SOLAR DRY

Patent Pending

Drainage, Drying and Thermal Performance

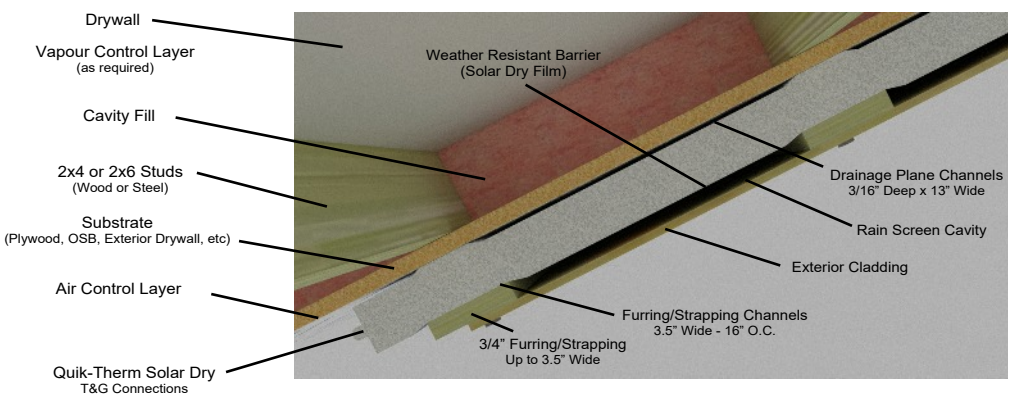
The following technical information is based on physical drainage and drying testing, Hygrothermal Analysis(s) and thermal performance testing for the Quik-Therm Solar Dry wall insulation system. However, as stated by the Building Science Corporation, from a building science perspective walls are roofs - roofs are walls.

"The same approaches can be applied to both roofs and walls. The argument being that similar loads and the same laws of Physics apply."

BSI – 090: Joseph Hayden Does The Perfect Wall – Building Science Corporation.

QUIK-THERM™ Inspired by Building Science

Solar Dry (SDI) is a vented and perforated outboard continuous rigid insulation technology. It has been designed, tested and engineered for framed hybrid (batt and continuous rigid insulation combined) and empty cavity walls. SDI is permeable. It manages vapour diffusion and channels bulk water to the outside. As a result, SDI reduces the risk of mold and building material degradation. For framed wall assemblies; SDI's thermal performance, drying and drainage (hygrothermal) capabilities have been tested, evaluated and validated by recognized Building Science organizations.



Solar Dry consists of engineered perforated metallic polymer facers - laminated over closed-cell, lightweight and resilient Type 2 expanded polystyrene. 3/16" deep drainage cavities occupy approximately 75% of its inboard panel surface. On the outboard side, furring materials (wood or steel) are mechanically fastened through SDI panels directly to framing members. Typical framing locations are identified by shallow depressions - but not mandatory.

Managing Moisture in Framed Walls

90% of all building envelope problems are related to water. Designing for moisture management is important to protect the building and keep its occupants safe from adverse health effects. Moisture control is adequate provided wet materials have the opportunity to drain and dry - preferably to the outside. "Note that in an assembly using conventional foam exterior insulation panels, there will be a double vapour barrier, which limits the drying capacity of the assembly. The cavity provided by Quik-Therm Solar-Dry provides a technical advantage. The vertical cavities, open at the base, provide a drying path to the outside." *Quik-Therm Solar Dry System in Above Grade Exterior Wall Applications. Mark Lawton, P.Eng, Morrison Hershfield*

Drainage Testing

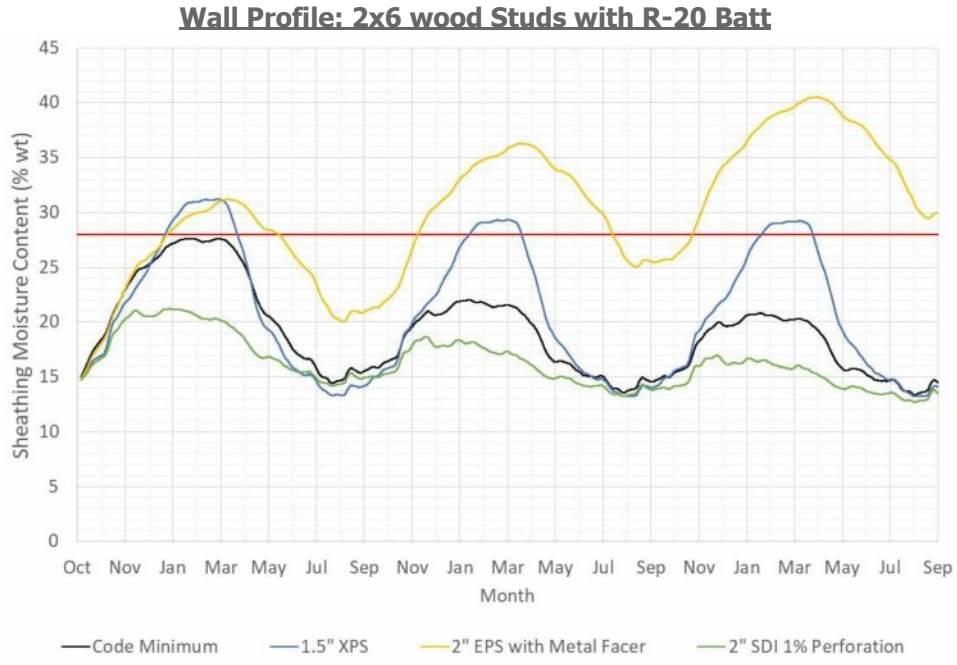
RDH Building Science Laboratories

"The excellent drainage performance and improvement in drying within the vented cavity under small (~2Pa) wind pressures of the wall assembly constructed with SDI reduces moisture durability risks of the enclosure that could result from water getting trapped and held between the components of the wall assembly. The drainage testing results showed very similar and repeatable drainage and storage between all three tests on the test wall. The wall stored between 102 and 117 grams (or millilitres) of water following 15 minutes of drainage after water was applied. This means that the wall drained nearly all of the water that was applied to the assembly." *Evaluation of Solar Dry Drainage and Drying Testing. Jonathan Smegal | MASc. Report No. 12682.000*

Hygrothermal Analysis

Morrison Hershfield

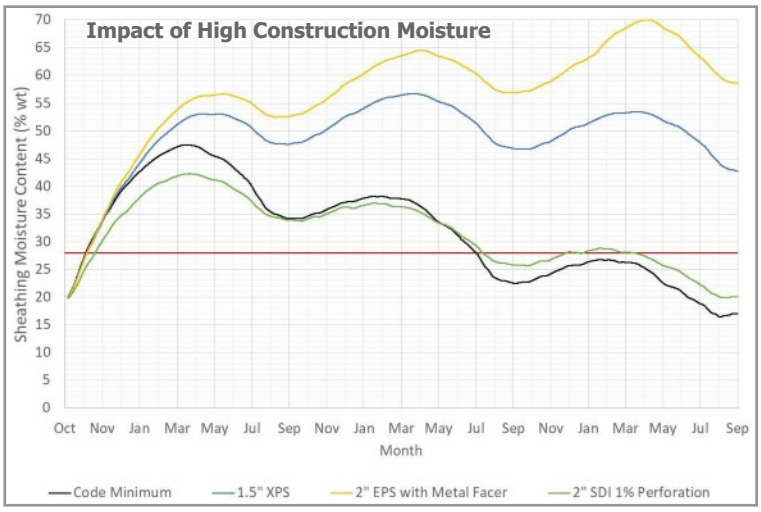
"We recognize our approach for evaluating the assembly's tolerance to rain penetration wetting is much more conservative than what is excepted out in the field. This approach assumes water is held against the sheathing and that air leakage is not present. However, the majority of bulk water present within the drainage gap of the SDI insulation system is expected to drain out of the wall assembly as demonstrated by RDH Building Science Laboratories 201815. In addition, some degree of air leakage is expected for all wall assemblies which will increase drying rates in the assembly from rain penetration and initial construction moisture." *Hygrothermal Analysis of Quik-Therm Solar Dry Insulation. Ivan Lee, P.Eng & Patrick Roppel P.Eng Report No. 1800859.00*



7-day plywood sheathing moisture content at mid-height for east facing split insulated wall assembly subject to 0.15% (max 0.02 L/h/m^2) driving rain penetration without air leakage in Vancouver

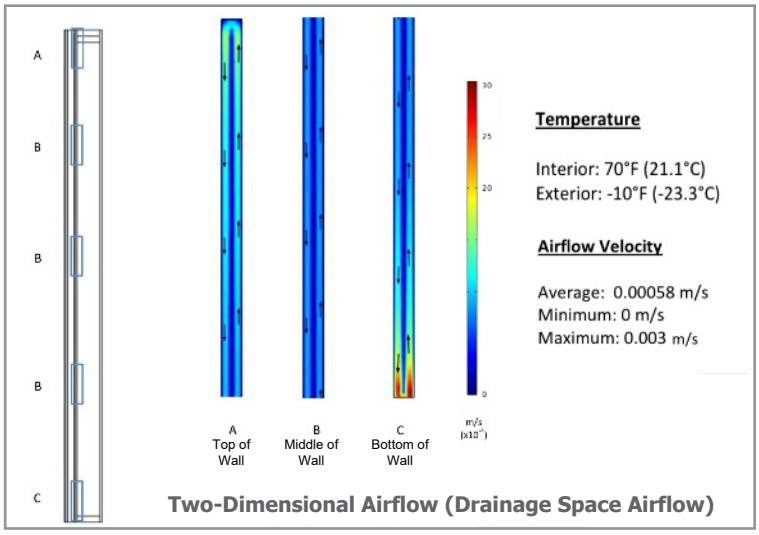
Hygrothermal Analysis

(Continued)



Morrison Hershfield

"Perforations in the polymer facer of the Quik-Therm SDI insulation improves the hygrothermal performance of split insulated wood frame wall assemblies, especially with regard to the ability to dry out moisture from rain leaks and high construction moisture." *Hygrothermal Analysis of Quik-Therm Solar Dry Insulation. Report No. 1800859.00*

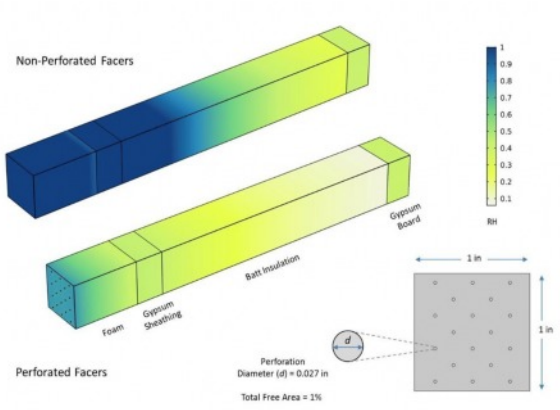


Built Environments Inc.

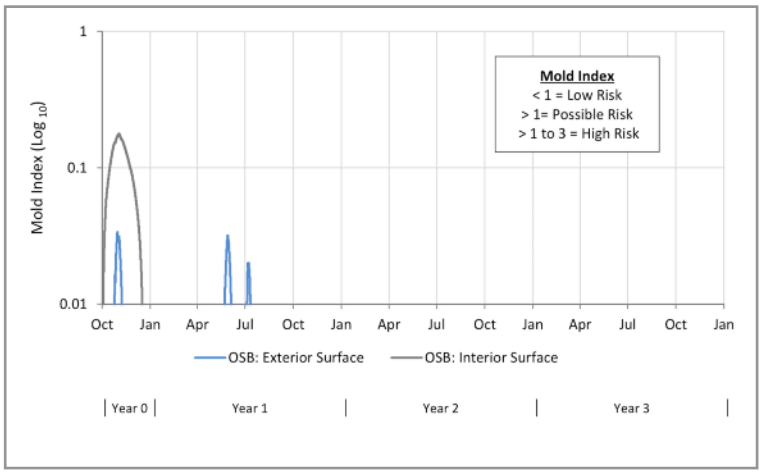
"Air flow velocities and resulting air changes within the drainage space were a function of temperature gradients across the wall. At large temperature differences (e.g. -10°F exterior; 70°F interior), average airflow velocities were only 0.00058 m/s. This corresponds to 0.34 air changes per hour when assuming 100% air exchange with the adjacent exterior air layer. The predicted reduction in thermal efficiency was less than 1%." *Thermal Performance Report. Steven Doggett PhD, LEED Report No. 012019-1*

Built Environments Inc.

"In all instances, moisture levels were maintained below critical thresholds associated with mold growth and material degradation. Natural convection within the open drainage channels did not significantly affect moisture or thermal performance. While the open channels enhanced vapor release, diffusion occurred primarily through the perforated insulation system." *Moisture Performance Report. Report No. 012019-2*



Perforation Design by Built Environments Inc.



Vapour Control

Interior vapour control has an impact on sheathing moisture. Increasing the vapour permeance of the vapour control layer to 60 ng/(Pa·s·m^2) reduces sheathing moisture levels and the risk of moisture accumulation.

Solar Dry Exempt From Ratio Table 9.25.5.2

Where a material has a water vapour permeance not less than 30 ng/(Pa·s·m^2) and a thermal resistance not less than 0.7 (m^2·K)/W and the heating degree-days of the building location are less than 6000, the assembly need not comply with Sentence (1). 1" Solar Dry is compliant for buildings located in climate Zone 7A or warmer.

Thermal Performance Testing

Morrison Hershfield

"Quik-Therm Insulation Solutions Inc. has undertaken a program of full scale thermal performance testing(1) to ASTM C1363-05 Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus. Testing was performed by Architectural Testing Inc. This testing included direct comparison of assemblies with Solar-Dry and a Quik-Therm Connect product that is similar but without the "flutes". The tests confirmed that the introduction of the 3/16" flutes and 2"x3/4" wood furring had no appreciable effect on the thermal performance of the wall assembly, provided that the flutes are sealed at the top of each wall panel to eliminate any convection air current." *Quik-Therm Solar Dry Systems. Mark Lawton P.Eng.*

(1) as per National Building 2015 / 9.36.2.2.(4)(b)

Built Environments Inc.

"Computational methods utilized in this analysis have been benchmarked against independent hot box studies performed in accordance with ASTM C 1363. Methods employed in this analysis achieve thresholds that are generally less than ±2.5% of tested transmittance values, which are well below the ±8% threshold criterion." *Thermal Performance Report. Report No. 012019-1.*

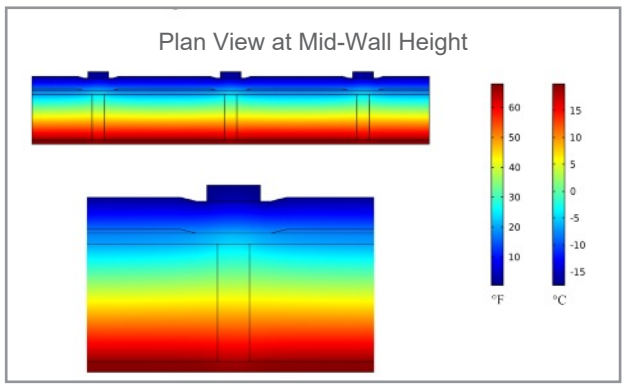
Thermal Performance Results

1.5" Solar Dry Insulation and R-20 Batt

Thermal Transmittance, U-factor	0.038 Btu/h·ft²·F
Overall Thermal Resistance (Air-to-Air)	26.0 (h·ft²·F)/Btu

4" Solar Dry Insulation and R-20 Batt

Thermal Transmittance, U-factor	0.028 Btu/h·ft²·F
Overall Thermal Resistance (Air-to-Air)	36.1 (h·ft²·F)/Btu



ASTM C1363 Test Results

Description of Test Samples Starting from Exterior	Overall Thermal Resistance (hr·ft²·F/Btu), R-value (R_u)
1" Quik-Therm, 7/16" OSB, 2x4 wood studs, empty cavity, ½" drywall	8.29
1" Quik-Therm, 7/16" OSB, 2x4 wood studs, R-11 fiberglass batts, ½" drywall	18.03
2" Quik-Therm (with flutes), 7/16" OSB, 2x4 wood studs, empty cavity, ½" drywall	13.2
Cement board siding, 2" Quik-Therm, 7/16" OSB, 2x4 wood studs, R-13 fiberglass batts, 6 mil. Poly vapour barrier, 3/8" drywall	23.1
2" Quik-Therm, 7/16" OSB, 2x6 wood studs, R-20 fiberglass batts, ½" drywall	28.3
5/8" OSB (in lieu of cladding), 3/8" rain screen, 3" Quik-Therm, 2x4 wood studs, R-12 fiberglass batts, ½" drywall	27.96

Morrison Hershfield

"The use of effective R-values when evaluating the thermal resistance of an assembly is preferable to using the nominal R-value of the insulation alone. The benefits of this approach have been demonstrated in results obtained through laboratory tests such as ASTM C1363 and by data published in ASHRAE 90.1." *Use of Effective R-values for Evaluation of Insulated Assemblies. Mark Lawton P.Eng.*

Quik-Therm Effective Thermal Resistance

SDI Thickness	2x4 Wood Frame with R-12 Batt	2x6 Wood Frame with R-20 Batt	Wood Frame Empty Cavity	2x6 Steel Frame with R-20 Batt
1"	18	23	8	NA
1.5"	21	26	11	17
2"	23	28	13	19
3"	28	32	17	23
4"	32	36	21	27
5"	36	40	25	31
6"	40	44	29	35

Nominal R-Value Testing ASTM C-518 = R-4.2 | Steel Framing ASHRAE Table A3.13

RDH Building Science Laboratories

Physical Test Wall was 4' wide by 8' tall. It was constructed with steel studs and OSB sheathing. 6 mil polyethylene was installed on both sides to isolate the OSB from water in the drainage cavity and the changing RH conditions in the laboratory. On the exterior of the polyethylene covered OSB, a sheet applied housewrap was installed. Solar Dry Insulation was installed as per Quik-Therm installation instructions. The vertical edges of the sample were sealed. This forced the wall to drain all the way vertically through the assembly, which simulates a long length of wall.

Morrison Hershfield

Hygrothermal Performance of the wall assemblies were evaluated using 2D finite element heat-air-moisture program DELPHIN5. The wall assemblies were evaluated using climatic data that are representative of a wet year as determined by the MEWS6 study as well as a cold year based on heating degree days. Exterior insulation levels are based on achieving effective R-values of R-22 (RSI 3.87) for Vancouver (Zone 5) and R-28 (RSI 4.93) for Edmonton (Zone 7) for 2x6 wood-framed walls with R-19 (RSI 3.35) batt insulation in the stud cavity.

Morrison Hershfield has validated the model and approach used for this project to published field studies.

Built Environments Inc.

Transient Moisture assessment employed WUFI® Pro 6.2 hygrothermal modeling software. Simulations were performed in accordance with design parameters outlined by ASHRAE 160-2009, Criteria for Moisture-Control Design Analysis in Buildings and Addendum E. Interior design conditions were determined by WUFI's integrated EN 15026 / WTA 6-2 interior climate method. Exterior weather data utilized WUFI's Cold Year meteorological data for Vancouver, British Columbia, Winnipeg, Manitoba and Toronto, Ontario.

Performance Criteria and Risk Evaluation Simulation outcomes were compared to the VTT Mold Index evaluation criteria as outlined in ASHRAE 160 (2009), Addendum E. The Mold Index was determined using the WUFI-integrated Mold Index VTT plug-in.

Steady-State Moisture Transport assessment applied Computational Fluid Dynamics to simulate coupled heat and moisture transport through two and three-dimensional wall assemblies. Simulations were performed using COMSOL Multi physics 5.4, which employs partial differential equations and Finite Element Analysis (FEM) to predict simultaneous flows of fluids, gasses, heat, and moisture.

Fire Code Compliance

National Building Code: Foam plastic insulation is permitted to be used in the exterior wall of mid-rise (up to six stories) wood buildings when a tested wall assembly passes the 15 minute CAN/ULC-S101 test per the prescribed criteria as required by Article 3.2.3.8., and an interior thermal barrier such as gypsum board is provided as required by Article 3.1.4.2.

6" thick Quik-Therm and fibre cement board siding met the requirements of Article 3.2.3.8. Sentence 2 when exposed to the time temperature curve of CAN/ULC-S101 for 15 minutes duration. *Test Report N: T1035-4 QAI Laboratories.*

Solar Dry is made with certified EPS conforming to CAN/ULC-S701-11 (CCMC 13457-L)

Quik-Therm Insulation Solutions Inc.

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Installation & Technical Data can be found at quiktherm.com

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