Product Information Bulletin

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NBC 2010 - Long-Term Thermal Resistance (LTTR) of Foam Plastic Insulation

Thermal resistance (RSI or 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 RSI/R-value indicating greater resistance to heat flow. The National Building Code of Canada (NBC) 2010 and 2015 require RSI/R-value for insulation to be determined based upon calculations and tests performed at an average/mean temperature of 24 ± 2 °C and under a temperature differential of 22 ± 2°C.

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. <u>Since gases occupy approximately 90 to 98 percent by volume of insulation, conduction through the gas portion is by far the most significant.</u> 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.

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

National Standards of Canada (CAN) for foam plastic insulation published by Underwriters' Laboratories of Canada (ULC) are referenced in the NBC 2010 and 2015. All CAN/ULC foam plastic insulation standards include **minimum LTTR compliance values**.

Long-term thermal resistance (**LTTR**) of foam plastic insulation is defined as follows:

> *The design thermal resistance of an insulation product containing a gas or mixture of gases, measured or predicted at standard laboratory conditions, equivalent to the thermal resistance resulting from gas exchange with ambient air after storage for 5 years at these conditions.*

LTTR are to be used for design purposes as follows:

> *All cellular plastic insulations manufactured with the intent to retain a blowing agent, other than air, for a period longer than 180 d, shall be tested for long-term thermal resistance (LTTR) in accordance with CAN/ULC-S770, Standard Method of Test for Determination of Long-Term Thermal Resistance of Closed-Cell Thermal Insulating Foams.*
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> *The measured LTTR value shall be the design thermal resistance value.*

Note: NBC 2010, Table A-9.36.2.4.(1)-D, note 6 {NBC 2015, note 8} includes the above requirements and states "***This LTTR value shall be input as the design thermal resistance value for the purpose of energy calculations in Section 9.36. Product standards contain a baseline LTTR for a thickness of 50 mm, from which the LTTR for other thicknesses can be calculated.***" NBC 2010 and 2015, Table A-9.36.2.4.(1)-D provide LTTR values for a thickness of 50 mm, from which the LTTR for other thicknesses can be calculated.

CAN/ULC-S770 is an accelerated laboratory test method that provides a means for ***predicting*** the **LTTR** of applicable foam plastic insulation. Examples of foam plastic insulations for which **LTTR** applies are extruded polystyrene (XPS), polyisocyanurate (PIR) and closed-cell spray polyurethane (PUR) insulation.

It should be noted that while CAN/ULC-S770 is a step forward, **it only predicts the LTTR for products like XPS, PIR or PUR insulation after 5 years in service**. The **actual long-term RSI/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.

LTTR requirements are not applicable to Plasti-Fab EPS insulation manufactured to CAN/ULC-S701, ***Thermal Insulation, Polystyrene, Boards and Pipe Covering***, 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.***

Note: NBC 2010, Table A-9.36.2.4.(1)-D, note 8 {NBC 2015, note 9} confirms that LTTR is not applicable to EPS insulation as follows: "***Expanded polystyrene insulation is not manufactured to be able to retain a blowing agent; it is therefore not necessary to test its LTTR.***"