EPS Insulation Advancements
& Technology Innovations

TECHNICAL BULLETIN

LTTR & Aged R-Value Understanding the Differences

Thermal insulation is vital to the conservation of energy used in the heating and cooling of buildings. Insulation products come in many forms, such as loose fill, insulation batts, and rigid plastic foams, to name a few. Each have performance characteristics that make them well suited to particular applications.

The use of rigid plastic foam insulation materials, such as polyisocyanurate, spray polyurethane, expanded polystyrene (EPS), and extruded polystyrene (XPS), is a versatile and cost-effective way of improving the thermal efficiency of buildings. While EPS and XPS are chemically alike – both are polystyrene, they also differ in important ways. Most notably, XPS has low conductivity (refrigerant) gasses in the foam cells, while EPS has air in the foam cells.

Because gasses leave the XPS over time and there are no such gasses in EPS, they differ in their thermal resistance, or R-value, over time. With buildings designed and built with a life expectancy of 50 years or more, the insulation's performance over the lifespan of the building becomes critical to determining its lifetime energy performance.

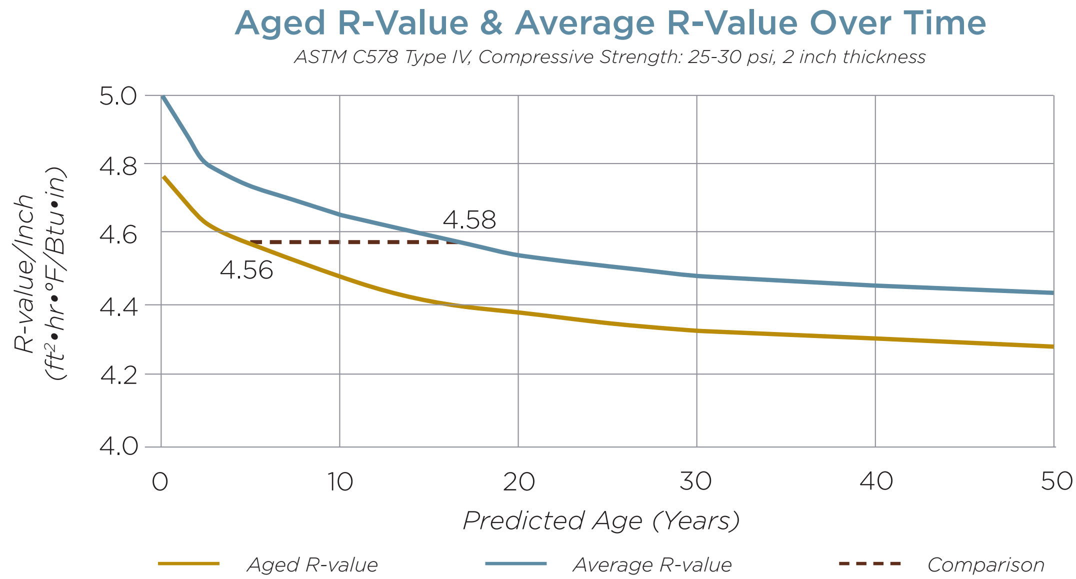
To address the aging of the R-value, Long-Term Thermal Resistance (LTTR) test methods have been developed to predict the aged R-value of insulations with retained blowing agents. The test methods are ASTM C1303 and CAN/ULC-S770. Each method involves cutting thin slices from the full insulation thickness. With exchange of the retained gas for air occurring more rapidly in the thin slices, the aged R-value of the full thickness of insulation can be predicted from this accelerated aging without waiting years between R-value tests.

The test methods can be used to determine the aged R-value at any point in time, such as at 5-, 25-, or 50-years following manufacture. They can also be used to predict the average R-value for the insulation over any time period. The methods prescribe the predicted 5-year aged R-value as the LTTR value to be used to enable comparisons between test specimens and insulation products.

LTTR Definition

The test methods, ASTM C1303 and CAN/ULC-S770, characterize LTTR somewhat differently, though equivalently:

- *ASTM C1303, Section 5.4: The values produced by the Prescriptive Method [for determining LTTR] correspond to the thermal resistance at an age of five years, which corresponds closely to the average thermal resistance over a 15-year service life.*
- *CAN/ULC-S770, Section 3.3: 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.*



Applying ASTM C1303, a sample of XPS insulation obtained commercially was evaluated and the predicted aged R-value determined. A comparison was made between the 5-year (point-in-time) aged R-value and the 15-year average R-value to demonstrate their equivalence as noted in ASTM C1303, Section 5.4. The 5-year aged R-value of 4.56 agreed quite well with the 15-year average R-value of 4.58 (see chart above).

The chart above reveals a common misconception concerning LTTR, namely that the test method predicts the product performance at 15 years. In reality, the product performance is much lower by year 15, as the "average" reported by the method includes performance of the product from the first year before any significant amount of the low conductivity gasses have permanently escaped.

While LTTR identifies the decreased R-value, it does not quantify the aged R-value at the life expectancy of the building, unless the life expectancy is only 5 years.

The chart above also reveals that when a building is 50 years old, 1 inch of XPS insulation will have an R-value that approaches that of 1 inch of EPS insulation (ASTM C578: Type VIII, II). Thus, the designer could use a similar thickness of EPS in the building design, avoid the gas emissions from the XPS into the environment, and be confident in the performance of the installed insulation over the entire lifetime of the building. If, however, XPS remains specified in the design, the XPS thickness should be increased to compensate for the eventual loss in performance. This thickness would approximate that needed for EPS to achieve equivalent performance.

In determining the thermal performance of a building design, architects and specifiers need to understand the aged R-value at the end of the expected lifespan of the building to assure that the building envelope's performance will meet the design targets throughout its lifetime. The 50-year R-value, not the 5-year LTTR data point will enable the proper design. Reliance on the 5-year LTTR value as a design criterion will likely be misleading for XPS insulation with a service life greater than 5 years.