Building Science

Venting Air or Venting Vapor or Not Venting at All?

Joseph Lstiburek, Ph.D., P.Eng, ASHRAE Fellow

presented by www.buildingscience.com
40% to 50% of vented area

50% to 60% of vented area
Leaky air handling unit and supply ducts

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.
Note: Colored shading depicts the building’s thermal barrier and pressure boundary. The thermal barrier and pressure boundary enclose the conditioned space.
Infiltration/Exfiltration
Controlled Ventilation

Interior sources

Interior sources
Melt water running under thin ice slab

Thin ice slab under snow

Melt water running down underside of sheathing

Ice

Ice dam

Icicles
Equation [4]

\[ k_{\text{eff}} = 0.138 - 1.010 \rho + 3.233 \rho^2 \]

\[ R^2 = 0.79 \]
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.
Outside

Inside

70°F

Dewpoint
(50% RH, 70°F)

Location of condensation and frost

Exterior sheathing

0°F
Simple linearized energy-temperature relation for water
From Straube & Burnett, 2005
The inside face of the exterior sheathing is the condensing surface of interest.

Wood-based siding
Building paper
Exterior sheathing
R-19 cavity insulation in wood frame wall
Gypsum board with any paint or wall covering

Temperature (°F)

Month

Dew point temp. at 50% R.H., 70°F
Mean monthly outdoor temperature
Dew point temp. at 35% R.H., 70°F
Dew point temp. at 20% R.H., 70°F
Potential for condensation
The inside face of the insulating sheathing is the condensing surface of interest.

- Wood-based siding
- R-7.5 rigid insulation
- R-13 cavity insulation in wood frame wall
- Gypsum board with any paint or wall covering

Graph:
- Insulation/sheathing interface temperature (R-7.5 sheathing, R-13 cavity insulation as shown in adjacent drawing)
- Mean monthly outdoor temperature
- Potential for condensation
- Dew point temp. at 35% R.H., 70°F

Month:
- APR
- MAY
- JUN
- JUL
- AUG
- SEP
- OCT
- NOV
- DEC
- JAN
- FEB
- MAR
- APR
- MAY
Figure 8-7. Outside vapour pressure, saturated vapour pressure and inside vapour pressure for Winnipeg.
Outside

Condensation and frost accumulating on underside of roof sheathing

Attic

Attic insulation

Inside

Dewpoint
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)
\( \frac{3}{8} \)" sheathing over rigid insulation
Roof sheathing
Sealant
Rigid insulation notched around roof trusses and sealed
Vinyl or aluminum siding
Unfaced batt insulation
Gypsum board with vapor semi-permeable (latex) paint
Building paper
Underside of roof sheathing is typically the "first" condensing surface
Drainage plane
The inside face of the roof sheathing forming the cavity is the first condensing surface.

OSB or plywood nail base for shingles

R-30 unfaced batt ceiling insulation compressed to fit within 2x8 rafters or damp spray cellulose or “netted” dry blown cellulose or fiberglass

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

Sealant

Rigid insulation notched around roof rafters and sealed

Vinyl or aluminum siding

Rigid insulation (taped, shiplapped or sealed joints)

Unfaced batt insulation

OSB or plywood roof sheathing

Gypsum board ceiling with semi-vapor permeable (latex) paint

Caulking or sealant

Gypsum board with semi-vapor permeable (latex) paint
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
Vinyl or aluminum siding
Rigid insulation
Building paper drainage plane
Unfaced batt insulation
Gypsum board with vapor semi-permeable (latex) paint
Underside of roof sheathing is typically the “first” condensing surface
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
OSB sheathing
Scupper
Two layers OSB
Cavity insulation; see Material Compatibility and Substitutions
Polymer modified (PM) or traditional cement stucco
Metal lath

Gypsum board with semi-permeable (latex) paint
Sealant, adhesive or gasket at top plate
Caulking or sealant
2X6 24" o.c. advanced framing

Cavity insulation; see Material Compatibility and Substitutions
Sill gasket acts as capillary break
Gypsum board caulked, glued or gasketed to bottom plate; held up from slab
Concrete slab

For termite protection provide 3'-0" of mulch and then drought-resistant plants

Ground slopes away from wall at 5% (6 in. per 10 ft.)
Sub-slab stone layer (no fines); see Building Science Details
Concrete grade beam
Polyethylene vapor barrier extended under grade beam where it also acts as a capillary break
Perforated drain pipe added to "T" in order to couple sub-slab pressure field to vent stack

Soil gas ventilation stack
Sealant at all slab penetrations

Soil gas stack vented through flashed roof penetration
Roof flashing

1/4" cant lip
Metal cap

OSB sheathing
Scupper

Sealant
Rigid insulation
OSB
Cavity insulation
Sealant

Polymer modified (PM) or traditional cement stucco
Metal lath

Building paper bond break over drainage plane

18" wide membrane strip under parapet folded down over exterior rigid insulation
Coping wedge
OSB
Rubber roofing membrane
Rigid insulation

Air barrier membrane (membrane roofing in very cold and cold climates; housewraps, building paper in all other climates)

Gypsum board with semi-permeable (latex) paint
Sealant, adhesive or gasket at top plate

1/4" cant/ft

Cavity insulation
Metal cap
18" wide membrane strip under parapet folded down over exterior OSB
Coping wedge
OSB
Rubber roofing membrane
OSB sheathing
Scupper
Two layers OSB
High density spray foam insulation
Polymer modified (PM) or traditional cement stucco
Metal lath
Building paper bond break over drainage plane

Gypsum board with semi-permeable (latex) paint
Cavity insulation
Sealant, adhesive or gasket at top plate
Caulking or sealant
Cavity insulation
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

Non-occupiable space

Gypsum board with latex paint (acts as thermal barrier separating occupiable space from non-occupiable space)
Building Science Corporation
OSB/plywood sheathing

Drainage plane

9” to 12” cellulose or spray fiberglass
1” HD spray foam
Gypsum board
2x6 frame wall
4½” cellulose or spray fiberglass
1” HD spray foam
1” HD spray foam

2x6 top chord

OSB/plywood sheathing

Drainage plane

Spray fiberglass; 8” nominal

Gypsum board

2x6 frame wall

4 1/2” 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)
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
Shingles

Roofing paper

Wood based roof sheathing

Open cell low density spray foam

Each “Ping” and “Pong” bounces the water molecules up the slope
OSB sheathing

Dense glass gold at ridge

Asphalt shingles

OSB sheathing

2x2 Framing

OSB sheathing