Condensation on Ductwork
Condensation on Ductwork
Ductwork in Vented Attics and Vented Crawlspaces
Vented and Unvented Attics
Vented and Unvented Crawlspace
There Is Nothing Wrong With A Vented Attic
There Is Nothing Wrong With A Vented Attic
But.....
Houses With Vented Attics Suck
Not all the Time.....but......
Leaky air handling unit and supply ducts

Supply

Return

Supply

Depressurized conditioned space inducing infiltration
Crawl Spaces
Conditioned Crawlspace Not Unvented Crawlspace
Need Supply Air
50 cfm/1000 ft2 of Crawlspace Area

Or
Dehumidification
Heat from enclosure

Interior
75 - 78°F Summer
68 - 72°F Winter

Ventilation air

Ground temperature
(always colder than enclosure interior)
RH = 70%  
MC = 13%  
75°F  

Fiberglass cavity insulation  

61 - 62°F  

Water droplets  

61 - 62°F  

Crawlspace air  
(65°F dewpoint)  

RH 100% at surface  
MC ≈ 25-28%  

Ground  

Floor assembly and ground are radiation coupled  

60°F
Interior vapor pressure lower than crawlspace vapor pressure (55°F dewpoint)

Impermeable flooring

Vapor closed floor sheathing

Inward moisture drive

Increasing moisture content

Vapor open insulation

Fiberglass cavity insulation

Uniform vapor pressure throughout crawlspace including within crawlspace insulation (65°F dewpoint)
Back to Ducts....
Not Easy To Put Them Inside....
Shingles

Roofing paper

Minimum R-50 rigid insulation in two or more layers with horizontal and vertical joints staggered

Nail base for shingles (plywood or OSB) screwed through rigid insulation to wood decking or timber rafters

Air barrier membrane

Wood decking

Timber rafter or exposed joist
Minimum R-50 rigid insulation in two or more layers with horizontal and vertical joints staggered.
Shingles

Roofing paper

R-19 batt insulation installed with wire stays or twine or netted cellulose

R-5 rigid insulation (vertical and horizontal joints offset from roof sheathing)

3/8" sheathing over rigid insulation

Roof sheathing

Sealant

Rigid insulation notched around roof trusses and sealed

Underside of roof sheathing is typically the “first” condensing surface

Vinyl or aluminum siding

Unfaced batt insulation

Gypsum board with vapor semi-permeable (latex) paint

Building paper drainage plane
Roofing tile

Roofing paper

Netted cellulose insulation or batt insulation installed with wire stays or twine

Roof sheathing

Underside of roof sheathing is typically the “first” condensing surface

Stucco

Unfaced batt insulation

Rigid insulation

Gypsum board with vapor semi-permeable (latex) paint

Building paper drainage plane
1” HD spray foam

2x6 top chord

OSB/plywood sheathing

Drainage plane

Spray fiberglass; 8” nominal

Gypsum board

2x6 frame wall

4’/2” cellulose or spray fiberglass

1” HD spray foam
Roof cladding

Roof underlayment

3" HD spray foam
(R-19.5)

6 1/4" spray fiberglass
(R-21)
Low density spray foam insulation

Asphalt shingles

Roofing paper

Roof sheathing

Raised heel truss

Rigid foam, or comparable, as backdam

Soffit

Roof underlayment sealed to drip edge

Gypsum board with latex paint (acts as thermal barrier separating occupiable space from non-occupiable space)
Conditioned Attics Not Unvented Attics
Conditioned Attics Not Unvented Attics Need Supply Air
Conditioned Attics Not Unvented Attics
Need Supply Air
50 cfm/1000 ft2 of Attic
Conditioned Attics Not Unvented Attics
Need Supply Air
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Or
Dehumidification
Low-Density Open-Cell Foam Is The Problem
Shingles

Roofing paper

Wood based roof sheathing

Open cell low density spray foam

Each “Ping” and “Pong” bounces the water molecules up the slope
Regimes of moisture storage in a hygroscopic porous material
From Straube & Burnett, 2005

A: Single-layer of adsorbed molecules
B: Multiple layers of adsorbed molecules
C: Interconnected layers (internal capillary condensation)
D: Free water in pores, capillary suction
E: Supersaturated Regime
Step 1
- Remove strip of OSB from each side of ridge

Step 2
- Create air seal with strip of vapor open membrane (tape seams)
- Vapor open membrane sheet sealed to OSB with acrylic caulk sealant
- Hold vapor open membrane sheet in place with metal strapping

Step 3
- Construct wood ridge vent with 2x2 furring
An Oops….That Became A Gift....
Failures Lead To Success
Hygric Buoyancy
Ratios

1:150
1:300
1:600
Conditioned Attics Not Unvented Attics
Need Supply Air
50 cfm/1000 ft2 of Attic

Or
Dehumidification
Burying Ducts
Vancouver Mold
Outside

Radiation to night sky

Roof sheathing

Condensation and frost accumulating on underside of roof sheathing

Roof sheathing and top of attic insulation are radiation-coupled

Attic

Condensation and frost accumulating on top of attic insulation

Inside

Attic insulation
Where It Started…..
Leaky air handling unit and supply ducts

Air handling unit

Supply
Return
Supply

Depressurized conditioned space
inducing infiltration

Note: Colored shading depicts the building’s thermal barrier and pressure boundary. The thermal barrier and pressure boundary enclose the conditioned space.
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