Technical Aspects of Reflective Insulations and Radiant Barriers

Reflective Insulation Systems (RIS)

Enclosed Air Spaces

Use low-emittance surfaces to reduce heat transfer by radiation.

RIS have R-values that can be measured or calculated as required for labeling.

R-values for RIS include all heat flows.

Radiant Barrier Systems (RBS)

Large Open Air Spaces

Use low-emittance surfaces to reduce heat transfer by radiation.

Radiation from hot roof deck is reduced.

Performance is often described as annual heat load reduction.

The Performance of RIS and RBS Depend on Low-Emittance Surfaces

Thermal Radiation in the Building Envelope

Surfaces are -30 °F to 150 °F (429 to 610 °R)

Surface above 0 °R emit thermal energy

T (°F)	T(°R)	Radiative Flux (Btu/ft^2·h) – Maximum
-30	429.7	58.4
0	459.7	76.5
75	534.7	140.0
150	609.7	236.7

Maximum occurs when emittance is 1.0 (a black body).

Lower Emittance to Reduce Radiation

Emittance Scale	0 → → → → → → → → → 1	
	no radiation	max radiation
Reflectance Scale	1 → → → → → → → → → 0	
	mirror-like	no reflection

Aluminum films and foils can be produced with emittances in the range 0.03 to 0.05.

T of Surface (°F)	Rad. Flux Max.	Rad. Flux with ε = 0.03
-30	58.4	1.8
0	76.5	2.3
75	140.0	4.2
150	236.7	7.1

Most Building Materials have a High Emittance

Material	Emittance
Common Brick	0.93
Gypsum	0.90
Marble	0.93
Paper	0.92
Wood	0.8 – 0.9
White Enamel Paint	0.91
Un-oxidized Metals	0.02-0.10
Aluminum Foil/Film	0.03=0.05

Net Radiative Transfer Between Surfaces Depends on Temperatures and Emittances

Example Case 100 °F → → → → → 75 °F

Surfaces	**Effective Emittance**	**Net Exchange (Btu/ft²·hr)**	
black-black	**1.0**	**28.2**	
wood-wood	**0.77**	**21.7**	**base**
wood-foil/film	**0.0299**	**0.8**	**down 96.4%**
foil-foil or film-film	**0.0152**	**0.4**	**down 97.9%**

This is valid for both RIS and RBS.
Radiation is not the only way heat moves.

Heat Moves Across Regions by Conduction and Convection

- Use the 100 °F to 75 °F
- Conduction depends on distance between surfaces.

Distance (Inches)	Heat Flux (Conduction) (Btu/ft^2·h)	
0.25	18.50	
0.75	9.25	
1.00	6.17	
12.00	4.63	
60.00	0.08	(attic space)

Low-Emittance Surfaces Changes the Way Heat is Transferred Across a Region

- 100 °F to 75 °F
- Wood – Wood Wood – Foil/Film
- Rad. Cond. Conv. Rad. Cond. Conv.

Up	23.0	2.31	8.89	0.84	2.31	8.88
Hor.	23.0	2.31	5.75	0.84	2.31	5.72
Down	23.0	2.31	0.34	0.84	2.31	0.36

- Units Btu/ft^2·h

Low-Emittance Surfaces Changes the Way Heat is Transferred Across a Region

100 °F to 75 °F

	Wood – Foil/Film			Wood – Wood		
	Rad.	Cond.	Conv.	Rad.	Cond.	Conv.
Up	7.0	19.2	73.8	67.6	6.8	26.0
Hor.	9.5	26.0	64.5	74.1	7.4	18.5
Down	24.1	66.2	9.7	89.6	9.0	1.4

Percentage of Total

Radiant Barrier Performance

- Attic radiant barriers reduce the heat transfer rate from roof deck to attic floor.
- Lowers the temperature of the attic floor insulation.
- Lowers the attic air temperature to improve efficiency of air handling system.

Annual Saving Depend on Geographical Location and the Amount of Insulation on the Floor of the Attic

- Orlando
- Cooling Load Reduction (Btu/yr)
- Per Thousand Square Feet of Ceiling
- Insulation R Factor MM Btu /yr

Insulation R	Factor	MM Btu /yr
11	2495	2.5
19	1374	1.4
22	1171	1.2
30	834	0.8

Duct Performance Improvement Can Be Significant

- Cooling Season
- Air in Duct 60 °F
- Attic Air no RBS 120 °F
- Attic Air with RBS 95 °F
- Duct Insulation R-6
- Compare (120-60)/6 with (95-60)/6
- 10 5.8
- A 42 % reduction.

Summary

RI and RB form Systems to reduce heat loads.

RIS have a major impact on radiative transfer across air spaces.

R-values can be determined for RIS.

RBS reduce heat loss/gain across ceilings/floors.

Attic RBS load reductions depend on geographical location.

Attic RBS improves the air-handling efficiency. (when ducts in attic)