SISALATION®

CALCULATIONS

METHODS AND VALUES FOR CALCULATION OF HEAT FLOW

The ability of Mass or Bulk materials to slow down or reduce the rate of energy flow, reducing the percentage of heat gain or loss, is dependent on their 'R' Resistance value to energy flow, which is based on the materials 'k' value or conductivity 'C' value. An 'R' Resistance value is reciprocal of the 'C' conductivity. 'C' and 'R' are dependent on the thickness, density and temperature (mean). Once the "k" value is determined by laboratory test method and procedures, the R-Values can be determined by the equation:

$$'R' = \frac{\text{thickness of material}}{\text{Conductivity}}$$

A 12mm thick Gypsum board is calculated thus:

$$\frac{0.012\text{mm}}{0.17\ '\text{C}'} = R = 0.071\ (\text{m}^2.\ \text{K})/\text{W}$$

As a "k" value (see definitions) cannot be determined for Reflective Membranes separately, the heat gain or loss is evaluated by calculating the 'U' value, being the amount of energy flow per degree centigrade difference in watts between the air on one side of the component and the air on the opposite side of the component, such as a roof assembly. The 'U' value will therefore include the Thermal Resistance of all the individual material components, as well as all air spaces and air surfaces internally and externally.

Thermal Transmittance - 'U' value of a system is determined on the following equation;-

$$\mathbf{u} = \frac{\mathbf{1}}{\frac{1}{ho} + \frac{1}{hi} + \frac{(d1}{(k1} + \frac{d2}{k2} + \frac{d3)}{k3)} + \frac{(1}{(a1} + \frac{1}{a2} + \frac{1)}{a3)}}\ \text{W/(m}^2\text{.K)}$$

- Where ho and hi: = Outside air surface and inside air surface respectively
- d1, d2, d3, etc: = Density and thickness of bulk / mass material
- k1, k2, k3 etc: = Conductivity 'C' of the materials
- a1, a2, a3 etc: = thermal conductivity of air spaces.

SURFACE COEFFICIENTS AND RESISTANCE VALUES

Table 1: Surface Coefficients and Resistance Values

Position of Surface	Direction of heat flow	Surface Coefficient W/(m².K)	R-Value (m².K)/W
Internal Air Surface Coefficient			
1. Vertical – non reflective	Horizontal	9.4	0.106
2. Horizontal – non reflective	Upward	11.0	0.091
3. Horizontal – non reflective	Downward	6.8	0.147
4. Horizontal – with underside with emissivity of 0.05	Downward	1.3	0.769
5. Horizontal – with underside with emissivity of 0.05	Upward	4.3	0.233
6. Vertical with emissivity of 0.05	Horizontal	3.2	0.313
7. External surfaces – non reflective	All directions	20.0	0.050

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AIR SPACES, COEFFICIENTS, THERMAL CONDUCTANCE S AND RESISTANCE VALUES

Table 2: Air Spaces Coefficients Thermal Conductance.s and Resistance Values

Position of Air Space	Direction of heat flow	Surface Coefficient W/(m².K)	R-Value (m².K)/W
Vertical - non reflective	Horizontal	6.2 0.161	
Horizontal - non reflective	Up	6.8 -7.4	0.147 - 0.135
Horizontal - non reflective	Down	5.2 - 5.3	0.192 - 0.189
45 angle - non reflective	Up	6.2	0.161
45 angle - non reflective	Down	5.7	0.175
Horizontal - underside of upper boundary surface with e 0.05			
a. Thickness of air space 100mm > or more	Down	0.68	1.470
b. Thickness of air space 40 mm	Down	1.10	0.909
c. Thickness of air space 20mm	Down	1.8	0.556
d. Thickness of air space 20mm >	Up	2.6	0.385

THERMAL RESISTANCE OF AIR SPACES (M2.K)/W

Table 3: Thermal Resistance of Air spaces @ Mean 30°C with Temperature difference of 6°C

Direction of Heat Flow		Horizontal			Horizontal		
		20mm	40mm	100mm	20mm	40mm	100mm
Air space thickness in mm Orientation Vertical Walls	With e 0.80	0.15	0.15	0.15	0.15	0.15	0.15
	With e 0.50	0.21	0.22	0.22	0.21	0.22	0.22
	With e 0.20	0.37	0.40	0.38	0.37	0.40	0.38
	With e 0.05	0.57	0.64	0.60	0.57	0.64	0.60
		Upward (Heat loss)			Downward (Heat Gain)		
Air space thickess in mm Orientation 45˚ Pitch Roof Slope	With e 0.80	0.14	0.14	0.14	0.15	0.16	0.16
	With e 0.50	0.20	0.20	0.21	0.21	0.24	0.24
	With e 0.20	0.33	0.33	0.35	0.37	0.45	0.44
	With e 0.05	0.48	0.48	0.52	0.58	0.80	0.76
		Upward (Heat loss)			Downward (Heat Gain)		
Orientation Horizontal Roof Flat	With e 0.80	0.13	0.14	0.14	0.15	0.17	0.18
	With e 0.50	0.18	0.19	0.20	0.21	0.25	0.28
	With e 0.20	0.28	0.30	0.32	0.37	0.49	0.60
	With e 0.05	0.39	0.42	0.47	0.58	0.95	1.44

DEFINITION: "e" Emissivity - The ratio of power per unit area radiated by a surface to that radiated by a black body at the same temperature. A black body therefore has an emissivity of 1 and a prefect reflection has an emissivity of 0. THE EMISSIVITY OF A SURFACE IS EQUAL TO ITS ABSORBPTANCE

- Air spaces in combination with reflective surfaces are an effective barrier to heat flow.
- Depending on the orientation of the air space, the thickness and depth of the space is not always the defining factor, as can be seen in the table, that increasing the thickness of the airs space on a vertical plane beyond 40mm thick will not yield much improvement in thermal resistance.
- For sloped orientation there is some improvement in the upward direction yet less efficiency in a downward direction, although ever so slight.
- Increasing the air space thickness on an orientation horizontal plane from 40mm to 100mm thick has a positive impact for downward heat flow; there is however a very small gain in upward heat flow.

  As is shown in the table (Walls), by increasing the number of air spaces in combination with reflective foils results in greater resistance to heat flow.