Construction Industry Issues With Air Barriers

Presented by:

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Industry Issue 1

Why do I want to make my building air tight?

How is it supposed to dry out?
Industry Issue 2

How is the wall supposed to “breathe“ if it has an air barrier in it?
Don’t you need to have air leaking into the building to keep the air inside it fresh?
The Wetting Potentials

Liquid Water Ingress

Moisture Transport Due To Air Flow

Dew Point

Vapor Migration
How Do We Properly Deal With These Four Wetting Potentials???

Good HAMM!!!
What the #$%@ is HAMM?

• HAMM is the 4 barriers needed to protect a building against the effects of weather. These barriers are:

H  Heat Barrier
A  Air Barrier
ML Water Barrier (Liquid Moisture)
MV Vapor Barrier (Gaseous Moisture)

HAMM is the WEATHER BARRIER SYSTEM
Hamm Order Of Magnitude

\( M_L \)  Water Barrier (Liquid Moisture)

\( A \)  Air Barrier

\( H \)  Heat Barrier

\( M_v \)  Vapor Barrier (Gaseous Moisture)
Good HAMM effectively deals with thermal transfer, wetting and drying potentials:

**Heat Barrier**
- Thermal loss, gain and bridging
- Wetting potential due to a dew point (location)

**Air Barrier**
- Thermal loss and gain
- Wetting potential due to moisture transport via air flow
Good HAMM effectively deals with thermal, wetting and drying potentials:

**Water Barrier**

- Wetting potential due liquid moisture intrusion into and through the Building Enclosure System.

**Vapor Barrier**

- Wetting potential due to vapor diffusion into and through the Building Enclosure System.
THE WATER BARRIER

- Resists the intrusion of moisture in its liquid form (water) into and through the building enclosure system.

- Over the history of Building Enclosure System use, water barriers have been:
  - Ineffective due to their inability to resist water penetration.
  - Ineffective due to improper installation.
  - Ineffective due to lack of longevity.

- If an air barrier is properly designed and installed in a building enclosure system and the air barrier material is also a water barrier, won’t the past deficiencies of water barrier be resolved?
Why is my building leaking?
Why is my building leaking?
Why stop the flow of air into and through the BES?

First and foremost...........

1.) Air flow has the ability to transport exponentially more moisture into and through the building enclosure system than occurs through vapor migration or diffusion. Estimates range from 30 to 200 times more moisture transport occurs via air flow than vapor migration.
Excess moisture in exterior walls causes:

Corrosion of metal items
Excess moisture in exterior walls causes:

The “M” Word

Photo of mold in wall. Photo supplied courtesy of Canadian Home Builders’ Association (CHBA) and Canadian Mortgage and Housing Corp. (CMHC)
Excess moisture in exterior walls causes:

Efflorescence
2.) Air flow into and out of buildings can affect the location of the dew point.

3.) Air leakage into and out of buildings causes the HVAC system to expend extraneous energy in order to maintain the building’s desired temperature and humidity levels.

4.) Air flow is a vehicle by which sound travels.

5.) Air flow is a vehicle by which particulate matter travels.

6.) Air flow is a vehicle by which odors and gaseous substances travel.
Vapor barriers are materials used in Building Enclosure Systems to retard the diffusion of vapor into and through the building enclosure system.

Why Are Vapor Barriers Needed?

By retarding the diffusion of vapor through the Building Enclosure System, conditions that create dew points within Building Enclosure Systems can be reduced or prevented and interior RH levels can be maintained.
What Is Vapor Diffusion?

Vapor diffusion is the process by which vapor seeks to equalize its content between different environments (the Ideal Gas Law).

The driving force (or “potential”) for this occurrence is vapor pressure.

Vapor pressure is a function of the vapor content of the air (RH) and the temperature.

Vapor diffusion is caused by a vapor pressure differential (ΔP) between different environments. The greater the ΔP between environments, the greater the amount of vapor diffusion that occurs.
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The Dew Point

The dew point is the temperature at which air that contains a certain amount of vapor can no longer hold that vapor and must exhaust itself of excess vapor by depositing it on adjacent surfaces in the form of condensation (water).
Where does the water on the outside of the glass come from?
The dew point is the temperature at which condensation forms on condensing surfaces. When air comes into contact with a surface that is at or below the dew point temperature of that air, condensation will form on it.

EXAMPLE 1: If the interior air temperature is 70˚ F and has an RH of 30%, the infiltration of air that is 37˚ F (the dew point temperature) can cool condensing surfaces to this temperature (37˚) causing dew to form on these surfaces.

EXAMPLE 2: If exterior air with a temperature of 85˚ F and an RH of 70% infiltrates into the building envelope, dew will form on condensing surfaces in the system that have temperatures of 74˚ F or less.
THE DYSFUNCTIONAL BUILDING ENCLOSURE SYSTEM

VENEER (PROTECTIVE LAYER)

CAVITY (DRAINAGE SPACE)

WATER RESISTANT BARRIER
   (DRAINAGE PLANE)

FIBERGLASS BATTS INSULATION
   (HEAT BARRIER)

LGMF & GWB (STRUCTURAL LAYER)

VAPOR BARRIER ???

INTERIOR
HEATED, COOLED
AND HUMIDITY
CONTROLLED
ENVIRONMENT

BRICK VENEER IS A “RESEVOIR”
CLADDING MATERIAL. IT WILL HOLD
MOISTURE AND WHEN HEATED BY SOLAR
RADIATION, WILL CREATE EXTREME
TEMPERATURES AND VAPOR PRESSURE
LEVELS IN THE CAVITY SPACE

GWB SHEATHING IS NOT PROTECTED FROM
MOISTURE INTRUSION IN ITS GASEOUS
FORM

GWB ABSORBS AND RETAINS MOISTURE
AND WILL DEGRADE OR DETERIORATE
UNDER FAIRLY LOW MOISTURE CONTENT
LEVELS AS WELL AS HOST MICROBIAL
GROWTH

LGMF SYSTEMS WITH GWB AND VAPOR
BARRIERS CREATE CHAMBERS FROM
WHICH VAPOR CANNOT BE EASILY VENTED

LGMF MEMBERS WILL CORRODE WHEN
EXPOSED HIGH RH LEVELS

DEW POINT RANGE
COLD CLIMATE

EXTERIOR AIR
30° F
30% RH
VP = 0.024 psi

HVAC SYSTEM

MOISTURE ADDED TO AIR IN THE HVAC SYSTEM TO ACHIEVE DESIRED INTERIOR RH LEVELS.

INTERIOR AIR
70° F
RH LEVELS
OFFICES 30%
APTS 30%
SCHOOLS 30%
HOTELS 30%
LIBRARIES 50%
MUSEUMS 50%
LABS 30%-50%
POOL HOUSES 80%
VP = 0.108 to 0.290

THEORETICAL DEW POINT

WATER INTRUSION

MOISTURE TRANSPORT DUE TO AIR FLOW

HEAT LOSS

VAPOR MIGRATION

AIR FLOW CAN CHANGE THE LOCATION OF THE DEW POINT.
WARM CLIMATE

EXTERIOR AIR
90° F
80% RH
VP = 0.558 psi

HVAC SYSTEM

DEW POINT TEMPERATURE REACHED IN THE HVAC CHILLER. CONDENSATION IS COLLECTED AND DRAINED AWAY.

INTERIOR AIR
70° F
RH LEVELS
- OFFICES 50%
- APTS 50%
- SCHOOLS 50%
- HOTELS 50%
- LIBRARIES 50%
- MUSEUMS 50%
- LABS 30%-80%
- POOL HOUSES 80%
VP = 0.108 to 0.290

THEORETICAL DEW POINT

MOISTURE TRANSPORT DUE TO AIR FLOW

WATER INTRUSION

HEAT GAIN

VAPOR MIGRATION

BRICK AND CAVITY AIR
UNDER SOLAR EXPOSURE
120° F  90% RH

AIR FLOW CAN CHANGE THE LOCATION OF THE DEW POINT
How Do Walls With Air Barrier Systems Work?
**VAPOR PERMEABLE AIR BARRIER SYSTEM**

**BRICK VENEER**

**CAVITY**

**GYPSUM SHEATHING, RIGID POLYSTYRENE INSULATION OR POLYOLEFIN FILMS W/ TERMINATIONS AND PENETRATIONS SEALED**

**CAVITY INSULATION (IF REQUIRED)**

**LIGHT GAGE METAL FRAMING BACK UP WITH FIBERGLASS BATTS INSULATION BETWEEN STUDS**

**POLYETHYLENE VAPOR BARRIER**

**INTERIOR GYPSUM WALL BOARD**

**NOTES**

1.) ALL SCREW PENETRATIONS THROUGH EXTERIOR GWB MUST BE SEALED

2.) ALL VENEER ANCHORS MUST BE BEDDED IN SHEET OR LIQUID APPLIED AIR BARRIER TO PREVENT AIR LEAKAGE

3.) TERMINATION OF EXTERIOR GWB AT THE UNDERSIDE OF RELIEVING ANGLES AND DECKS MUST BE SEALED WITH SHEET APPLIED AIR BARRIER.

4.) TOP EDGES OF SHEET APPLIED AIR BARRIER MUST BE SEALED WITH LIQUID MEMBRANE OR MASTIC.
Cold Climate Vapor Permeable Air Barrier System: Winter

**EXTERIOR AIR**
- 30°F
- 30% RH

**WATER INTRUSION**

A DEW POINT DOES NOT OCCUR WITHIN THE BES DUE TO AN EFFECTIVE VAPOR BARRIER

**HEAT LOSS**

**WIND AND NEGATIVE STACK PRESSURE**

**FAN AND POSITIVE STACK PRESSURE**

**INTERIOR AIR**
- 70°F
- 30% RH

**VAPOR MIGRATION**

THERMAL BRIDGING AT LGMF CAUSES HEAT LOSS AND THUS REDUCES THE EFFECTIVENESS OF THE INSULATION
Cold Climate Vapor Permeable Air Barrier System: Summer

EXTERIOR AIR
90°F
80% RH

WATER INTRUSION

WIND AND NEGATIVE STACK PRESSURE

FAN AND POSITIVE STACK PRESSURE

HEAT GAIN

THERMAL BRIDGING AT LGMF CAUSES HEAT GAIN AND THUS REDUCES THE EFFECTIVENESS OF THE INSULATION

VAPOR MIGRATION

Theoretical dew point

THE SUCCESS OF THIS SYSTEM DEPENDS ON THE AMOUNT OF TIME THAT A DEW POINT IS ACHIEVED IN THE STUD CAVITY AND THE ABILITY OF THE BES TO DRY TO THE EXTERIOR.

INTERIOR AIR
70°F
30% RH
AIR AND VAPOR BARRIER SYSTEM

FACE BRICK
CAVITY
RIGID INSULATION
SHEET OR LIQUID APPLIED AIR BARRIER MEMBRANE
(AIR AND VAPOR BARRIER)
GYPSUM WALL BOARD
LIGHT GAGE METAL FRAMING
INTERIOR GYPSUM WALL BOARD

NOTES:
BY INSTALLING THE RIGID INSULATION IN THE CAVITY, THE VAPOR BARRIER CAN BE LOCATED AT THE EXTERIOR FACE OF THE EXTERIOR GWB SHEATHING.

Cold Climate Air And Vapor Barrier System: Winter

EXTERIOR AIR
30°F
30% RH

WATER INTRUSION

WIND AND NEGATIVE STACK PRESSURE

FAN AND POSITIVE STACK PRESSURE

THERMAL BRIDGING DOES NOT OCCUR DUE TO CONTINUITY OF THE HEAT BARRIER

A DEW POINT DOES NOT OCCUR WITHIN THE BES DUE TO AN EFFECTIVE VAPOR BARRIER

HEAT LOSS

VAPOR MIGRATION

INTERIOR AIR
70°F
30% RH
Cold Climate Air And Vapor Barrier System: Summer

**EXTERIOR AIR**
- 90°F
- 80% RH

**INTERIOR AIR**
- 70°F
- 30% RH

**Dew point**

THE DEW POINT OCCURS WITHIN HEAT BARRIER WHICH IS TO THE EXTERIOR OF THE DRAINAGE PLANE.

NOT A PROBLEM!!!

- **WATER INTRUSION**
- **WIND AND NEGATIVE STACK PRESSURE**
- **HEAT GAIN**
- **VAPOR MIGRATION**
- **FAN AND POSITIVE STACK PRESSURE**

**INTERIOR AIR**
- 70°F
- 30% RH
HOT HUMID CLIMATE
( OVER 3000 DEGREE COOLING DAYS )

AIR AND VAPOR BARRIER SYSTEM

FACE BRICK
CAVITY
SHEET OR LIQUID APPLIED AIR BARRIER MEMBRANE
( AIR AND VAPOR BARRIER )
GYPSUM WALL BOARD
LIGHT GAGE METAL FRAMING BACK UP WITH FIBERGLASS BATTs
INSULATION BETWEEN STUDS
INTERIOR GYPSUM WALL BOARD
Warm Climate Air And Vapor Barrier System

3000 Cooling Degree Days or more

EXTERIOR AIR
90° F
80% RH

WATER INTRUSION

WIND AND NEGATIVE STACK PRESSURE

FAN AND POSITIVE STACK PRESSURE

THERMAL BRIDGING AT LGMF CAUSES HEAT GAIN AND THUS REDUCES THE EFFECTIVENESS OF THE INSULATION

A DEW POINT DOES NOT OCCUR WITHIN THE BES DUE TO AN EFFECTIVE AVBS

HEAT GAIN

VAPOR MIGRATION

INTERIOR AIR
70° F
30% RH
THANK-YOU