INSULATION FOR SINGLE-LAYER ROOFS AND ENCLOSURES

Single-layer roof panels work best with reflective insulation. This type of insulation is flexible, lightweight and thin, and it usually comes in rolls, making it easy to transport and store.

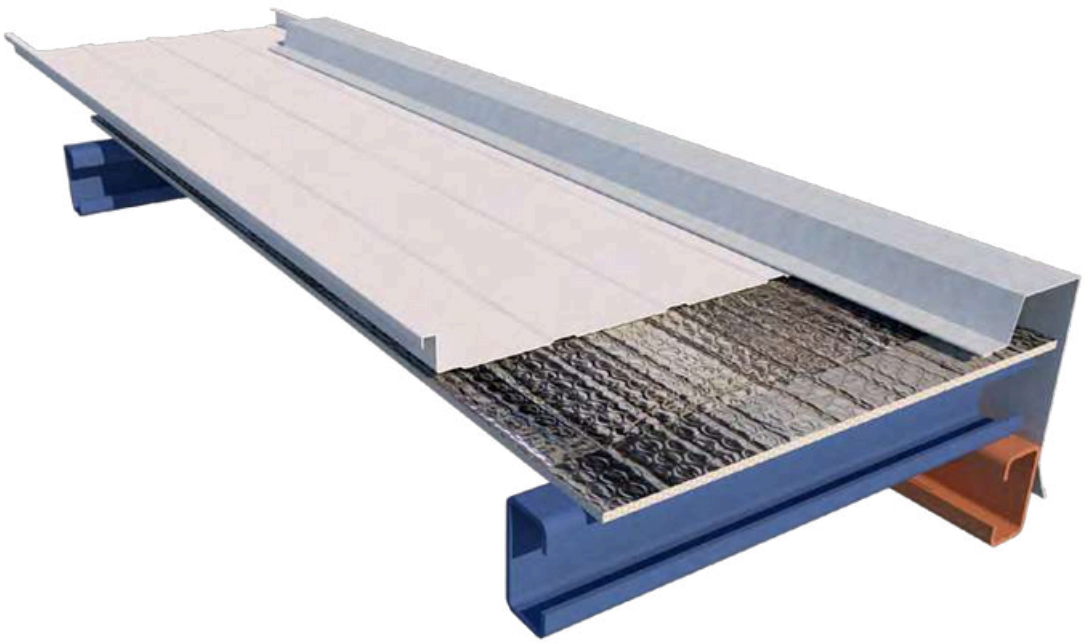
Despite its thinness, reflective thermal insulation has a low conductivity coefficient and offers good heat resistance.

As the insulation disrupts thermal bridges, heat is not transferred outdoors in the winter or indoors in the summer, providing for remarkable energy savings in heating and air conditioning.

Reflective insulation is very resistant to moisture and water, and to all their correlated problems such as mold or bacteria.

It also contributes acoustic insulation properties against aircraft and impact noises. Further, it is very durable, it does not lose its insu- lation properties with time, and it does not require frequent maintenance.

The main types of reflective insulation Cielo Vivo works with are bubble and closed cell.



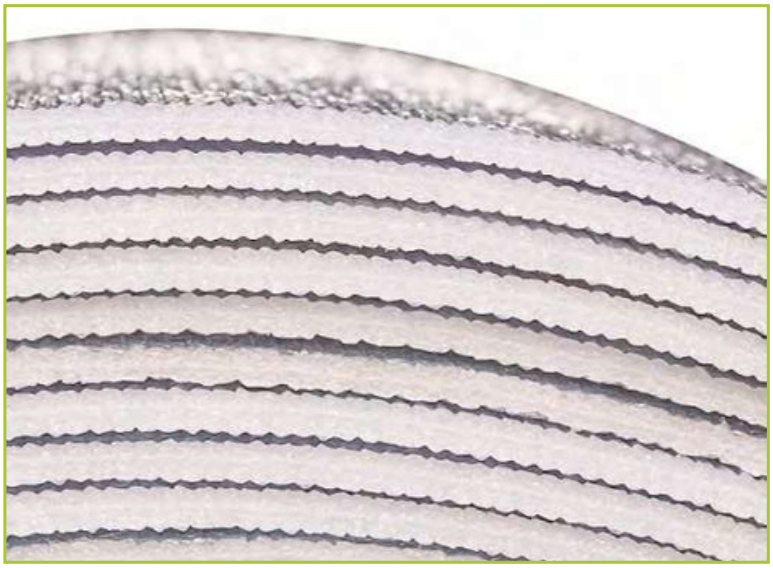
REFLECTIVE BUBBLE INSULATION

Consists of a layer of polyethylene bubbles or foam sandwiched between two layers of aluminum foil.

BUBBLE INSULATION TECHNICAL SPECIFICATIONS

	4 mm - POLYETHYLENE AIR BUBBLES + TWO LAYERS OF ALUMINUM POLYESTER	8 mm - POLYETHYLENE AIR BUBBLES + TWO LAYERS OF ALUMINUM POLYESTER	STANDARD
Thickness	4 mm–5 mm	8 mm–10 mm	
Dimensions	1.22 m W x 38.1 m L	1.27 m W x 20 m L	
Effective width	1.17 m	1.17 m	
Average weight per m2	0.149 g/m2	0.229 g/m2	
Water vapor permeability	Complies with		ASTM E96/CGSB-51.33-M89
Mold resistance	Does not promote mold/mildew growth		ASTM C1338 ASTM C1224
Delamination resistance	Complies with		ASTM C1224 ASTM C1224
R-value	R 14.7 Heat flow down	R 15.2 Heat flow down	ASTM C1224 ASTM C411
	R 6.1 Heat flow up	R 6.6 Heat flow up	ASTM E84 ASTM C1371
	R 8.0 Horizontal heat flow	R 8.5 Horizontal heat flow	
Temperature range	-32.9 °C to 381.6 °C		
Fire rating	Class 1 / Class A		
Emittance	0.06		

REFLECTIVE CLOSED-CELL INSULATION



Consists of a variable-width layer of closed microcell polyethylene foam sandwiched between two layers of aluminum foil or one layer of film and one layer of aluminum foil.

CLOSED CELL INSULATION TECHNICAL SPECIFICATIONS

	5 mm - CLOSED-CELL POLYETHYLENE FOAM + SINGLE ALUMINUM POLYESTER LAYER	10 mm - CLOSED-CELL POLYETHYLENE FOAM + SINGLE ALUMINUM POLYESTER LAYER	5 mm - CLOSED-CELL POLYETHYLENE FOAM + DOUBLE ALUMINUM POLYESTER LAYERS	10 mm - CLOSED-CELL POLYETHYLENE FOAM + DOUBLE ALUMINUM POLYESTER LAYERS	NORMA
Thickness Dimensions	5 +- 0.35 mm 1.22	10 +- 0.7 mm 1.27	5 +- 0.35 mm 1.22	10 +- 0.7 mm 1.27	
Effective width Average	m W x 20 m L	m W x 20 m L	m W x 20 m L	m W x 20 m L	
weight per m2 Water	1.17 m 0.214	1.22 m 0.374	1.17 m 0.374	1.22 m 0.414	
permeability Water	kg/m2	kg/m2	kg/m2	kg/m2	
vapor permeability Mold	Waterproof 0.033 g/m²·h·kPa | 0.05 perms				UEAtc
resistance Corrosion	(gr/ft²·h·inHg) Does not promote				ASTM E96 / IRAM 1735
resistance Crack	mold/mildew growth Complies with				ASTM C1338
resistance Delamination	Complies with Complies with Complies				ASTM C1224
resistance Moisture	with				ASTM C1224
resistance R-value					ASTM C1224
Temperature range Fire					ASTM C1258*
rating Smoke	R 9.56 (°F•ft²•h/BTU)		*A: 15.67 B: 21.12 (°F•ft²•h/BTU		ASTM C-236
development rating	-20 °C–80 °C			*A: 16.55 B: 31.01 (°F•ft²•h/BTU)	ASTM C1224
Emittance	0				ASTM E84-99
	15				ASTM E84-99
	0.3				ASTM C1371-98

*TEMPERATURE RANGE -20 °C–80 °C (ASTM C1224

INSULATION FOR COMPOSITE PANEL ROOFS AND ENCLOSURES

For composite panel roofs, there are several thermal and acoustic insulation options available on the mar- ket that can be fitted between two roofing panels.

A particular condition of this solution is that the thickness of the insulation material must not be less than the height of the standing seam, as the air gaps reduce the insulation capabilities of the panel.

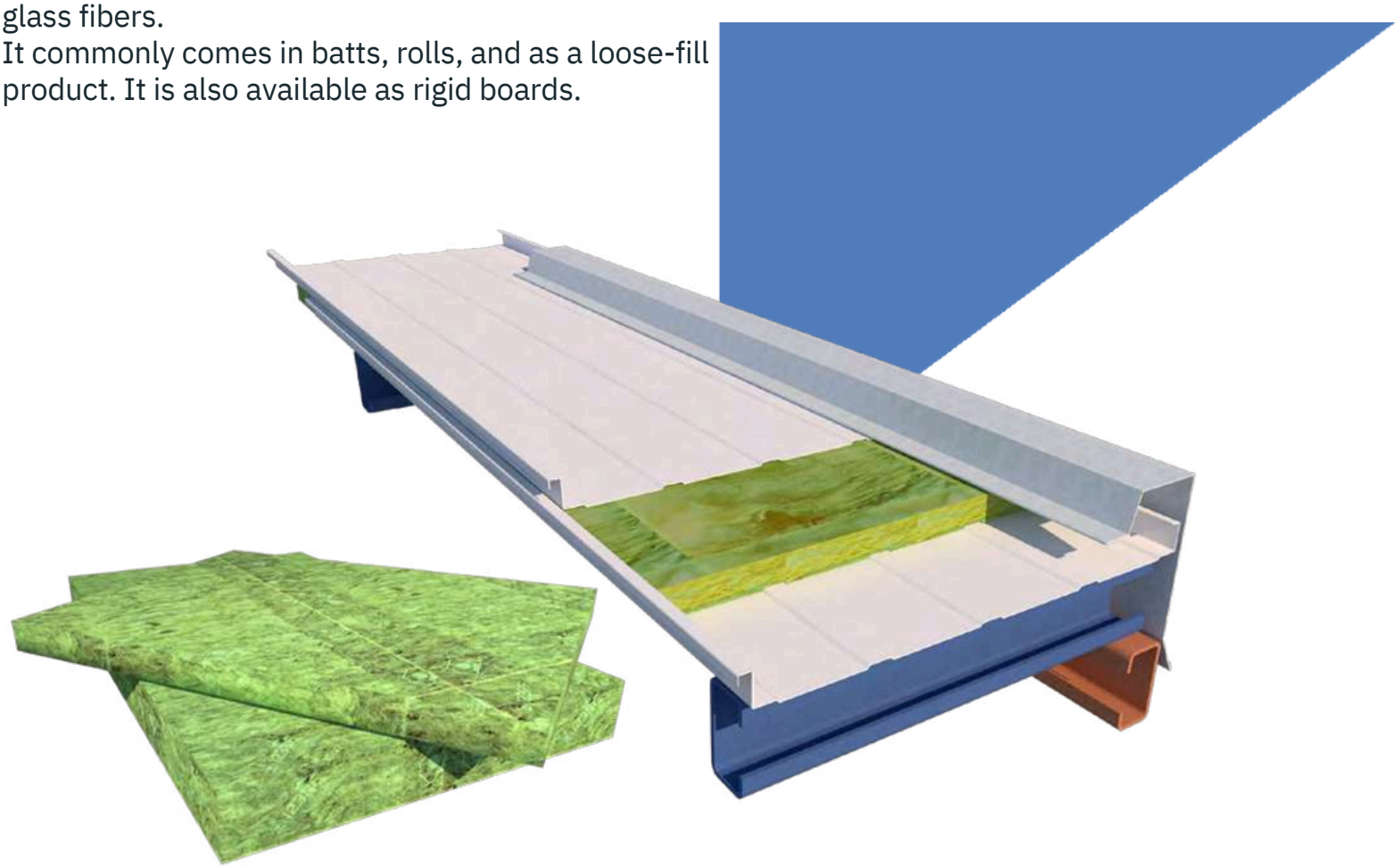
The type of insulation used in these panels is known as bulk insulation. Conventional bulk insulation materials can break up. the path of conductive heat flow (e.g., 25% of the total heat flowing into a building), slowing down or resisting the transmission of heat from one side of the material to the other.

Bulk insulation materials are generally evaluated in terms of their heat transfer (or thermal) resistance by assigning them a rating known as R-value.

Below are the most common types of bulk insulation we use at Cielo Vivo.

FIBERGLASS INSULATION

Fiberglass insulation is composed of extremely fine glass fibers.
It commonly comes in batts, rolls, and as a loose-fill product. It is also available as rigid boards.



ACOUSTIC PERFORMANCE IN OCTAVE BAND FREQUENCIES

3 ½" unfaced insulation*	Typical mounting	125	250	500	1000	2000	4000	NRC***
	Type-A**	0.34	0.85	1.09	0.97	0.97	1.12	0.95

*Material exposed to sound.
**Type-A mounting: Material installed near a solid partition, such as a brick wall.
***NRC=Noise Reduction Coefficient. Typical expected value according to comparable product ratings.

	UNFACED	PAPER-FACED	FOIL-FACED
DIMENSIONS	15.24 m (600") L x 1.22 m (48") W x 3.5" and 2.5" thick R	15.24 m (600") L x 1.22 m (48") W x 3.5" and 2.5" thick R 11	15.24 m (600") L x 1.22 m (48") W x 3.5" and 2.5" thick
THERMAL RESISTANCE (°F•ft²•h/BTU)	11(3.5") R 8 (2.5")	0,8 Type-A	R 11
NOISE REDUCTION COEFFICIENT (NRC)	0.85 (2.5") 1.05 (3.5") Type-A mounting	mounting	0,8 Type-A mounting
SURFACE BURNING CHARACTERISTICS	ASTM E84 – FS/SD 25/50		
PACKAGING	Compression-packaged rolls in poly bags		

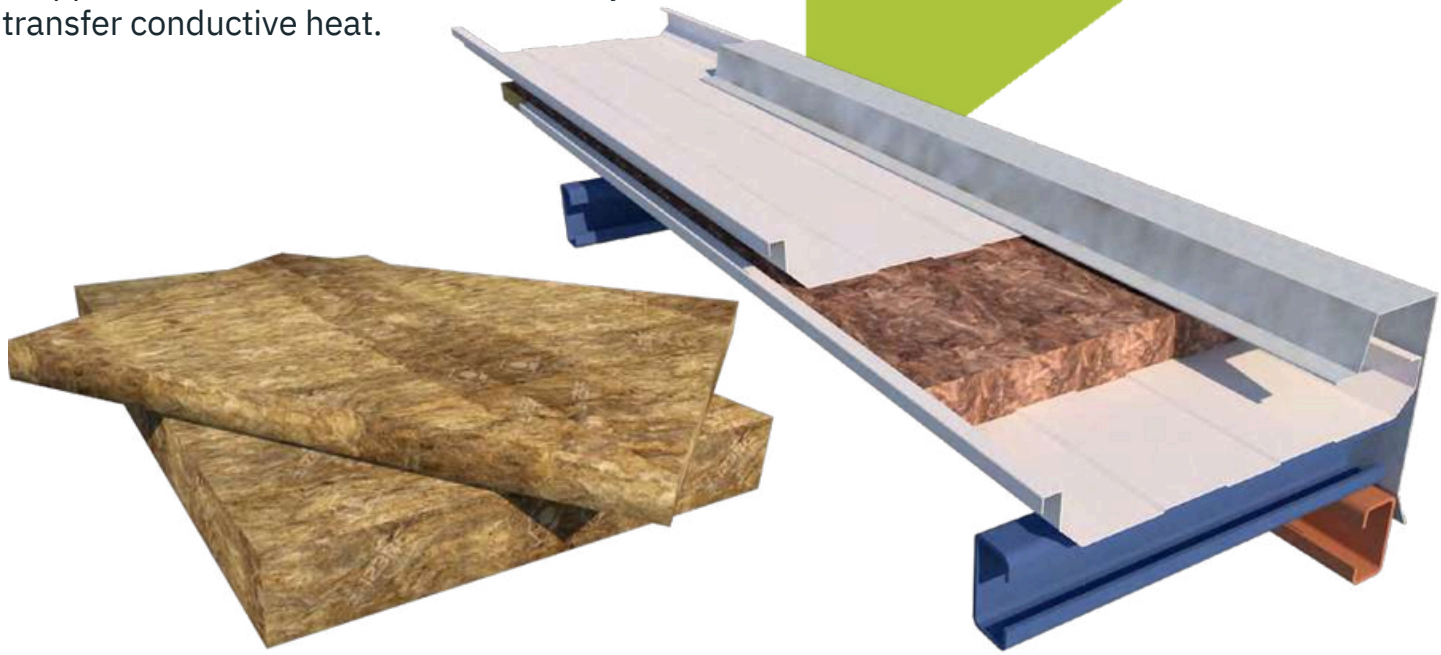
MINERAL WOOL INSULATION

Mineral wool insulation is composed primarily of natural rock.

As such, it is considered a sustainable material and it can also be recycled.

During the production process of the insulation mats, fibers are compressed, and air is trapped between them.

Trapped air reduces the material's ability to transfer conductive heat.



ASTM C518 TEST METHOD

Density	Thermal conductivity (k) @ 75 °F (24 °C) BTU•in/ft²•h•°F	R-value per inch of thickness*
2.5pcf	0.27	3.7
4.0 pcf	0.23	4.3

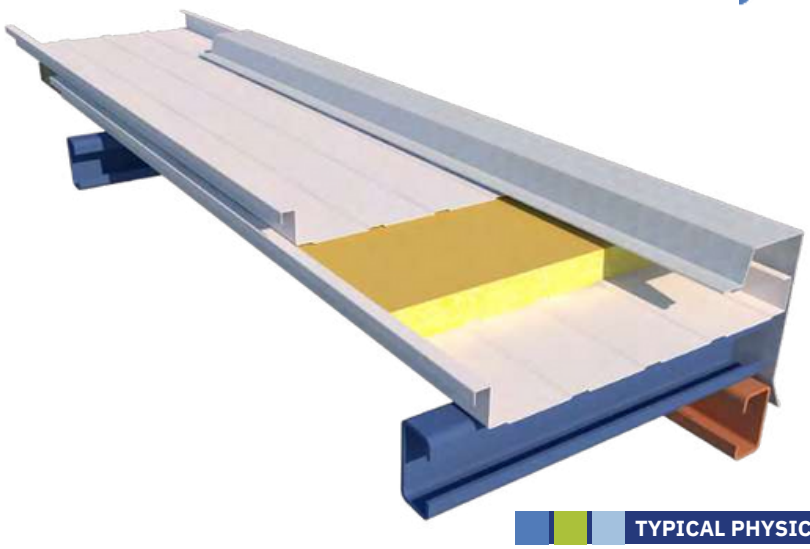
*R = thickness divided by "k"

ACOUSTIC BEHAVIOR

FREQUENCY COEFFICIENTS PER ASTM C423								
	THICKNESS	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	NRC
DENSITY 2.5 pcf	2"	0.34	0.61	1.07	1.09	1.07	1.1	0.95
	3"	0.51	0.99	1.18	1.03	0.99	0.96	1.05
	4"	0.83	1.19	1.27	1.12	1.12	1.13	1.20
	6"	1.37	1.32	1.23	1.16	1.12	1.12	1.20

POLYURETHANE AND POLYISOCYANURATE INSULATION

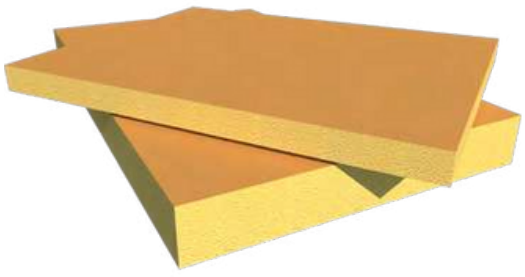
The main properties of these types of insulation in- clude high thermal resistance —allowing for thinner insulating panels—, rigidity and lightness, which facil- itate handling and installation. Rigid polyurethane foam (PUR) is an excellent thermal insulator with low thermal conductivity, light weight, high durability and optimal chemical and organic sta- bility. Rigid polyisocyanurate (PIR) is a variant of PUR foam with similar appearance and mechanical and thermal properties but offering greater fire and temperature resistance.



THERMAL AND PHYSICAL PROPERTIES

THICKNESS		LTTR	Max. Flute-Span Capability	
in	mm	(R-Value**)	in	mm
1.0	25.4	5.7	2 5/8	66.7
1.5	38.1	8.6	4 3/8	111
2.0	51	11.4	4 3/8	111
2.5	64	14.4	4 3/8	111
3.0	76	17.4	4 3/8	111
3.5	89	20.5	4 3/8	111
4.0	102	23.6	4 3/8	111
4.5	114	26.8	4 3/8	111

*Long Term Thermal Resistance (LTTR) values provide a 15-year time weighted average in accordance with CAN/ULC S770.
Note: Physical and thermal properties shown are based on data obtained under controlled laboratory conditions and are subject to normal manufacturing tolerances.



TYPICAL PHYSICAL PROPERTIES

PROPERTY	VALUE	MÉTODO DE PRUEBA
Water absorption, % by volume – 2 hrs. (under 1" [25.4 mm] of water)	1.5 max.	ASTM C209
Dimensional stability change, 7 days @ 158 °F (70 °C), 97% RH • Length + Width	<2%	ASTM D2126
Compressive strength – psi (kPa)	25 (172) nom. Grade 3 20 (138) nom. Grade 2	ASTM D1621
Tensile strength – psf (kPa)	≥ 500 (23.9)	ASTM C209
Moisture vapor transmission	<1.5 perm (85.8 ng/Pa s m2)	ASTM E96 (Procedure A)
Flame spread index1, 2	<75	ASTM E84
Service temperature	-100–200 °F (-73.3–93.3 °C)	

[1] Foam core only.
[2] These numerical ratings are not intended to reflect hazards presented by these or any other material under actual fire conditions.

POLYSTYRENE INSULATION

Polystyrene is a plastic derivative that is made from various petroleum-based products.

Expanded polystyrene (EPS) is marketed as an insulation material in the form of EPS rigid foam.

It is one of the most common materials used in roofing because in addition to having good thermo-acoustic properties, it is affordable and easy to transport and install, creating significant saving for composite panel roofing projects.

BOARD THICKNESS		R-VALUE		
mm	in	Dens. 12 kg/m³	Dens. 15 kg/m³	Dens. 20 kg/m³
25	1″	3.59	3.84	4.06
32	1.25″	4.6	4.91	5.19
38	1.5″	5.46	5.83	6.16
50	2″	7.19	7.67	8.11
63	2.5″	9.06	9.67	10.22
75	3″	10.78	11.51	12.17
95	3.5″	13.66	14.58	15.41
100	4″	14.38	15.35	16.22
125	5″	17.97	19.18	20.28
150	6″	21.56	23.02	24.34
175	7″	25.16	26.86	28.39
200	8″	28.75	30.69	32.45
Fire resistance Flame spread index	Complies with: DIN 4102 Class B1, ASTM E84 and IBC 2009 Section 2603, NBC 3.1.14.2.1 and CAN/ULC-S126			
Smoke spread index	10, according to ASTM E84			
Temperature range	Between 15 and 40, depending on thickness, according to ASTM E84			
Production standard	-100 °C–75 °C, ASTM C1258, up to 85 °C for short periods			
Water absorption	According to ASTM C578			
Mold resistance	After being submerged for 1 month, less than 4% by volume			
	Resistant			