Vapor Drive and How it Affects Mold Growth in Buildings

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What is Vapor Drive?

• Diffusion – governed by 2\textsuperscript{nd} law of thermodynamics

• Entropy – energy becomes diffused (unless constricted)

• Concentration gradient & thermal gradient
  – Vapor moves from more to less
  – Vapor moves from warmer to colder
What is Vapor Drive?

- When a solid object (i.e.: a wall) is in between the gradients, the force of the vapor molecules to pass through is the “vapor drive”.

- The greater the vapor concentration or temperature differential, the stronger the “drive”.
What is Air Transport?

• An air current is the second mechanism that moves water vapor.

• In this presentation it is assumed that wall penetrations are sealed and wall construction is substantial enough to be considered an “air transport barrier”.
Building Assemblies

• Wall, floor and roof materials and assemblies vary in their resistance to vapor drive.

• This amount of resistance is called a “Perm Rating” (ASTM E-96)
Perm Categories

• Vapor impermeable = “vapor barrier”
  ▪ 1 Perm or less (i.e.: plastic sheets, vinyl wall covering and foils)

• Semi-permeable = “vapor retarders”
  ▪ 1 to 10 Perms (i.e.: installed; painted wallboard, asphalt paper faced insulation batts, OSB, plywood)

• Vapor permeable = “breathable material”
  ▪ 10 Perms or more (i.e.: Tyvek™ house wrap, unpainted gypsum board)
Climate Considerations

- **Cold Climates**
  - Vapor retarders (1-10 perms) used near interior (warm) surfaces with permeable (>10 perm) exterior sheathing

- **Hot Climates**
  - Vapor retarders used near exterior (warm) surfaces with permeable interior wall materials

- **Mixed Climates**
  - Many vapor retarding material and design combinations possible to prevent condensation and to allow drying
Vapor Drive Example

- Warm summer Rain
- Air conditioned Interior
- Wet Brick
- Interior Wall
Vapor Drive In Walls

Mixed Climate Location

Vapor drive blocked by plastic sheet (vapor barrier) under drywall: condensation formation occurs.
Mixed Climate - Case 1

- Newer building
- Brick over block construction
- Vapor barrier under drywall
- No vapor retarder between block & brick
- No air space between block & brick
Case 1 Wall Section

- BRICK MASONRY
- 4” CONCRETE HOLLOW MASONRY UNITS
- 1-1/2” WOOD FURRING STRIPS
- 1-1/2” FIBERGLASS BATT INSULATION
- 4 MIL. POLYETHYLENE VAPOR BARRIER
- 5/8” THICK GYPSUM WALLBOARD
Case 1 – Mold @ Base Only

Stachybotrys Chartarum and Chaetomium dominant
Case 1 – Water Staining

Water stains on sub-floor appear to originate in wall
Case 1 – Interior Wall

Vapor Drive Through Masonry And Condensation On VB

Corrosion on electrical outlet. Stain pattern on wood mirrored on plastic vapor barrier
Mixed Climate Case 2

- 1 – Story office bldg.
- Slab on grade
- Wall below windows = concrete block
- Soil sloped against wall
- Odor complaints
- No apparent water damage or mold
Case 2 Wall Section

- Window Unit
- Concrete Masonry Units
- 1-1/2” Metal Furring Strips
- Loose-Laid Rigid Foam Insulation
- 5/8” Thick Gypsum Wallboard
- Concrete Floor Slab

- Poorly Applied Brushed-On Waterproofing
- Soil
Case 2 - Interior

Mold found only on vinyl covered walls

Drywall

Vinyl Wall Covering
Case 2 - Interior

- No evidence of liquid water intrusion
- Rooms without vinyl wallpaper had no mold
Hot Climate Case 3

- Recently renovated older building
- Solid masonry walls >12” thick

Photo of a similar building
(not Case 3 building)
Case 3 - Wall Section

- 3-WYTHE BRICK MASONRY
- AIR SPACE
- 3-1/2” METAL STUDS
- UNFACED FIBERGLASS BATT INSULATION
- 5/8” THICK GYPSUM WALLBOARD
- VINYL WALL COVERING
Case 3 Wall Structure

Stripped wall reveals interior face of exterior masonry wall.
Case 3 Interior

- Crown Molding
- Chair Rail
- Base Cove
- Vinyl Wall Covering (did not extend under moldings)
Case 3 Wall

Abundant mold growth under wall covering.

Vinyl wall covering acting as vapor barrier.

Condensation formed under wall covering.
Case 3 Mold Condition

No mold under crown molding

Mold under vinyl wall covering
Case 3 Mold Conditions

Mold under vinyl wall covering

No mold under chair rail
Conclusions

- Vapor drive is too often not well understood by designers and builders.
- Designs that keep out the rain do not assure a dry interior structure.
- Correct selection of building materials and assemblies for a given climate are critical for mold prevention.
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