

AIR BARRIER ASSOCIATION OF AMERICA
MARCH 2019

Why air barrier specialists need to understand water.

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Learning Objectives:



- Recognize the differences and relationship between vapor, air, and thermal control.
- Understand key building science principles that determine how water vapor and liquid water move through materials and assemblies.
- Identify critical details and transitions that impact rain and air control.
- List common moisture-related problems and their impacts on buildings and building occupants.



Today



- Vince- control pressure to control flow
- Chris- performance & energy
- Sarah/Andrew- water leaks





Why care about moisture?

- Moisture is involved in most building enclosure performance problems
 - Construction cycle and in-service durability
- Examples:
 - rot,
 - corrosion,
 - mould (IAQ)
 - buckling
 - termites, insects
 - staining
 - etc.



Why Air Barriers and h_2O ?

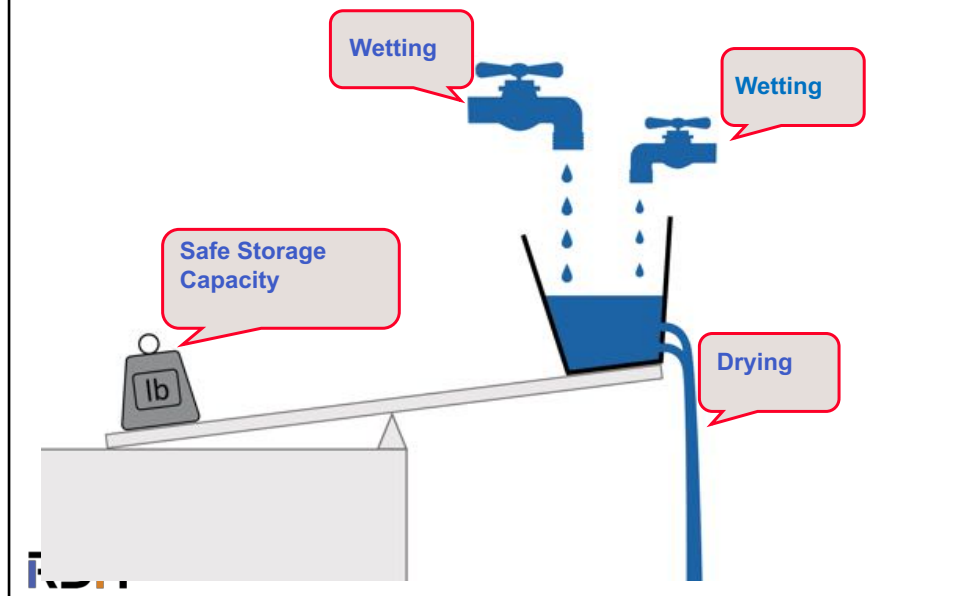
1. Air barriers limit airflow and hence limit condensation
2. Many air barrier products also used as Water Resistant Barriers
3. Air barrier products may also be vapor control layers (& hence control condensation)

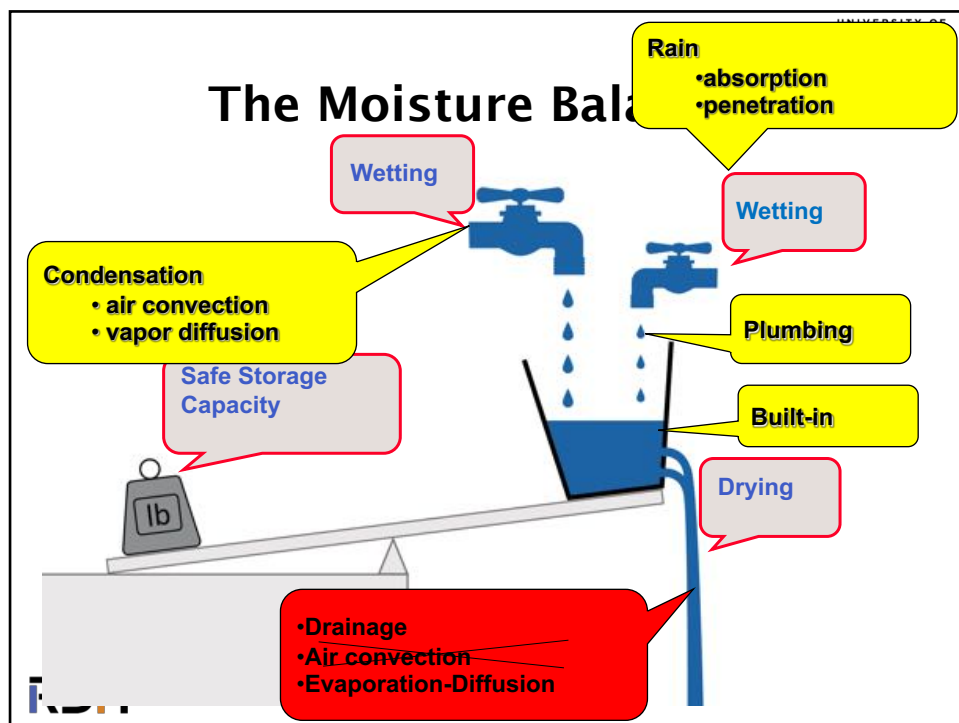
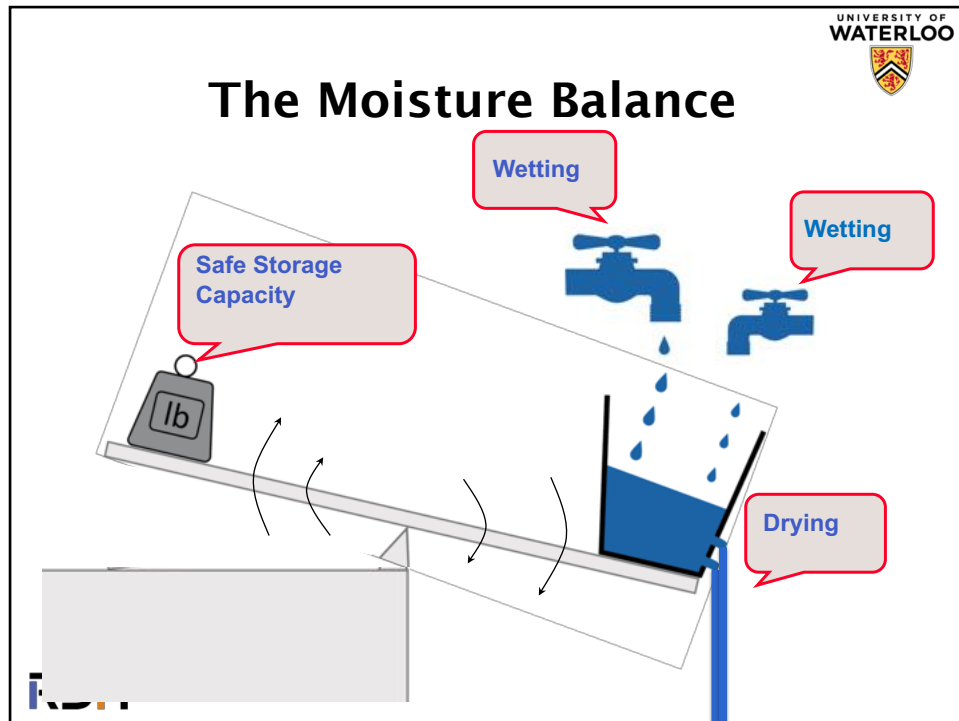


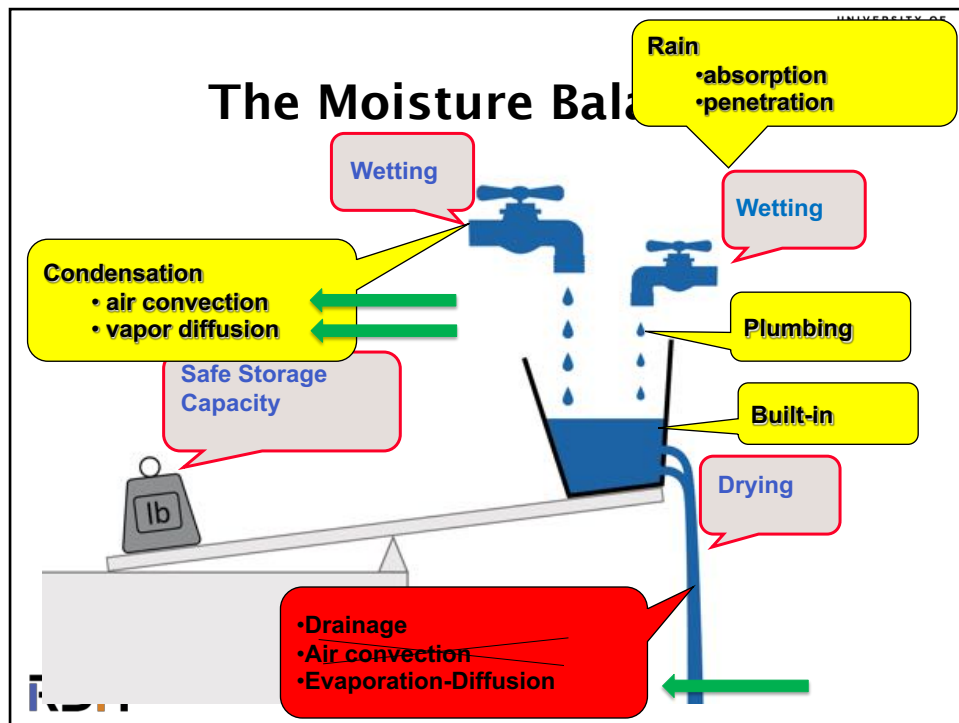
Some definitions

- Water ... *usually* liquid H_2O
- Moisture ... liquid *and* vapor?
- Ice .. Unambiguous solid water
- So,
 - Air Barrier?
 - Vapor barrier?
 - Moisture barrier?
 - Water Barrier?


The Moisture Balance





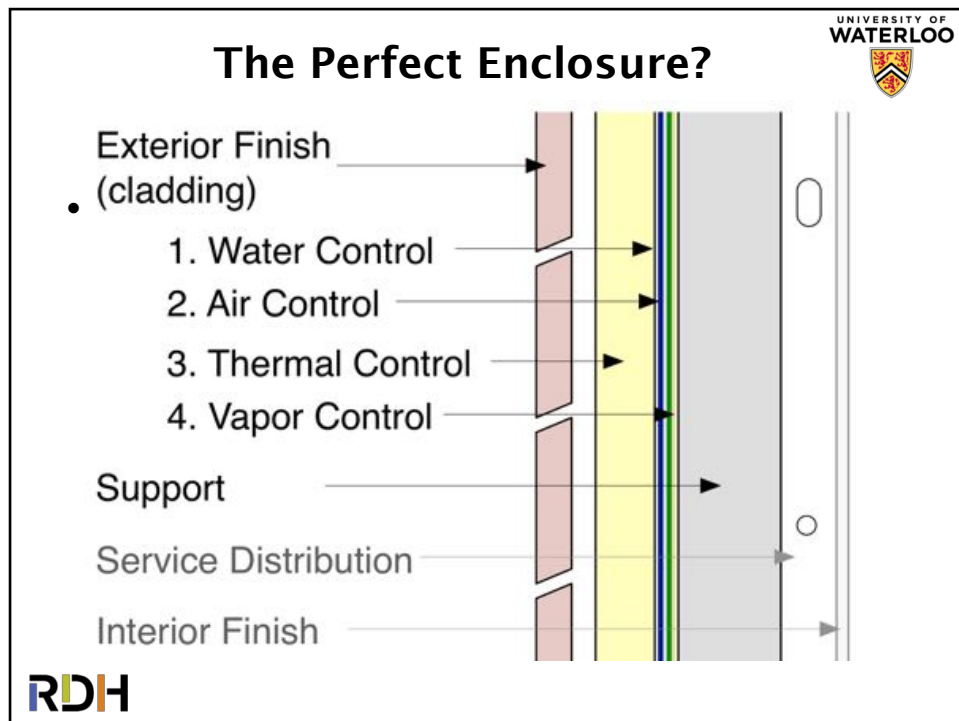



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Review of enclosure design basics

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Walls we commonly build

- Hybrid/split walls
- Water-Air control in middle
- Don't always need vapor layer

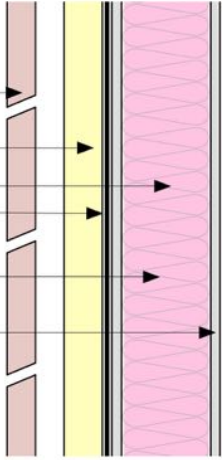
Cladding


Thermal control

Water-Air Control (Vapor permeable)

Support (w/ insulation)

Finish





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Water Barrier & Air Barrier outside insulated frames






Vapor permeable
on exterior

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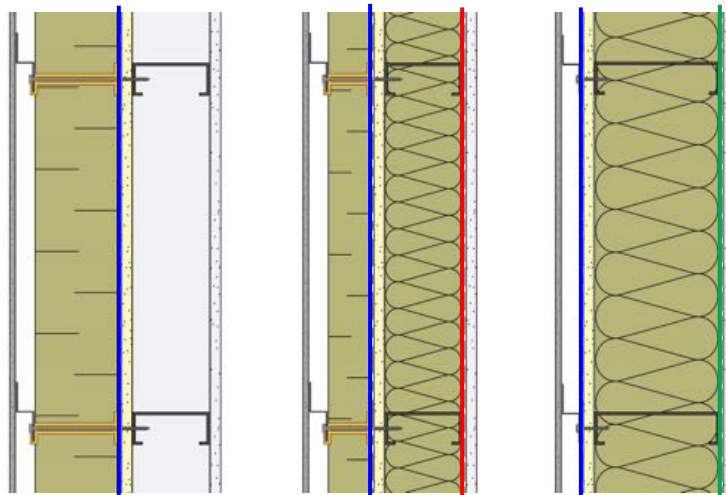


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Air Barrier, WRB, VB Placement Considerations

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Air-Water-Vapor permeable Air-Water Vapor permeable Water Air-vapor




RDH All Exterior insulated

Split (exterior & stud) insulated

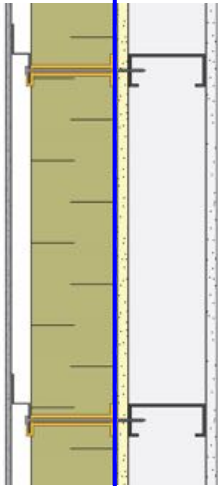
Interior (stud) insulated

Air Barrier, WRB, VB Placement Considerations



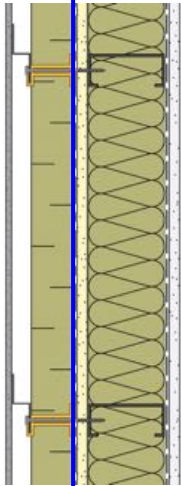
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Air-Water-Vapor



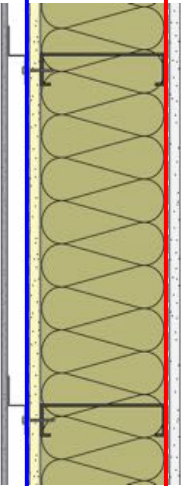
RDH All Exterior insulated

Air-Water-Vapor




Split (exterior & stud) insulated

permeable
Air-Water
Vapor

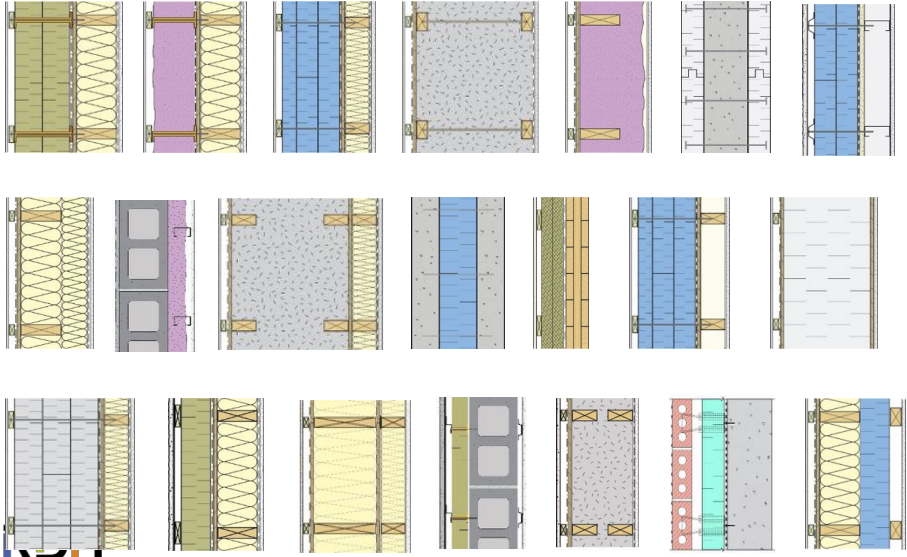


Interior (stud) insulated

There are some variations



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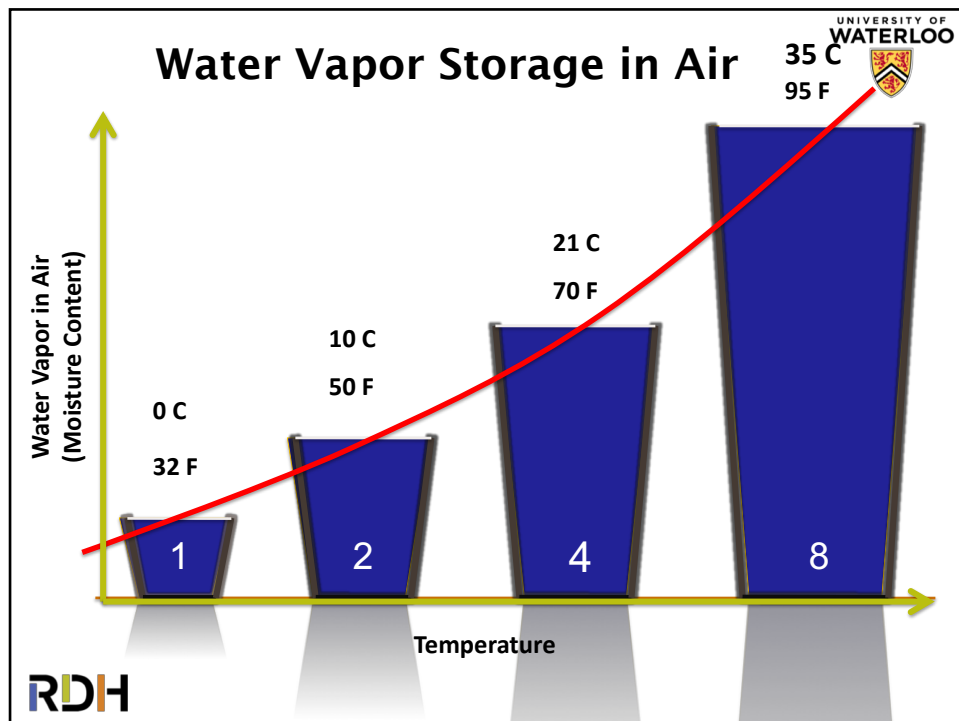
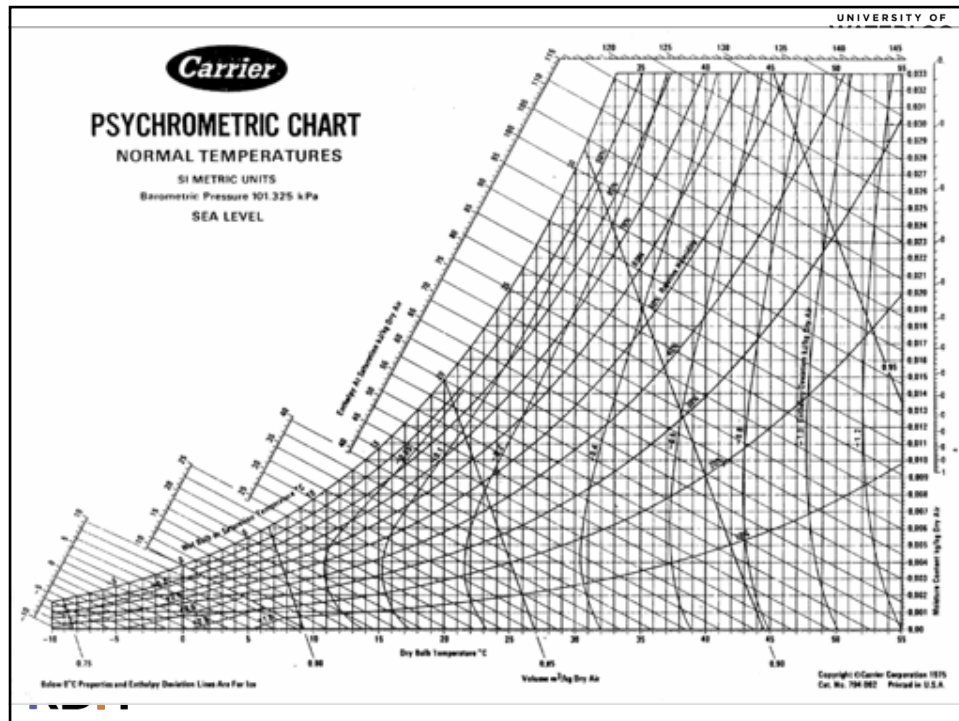
Back to Moisture: Psychrometrics

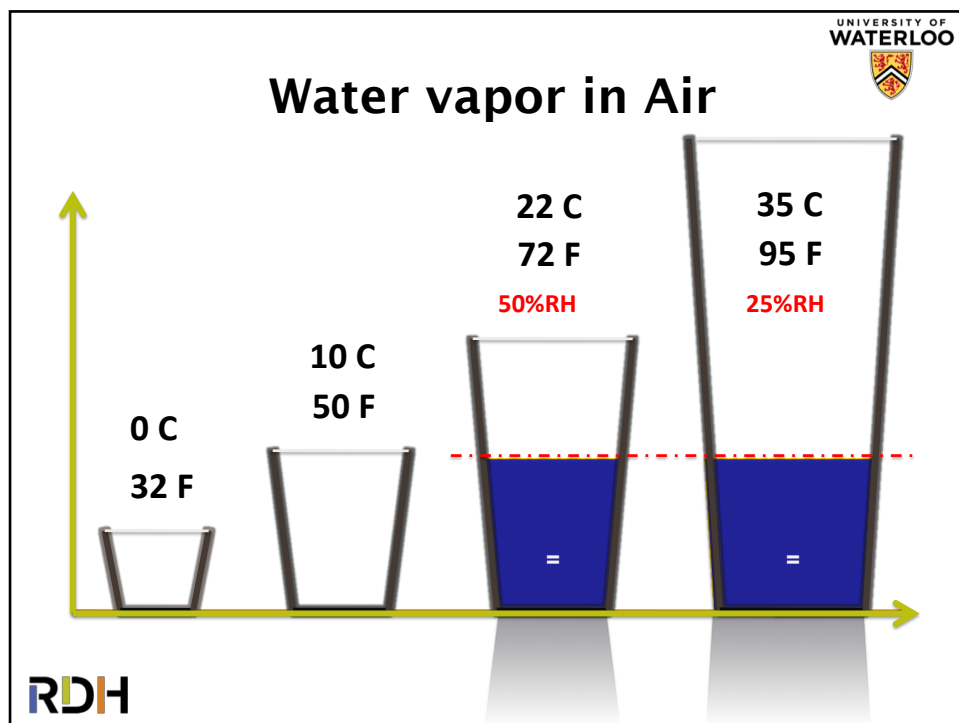
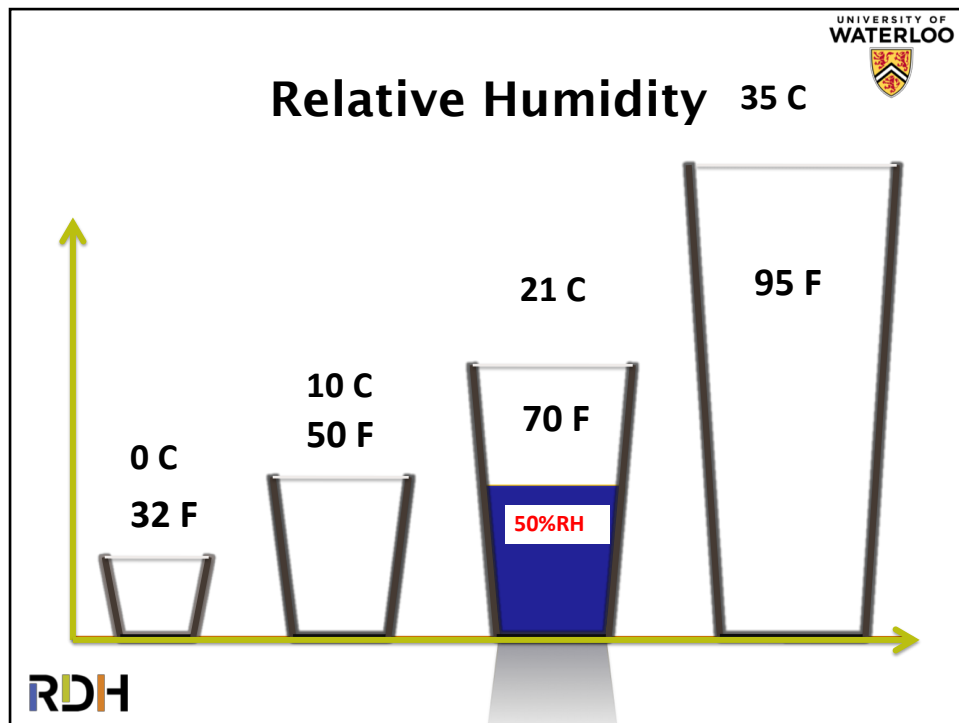


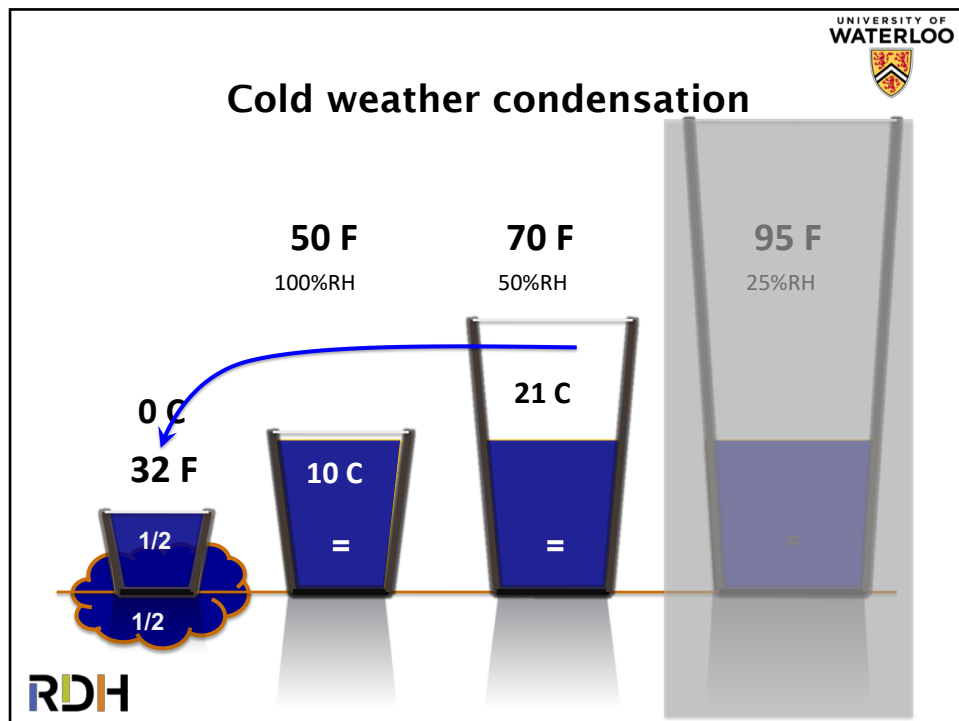
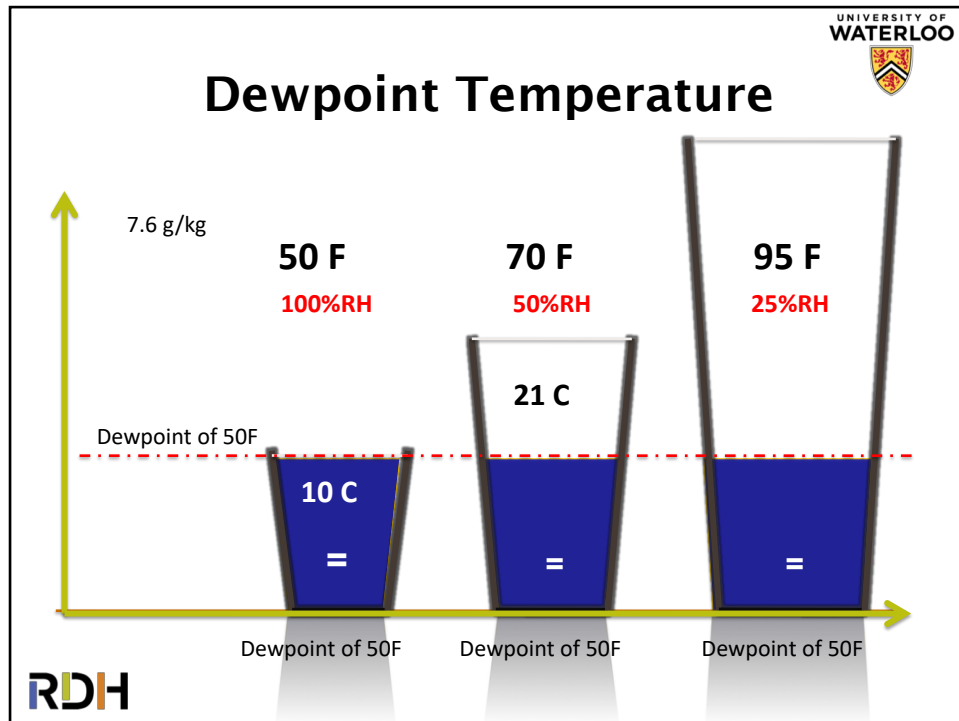
Psychrometrics

- The study of air and its water and energy content
- Explains when, where, how much condensation







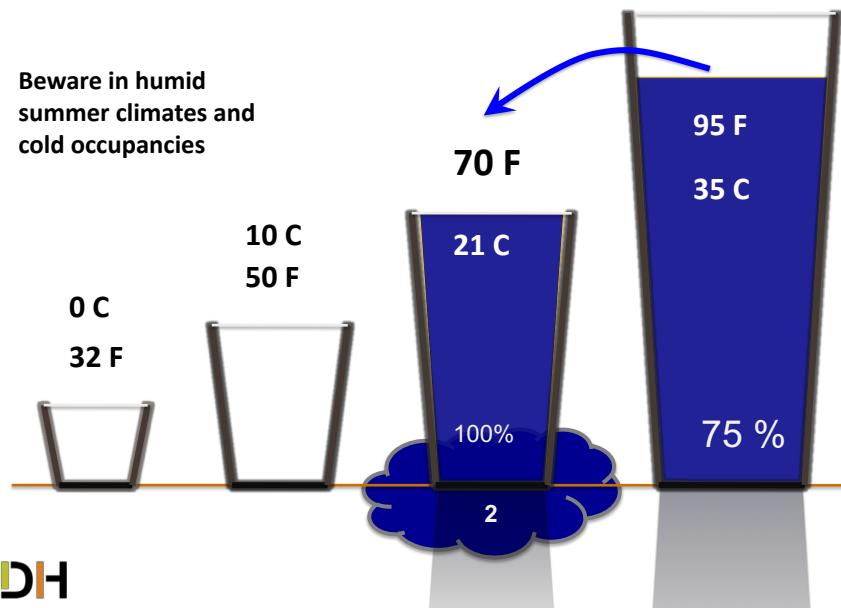


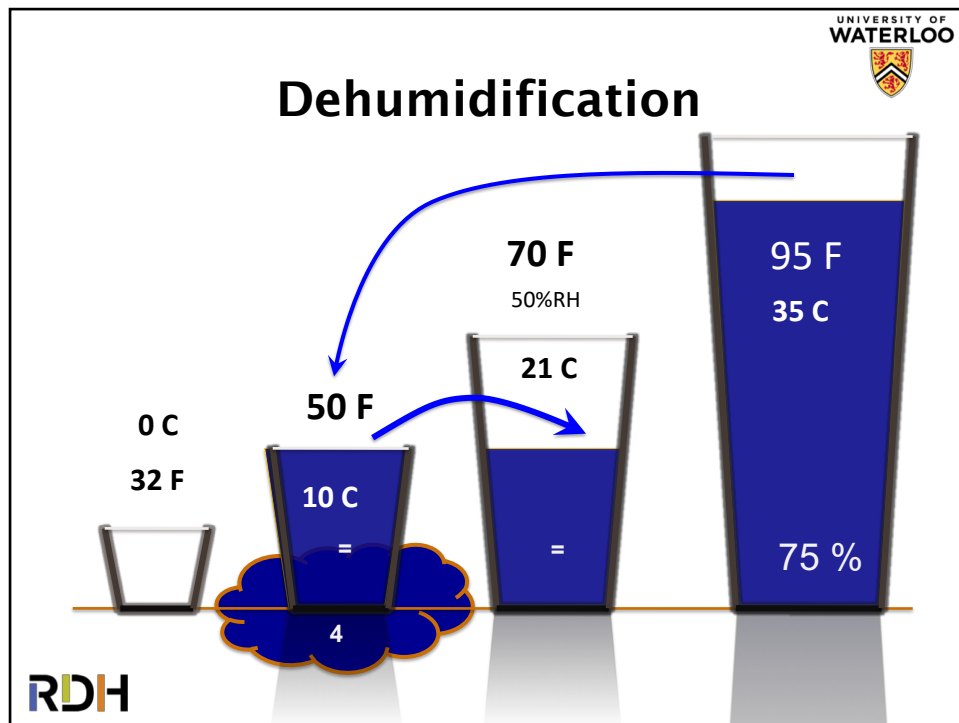
Surface Condensation



Warm weather condensation

Beware in humid
summer climates and
cold occupancies



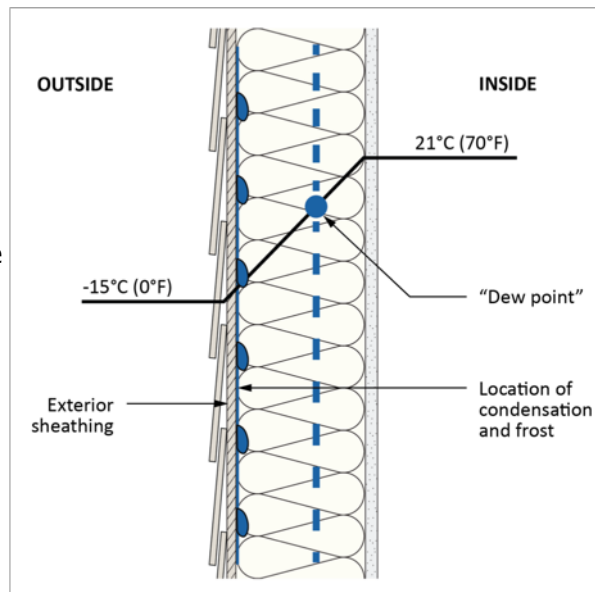


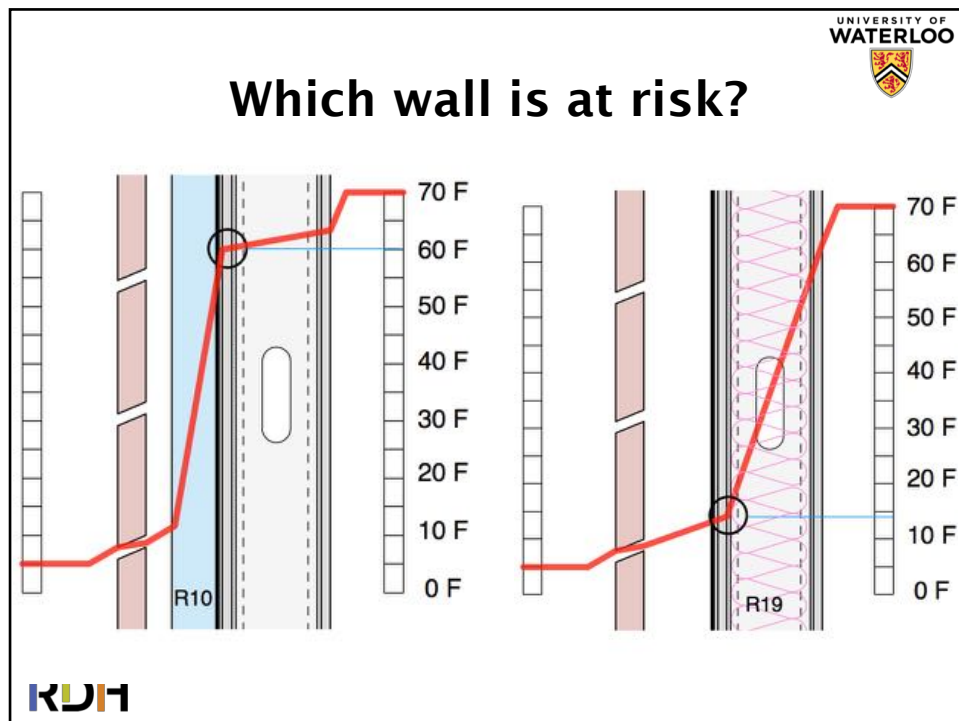
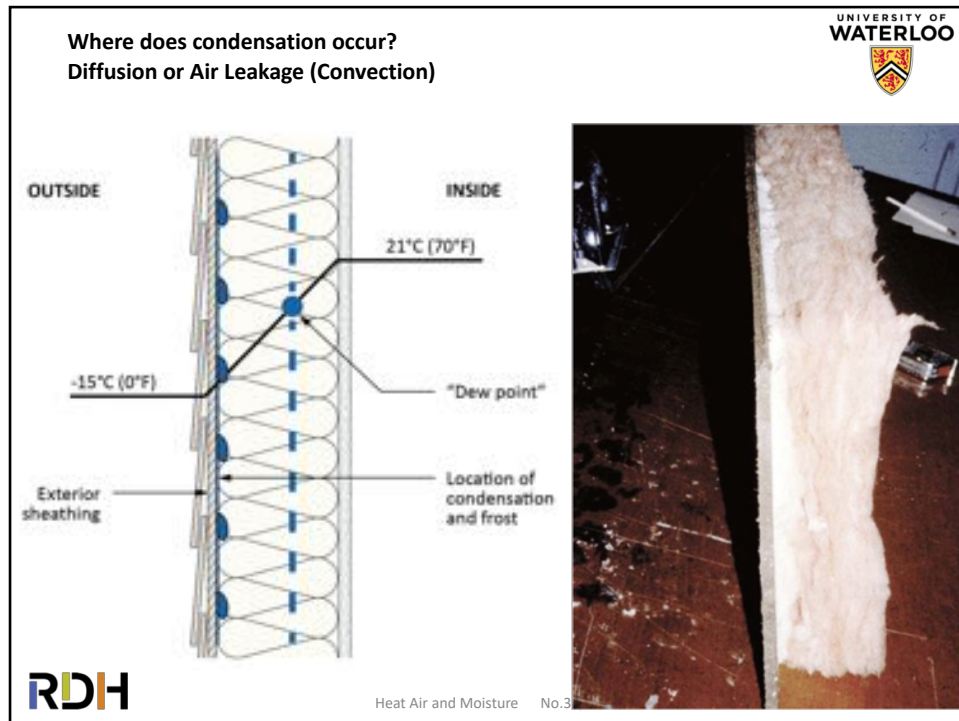
Interstitial Condensation

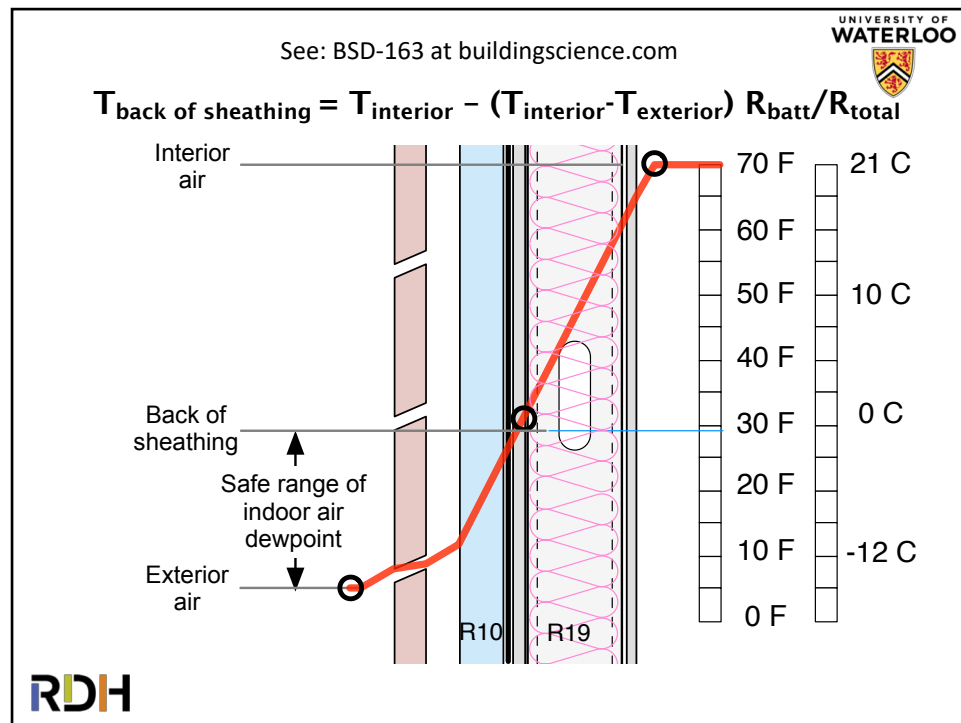
- Condensation within enclosures
- Hidden and hence can be problem
- Water vapor delivered by air leakage and/or diffusion

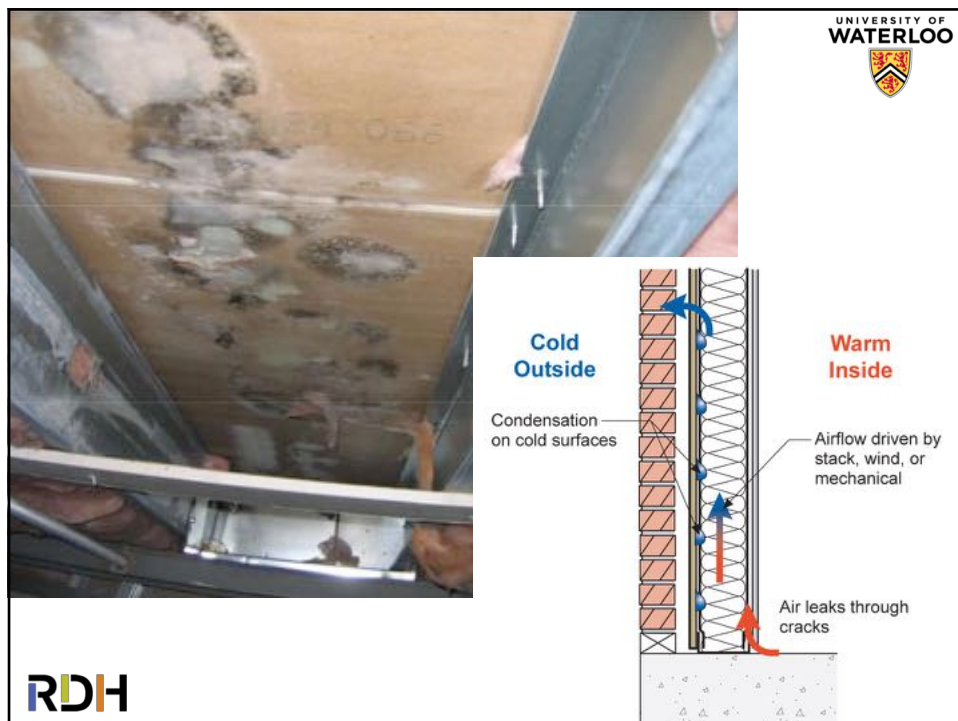
Condensation • Plane

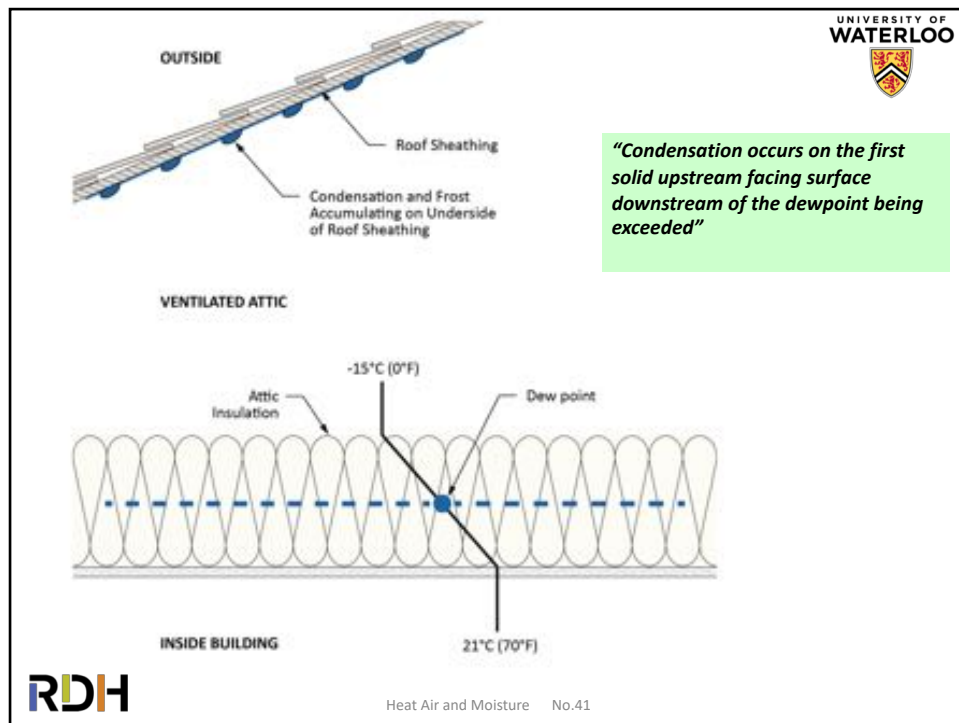
- Condensation occurs on solid surfaces
- Not within batt
- “Next solid surface colder than dewpoint”





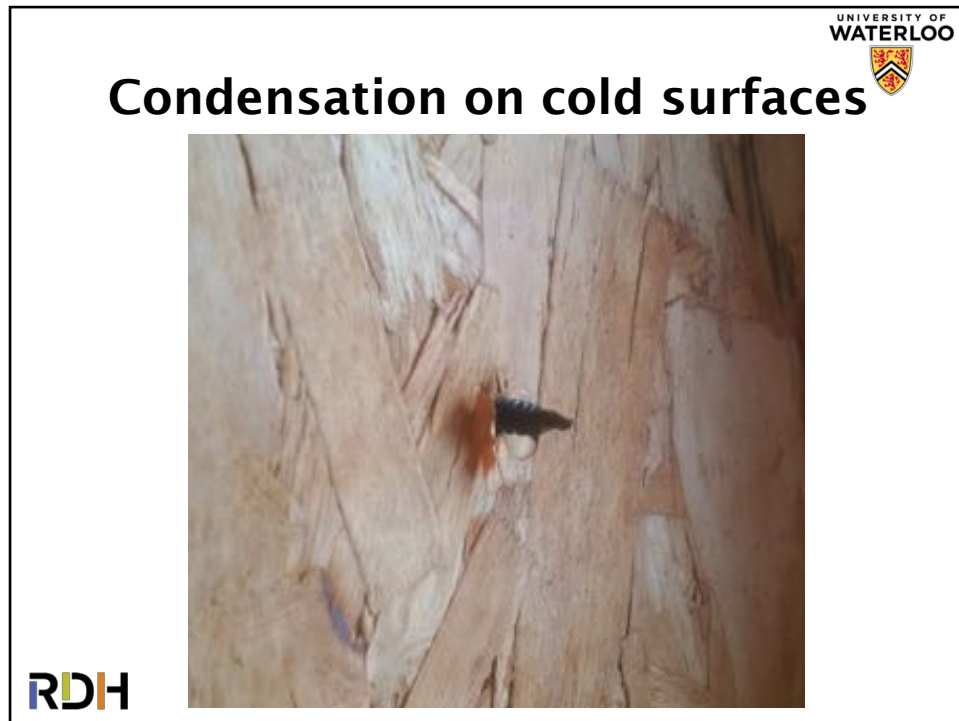






Inside of roof sheathing from attic hatch



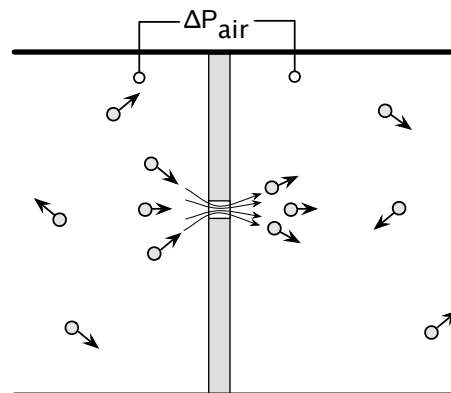


Vapor Transport

- How does vapor get to cold surface?
 1. Vapor Diffusion
 2. Air leakage (convection)
- Air leakage moves much more vapor in most cases!
- Diffusion still important for drying wet materials, inward solar drives

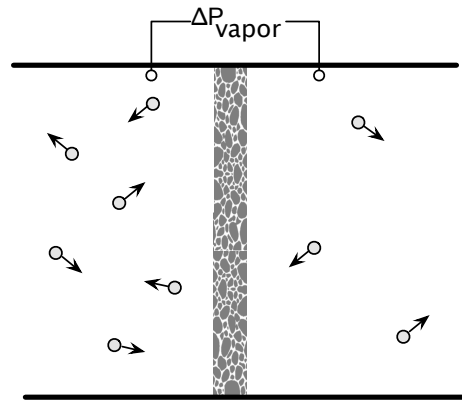
Vapor convection (w/air flow)

- Vapor molecules flow along with air (O_2 and N_2 molecules are much more numerous and not shown)

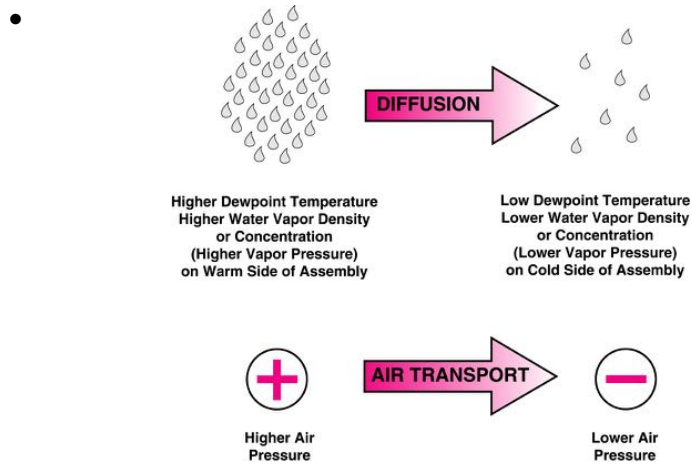


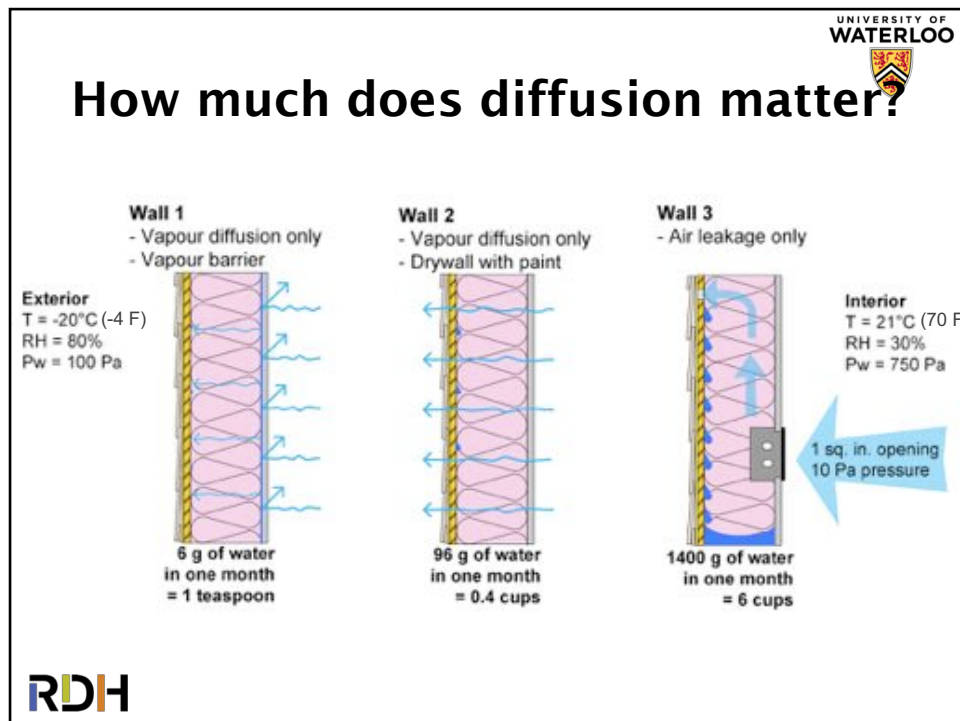
Diffusion through layers

- Vapor molecules moves through microscopic pores in materials



Forces Driving Vapor Flow





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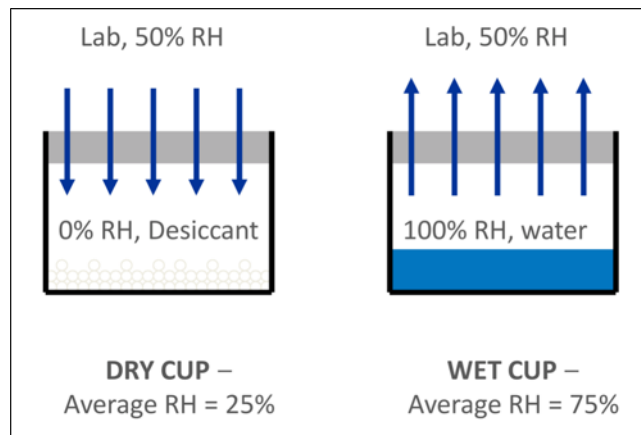
When is a layer permeable?

- Test the vapor permeance of a layer
- Most materials provide data
- Beware:
 - units (WVTR vs perm)
 - Test conditions
 - thickness

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Vapor permeance ASTM Testing

- ASTM E96: Wet cup, dry cup

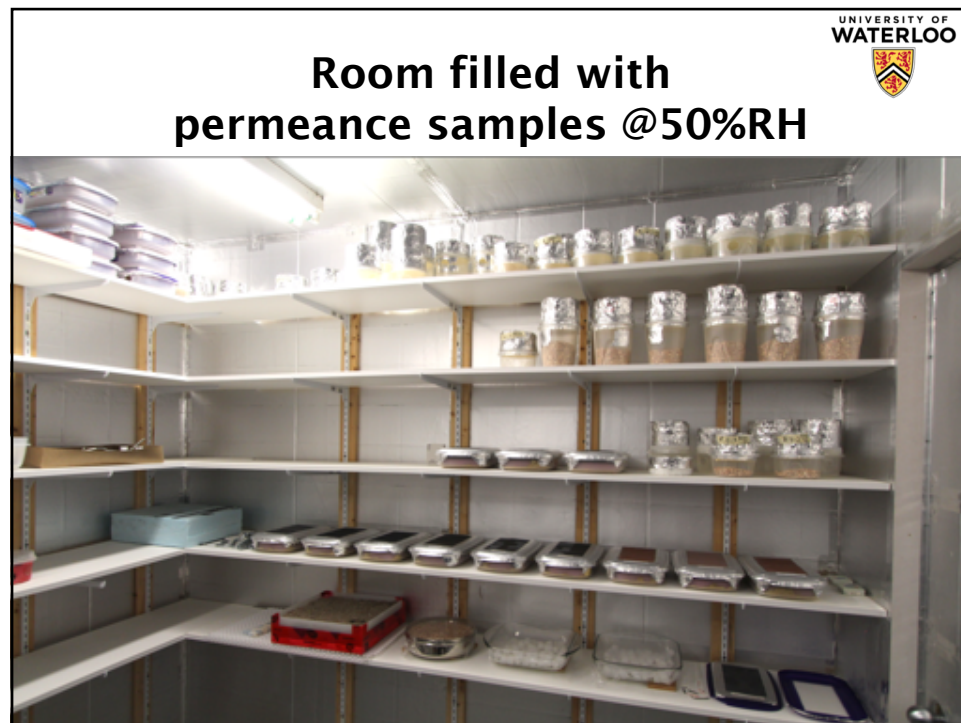


Vapour Permeance



Dry Cup

Wet Cup



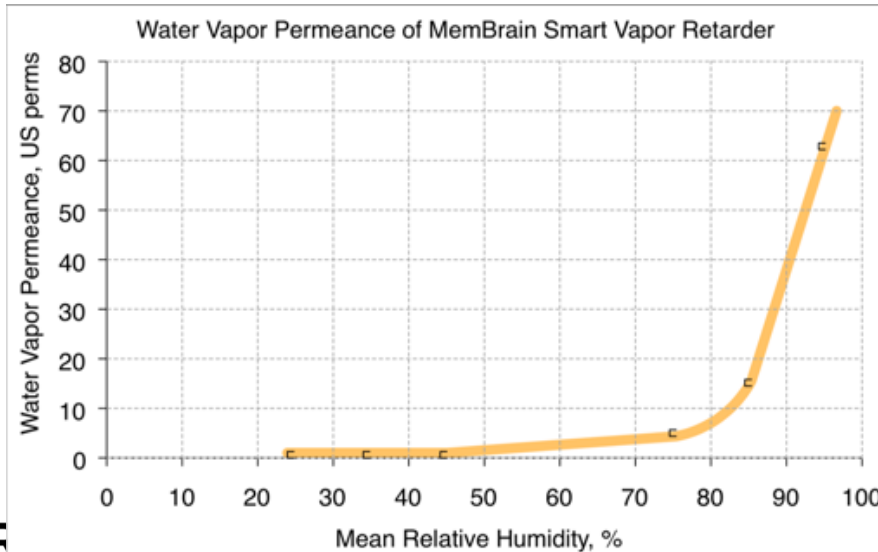
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Why test wet and dry?

- The permeance of many products varies between wet and dry cup!
- Interiors during cold weather have a low RH
 - Thus vapor barriers best rated by dry cup
- Exteriors during cold weather, or when wall is wet, have a high RH
 - Permeable WRBs best rated by *wet cup*

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Smart Membranes



Inward Drives

Exterior Conditions

Temperature: 25°C (77°F)
 Relative Humidity: 80%
 Vapour Pressure: 2.5 kPa

Brick Cavity Conditions

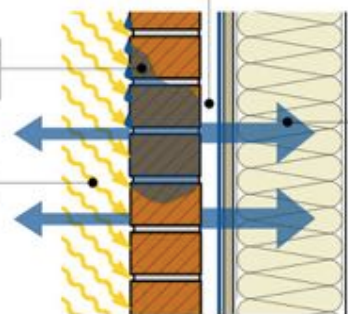
Temperature: 40°C (104°F)
 Relative Humidity: 100%
 Vapour Pressure: 7.4 kPa

Interior Conditions

Temperature: 21°C (70°F)
 Relative Humidity: 60%
 Vapour Pressure: 1.8 kPa

1. Cladding (brick, stucco, or adhered stone) is saturated with rainwater.

2. Solar radiation strikes wall and heats cladding.



3. Vapour is driven inward and outward by a vapour pressure gradient between the brick and the interior (5.6 kPa) and the brick and the exterior (4.9 kPa).

The amount of vapour transmission to the interior is dependent on the vapour permeance of the materials (i.e., sheathing membrane, insulation, vapour control layer).



Inward Drive Summer



Trump Taj Mahal, Atlantic City, NJ

Mark Makela for The New York Times



Design for Diffusion

- Should balance between cold weather and warm weather performance
- *Location* of low permeance layers matters
 - “vapour barrier” label is not important: materials that have low permeance act as vapor barriers
- Ventilation (airflow) of inner or outer layers bypasses vapor diffusion resistance
 - E.g. vinyl siding, metal panels, roofing



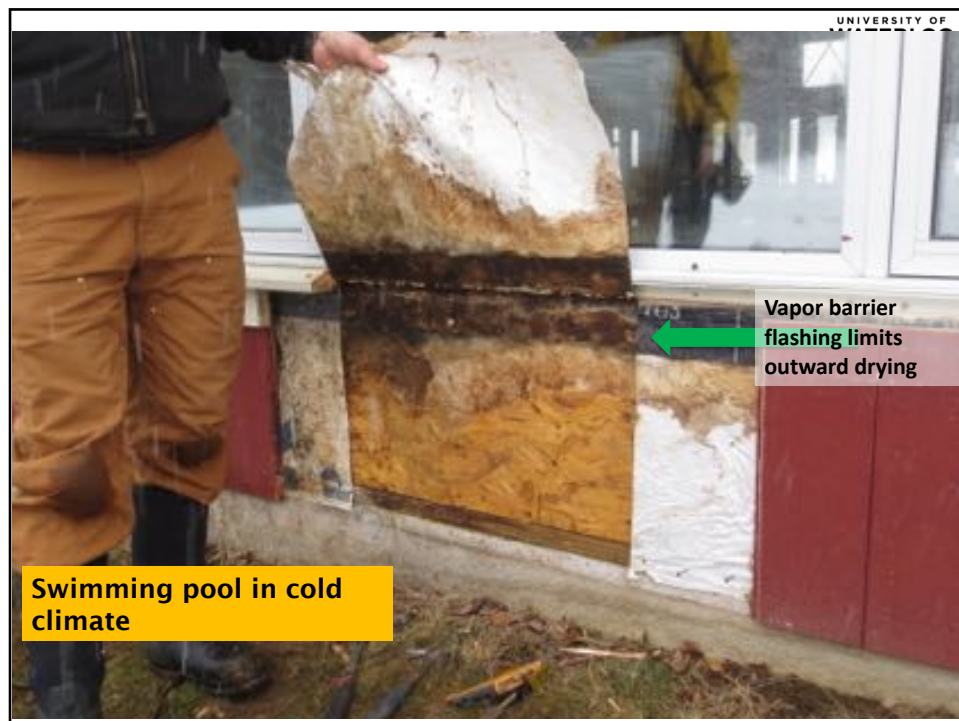
Heat Air and Moisture No.59/78



Details

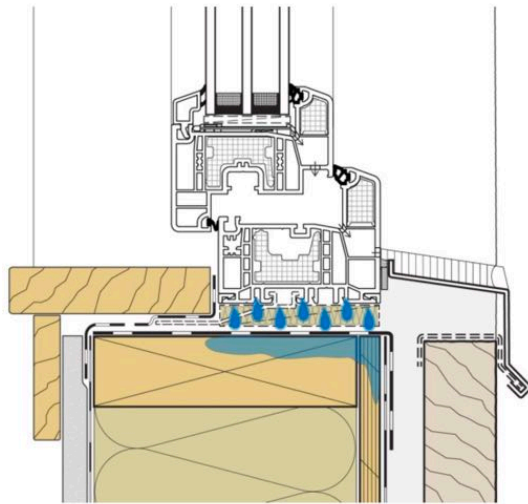
- Sometimes small areas of low permeance matter





Water pooling

- Small leaks through window & opening
- Sits on sub sill flashing
- Can diffuse into framing
- Need to balance



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Impermeable sub-sill over permeable air-water barrier



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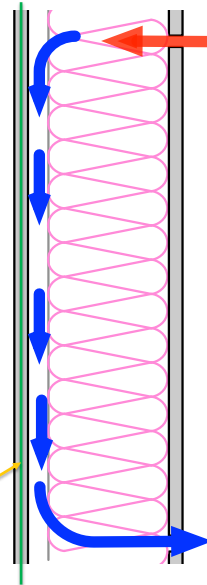
When don't air barriers stop condensation?

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Answer: when they are misplaced

- Cool air is denser
- Cool air falls
- = **convection loop**
- Perfect air barrier
..... But energy loss
and condensation

Airtight plane




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Case Study: Architectural Precast

- Air gap intentionally provided in design!
- Imperfect air seal at upper and lower levels allowed



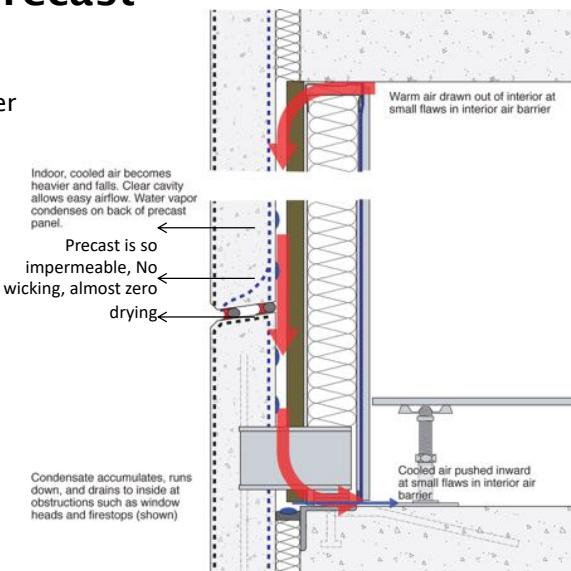
Indoor, cooled air becomes heavier and falls. Clear cavity allows easy airflow. Water vapor condenses on back of precast panel.

Precast is so impermeable, No wicking, almost zero drying

Condensate accumulates, runs down, and drains to inside at obstructions such as window heads and firestops (shown)

Warm air drawn out of interior at small flaws in interior air barrier

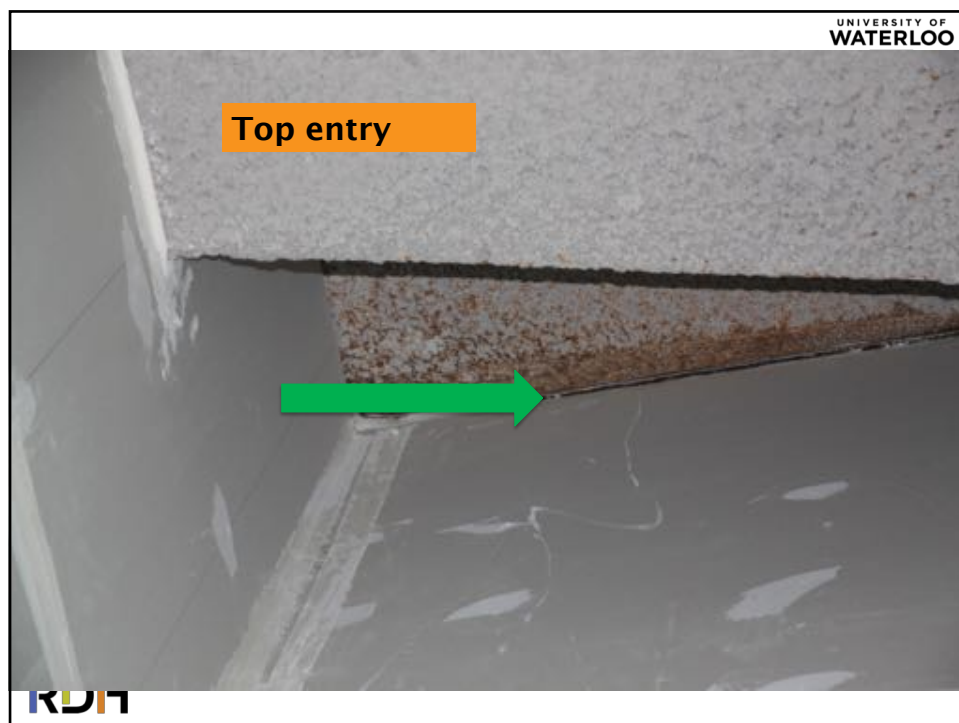
Cooled air pushed inward at small flaws in interior air barrier

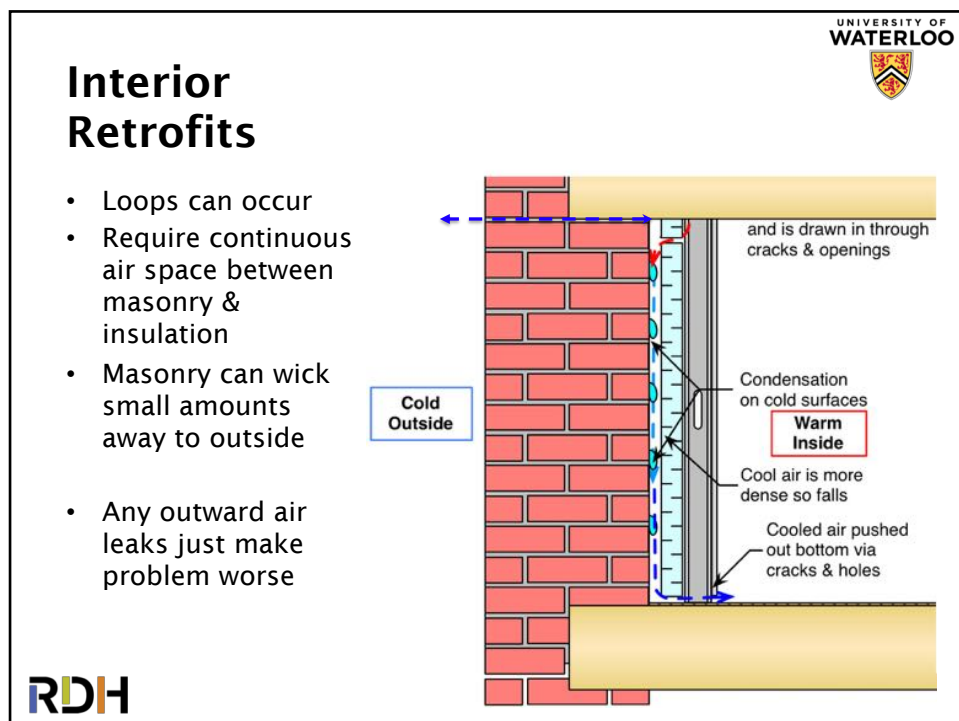


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Interior/back of precast panel when insulation removed during inspection



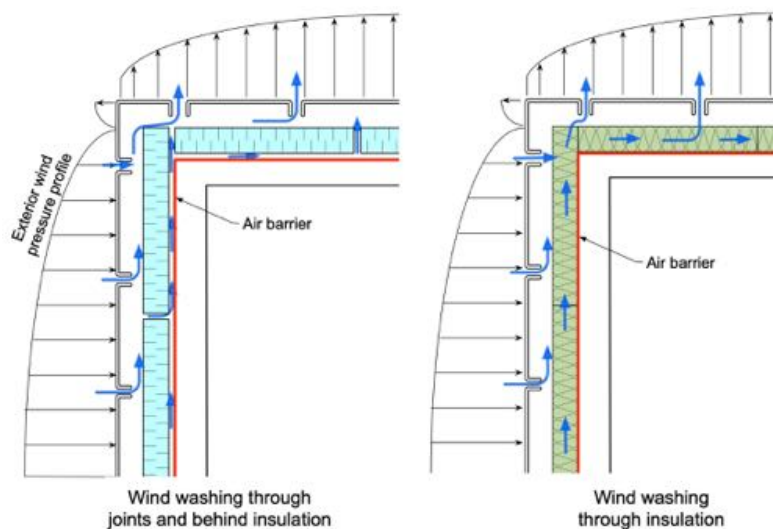


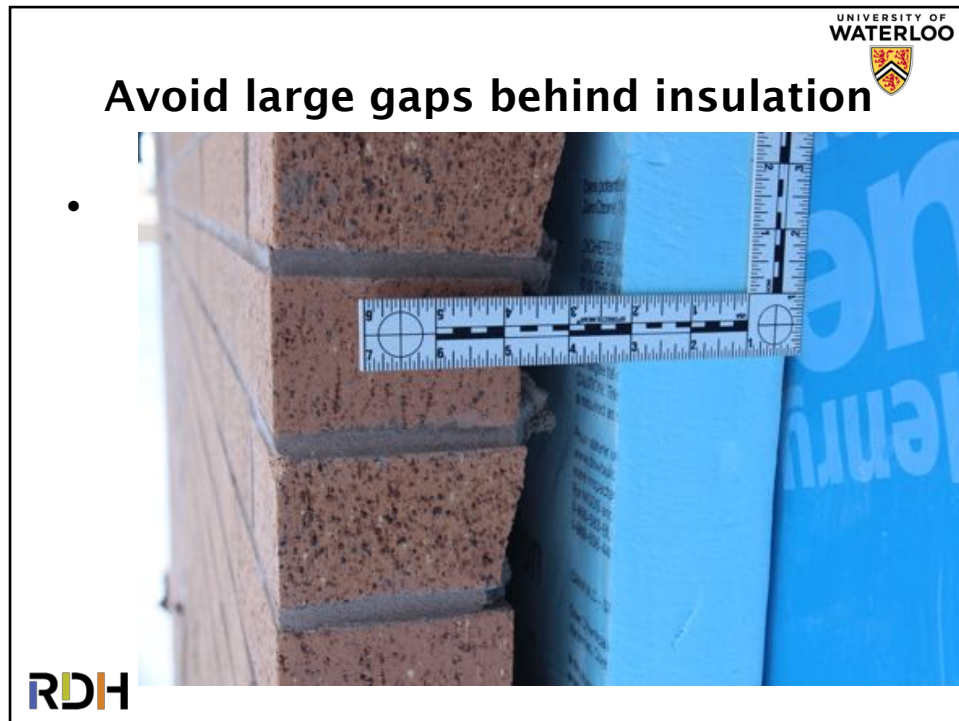


Convection Loop Solutions

- Locate air barrier closer to inside
- Make it very airtight (hard)
- Avoid airgaps!! Press insulation tight to surface
 - Eg spray foam, attached boards, compressed fibrous batt

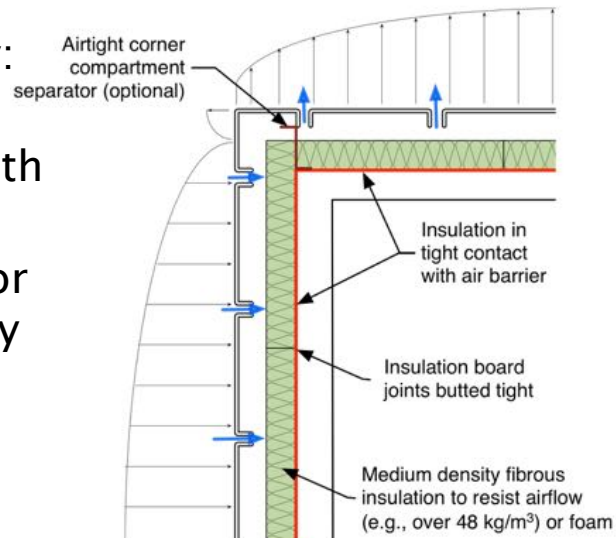
Wind Washing





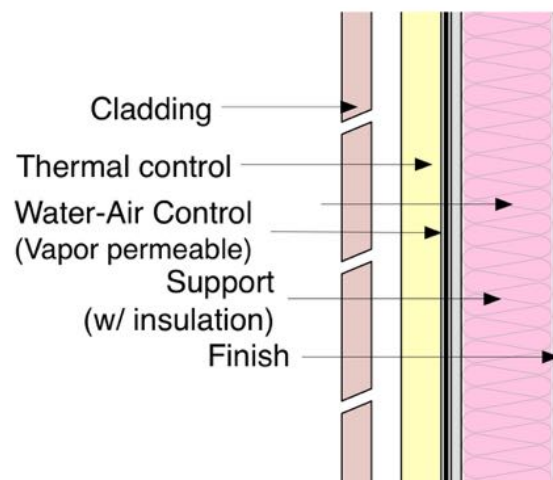
Wind washing Solutions


- Pretty easy:
- Keep AB in contact with insulation
- Use foam or mid-density fiber





Wind washing & convection solved?

- Split wall






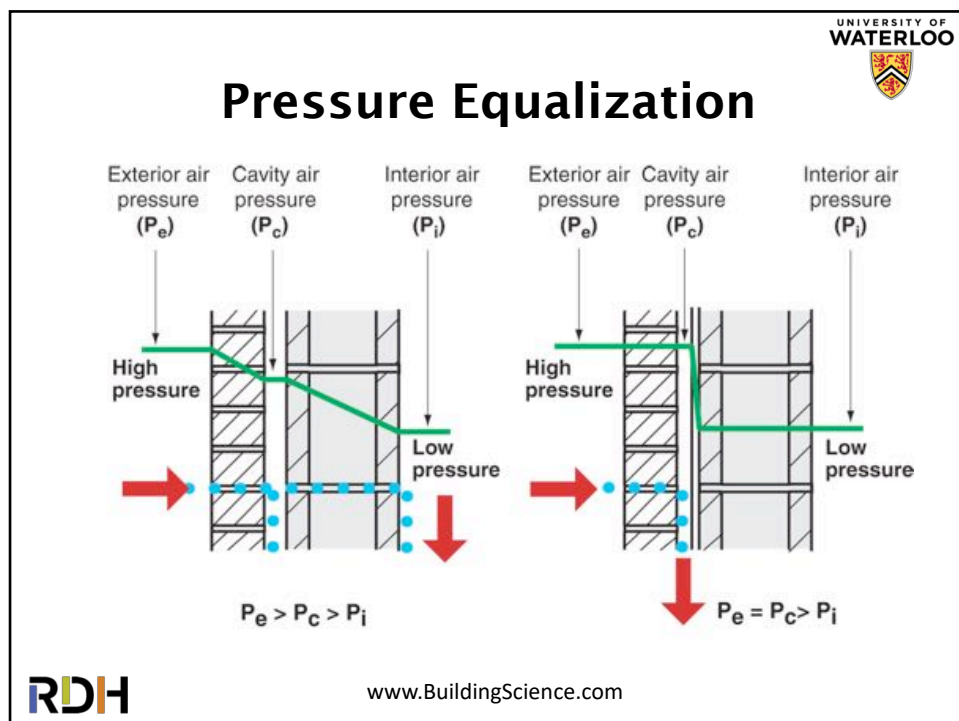
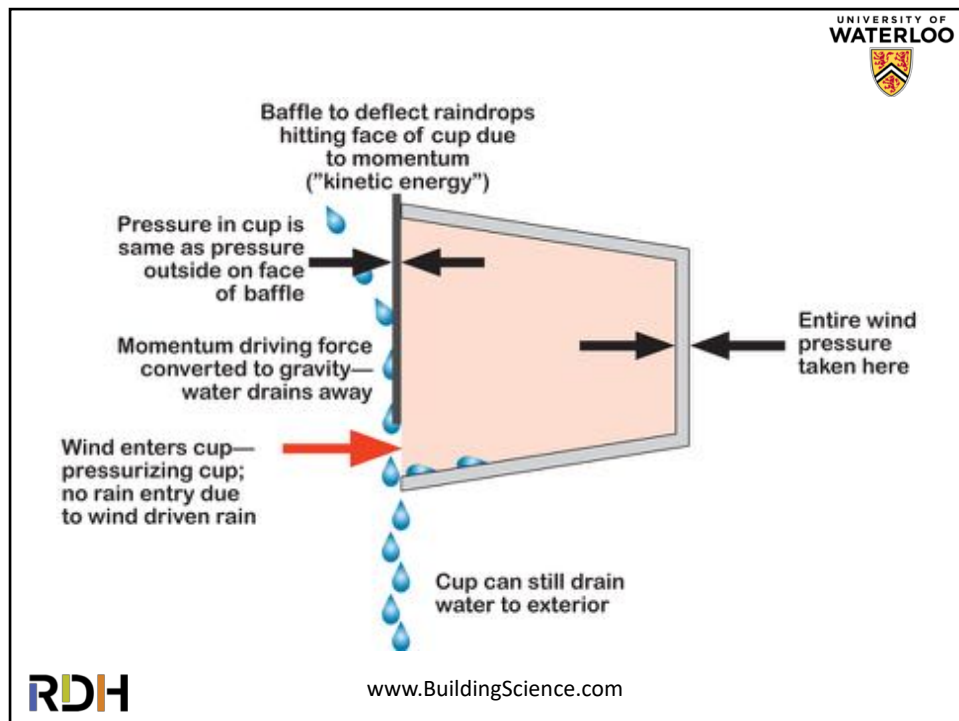
Air Barriers and Rain Penetration

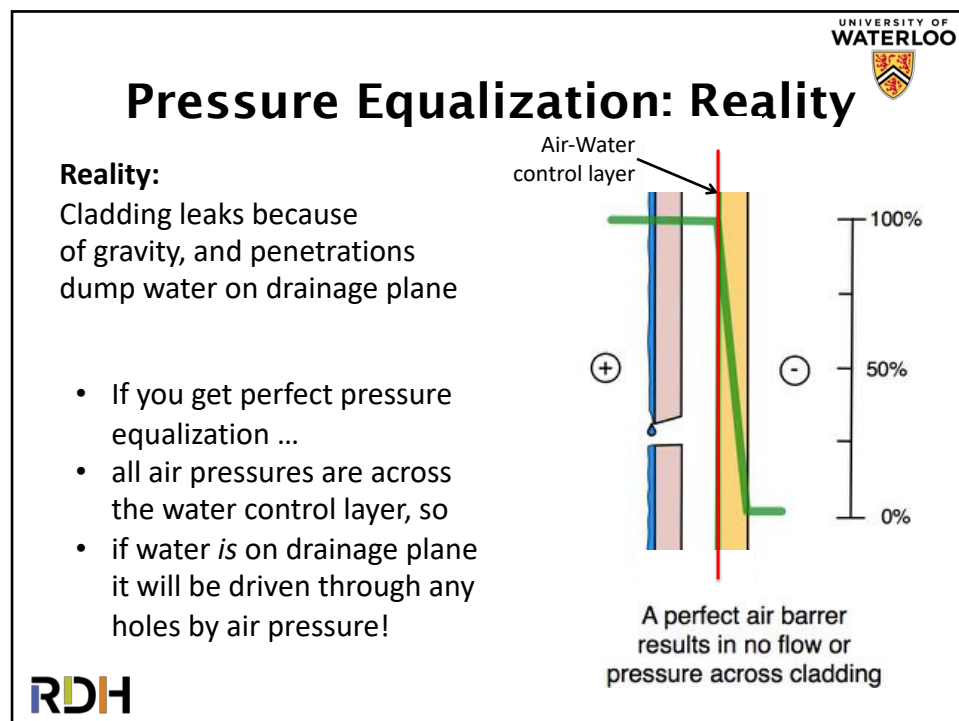
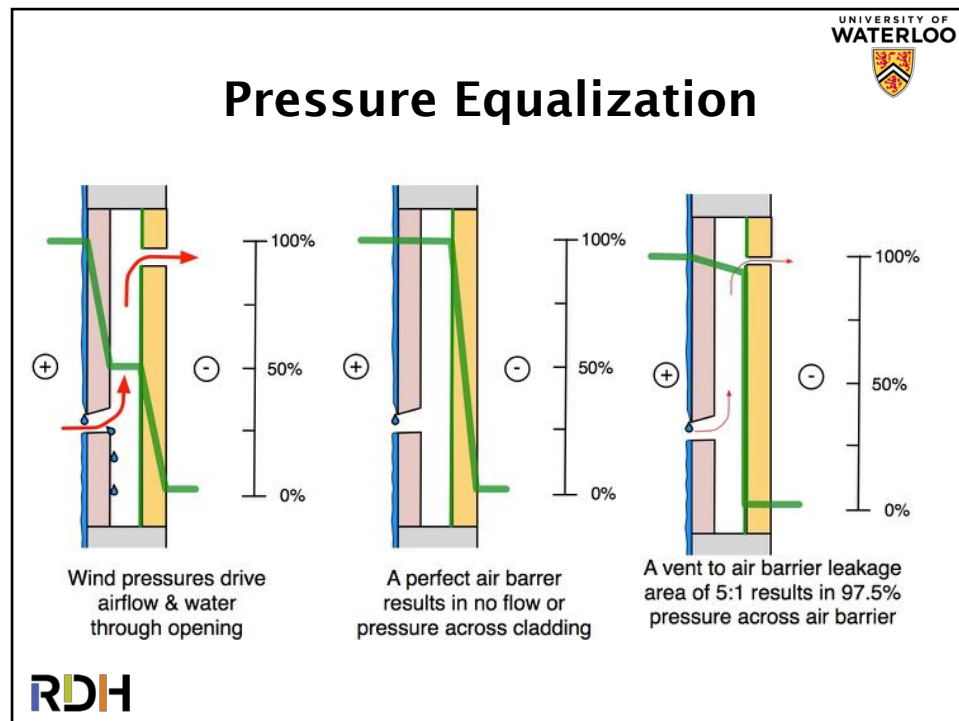


Water penetration & air barriers

- Air leakage through air barrier may increase rain leakage
- Is the air and water barrier at the same location?









Conclusions

- Stop air leakage through enclosure!

But . . .

Also consider

- vapor permeance
- Location, location
- Climate
- occupancy



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Discussion + Questions

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