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Cellulose: Building Insulation with High Recovered Content, Low Embodied Energy

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Abstract

Building insulation is an inherently "green" building material, because of its energy-conservation attributes. A compelling case can be made that cellulose insulation is the "greenest of the green" insulation materials. Cellulose is an inherently recycled material with low embodied energy that typically delivers superior installed performance.

Keywords: Insulation, energy saving, cellulose, recycled products

Recycling

Cellulose building thermal insulation is a recycled product made from recovered newsprint and other paper (wood fiber) feedstocks. Paper, especially newsprint, represents one of the largest single components of the residential waste stream, and a major disposal problem for communities throughout the nation. Insulating a typical 1,500 square foot ranch-style home with cellulose insulation productively recycles as much newsprint as an individual will consume in 40 years.[1] If America's new homes were insulated with cellulose, over 3.2 million tons of waste newsprint could be removed from the waste stream every year and put to productive use conserving vital energy resources. This projection is based on 1.5 million new homes with an average area of 1,500 square feet, insulated to R-30 in the attics and R-13 in the side walls.[2] If more stringent insulation standards, such as those of the Model Energy Code, were followed more recyclable material would be removed from the waste stream.

Energy Conservation

Just as significant as its recycling advantage is the superiority of cellulose as an insulating material. Many independent insulation authorities agree that cellulose is the best fiber thermal insulation, and an impressive body of scientific research supports this belief. Studies at Oak Ridge National Laboratory have proven that cellulose is not subject to the convective effects that degrade the actual R-value of other loose-fill fiber insulation materials at low attic temperatures. Using the Large Scale Climate Simulator at Oak Ridge, scientists have found that the effective R-value of tested mineral fiber insulation dropped from approximately R-18 at +45 degrees F to R-11.1 (and in one test run to R-9.2) at -18 degrees F. Over a similar temperature range nominal R-19 cellulose showed a slight R-value gain of about 10 percent.[3,4]

Cellulose has long been regarded as superior to other fiber insulation materials in sealing the building envelope against air infiltration. This characteristic, which has been informally reported by a number of authorities, was studied by researchers at the University of Colorado at Denver in the winter of 1989-90. Two structures identical in every respect, except for the insulation systems used, were built. One building was insulated with R-19 of wet-spray cellulose in the walls and R-30 of loose-fill cellulose over the ceiling. The second building was insulated with R-19 unfaced mineral fiber batts in the walls and R-30 kraft-faced batts over the ceiling. Blower door tests demonstrated that cellulose insulation tightened the building 36 to 38 percent more than the mineral fiber material.

After recording the actual energy performance of the buildings over a period of many weeks the researchers reported that the cellulose-insulated structure had used 26.6% less energy for heating and they stated: "The research suggests that the performance of cellulose versus fiberglass is as much as 38 percent better. Cellulose achieves a tighter building cavity, allowing less heat loss due to air infiltration and its overall performance appears to be about 26 percent better in tempered climates. It may be concluded that this benefit would become more significant in more severe climates."[5]

Additional energy efficiency factors

Cellulose not only insulates better than mineral fiber materials, it has two other important energy advantages. The first is less “embodied energy.” Mineral fiber insulation is produced in furnaces that burn natural gas and release greenhouse gases into the atmosphere. These furnaces burn day and night, month after month, regardless of how much insulation is needed. Cellulose is produced in electrically-driven mills. They consume relatively little energy when they are operating, and no energy once the production day ends.

On a strictly theoretical basis it can be calculated that “R” for “R” mineral fiber insulation takes 15 to 20 times more energy to make than cellulose insulation. Data reported to the Canadian Standards Association suggest mineral fiber production actually requires 59 times more energy than cellulose production, on a pound for pound basis.[6] Adjusting for weight differences, mineral fiber materials take at least 25 to 30 times more energy to make than cellulose of equivalent R-value.

Adding to the “embodied energy” advantage of cellulose is the fact that most cellulose insulation is made with a high percentage of locally-generated raw materials. Other than the fire retardants, which are about 20 percent of cellulose insulation by weight, it is not necessary to transport feedstocks long distances to cellulose insulation plants. In addition, recycling newsprint locally as cellulose insulation makes it unnecessary to expend energy transporting it to distant landfills or deinking plants.

Safety

Because it is an organic material cellulose is treated with fire retardants. It is the only common wood fiber-based residential and light commercial construction material that always receives such treatment. This makes cellulose insulation one of the safest construction materials on the market. Studies of actual fires and demonstration burns have proven that the dense fiber structure of cellulose and the fire retardants slow the spread of fire through a building, giving occupants more time to escape and fire fighters more time to save the structure.[7] Scientists at the National Research Council Canada have reported that cellulose insulation increases the fire resistance of insulated building assemblies by 22% to 55%. In contrast, fiber glass insulation decreases the fire resistance of assemblies identical in every way, except for the insulation.[8]

Tests, studies and literature reviews by such diverse organizations as Tennessee Technological University, the University of California, Allied Signal Corp., US Borax, United States Testing Company, and Underwriters Laboratories have confirmed that cellulose insulation retains its fire retardant properties over time.[9,10,11,12,13,14,15] Three of these reports were based on insulation from actual attics with installed ages ranging from 4 to 14 years.

Technology

Cellulose has been regarded as a relatively low technology product, but today's cellulose insulation and installation technology is actually highly sophisticated. Light density cellulose insulation is an example of this sophistication. In the 1980s 2.6 pounds per cubic foot was a typical settled density for cellulose. Today conventional cellulose products with settled densities of 1.5 to 1.7 pcf are common. Several producers offer material for attic installation that uses adhesive and a small amount of water to limit settling. These products are marketed under various brand names, and are sometimes referred to as “stabilized cellulose." Stabilized cellulose may have a settled density as low as 1.3 pcf.

Traditionally “open blow” installation of any insulation has been a dusty process, and cellulose has been regarded as especially dusty. Now low-dust cellulose for blown installation is available. This material produces virtually no visible dust during installation, resulting in a much cleaner job and more pleasant working conditions for installers.

Wet-spray cellulose, which is installed in wall cavities and covered by sheet rock, is one of the fastest-growing insulation products in new construction. This material is much more effective in preventing air infiltration than insulation batts, as the Colorado study demonstrated, and it is not subject to settling.

Settling is the subject of much misconception. All loose-fill insulation settles to some extent. Sellers of other insulation materials occasionally attempt to mislead consumers by stating that the R-Value of cellulose insulation decreases as the material settles. It does, but under federal law and in accordance with the accepted industry standard, cellulose insulation R-values and coverage data are always stated at settled density. Far from being “cheated” out of R-Value as the insulation settles, home owners with cellulose systems actually benefit from bonus R-Value until the material reaches settled density.

Standards & specifications

Cellulose insulation is covered by the following government and industry standards.

16 CFR Part 1209 — This is the consumer products safety commission safety standard that covers four product attributes, settled density, corrosiveness, critical radiant flux (a measure of surface burning), and smoldering combustion. It is illegal to market cellulose insulation that does not conform with this section of the Code of Federal Regulations.

ASTM Standard C-739 — This is the industry standard for loose-fill cellulose insulation. It covers all the factors of the CPSC regulation and five additional characteristics.

ASTM Standard C-1149 — The industry standard for self-supported spray-applied cellulose insulation for exposed or wall cavity application.

16 CFR Part 460 — This Federal Trade Commission regulation, commonly known as the "R-Value Rule," is intended to eliminate dishonest or misleading insulation marketing claims and to insure publication of accurate R-Value and coverage data.

State Regulations — The states of California and Minnesota have state laws and regulations that apply to cellulose insulation and other insulation products. In the case of cellulose both states base their legal requirements on the ASTM standards.

HH-I-515E — Federal government purchasing agents and specifiers working on federal projects should reference this General Services Administration specification. It requires conformance with ASTM C-739, but adds certain standard federal packaging and marking requirements.

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