Poly in walls: Evil or Necessity
Field Studies from a cold climate

Affordable Comfort
John Straube, Univ. of Waterloo
Kohta Ueno (now Building Science Consulting)
David De Rose /James Wilkinson, Halsall Associates Ltd.
Don Fugler, CMHC

CMHC SCHL
University of Waterloo
Halsall

Overview

1. Don will look at the poly vs no poly debate in above-grade walls and basement interior insulation assemblies
2. John will likely interrupt to clarify
3. **John will present on the CMHC-funded lab, field, and modelling work that is in progress**
4. Don will likely offer alternative conclusions
5. This is an advanced session, based on research in progress
6. Don't stay if you are looking for certainty

Presentation

- Will present information about poly in walls
- CMHC / Don Fugler sponsored some field measurements
- They do not necessarily agree

Research Program

Objectives:

- determine significance/insignificance of potential moisture problems due to plastic sheeting in above-grade and below-grade wall assemblies
- outline cases where performance can be improved and how
- delineate where plastic sheeting is necessary, potentially damaging, or where its use is unimportant

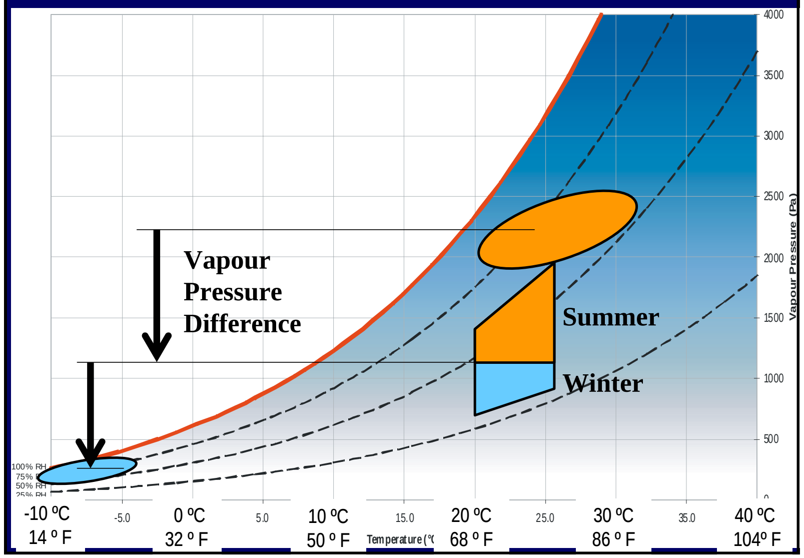
Why plastic sheet?

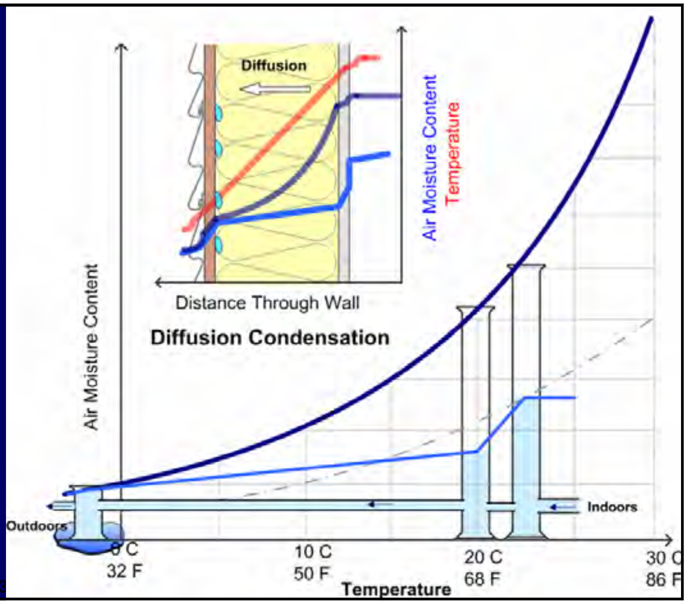
- Control cold weather diffusion condensation
- May Control air leakage
  - If detailed and supported
- To meet codes and code officials

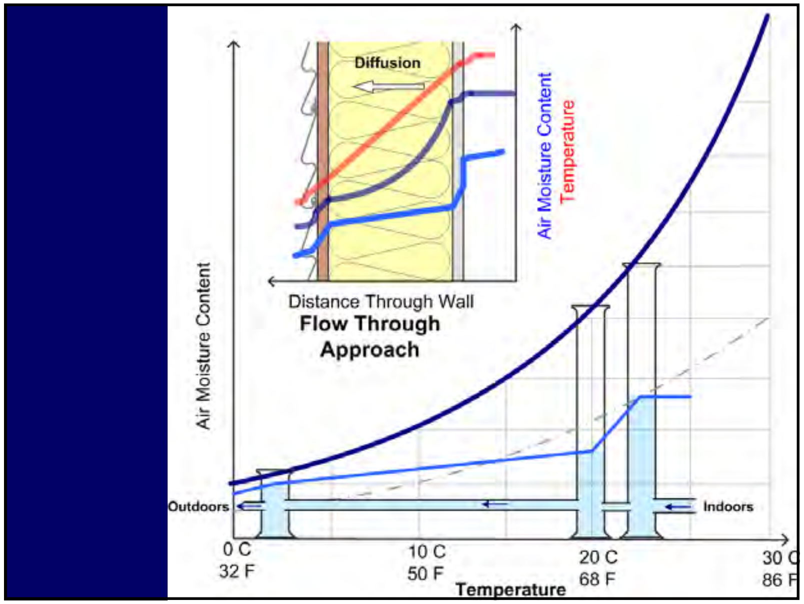
Winter diffusion condensation

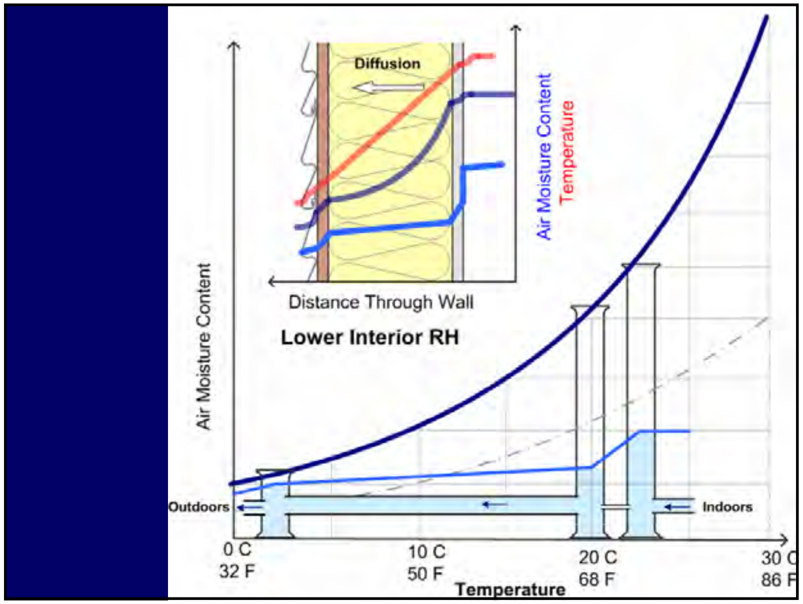
- Can solve condensation by:
  1. Allowing vapor to flow through
  2. Reduce interior RH
  3. Restrict vapor entry (paint, poly)
  4. Warm surface using exterior insulation
- Condensation by Diffusion is small!
  - Air leakage condensation is much worse

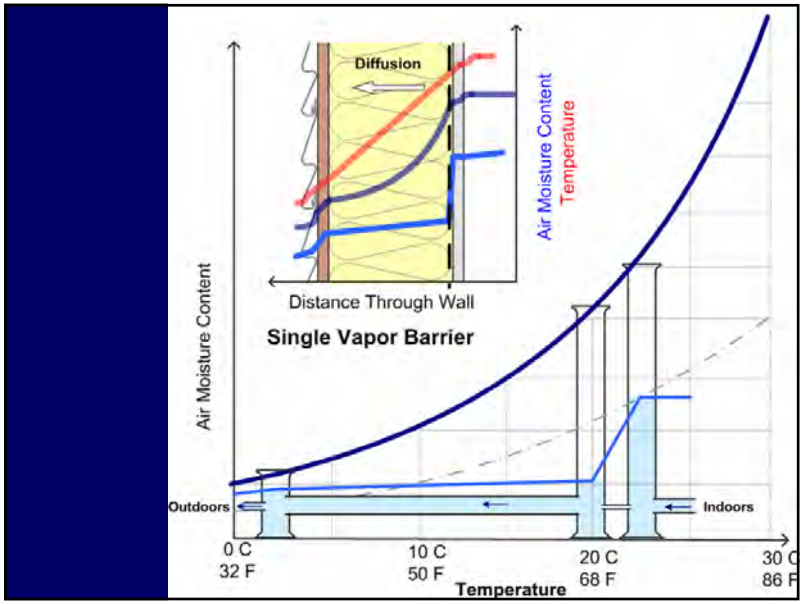
Indoor vs Outdoor Conditions

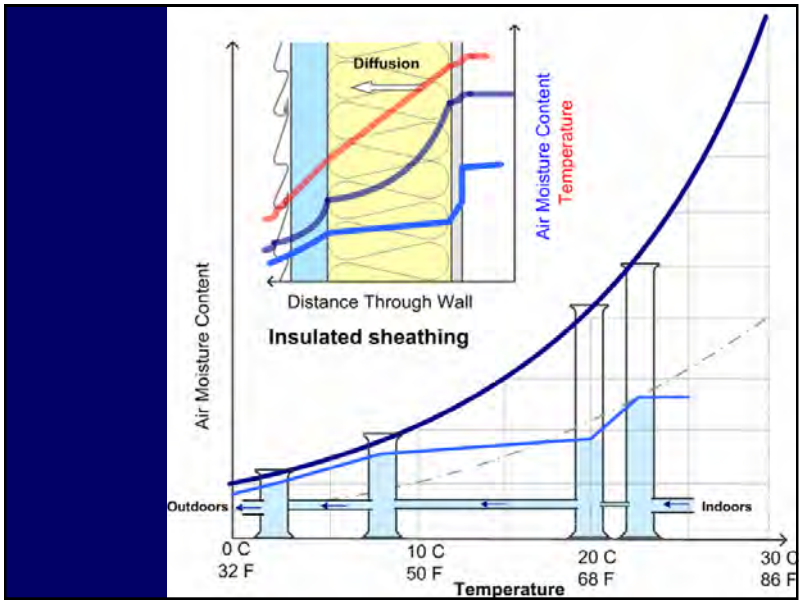





Diffusion
Air Moisture Content
Temperature
Distance Through Wall
Flow Through Approach
Air Moisture Content
Outdoors
Indoors
0 C
32 F
10 C
50 F
20 C
68 F
30 C
86 F
Temperature


Diffusion
Air Moisture Content
Temperature
Distance Through Wall
Lower Interior RH
Air Moisture Content
Outdoors
Indoors
0 C
32 F
10 C
50 F
20 C
68 F
30 C
86 F
Temperature


Diffusion
Air Moisture Content
Temperature
Distance Through Wall
Single Vapor Barrier
Air Moisture Content
Outdoors
Indoors
0 C
32 F
10 C
50 F
20 C
68 F
30 C
86 F
Temperature


Diffusion
Air Moisture Content
Temperature
Distance Through Wall
Insulated sheathing
Air Moisture Content
Outdoors
Indoors
0 C
32 F
10 C
50 F
20 C
68 F
30 C
86 F
Temperature

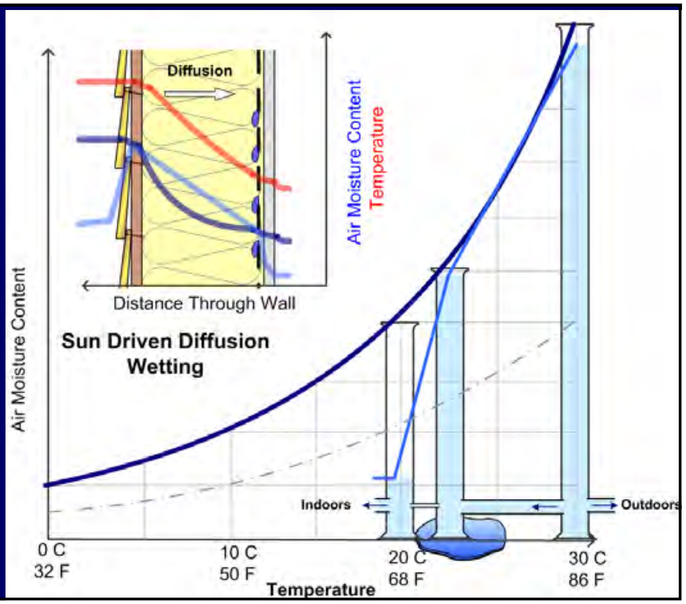
Why not plastic sheet?

- Avoid Summer Condensation
- Allow inward Drying
- Why if we don't need it?
- Can't glue drywall

Inward Drives

Factors that affect the significance of solar-driven inward diffusion:

1. orientation to wind-driven rain and solar heating
2. rain uptake and storage of the cladding
   - brick, shakes, stucco, wood even fiber cement siding
3. Back ventilation of the cladding
   - good ventilation helps control
4. vapour permeance of the sheathing layers
   - low permeance (<2-3 perms) throttles flow inward
5. vapour permeance of the interior layers
   - permeance close to the sheathing permeance
6. interior temperature
   - colder means condensation more often

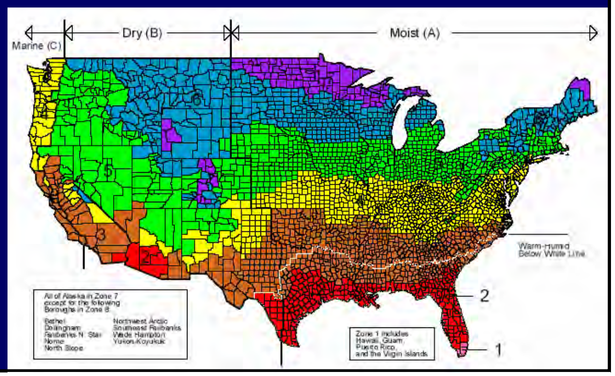


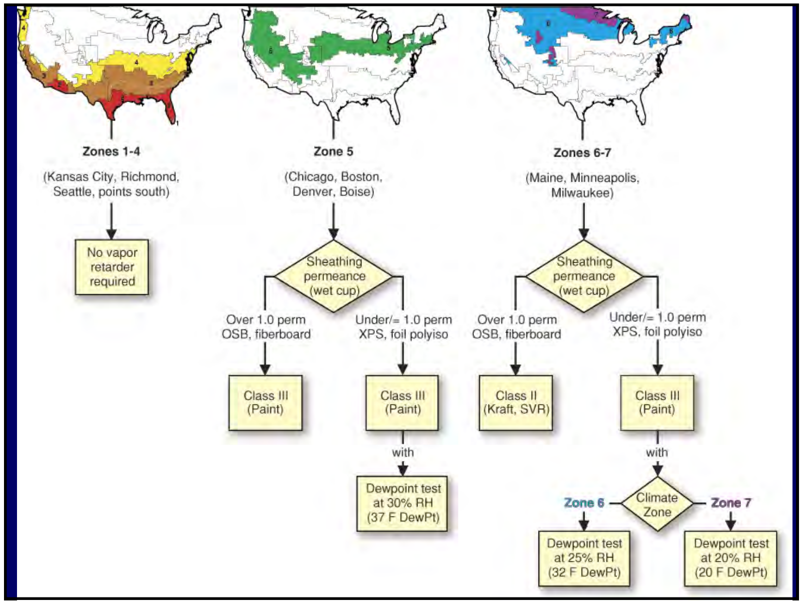
Codes: almost never require poly

- IRC
  - New section 402.5 defines retarders
  - Class I <0.1 perm
  - Class II 0.1 to 1.0 perm
  - Class III 1.0 to 10 perm
  - Permeable >10 perm
- NBCC
  - Part 5
    - Control diffusion condensation that could damage building or affect health and safety

Where are you?

- Vapor retarder / insulation depends on location





Research Framework

- A literature review (over 60 papers);
- Field testing: 6 common above-grade wall assemblies (w+ w/o poly) in the U. of W. test exposure facility (BEGHut);
- Field testing: 4 common below-grade wall assemblies (w+ w/o poly) in a southern Ontario home

Literature Review Above-Grade Walls

- No consensus on maximum vapour permeance allowable on the interior of Canadian walls to reduce cold weather diffusion problems;

- There is little doubt that a layer with the vapour permeance of polyethylene sheeting will control winter diffusion;

- Lawton & Brown (2003) suggest that plastic sheeting protects drywall from wetting/ mould under inward drives

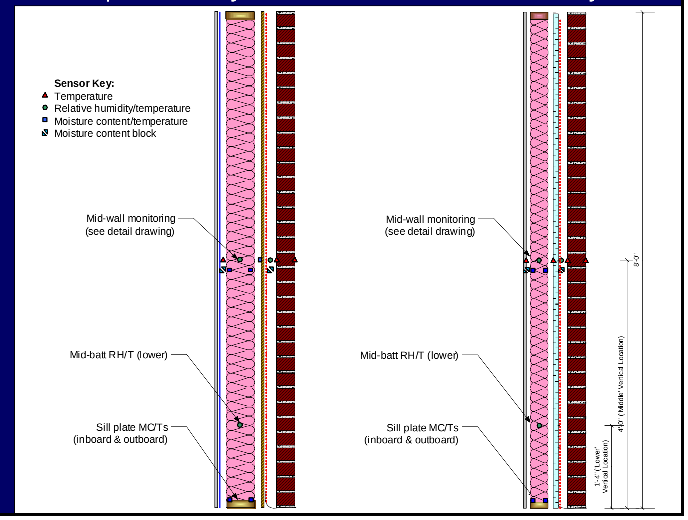
  when is this a problem?

- Omission of plastic sheeting increases vapour flow into wall assemblies at other times; typically during cold weather

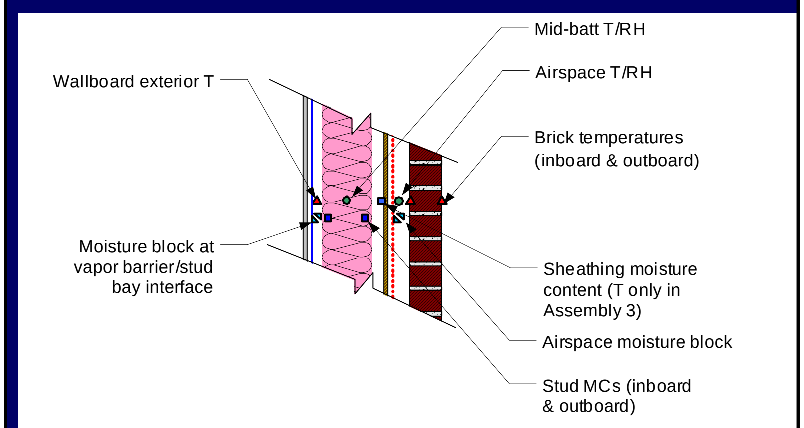
  when is this a problem?

BEGHut Field Testing: Above-Grade Walls

BEGHut Field Testing:Above-Grade Walls
3N / 3S - latex paint on drywall, brick w bottom vents only

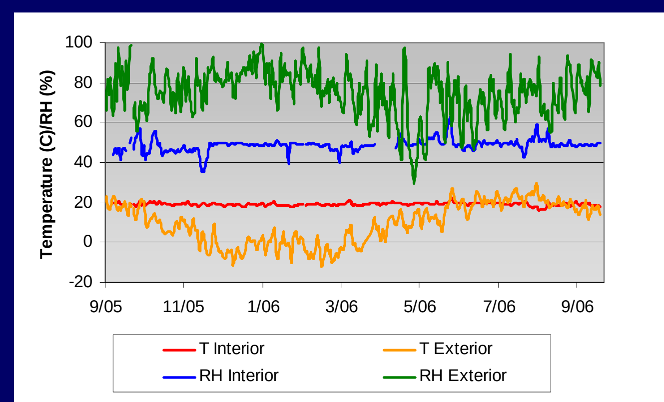


BEGHut Field Testing:Above-Grade Walls

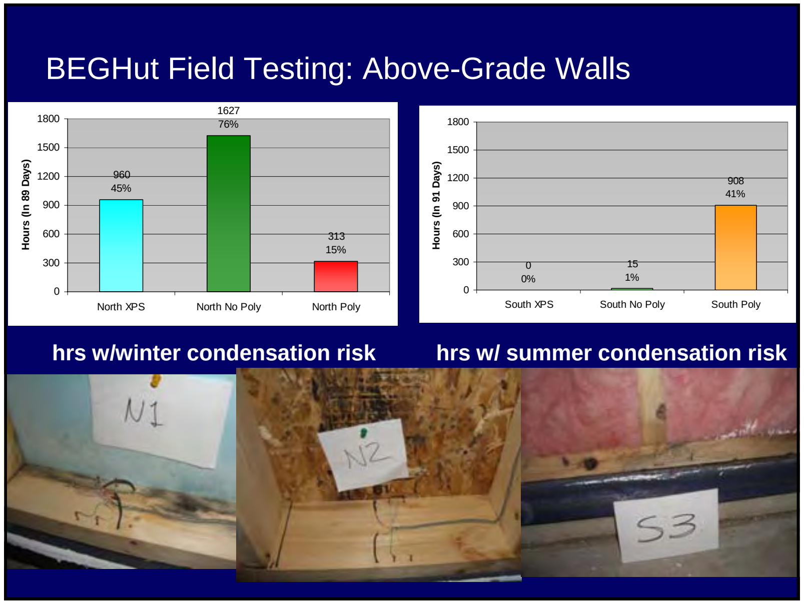


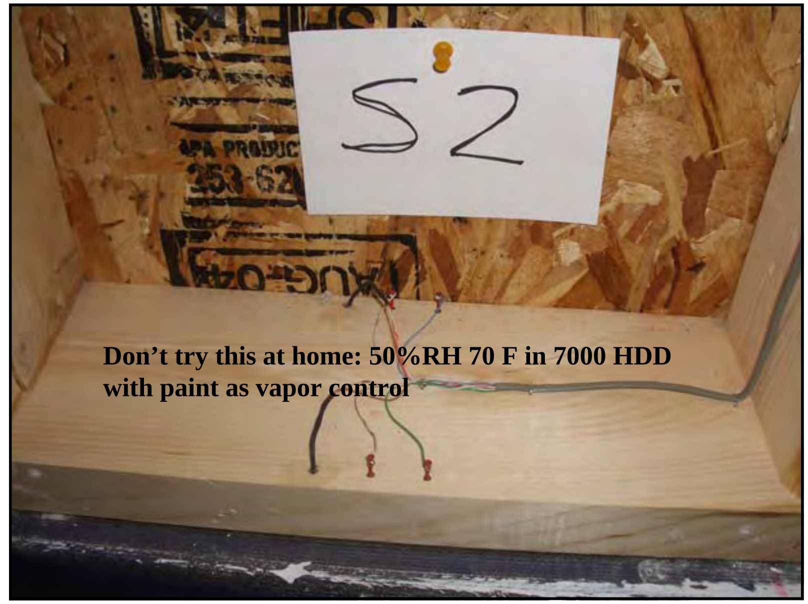
All Walls used airtight drywall to control airflow

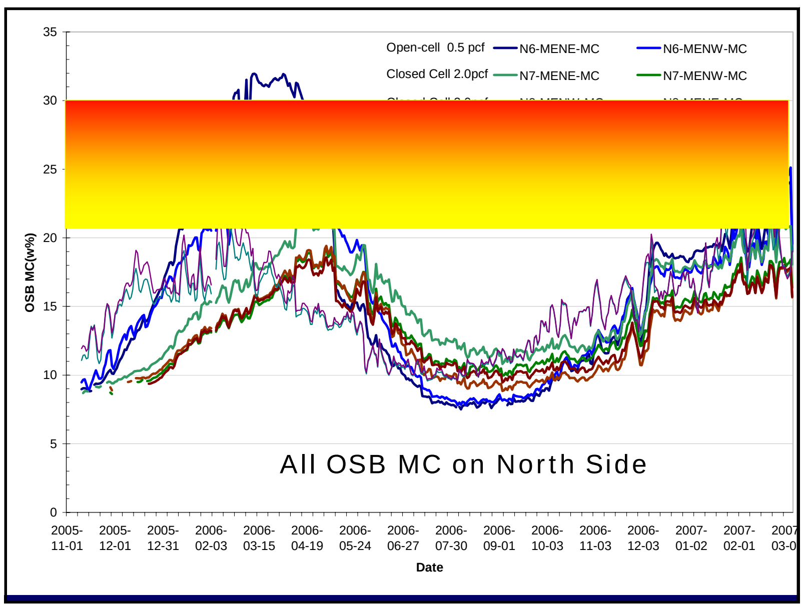
BEGHut Field Testing:Above-Grade Walls

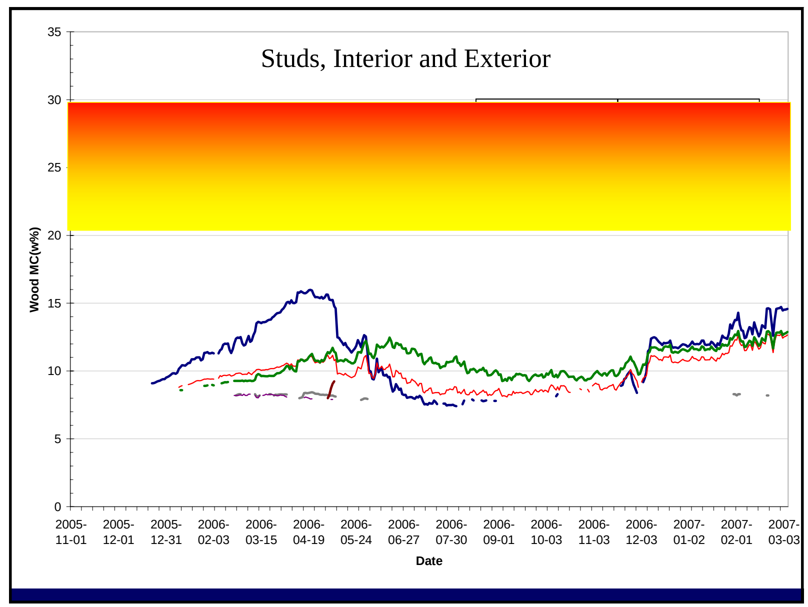


High interior moisture load: 50%RH. When do walls fail?
- Air conditioned to 70 F. more than normal?


BEGHut Field Testing: Above-Grade Walls
1800
1500
1200
900
600
300
0
Hours (in 89 Days)
960
45%
1627
76%
313
15%
North XPS
North No Poly
North Poly
Hours (in 91 Days)
0
0%
15
1%
908
41%
South XPS
South No Poly
South Poly
hrs w/winter condensation risk
hrs w/ summer condensation risk
N1
N2
S3

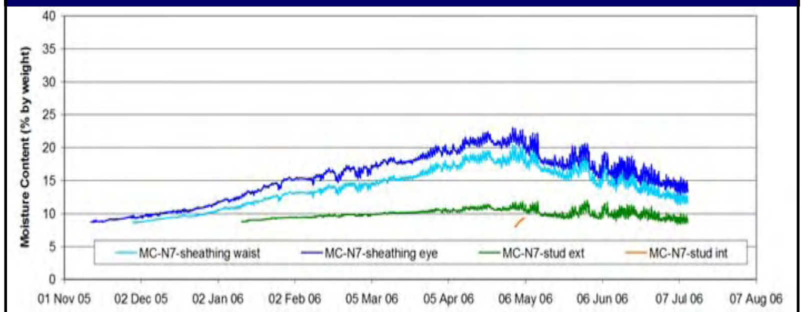

S2
Don't try this at home: 50%RH 70 F in 7000 HDD
with paint as vapor control


Open-cell 0.5 pcf
N6-MENE-MC
N6-MENW-MC
Closed Cell 2.0pcf
N7-MENE-MC
N7-MENW-MC
OSB MC(w%)
35
30
25
20
15
10
5
0
All OSB MC on North Side
2005-11-01
2005-12-01
2005-12-31
2006-02-03
2006-03-15
2006-04-19
2006-05-24
2006-06-27
2006-07-30
2006-09-01
2006-10-03
2006-11-03
2006-12-03
2007-01-02
2007-02-01
Date

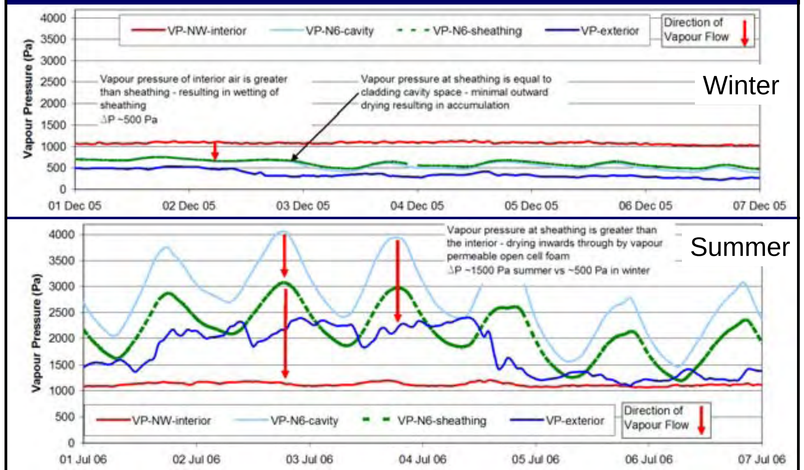

Studs, Interior and Exterior
Wood MC(w%)
35
30
25
20
15
10
5
0
2005-11-01
2005-12-01
2005-12-31
2006-02-03
2006-03-15
2006-04-19
2006-05-24
2006-06-27
2006-07-30
2006-09-01
2006-10-03
2006-11-03
2006-12-03
2007-01-02
2007-02-01
2007-03-03
Date

Closed Cell Foam

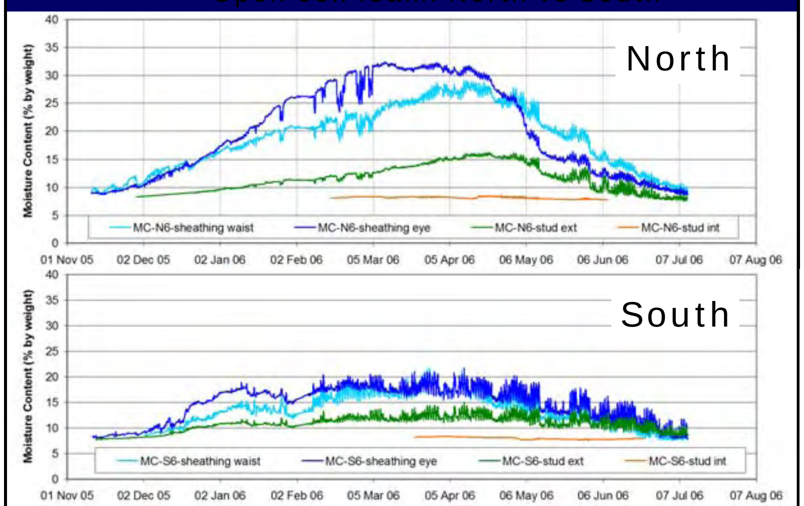
- Still safe with 50%RH inside and north face



Inward Drives Wet the Sheathing

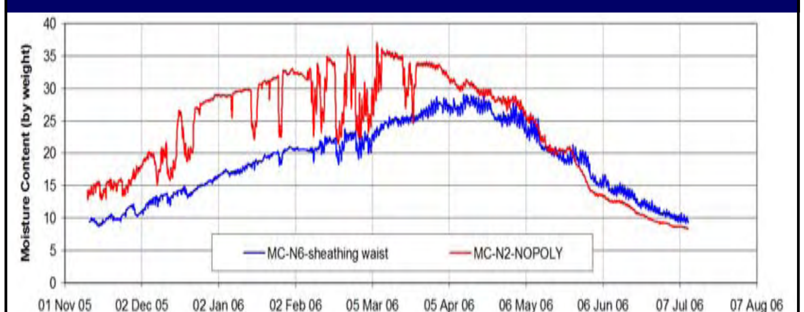


Open cell foam: North vs South



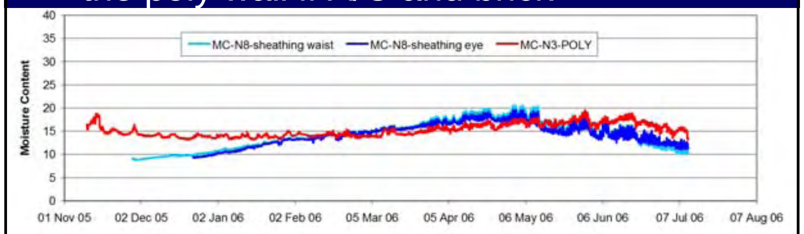
Comparisons to other Walls

- Open cell foam controls better than fibreglass w/ just latex paint



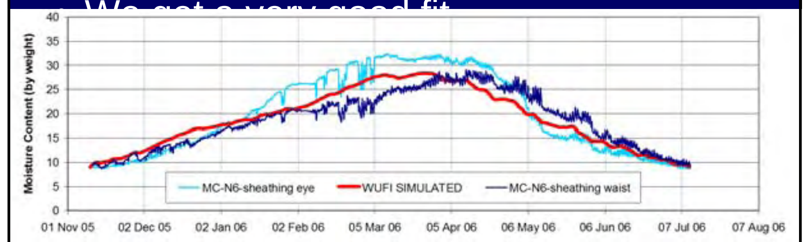
Closed-cell SPUF vs poly FG

- Sheathing MC about the same (assuming airtight!)
- BUT, summer condensation occurs in the poly wall if A/C and brick

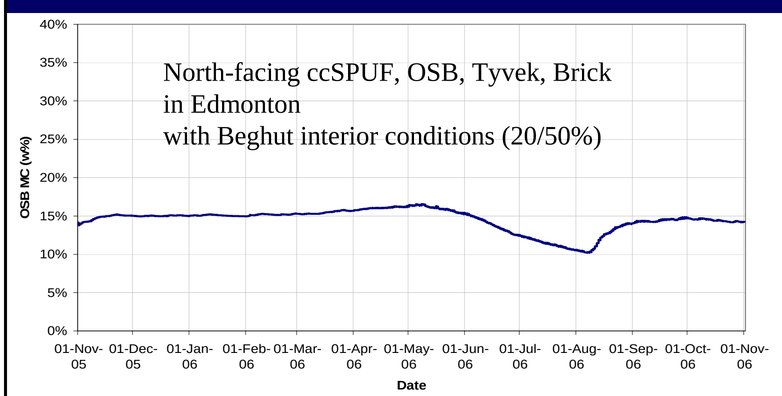


Simulations

- 1. Validate model
- 2. Then extrapolate to other conditions
  - Using WUFI 4.1

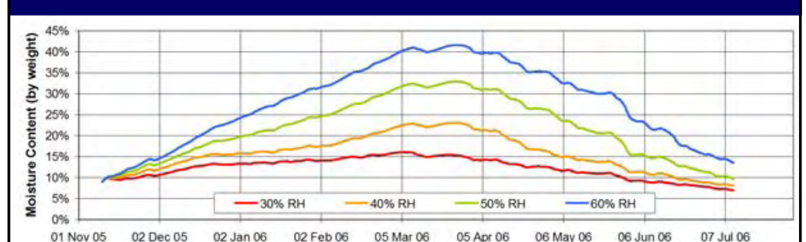


Closed Cell SPUF- Cold Climate



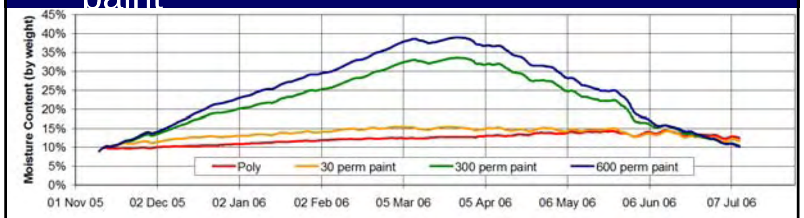
Open cell foam

- Exterior Conditions: Toronto, North side
- Interior Conditions: vary from 30-60%RH
- Open Cell- Interior Conditions Matter



Vapor Control Layers

- Open Cell Foam
- North-facing, Toronto 21 C/50%RH
- Poly, vapor-control paint, open latex paint



Summary: Closed Cell

- Closed-cell SPUF does not need low perm barrier in most cases
- Closed-cell SPUF controls vapor flow even in challenging conditions
  - If RH >>50% and HDD >>4000 consider
    - Add exterior foam, vapor permeable sheathing (DensGlas), vapor barrier paints
    - And/or check with WUFI

Summary: Open Cell

- ½ pcf SPUF may need vapor control in some cold climates / high humidity cases
  - Control humidity
  - Add exterior insulation (increase R-value)
  - Add interior insulation vapor resistance
  - Add vapor control paint / layer
- WUFI validated with field results
  - Can use this to help decide on need

Inward Drives:

Findings Field Testing: Above-Grade Walls

- poly v/b controls winter condensation at high int. rh (50%)
- poly significantly increased summer condensation risk (w absorptive/non-ventilated cladding, higher permeance sheathing, and low summer setpoint (70 F))
- XPS sheathing: greatest resistance to summer condensation from inward diffusion
- Paint and 50%RH is dangerous!!
  - Don't try this at home
  - 1,5" foam will work
- Paint and 40 RH
  - Works with 1" foam
- drywall was in good condition after 1 year of monitoring in walls without polyethylene sheeting

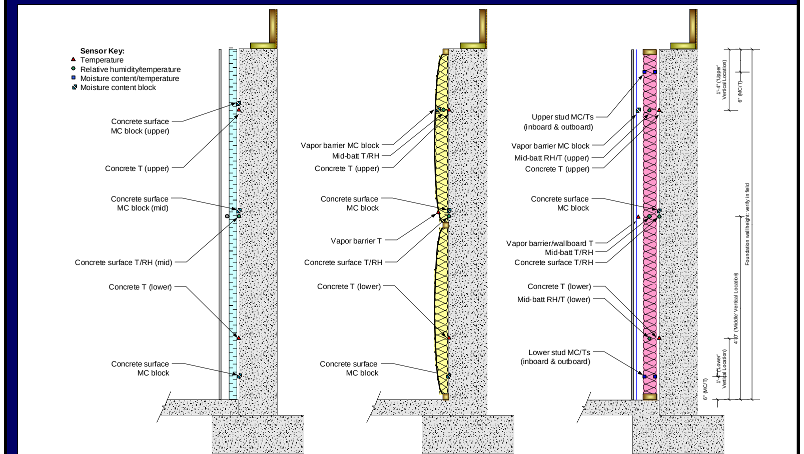
Resources

- This presentation will be at
  - **www.BuildingScienceSeminars.com**
- Much more free downloadable info at
  - **www.BuildingScience.com**

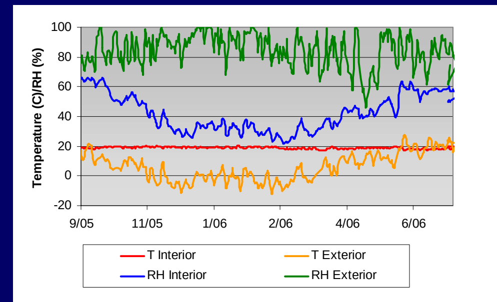
Field Testing (Kitchener Home): Below-Grade Walls

- extruded polystyrene/ roll blanket / fibreglass batt,framing,(no) poly
- all walls on south elevation

Field Testing: Below-Grade Walls

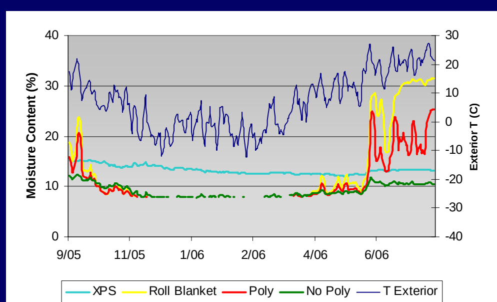


Field Testing: Below-Grade Walls



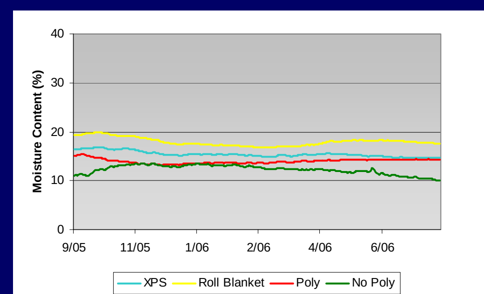
avg winter dewpoint: 1.9 ºC (> 60% of basements in a CMHC study)

Key Findings
Field Testing: Below-Grade Walls



- moisture content wafer response interior side, upper height
- moisture behaviour in roll blanket and poly walls is correlated strongly with the outdoor temperature

Key Findings
Field Testing: Below-Grade Walls



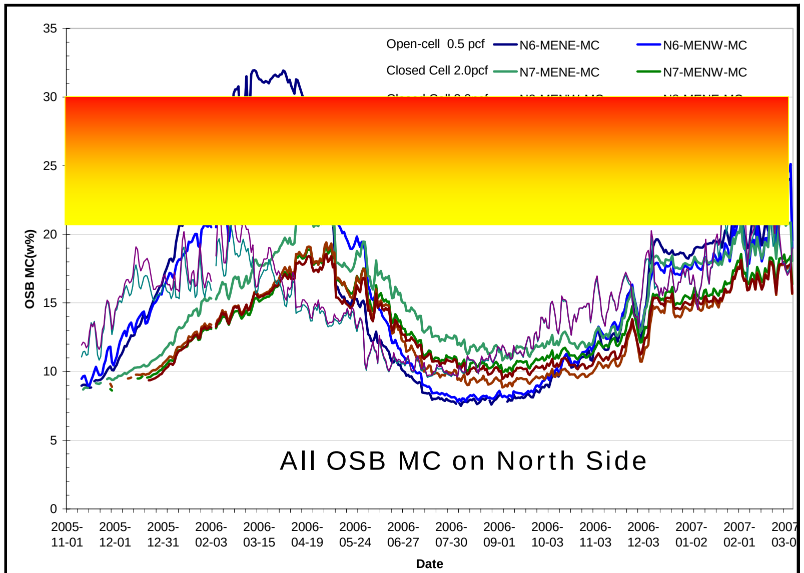
- m.c. at wafers, concrete-insulation interface, mid-height
- below-grade more static response than above-grade portion
- even framing in upper no poly wall – m.c. peaked 12-13%

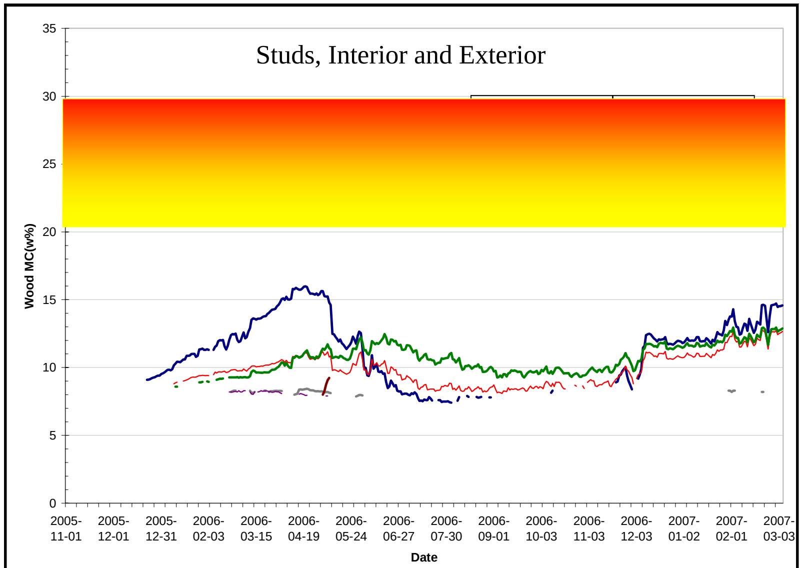
Key Findings
Field Testing: Below-Grade Walls

- minor staining at the inboard side of the poly wall
- moisture accumulation evidence (discolouration) was seen in the upper batt in the roll-blanket wall

Key Findings
Field Testing: Below-Grade Walls

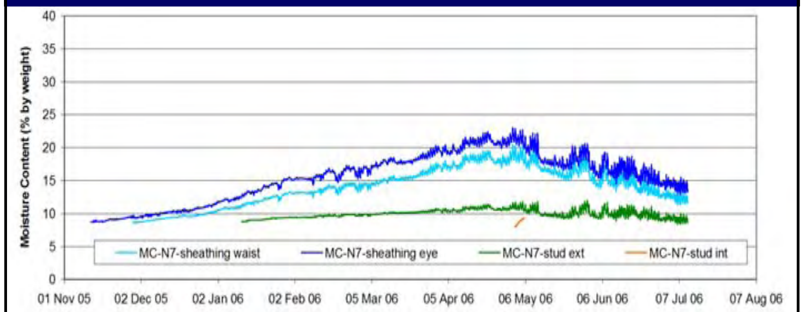
- summer inward vapour drives can cause significant moisture accumulation and condensation in impermeable wall assemblies, especially the "roll blanket" insulation
- both the no poly and XPS walls show more favourable moisture levels throughout the year
- no drywall damage was visible after 1 year of monitoring
- The interior rh was considered moderate for this climate
- Computer modeling: impacts of higher interior rh, vapour barrier paint (permeance between poly and latex), different exterior climate (Vancouver, St. John’s, Edmonton)



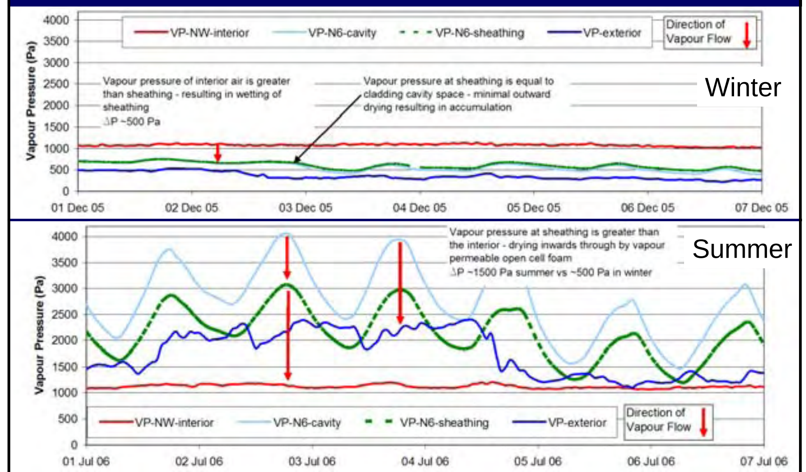


Closed Cell Foam

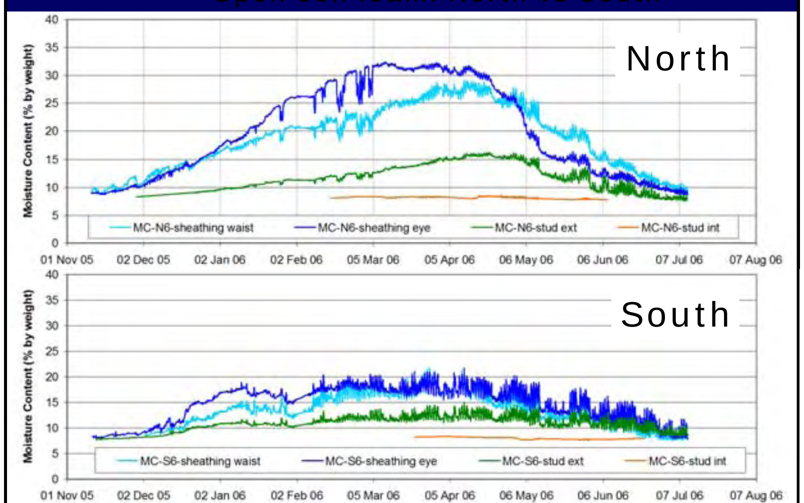
- Still safe with 50%RH inside and north face



Inward Drives Wet the Sheathing

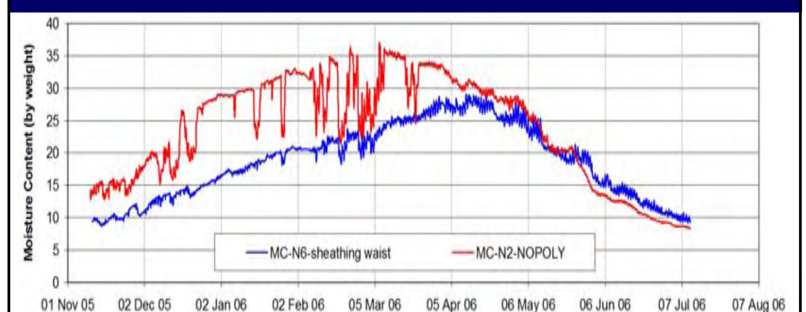


Open cell foam: North vs South



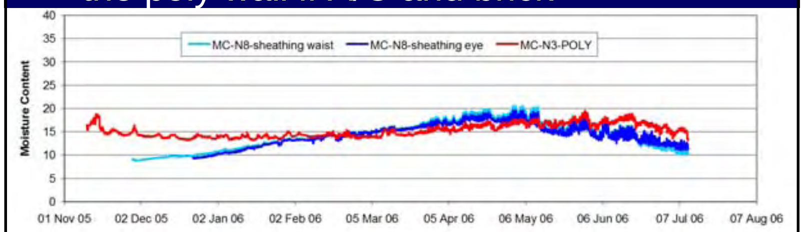
Comparisons to other Walls

- Open cell foam controls better than fibreglass w/ just latex paint



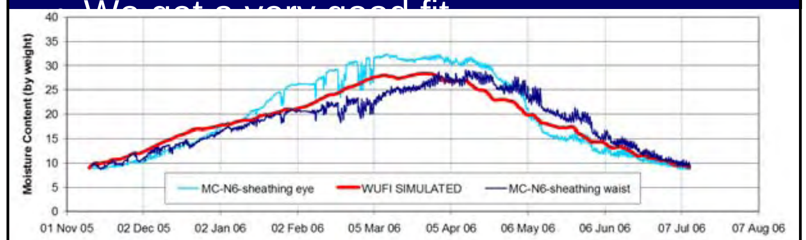
Closed-cell SPUF vs poly FG

- Sheathing MC about the same (assuming airtight!)
- BUT, summer condensation occurs in the poly wall if A/C and brick

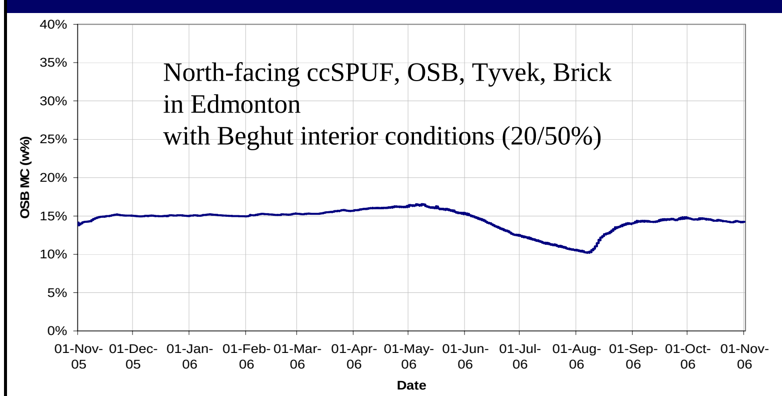


Simulations

- 1. Validate model
- 2. Then extrapolate to other conditions
  - Using WUFI 4.1

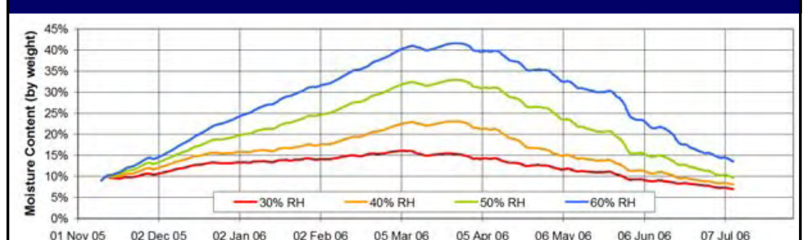


Closed Cell SPUF- Cold Climate



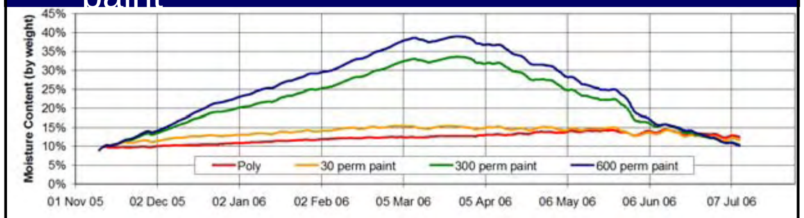
Open cell foam

- Exterior Conditions: Toronto, North side
- Interior Conditions: vary from 30-60%RH
- Open Cell- Interior Conditions Matter



Vapor Control Layers

- Open Cell Foam
- North-facing, Toronto 21 C/50%RH
- Poly, vapor-control paint, open latex paint



Summary: Closed Cell

- Closed-cell SPUF does not need low perm barrier in most cases
- Closed-cell SPUF controls vapor flow even in challenging conditions
  - If RH >>50% and HDD >>4000 consider
    - Add exterior foam, vapor permeable sheathing (DensGlas), vapor barrier paints
    - And/or check with WUFI

Summary: Open Cell

- ½ pcf SPUF may need vapor control in some cold climates / high humidity cases
  - Control humidity
  - Add exterior insulation (increase R-value)
  - Add interior insulation vapor resistance
  - Add vapor control paint / layer
- WUFI validated with field results
  - Can use this to help decide on need