Product Information Bulletin

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Facts About Thermal Resistance of Reflective Insulation

Reflective insulation materials have been on the market since at least the early 1980s. Two common types currently being marketed consist of either a moulded expanded polystyrene (EPS) insulation board that is faced with reflective foil or a bubble pack core material faced with reflective foil.

A number of manufacturers have obtained CCMC evaluation listings for EPS insulation with a reflective foil facer. The evaluation of these materials is based upon compliance with the National Standard of Canada for EPS insulation, CAN/ULC-S701, ***Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering***. The thermal recognized resistance value for the listed products is the minimum value required for EPS insulation conforming to CAN/ULC-S701, type 1– i.e. RSI-0.65 m^2·°C/W per 25-mm (R-3.75 ft^2·hr·°F/BTU per inch).

General requirements and physical properties of reflective insulation are addressed in ASTM C1224-11 ***Standard Specification for Reflective Insulation for Building Applications.*** This specification states clearly in the scope section that: "***Reflective insulations derive their thermal performance from surfaces with an emittance of 0.1 or less, facing enclosed air spaces.***" The specification includes requirements that the thermal performance of reflective insulation shall be determined in accordance with ASTM Test Method C1363 and provides specific description of test criteria. One of the key requirements of the thermal performance test shall be performed at a cavity mean temperature of 75 ± 4°F (24 ± 2°C) with a temperature difference across the insulated cavity of 30 ± 2°F (16.7 ± 1°C).

ASTM C1224 is not referenced in the 2009 International Residential Code (2009 IRC). There is no National Standard of Canada for reflective insulation and ASTM C1224 is not referenced in the National Building Code of Canada 2010 (NBC2010). The NBC 2010 and Provincial Building Codes do not recognize reflective insulation on its own as an acceptable insulation material. In fact, Sentence 2.1.1.1.(5) of the 2006 Ontario Building Code, Supplementary Standard B-12, Energy Efficiency for Housing, states the following: "***Reflective surfaces of insulating materials shall not be considered in calculating the thermal resistance of building assemblies.***"

The NBC 2010 addresses reflective insulation as follows:

- Footnote 4 to Table A-9.36.2.4.(1)D., ***Thermal Resistance Values of Common Building Materials***, the 2010 NBC states:

  Reflective insulation material may contribute a thermal property value depending on its location and installation within an assembly. Where a value is obtained through evaluation carried out in accordance with Clause 9.36.2.2.(4)(b), it may be included in the calculation of the thermal resistance or transmittance of the specific assembly.

- NBC 2010, Clause 9.36.2.2.(4)(b) states

  The effective thermal resistance of opaque building assemblies shall be determined from
  a) calculations conforming to Article 9.36.2.4., or
  b) laboratory tests performed in accordance with ASTM C 1363, "Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus," using an indoor air temperature of 21±1°C and an outdoor air temperature of -35±1°C.

Thermal Performance

Test data is available to quantify the thermal performance of reflective insulations using ASTM C1363 as specified in the NBC 2010.

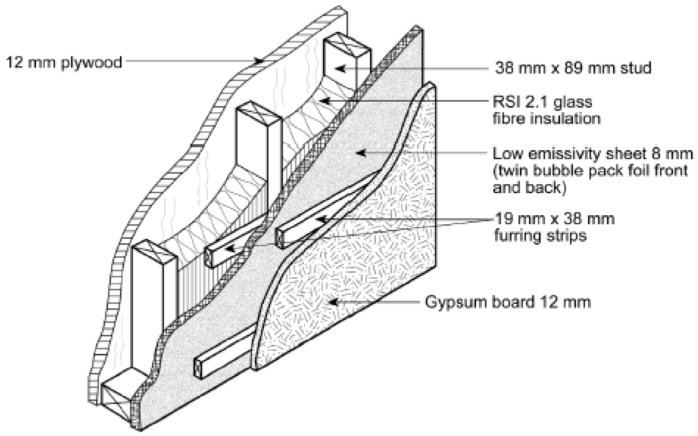

Figure 1 - CCMC Evaluated Wall Assembly

The Canadian Construction Materials Centre (CCMC) has evaluated a number of reflective insulation wall systems in the past. The basis for evaluation was testing using ASTM C1363.

Figure 1 provides details of one CCMC evaluated wall assembly containing reflective insulation. The wall assembly in this detail consists of a low emissivity reflective material on the "warm" side of the wall assembly, a sealed air space on each side of the reflective material and RSI-2.1 (R-12) glass fibre insulation in the 89 mm (3 ½") stud space

This wall system had a thermal resistance value of RSI-3.41 (R–19.37). The wall system was tested in accordance with ASTM C1363 with a room side air temperature of 20°C a and weather side air temperature of -35°C.

The test results evaluated by CCMC were used to benchmark a mathematical model that was then used to analyze the thermal performance of the wall system under the reported air temperature differential. The report for this product indicated that the thermal resistance of the low emissivity reflective material, including two 19-mm (3/4") air spaces and furring assembly, was RSI-1.15 (R-6.53). About 14% of this thermal resistance was attributable to radiation heat transfer as a result of the low emissivity of the foil surfaces. The CCMC report indicated that if the emissivity of the surfaces of the foil-faced sheet material were to be changed to 0.9 from 0.04, the thermal resistance of the airspaces and furring assembly with low emissivity reflective material would decrease to RSI-0.55 (R-3.12), mainly due to the increase in heat transfer by radiation.

The thermal performance of reflective insulation with air spaces is also discussed in an article in **Home Builder** magazine written by *M.C. Swinton,* a research officer in the Building Performance Laboratory of the Institute for Research in Construction/Na*tional* Research Council Canada. The article entitled ***Radiant Barriers and Reflective Insulation***, highlights the fact that the thermal performance of reflective insulations is dependent upon having low-emittance facing materials in combination with a perfectly sealed air space in the construction.

Canada Housing and Mortgage Corporation (CMHC) also published a Research Highlight entitled, ***Comparison of Under-Floor Insulation Systems*** (Technical Series 04-127) in October 2004. This CMHC research highlight evaluated the thermal resistance of a double-layer bubble pack with an intermediate foil layer in an under-floor application and found it to be RSI-0.40 (R-2.27).

So why is there a difference in stated and actual performance? There are several reasons:

1. Many marketers of reflective insulations make generalized efficiency and performance claims based on very specific test configurations performed in "lab" conditions.
2. The critical installation details used for tested assemblies are not easily achieved in an actual application.
3. Claimed thermal resistance values are for the total construction including thermal resistance of inside and outside air films and sealed air spaces.

The above test conditions are normally not even reported by the reflective insulation marketers.

Surface Emissivity Value

As noted above, the emissivity value of the foil surface plays an important roll in the thermal resistance of reflective insulation. Reflective insulation manufacturers typically base their product performance claims on new materials with a bright foil surface. However, normal deterioration due to aging, dust accumulation, surface oxidation or exposure to polluted environments can increase the surface emissivity, which, in turn, decreases the thermal performance. The presence of light condensation can also increase the surface emissivity substantially.

ASHRAE Chapter 25 states "*Values for foil insulation products supplied by manufacturers must also be used with caution because they apply only to systems that are identical to the configuration in which the product was tested. In addition, surface oxidation, dust accumulation, condensation, and other factors that change the condition of the low-emittance surface can reduce the thermal effectiveness of these insulation systems.*" This is the reason product evaluations recognize the thermal resistance of the insulation material alone. When the contribution of the reflective surface is recognized in an evaluation report, a complete description of the tested building system is provided.

Dead Air Space

Typical installation instructions from reflective insulation manufacturers discuss the value of "dead air space" in thermal performance. In actual application, heat transfer across an air space involves conduction, convection and radiation and is usually reported as one combined value. However, in order for these dead air spaces to be effective with reflective insulation, they must be sealed to prevent any air movement. Creating a true, leak-free uniform air space in an actual application is very difficult to accomplish.