Plasti·Fab®
EPS PRODUCT SOLUTIONS
Better building ideas from PFB™

Product Information Bulletin

BULLETIN NO.	314
ISSUED:	August 25, 2017
REPLACES:	May 6, 2016

ASTM Long-Term Thermal Resistance (LTTR) of Foam Plastic Insulation

Thermal resistance (R-value) is a relative measure of the ability of a material to resist heat flow through a given area as a result of a temperature difference from one side to the other of the material with a higher R-value indicating greater resistance to heat flow.

Heat transfer for all cellular plastic insulation materials occurs through three distinct mechanisms convection, radiation and conduction[1] as follow:

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 expanded polystyrene (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 gas within the closed cell structure of EPS insulation is air. However, some types of foam plastic insulation are manufactured with a gas (blowing agent), other than air, that is intended to be retained within their cellular structure.

The blowing agents used typically have a lower thermal conductivity (higher thermal resistance) 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 the blowing agent within the cellular structure diffuses out and is replaced by air over time as the gases within the cellular structure reach equilibrium with the environment. This phenomenon is known as thermal drift.

Long-term thermal resistance (**LTTR**) is defined as the thermal resistance of an insulation product containing a gas or mixture of gases, **measured or predicted** at standard laboratory conditions, and intended to be equivalent to the thermal resistance resulting from gas exchange with ambient air **after storage for 5 years at these conditions**. **LTTR** is typically reported based upon calculations and tests performed at an average temperature of 75 ± 2°F.

---

[1] Sirdeshpande, Gourish and Khanpara, J. C., ***Heat Transfer Through Elastomeric Foams - A Review***, Volume 66, Rubber and Chemistry Technology.

Reporting of **LTTR** values is applicable to foam plastic insulations manufactured with the intent to retain a blowing agent, other than air, for a period longer than 180 days. Examples of foam plastic insulations for which **LTTR** applies are extruded polystyrene (XPS), polyisocyanurate (PIR) and closed-cell spray polyurethane (PUR) insulation.

US codes reference test methods and material specifications published by ASTM International (ASTM). The ASTM test method used to determine and report **LTTR** of foam plastic insulation is C1303/C1303M, ***Standard Test Method for Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation***. Reference to ASTM C1303 has been adopted into a number of ASTM foam plastic insulation specifications, but **there are no minimum LTTR compliance values in any ASTM specifications** and not all specifications include reporting requirements.

ASTM C578, ***Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation*** and ASTM C1289, ***Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board*** have adopted a requirement that **LTTR is to be determined and reported** in accordance with tests performed using C1303 or CAN/ULC-S770, ***Standard Test Method for Determination of Long-Term Thermal Resistance of Closed-Cell Insulating Foams***, a National Standard of Canada published by Underwriters' Laboratories of Canada (ULC). However, again **there are no minimum LTTR compliance values in either specification**.

It should also be noted that C1303 and S770 are accelerated laboratory test methods for ***predicting*** **LTTR**. While development of these test methods is a step forward for the foam plastic insulation industry, **LTTR only predicts the R-value for products like XPS, PIR and PUR insulation after *5 years in service***. The **actual long-term R-value** for foam plastic insulations to which LTTR is applicable **continues to decrease with time of service in an application as they continue the process of gas exchange with ambient air** – i.e., they continue to lose blowing agent from within their cellular structure. See Plasti-Fab PIB 288 for more information on actual **LTTR** for PIR insulation.

The above LTTR requirements are **not applicable to Plasti-Fab EPS insulation** manufactured to ASTM C578 since EPS insulation thermal resistance does not depend upon a blowing agent within the rigid closed cell structure. ***EPS insulation design thermal resistance does not change with time of service in an application.***