

Product Information Bulletin

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Thermal Resistance of SIP Panel Core Material

The thermal resistance of an insulation material is expressed as R-Value (inch-pound units) or RSI-Value (SI System). Thermal resistance is a relative measure of the ability of the insulation material to resist heat flow through it. A higher R-Value/RSI-Value indicates a greater resistance to heat flow.

Heat transfer for all cellular plastic insulation materials occurs through three distinct mechanisms: convection, radiation and conduction¹.

- 1) Heat transfer by convection occurs due to a temperature difference between two surfaces in the direction of heat flow - in the case of cellular plastics between the cell walls. Because the cell size is small in foam plastic insulation such as EPS, the temperature difference is very small and heat transfer as a result of convection is minimal.
- 2) Heat transfer by radiation occurs through cell walls. Lighter density cellular plastics, as well as thinner sections, are especially subject to heat transfer through radiation, because the cell walls are more transparent to radiation. However, as density and thickness increase, the contribution to heat transfer as a result of radiation decreases.
- 3) Heat transfer by conduction occurs in foam plastic insulation through both the gas and solid portions of the foam. Since gases occupy approximately 90 to 98 percent by volume of insulation, conduction through the gas portion is by far the most significant. Therefore, the thermal conductivity of the gas within the cellular structure affects the thermal resistance value of the foam plastic insulation.

The closed cell structure of EPS insulation contains only air. For this reason, ***the thermal resistance of EPS insulation does not decrease with age.*** Other types of foam plastic insulation are manufactured with the intent to retain a blowing agent, other than air, for a period longer than 180 days. The captive blowing agents used typically have a lower thermal conductivity than air in order to yield a foam plastic insulation with a higher thermal resistance value. However, since the insulation material is not enclosed within a gas impermeable barrier, eventually some of the gas in the cells diffuses out and is replaced by air. This phenomenon is known as thermal drift.

Polyurethane foam insulation used by some SIP manufacturers contains a captive blowing agent within its cellular structure. However, since the facers used for SIP manufacture are not gas impermeable barriers, the thermal resistance value will be subject to thermal drift. CAN/ULC-S770² published by the Underwriters' Laboratories of Canada (ULC) provides a test method for determining the long-term thermal resistance value for design purposes. As per CAN/ULC-S705.1-01³, Amendment 2 published in June 2005, the long term thermal resistance of polyurethane foam insulation at a mean temperature of 24 °C is 0.90 to 1.00 m²•°C/W for a 25-mm insulation thickness (R-5.19 to 5.77 ft²•hr•°F/BTU per inch). The long term (design) thermal resistance is the value after thermal drift has occurred.

¹ Heat Transfer through Elastomeric Foams - A Review; Ghourish Sirdeshpande, J.C. Khampara, Volume 66.

² National Standard of Canada, ***Standard Method of Test for Determination of Long Term Thermal Resistance of Closed-Cell Thermal Insulation Foams***

³ CAN/ULC-S705.1-01, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density, Material Specification.

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