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 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

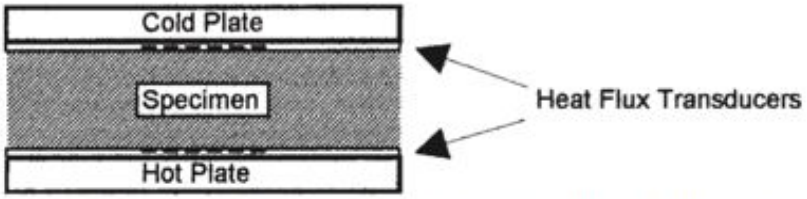
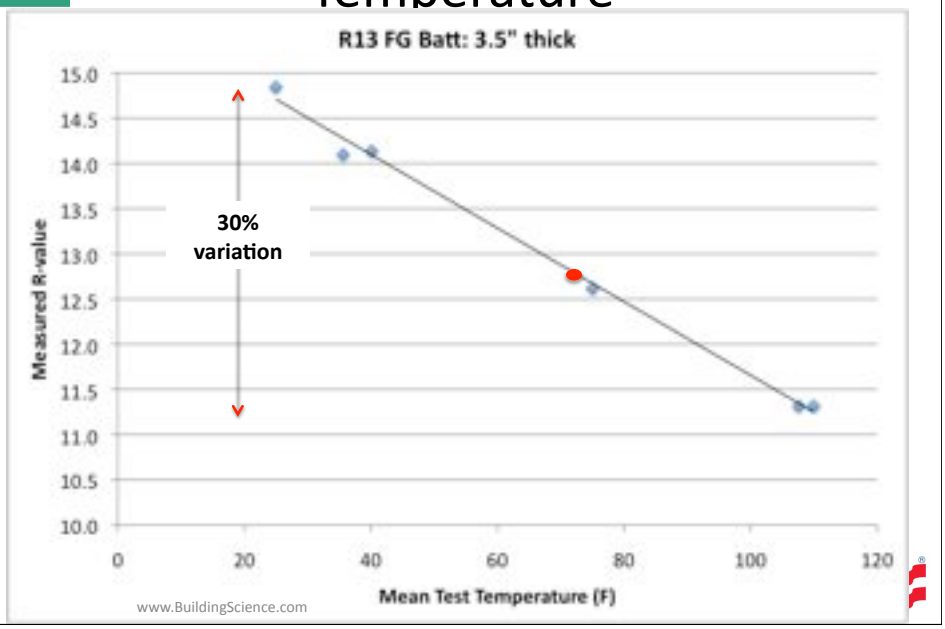


FIG. 3 Apparatus with Two Heat Flux Transducers and One Specimen

Factors influence Heat Flow

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

Temperature



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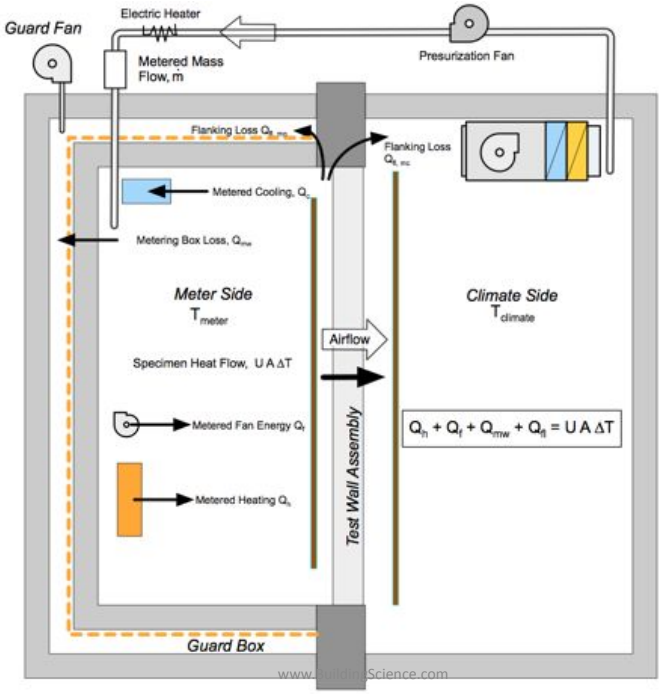
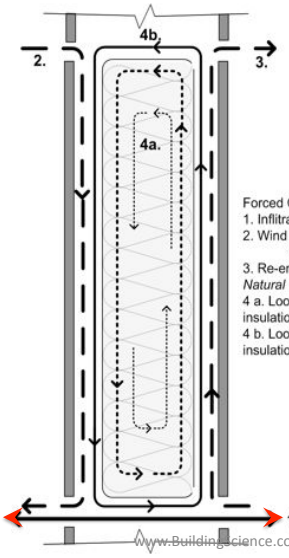
Thermal bridging : wood framing 20-25% reduction
: steel framing 60-80% reduction



Airflow Modes



Forced Convection
1. Inflitration / Exfiltration
2. Wind Washing (Forced Convection)
3. Re-entrant Loop

Natural Convection
4 a. Looping in air permeable insulation
4 b. Looping through gaps around insulation

Air barrier stops this

Energy and Through-flow

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

$q = dm/d\theta\ c_o \cdot \Delta T$ [1]

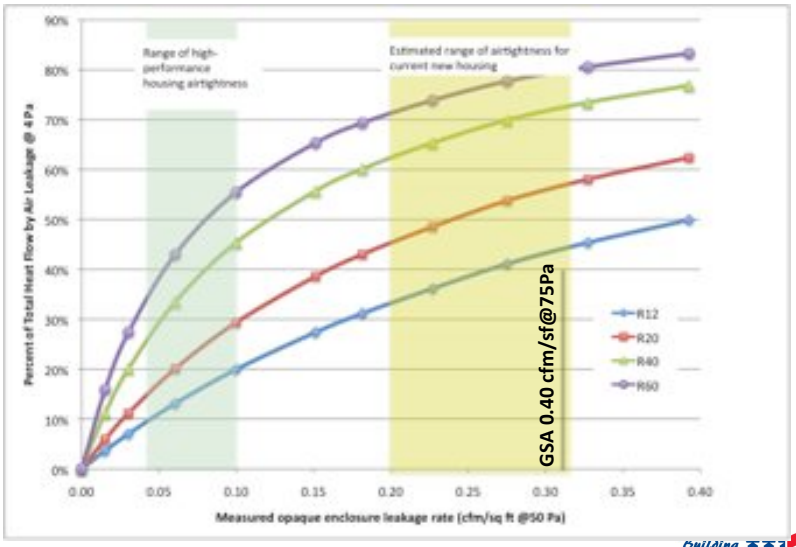
where θ represents time and

$dm/d\theta$ is the mass flow rate of the fluid (kg/s) per unit time,

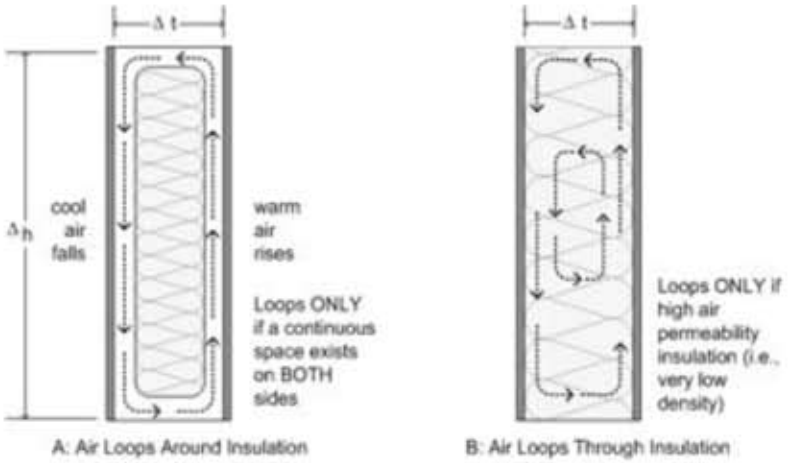
c_o is heat capacity of the fluid (J / (kg·K)), and

and ΔT is the temperature difference (K).

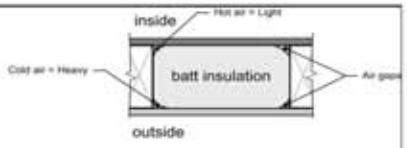
Airflow vs R-value



Convection Loops

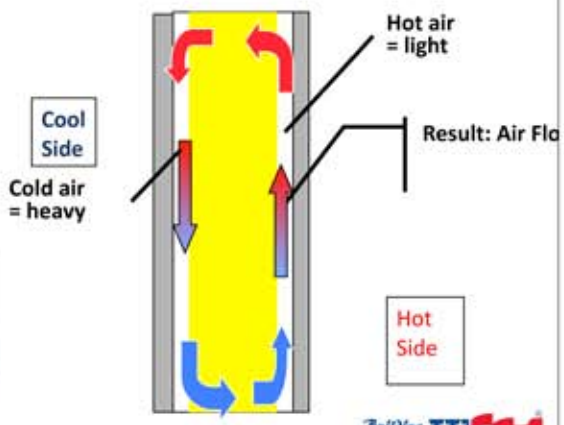


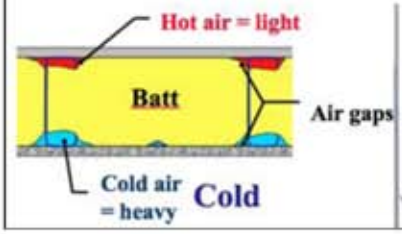
Convection Loops



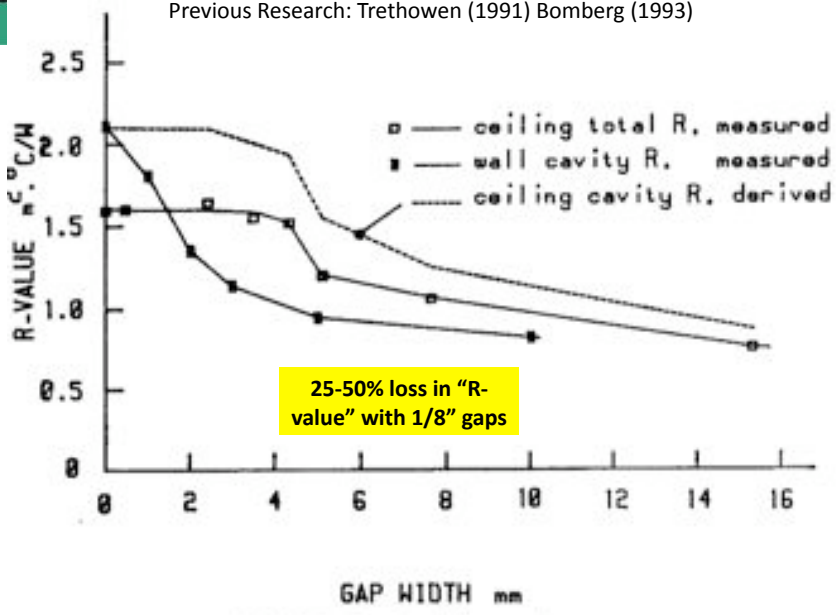
- Small gaps in batt insulation on both sides
- closed circuit
- energy cost
- cold surfaces

Cold or Hot Weather





Previous Research: Trethowen (1991) Bomberg (1993)

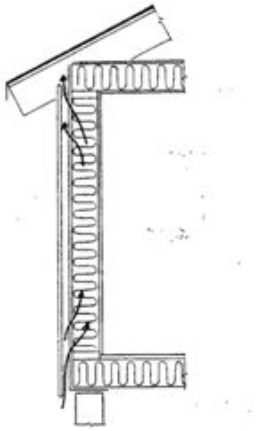


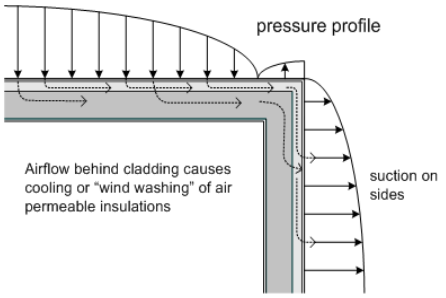
25-50% loss in "R-value" with 1/8" gaps

FIGURE 3. R-value with convective gaps.

Windwashing

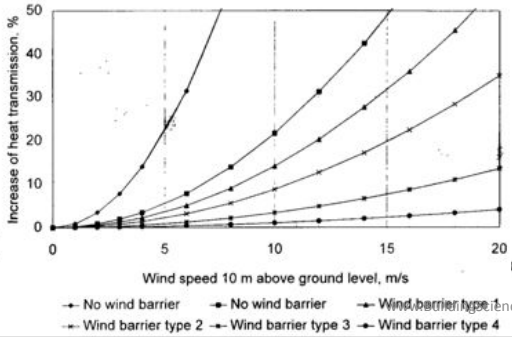
- Wind driven convection through exterior layers

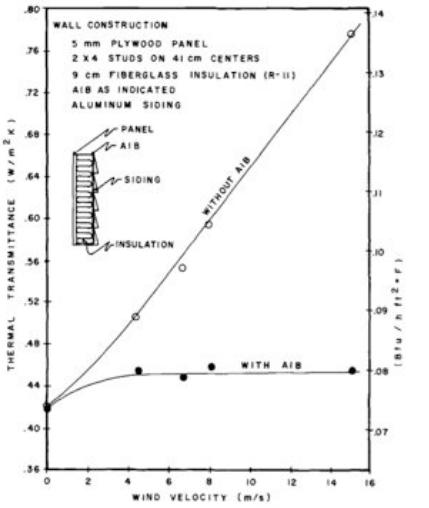




Previous Research

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





IG. 1—*Effect of wind on heat loss through an insulated exterior mobile home wall.*

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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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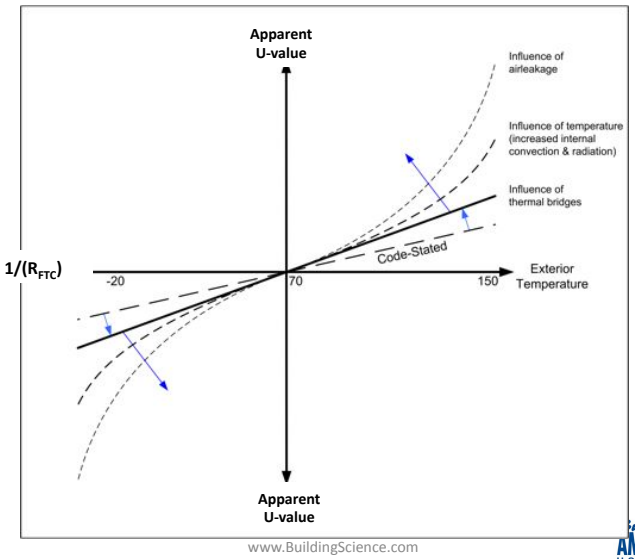
Example Results



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