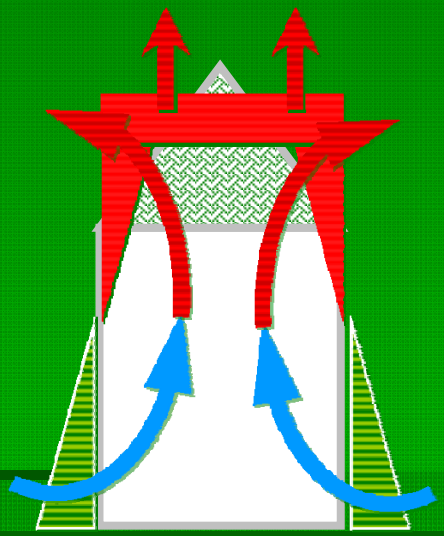
COMMON PROBLEMS:

- **Un-insulated / under-insulated**
  Missing, compressed or poorly-fitted fiber glass batts
- **No air sealing**
  Air leaks through common joint for framing and sheathing
- **Improper moisture control**
  Missing or reversed vapor retarder can result in condensation, especially in moist interiors

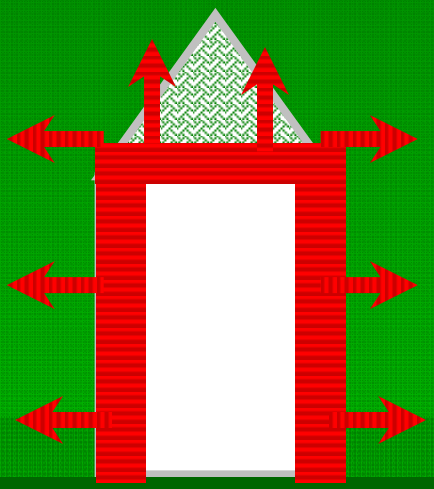
Sources of Air Pressure Differential in Houses



Wind Pressure

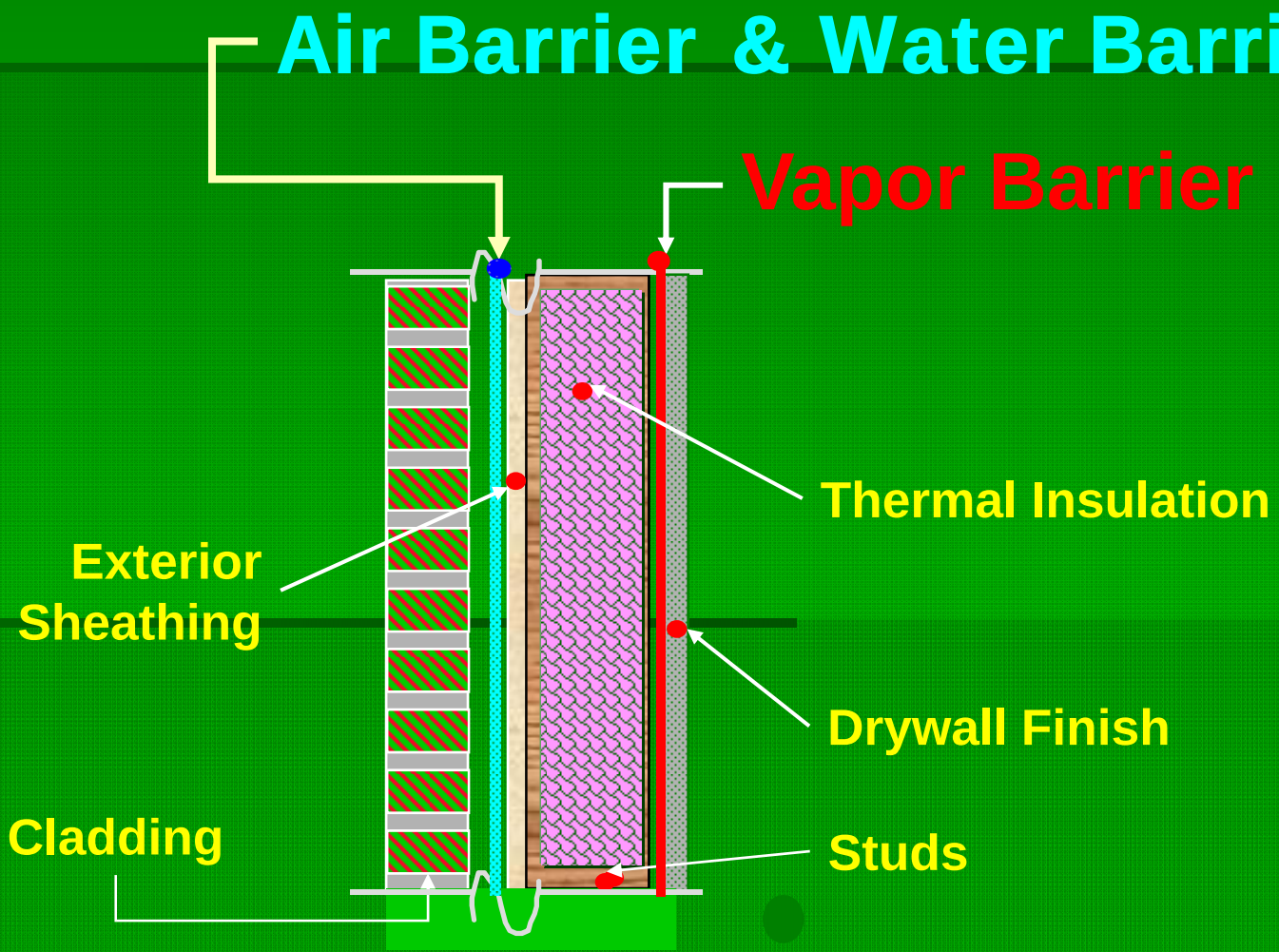


Stack Pressure



Mechanical Pressure (HVAC)

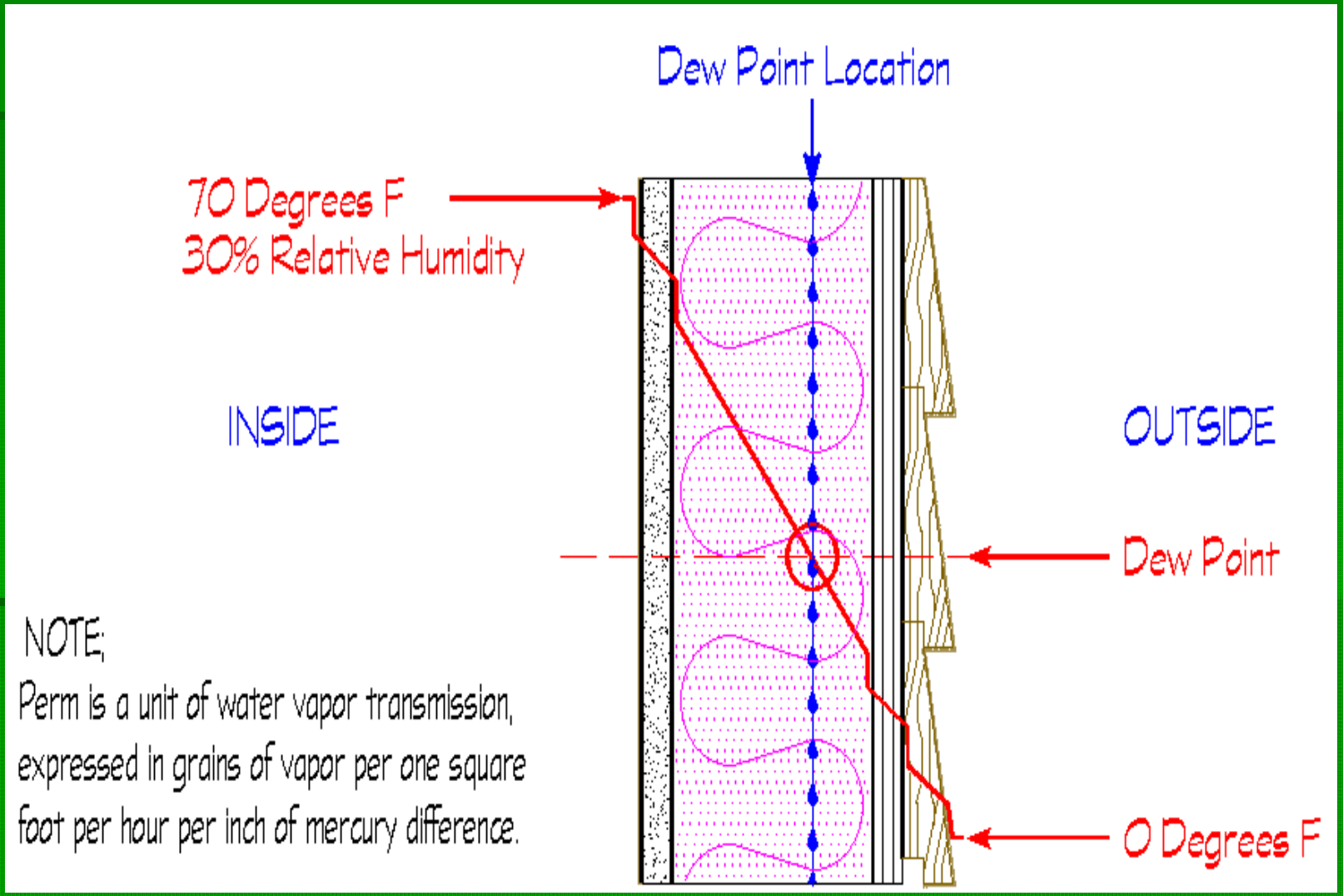
The Three Barriers

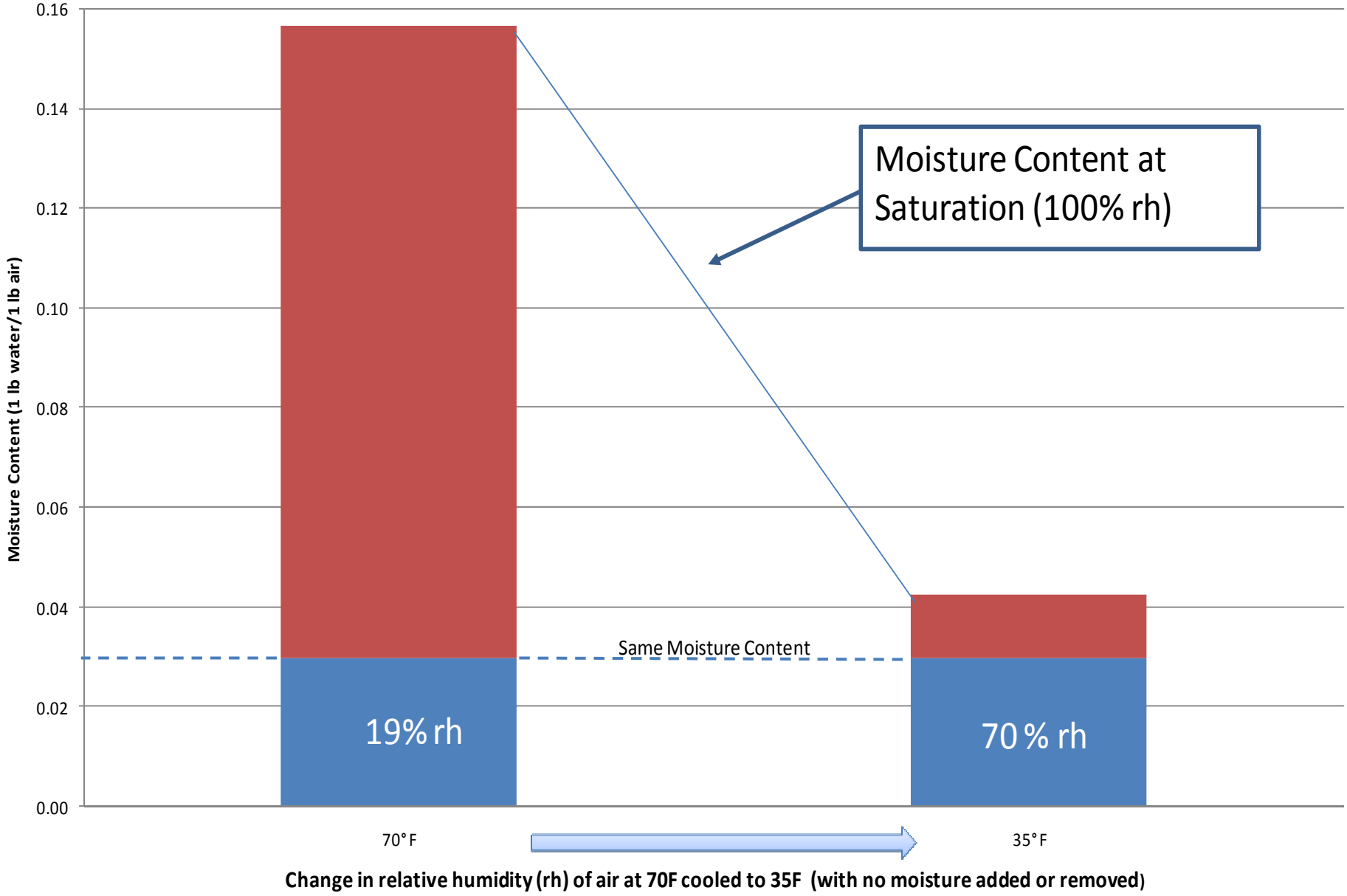


Air, water barrier costs

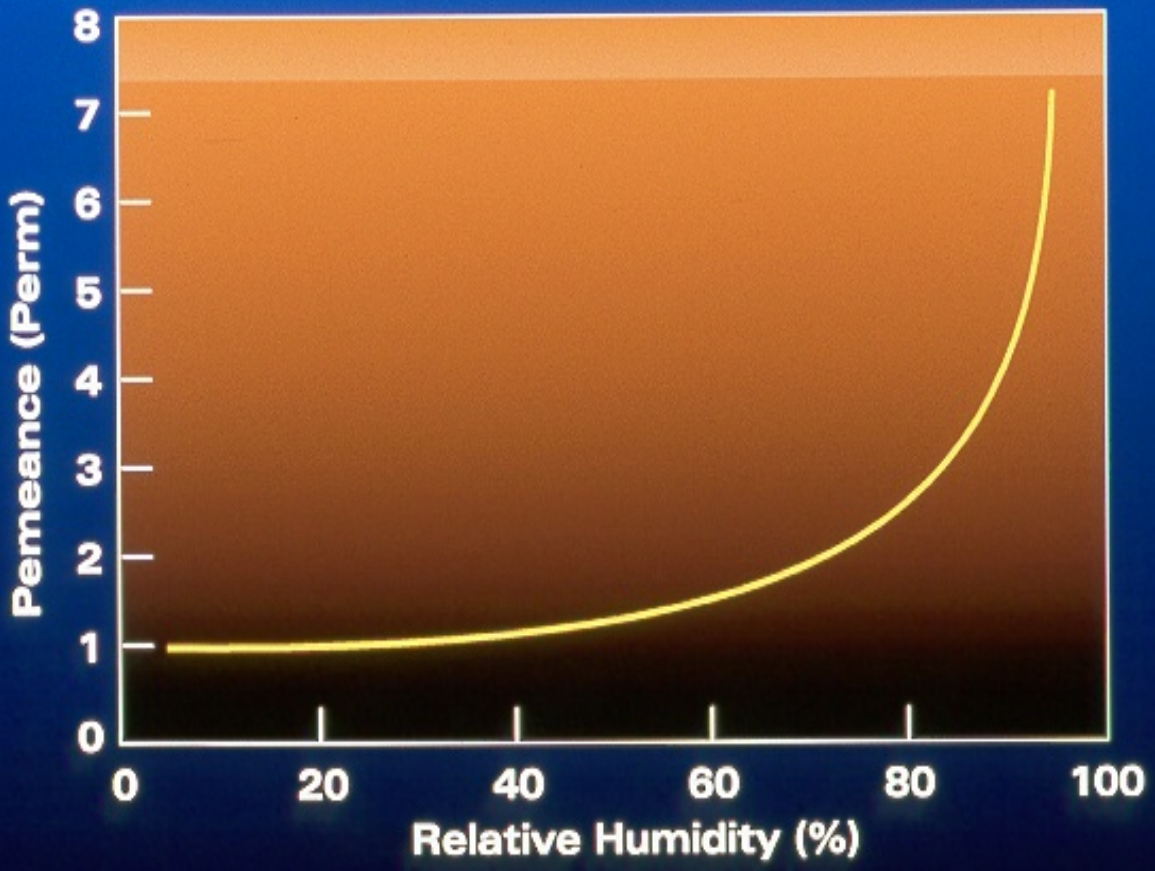
- **The system costs about 1/2 of 1% of the cost of an average house.**

DEW POINT


Dew Point Location
70 Degrees F
30% Relative Humidity
INSIDE
OUTSIDE
Dew Point
0 Degrees F
NOTE:
Perm is a unit of water vapor transmission, expressed in grains of vapor per one square foot per hour per inch of mercury difference.

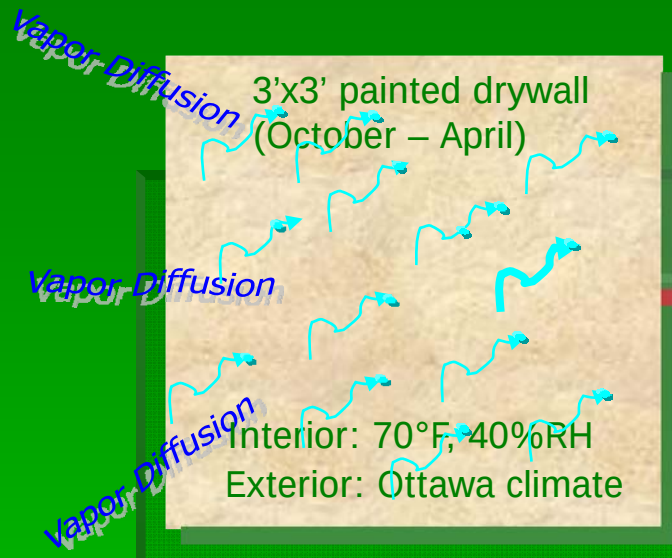

0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Moisture Content (1 lb water/1 lb air)
Moisture Content at Saturation (100% rh)
Same Moisture Content
19% rh
70 % rh
70° F
35° F
Change in relative humidity (rh) of air at 70F cooled to 35F (with no moisture added or removed)

Permeance of Kraft Paper



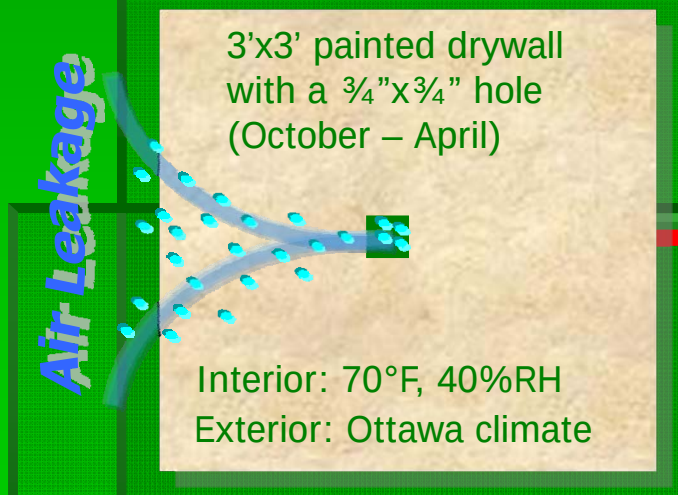
Source: NIST

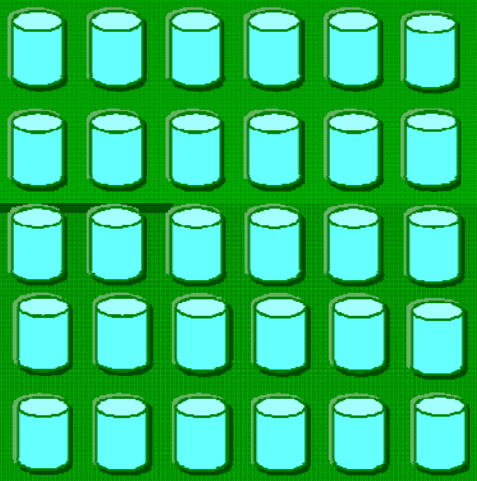
Diffusion *vs.* Air Leakage



~1/2 qt.

Moisture transported by air currents can account for 98% of all water vapor movement





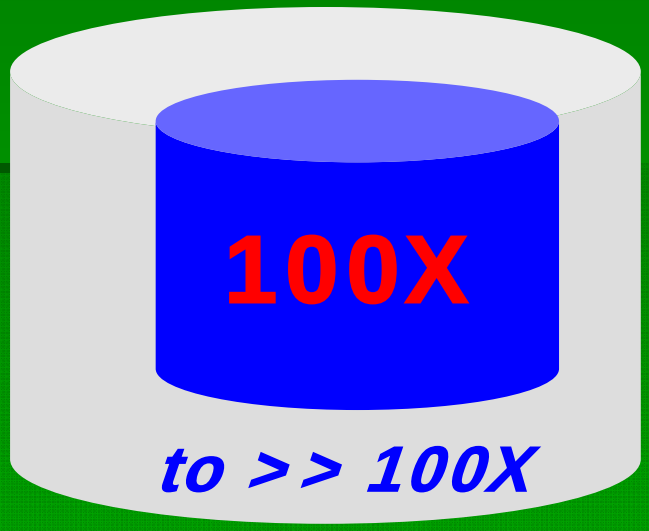
30 quarts

60X

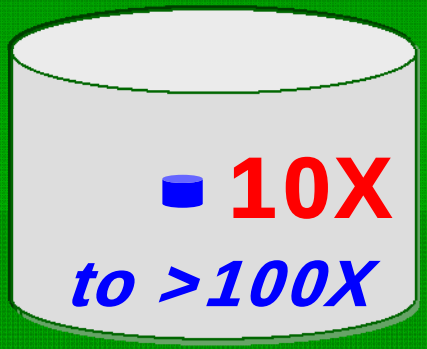
Courtesy: Tony Woods

Rating of Moisture Sources in Buildings

1) Liquid water → →



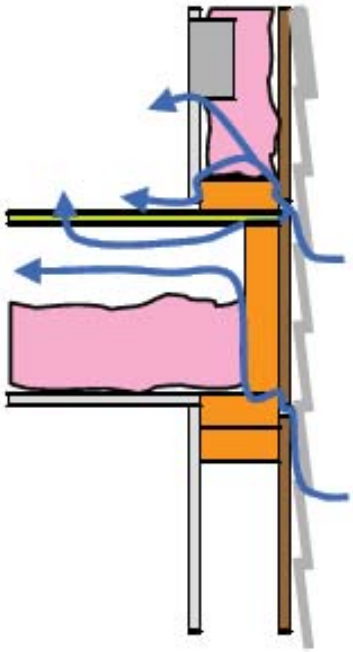
2) Vapor transported by air currents → →



3) Vapor diffusion → → 1X

Causes of Mold in Homes

- Moisture problems cause by defective design.
- Construction assembly related moisture problems.
- Occupant generated moisture problems.



COMMON PROBLEMS:

- **Uncomfortable rooms**
  Too hot in summer, too cold in winter

  Caused by air movement between settled/undersized insulation and subfloor

  BIG source of builder call-backs

- **Plumbing problems**
  In extreme cases, supply and drain lines freeze

- **Poor indoor air quality**
  Exhaust fumes and off-gassing of solvents, fuels, pesticide, herbicides and other household chemicals stored in garage enter living space above.