Airflow Control, Air Barriers, and Energy

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Introduction

- Energy and R-value
- Airflow Control vs Air Barriers
- Airflow and Energy
- Metrics and Measurement
Energy is important

- Slowing heat loss/gain through enclosures is an important part of future buildings
- “High R” walls are required, new/retrofit
- But R-value is not a good measure for good enclosures

R-value: ASTM C518

- FTC “Rule” R-value reported at mean temperature of 75 F
- Typical hot plate: 95F, cold plate 55F
Factors influence Heat Flow

- Temperature
- Thermal bridging
- Insulation installation defects
- Airflow
Temperature

30% variation

Experimental Validation: Temperature, Thermal Bridging, Airflow
Thermal bridging: wood framing 20-25% reduction
: steel framing 60-80% reduction
Airflow Modes

Air barrier stops this
Energy and Through-flow

• Easy to calculate energy from *through* flow
• Hard to quantify other terms

\[ q = \frac{dm}{d\theta} c_o \cdot \Delta T \]  \[ \text{[1]} \]

where \( \theta \) represents time and

\( \frac{dm}{d\theta} \) is the mass flow rate of the fluid (kg/s) per unit time,
\( c_o \) is heat capacity of the fluid (J / (kg・K)), and
\( \Delta T \) is the temperature difference (K).

Airflow vs R-value

[Graph showing airflow vs R-value with data points and ranges for different conditions.]
Convection Loops

A: Air Loops Around Insulation
- Cool air falls
- Warm air rises
- Loops ONLY if a continuous space exists on BOTH sides

B: Air Loops Through Insulation
- Loops ONLY if high air permeability insulation (i.e., very low density)

Convection Loops

- Small gaps in batt insulation on both sides
- Closed circuit
- Energy cost
- Cold surfaces

Cold or Hot Weather

- Hot air = light
- Cold air = heavy

Result: Air Flow
**Windwashing**

- Wind driven convection through exterior layers

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25-50% loss in "R-value" with 1/8” gaps
Previous Research

• Henning (1983)
• Uvslokk (1996)
• Impacts of 0-50%

![Graph showing the relationship between wind speed and the percentage increase in heat transmission.](image)

Need for a new metric

• Thermal bridging 25-75%
• Temperature -15 to +15%
• Airflow
  – Through wall 5-50%
  – Within wall 0 – 30%
  – Windwashing 0 – 50%
• If we are serious about energy, we need to account for these in design

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Example Results

Summary

- R-value measures insulation
  - We need assembly values, as built
- Air barriers are good start
  - But *controlling* airflow is what is needed
- What you cant measure, you cant control
  - We need better metrics, then standards to follow
  - Material airtightness is not very useful