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Spray Foam 2010
Moisture and Condensation

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Overview

- Moisture and Damage
- Moisture Balance
 - Wetting, Drying Storage
- Porous materials
- Moisture Storage
- Moisture transport

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Moisture and Buildings

- Moisture is involved in almost all building envelope performance problems
 - In-service Durability
- Examples:
 - rot,
 - corrosion,
 - mould (IAQ)
 - termites, (!),
 - staining
 - etc.

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Moisture Damage

- Damage caused by
 - Very high humidity for a long time
 - Wet (100%RH) for a shorter time
- Time required depends
 - on material
 - Temperature
 - Higher temperature accelerates process

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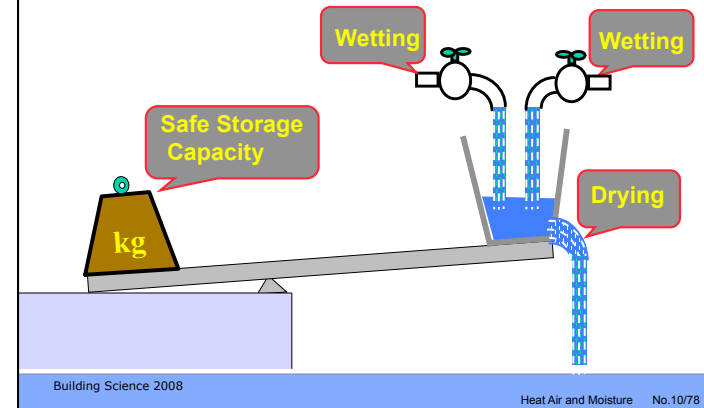
Moisture Control

- Moisture-related Problems
 1. **Moisture** must be available
 2. There must be a route or **path**
 3. There must be a **force** to cause movement
 4. The material must be **susceptible** to damage
- Theory:
 - eliminate any one for complete control
- Practice:
 - control as many as possible

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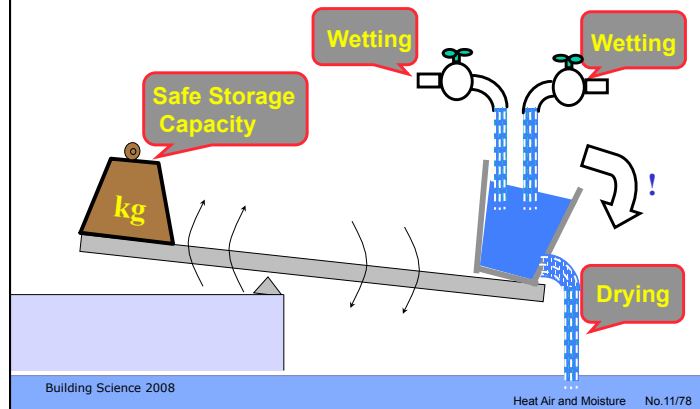
Moisture Balance



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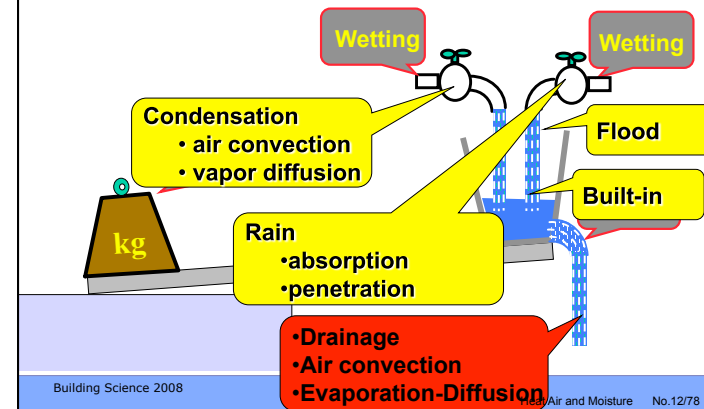
Moisture Balance: Accumulation



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Moisture Balance



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Wall + Roof Wetting Sources/ Mechanisms

- 1. Rain**
 - absorption
 - penetration
 - splash and drips
- 2. Water Vapor Movement**
 - Diffusion
 - Convection (air leaks)
- 3. Built in**
- 4. Ground**
 - Capillary (wicking)
 - Gravity
 - Diffusion

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Wall + Roof Drying Sinks and Mechanisms

- 1. Surface Evaporation**
 - Wicking to surface
- 2. Vapor Movement**
 - i) Diffusion
 - ii) Convection
- 3. Drainage**
- 4. Intentional Convection = Ventilation Drying**

Note above and below grade

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Ventilation Drying

- Ventilation provides drying to the exterior
- Can be important for:
 - 1. vapor impermeable cladding**
 - metal panels
 - most roofing
 - 2. systems which retain rainwater**
 - Improves survivability of small rain leaks and condensation

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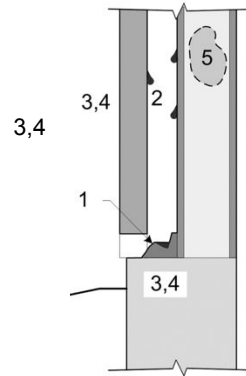
Storage

- Bridges gap in time between wetting and drying
- How much moisture for how long before damage
- Safe storage: safe against what?
 - mold, rot, freeze-thaw, corrosion
- Basic mechanisms
 - Absorbed into materials= capillary pores (*bound liquid*)
 - Adsorbed to materials = sorption (*vapor*)
 - pools and puddles (*free liquid*)

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Moisture Storage in Assemblies

1. Trapped / undrained
2. Surface tension
 - Liquid or solid
3. Adsorbed
4. Absorbed
5. Vapor
 - small



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Design Choices

- Either **avoid wetting**
- Or, **provide enough drying** to accommodate wetting
- Depending on the **storage provided**

The balance has shifted over time

- **Amount** of storage has changed over last 100 yrs
 - e.g. steel stud, vs wood stud vs concrete block
 - 1: 10 : 100+
- Wetting is usually less
- Drying is often much less

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Design Solutions

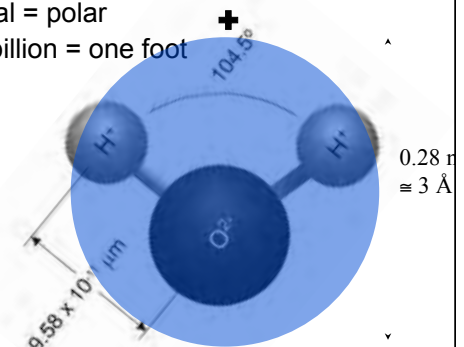
- Balance wetting, drying, and storage
- Practical Rules
 - Provide a **continuous** plane of **rain** control including each enclosure detail
 - Provide **continuous air barriers** and **insulation** to control condensation problems
 - Allow **drying** of built-in and accidental moisture – beware drying retarders

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The Water Molecule

- Asymmetrical = polar
- Small: one billion = one foot

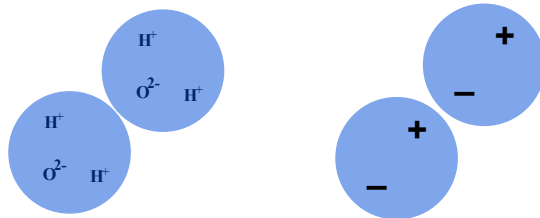


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The Polar Molecule

- Hydrogen end is “more” positive
- Oxygen end is “more” negative



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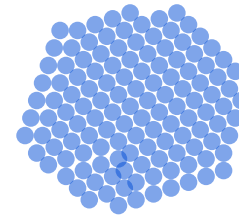
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Water: Liquid vs Vapor

- Vapor is a single molecule
- Liquid is molecular clumps, 60 or more
- Tyvek vs asphalt



Vapor

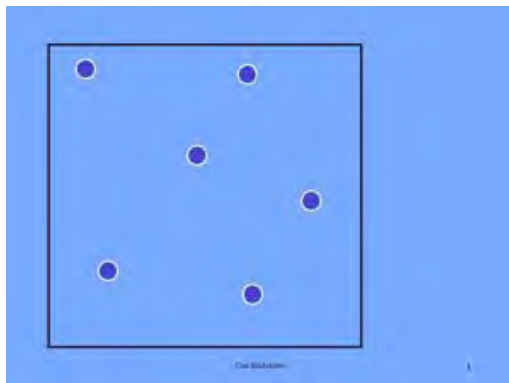


Liquid

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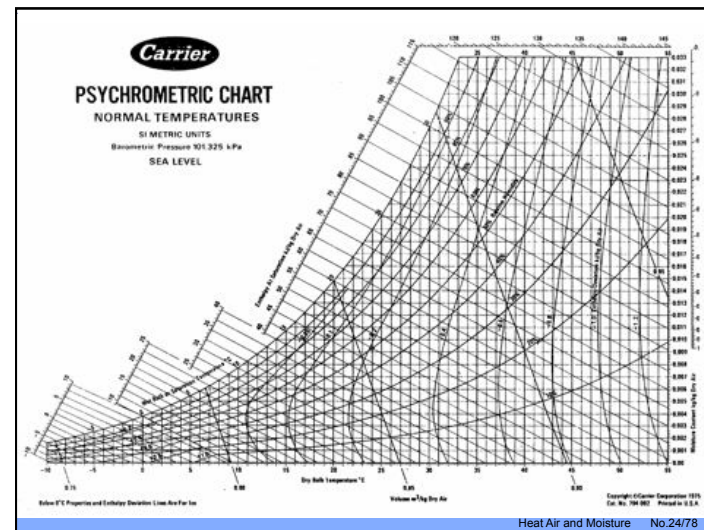
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Moisture as a Gas (water vapor)

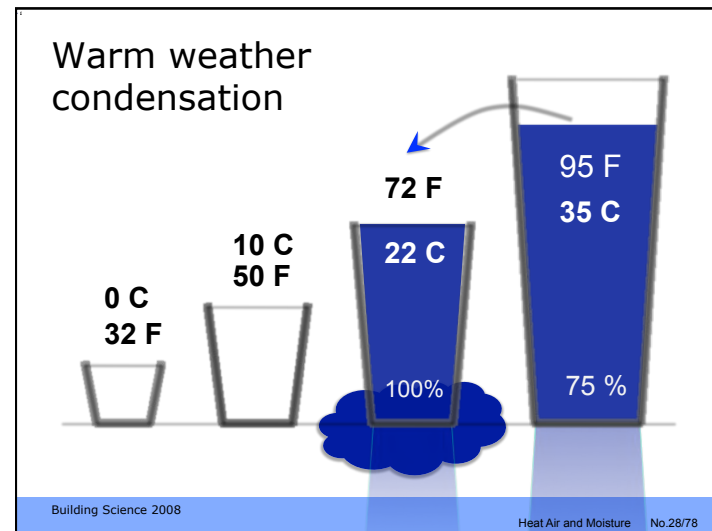
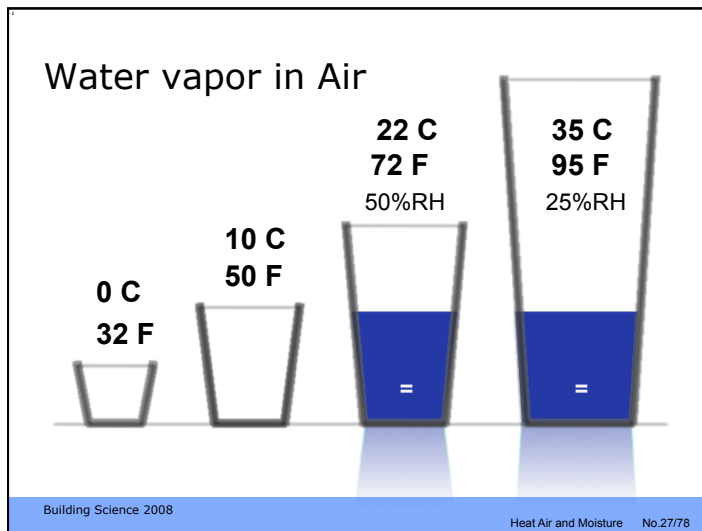
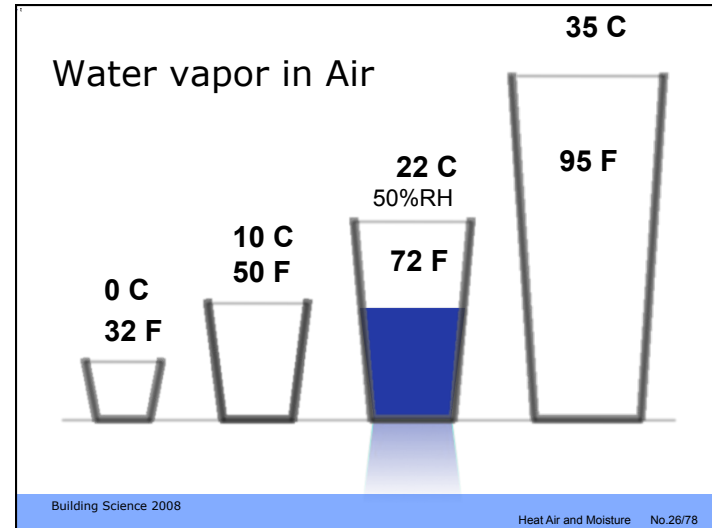
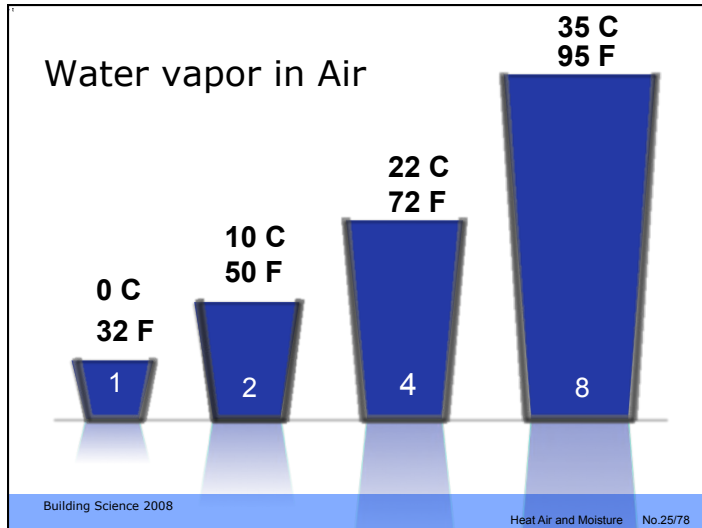


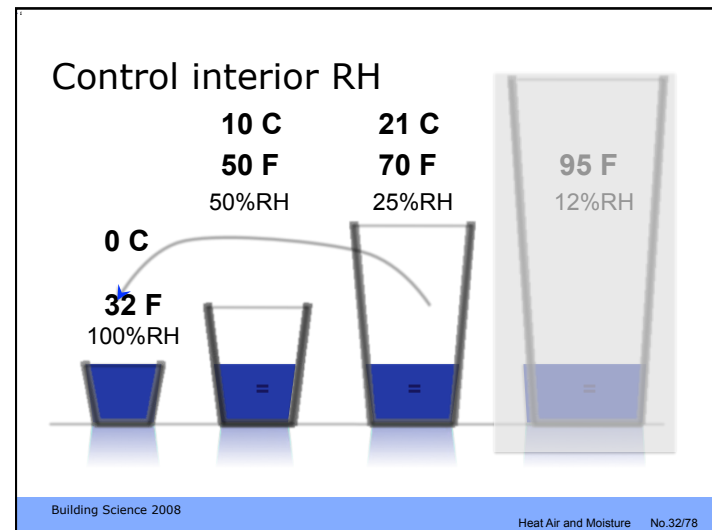
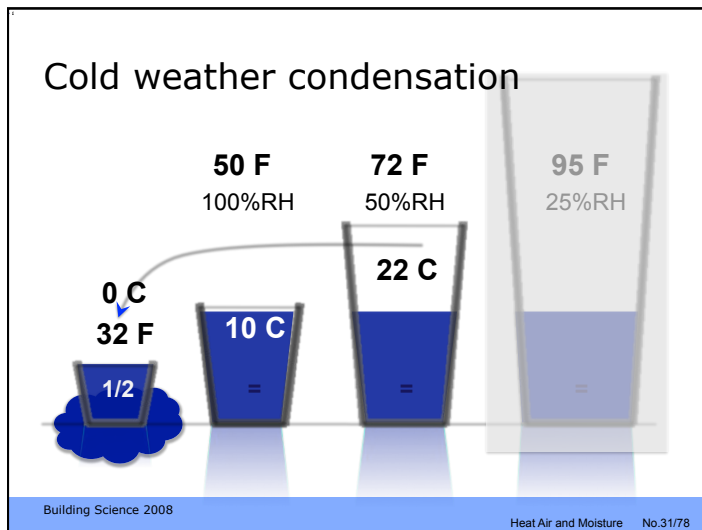
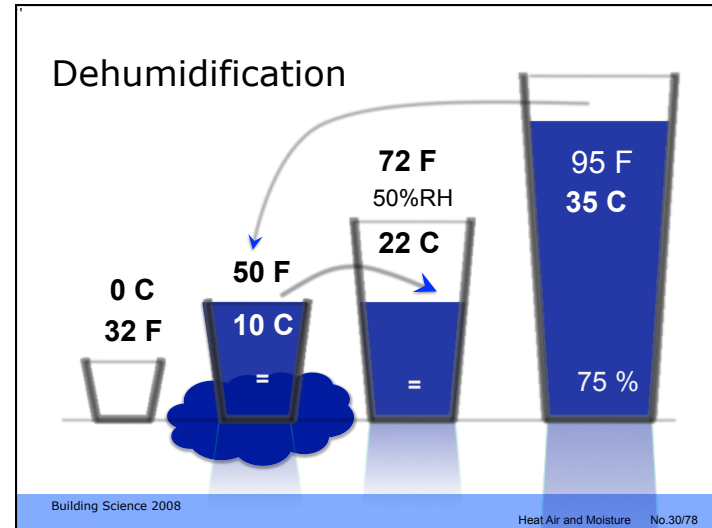
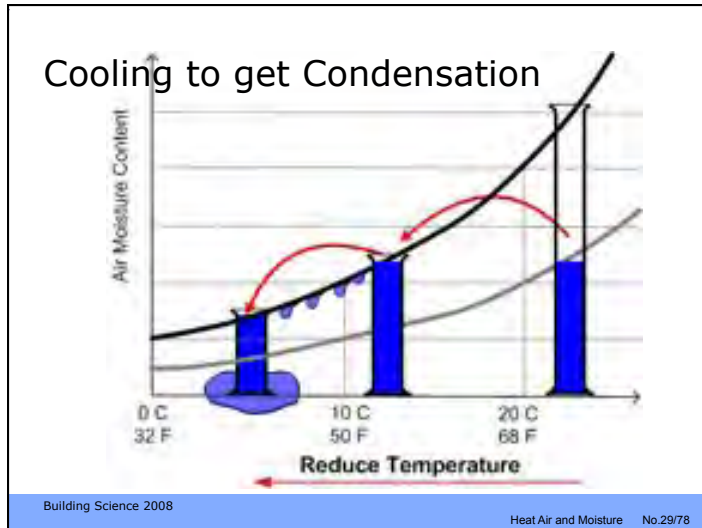
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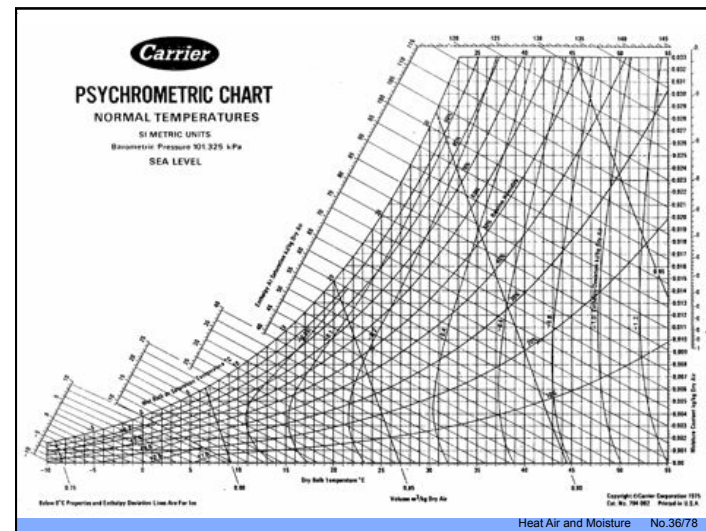
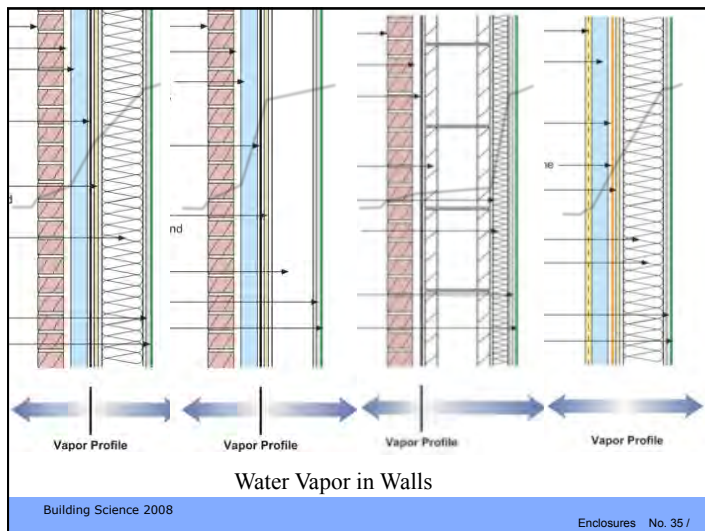
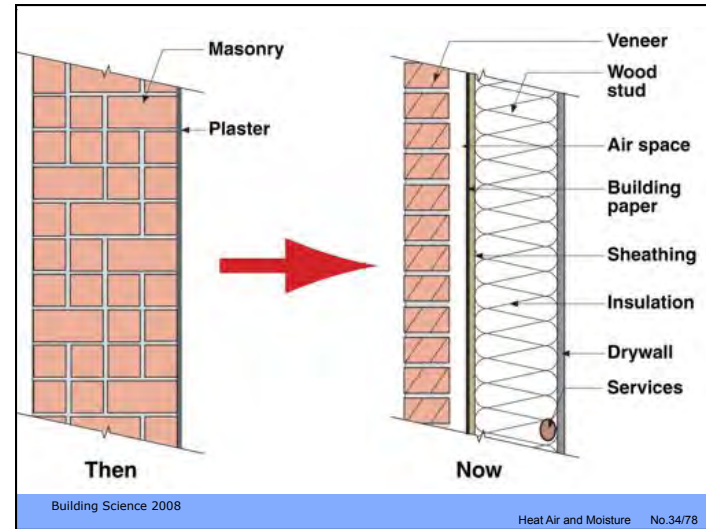
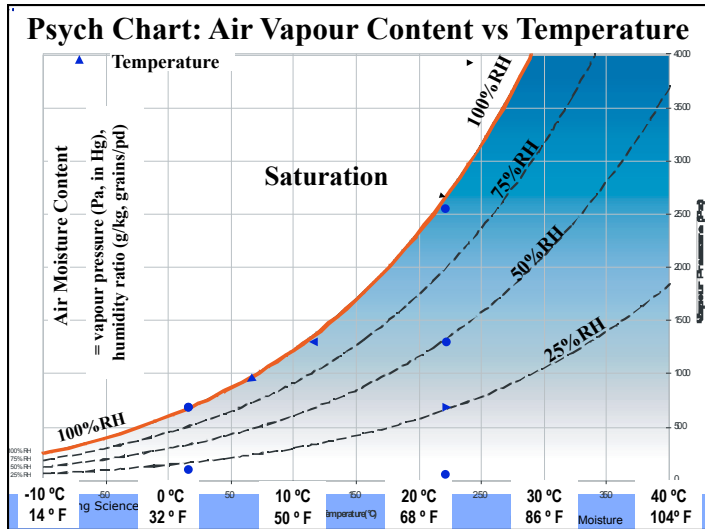
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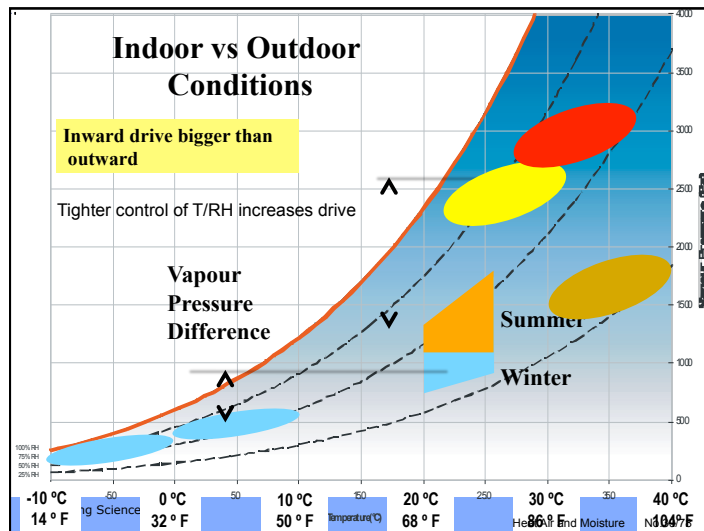
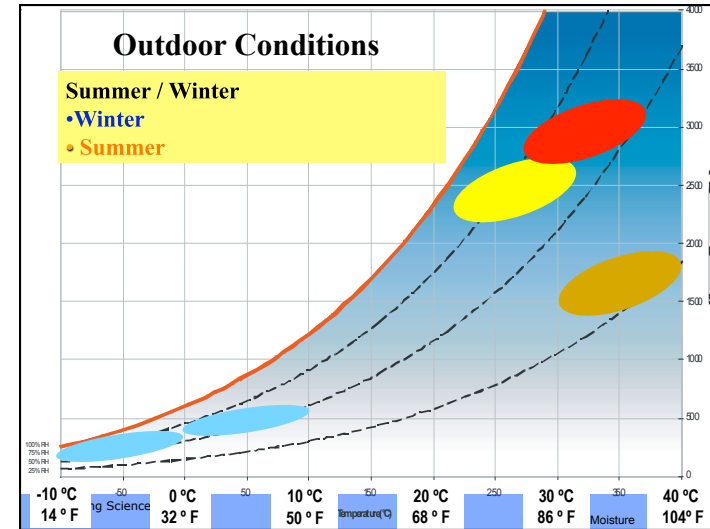
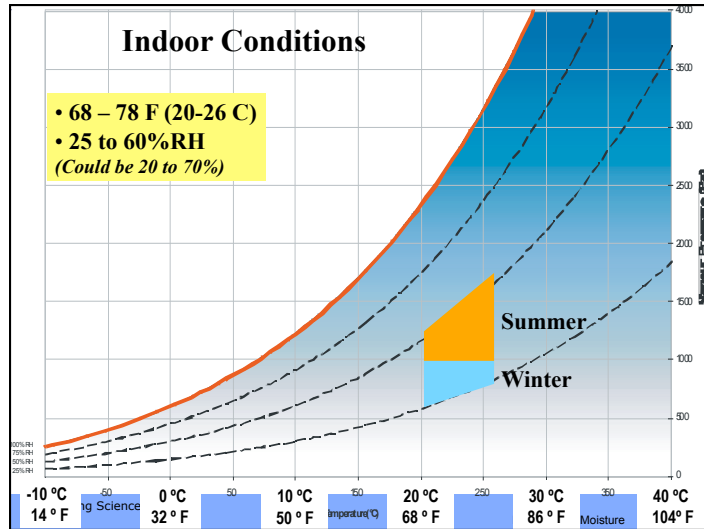


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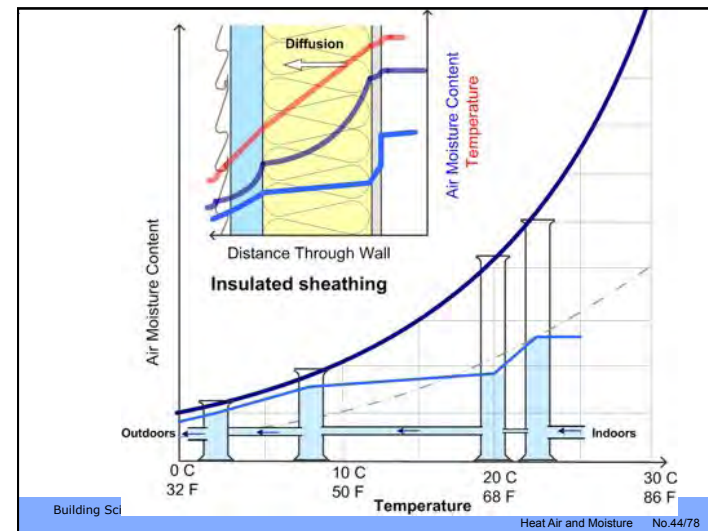
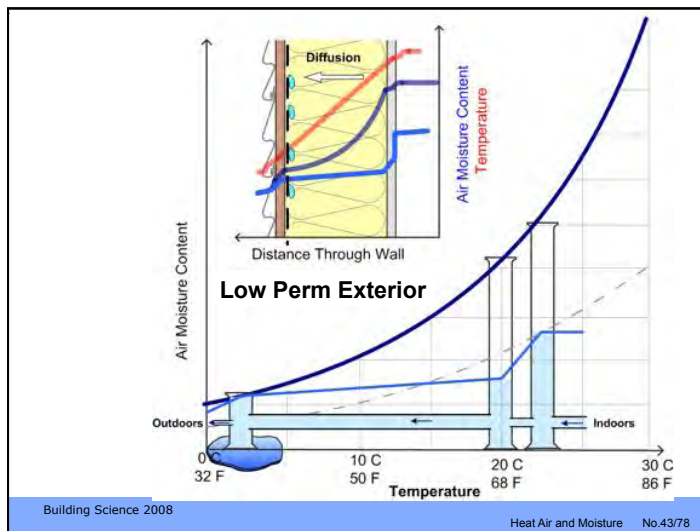
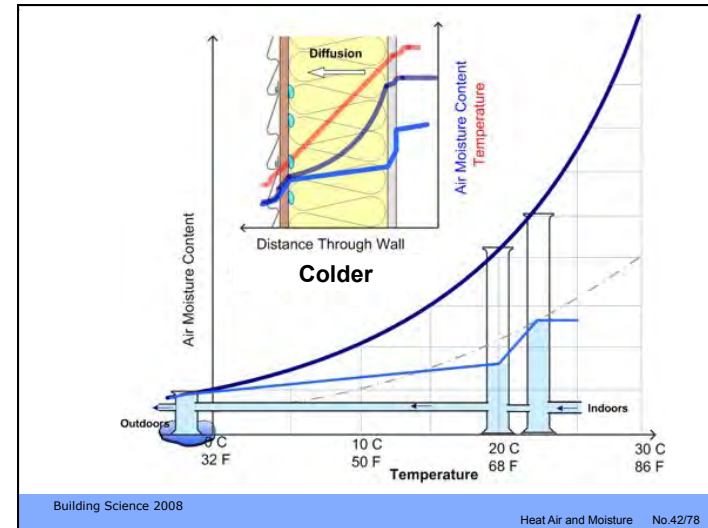
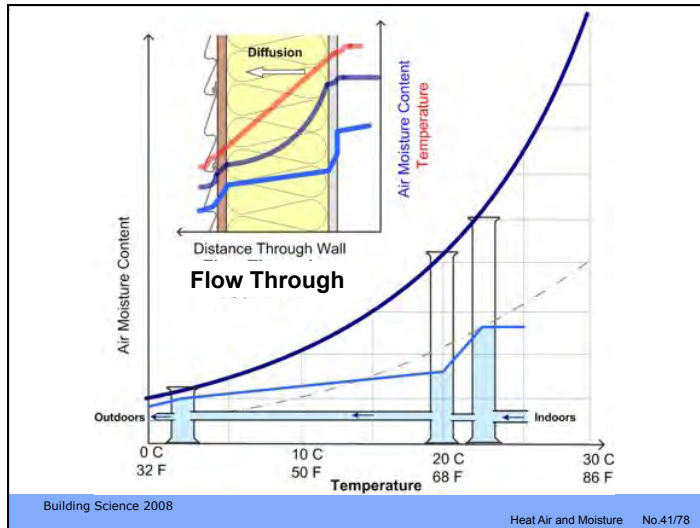


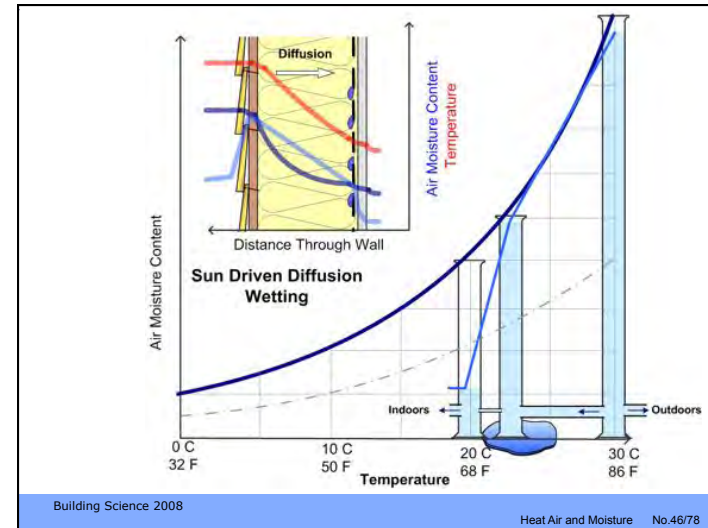
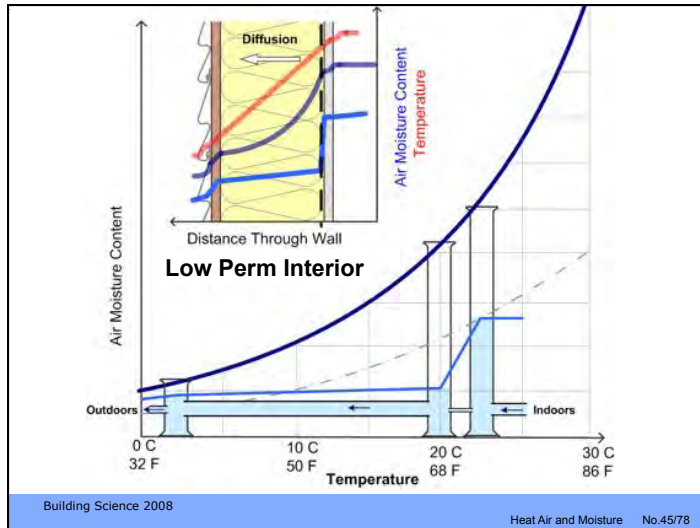




Water Vapour Transport

- Vapour Diffusion (like heat conduction)
 - more to less vapor
 - No air flow
 - Flow through tiny pores
- Air Convection (like heat convection)
 - more to less air pressure
 - flow through visible cracks and holes
 - vapour is just along for the ride



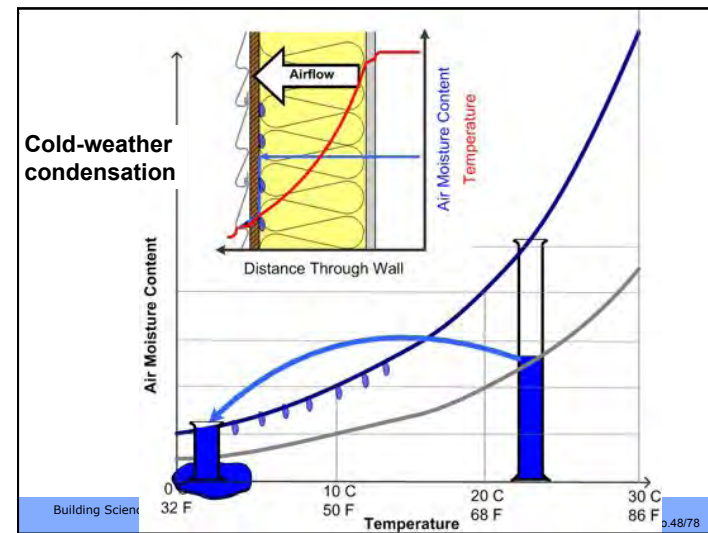


Air leakage

- Much more vapor can be carried on back of air flow than diffusion
- Condensation only happens if air flows towards cold surface

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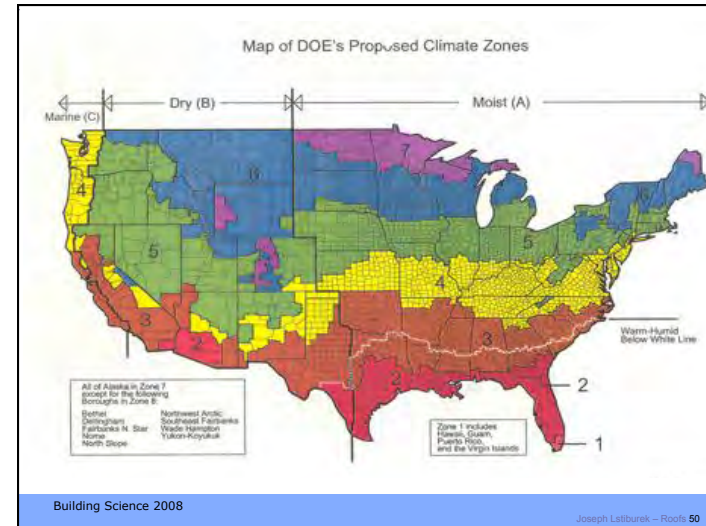
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Additional Information

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Joseph Labibarek - Roofs 50

IRC 2009 Supplement

TABLE N1102.5.1
CLASS III VAPOR RETARDERS

Zone	Class III vapor retarders permitted for:
Marine 4	Vented cladding over OSB Vented cladding over plywood Vented cladding over fiberboard Vented cladding over gypsum Insulated sheathing with R-value ≥ 2.5 over 2x4 wall Insulated sheathing with R-value ≥ 3.75 over 2x6 wall
5	Vented cladding over OSB Vented cladding over plywood Vented cladding over fiberboard Vented cladding over gypsum Insulated sheathing with R-value ≥ 5 over 2x4 wall Insulated sheathing with R-value ≥ 7.5 over 2x6 wall
6	Vented cladding over fiberboard Vented cladding over gypsum Insulated sheathing with R-value ≥ 7.5 over 2x4 wall Insulated sheathing with R-value ≥ 11.25 over 2x6 wall
7 and 8	Insulated sheathing with R-value ≥ 10 over 2x4 wall Insulated sheathing with R-value ≥ 15 over 2x6 wall

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