Generic Cellulose

Product Selection and Description

Blown cellulose insulation is produced primarily from post-consumer wood pulp (newspapers), typically accounting for roughly 85 % of the insulation by weight. Cellulose insulation is treated with fire retardant. Ammonium sulfate, borates, and boric acid are used most commonly and account for the other 15 % of the cellulose insulation by weight.

BEES performance data are provided for thermal resistance values of R-13 for a wall application and R-38 for a ceiling application. The amount of cellulose insulation material used per functional unit is shown in the following Table, based on information from the Cellulose Insulation Manufacturers Association (CIMA) and the U.S. Department of Energy.

Table 1: Blown Cellulose Insulation by Application

Application	***Thickness cm (in)***	***Density kg/m^3 (lb/ft^3)***	***Mass per Functional Unit kg/m^2 (lb/ft^2)***
Wall--R-13	8.9 (3.5)	35.3 (2.20)	3.13 (0.641)
Ceiling--R-38	27.6 (10.9)	27.2 (1.70)	7.52 (1.54)

Flow Diagram

The flow diagram below shows the major elements of the production of this product, as it is currently modeled for BEES.

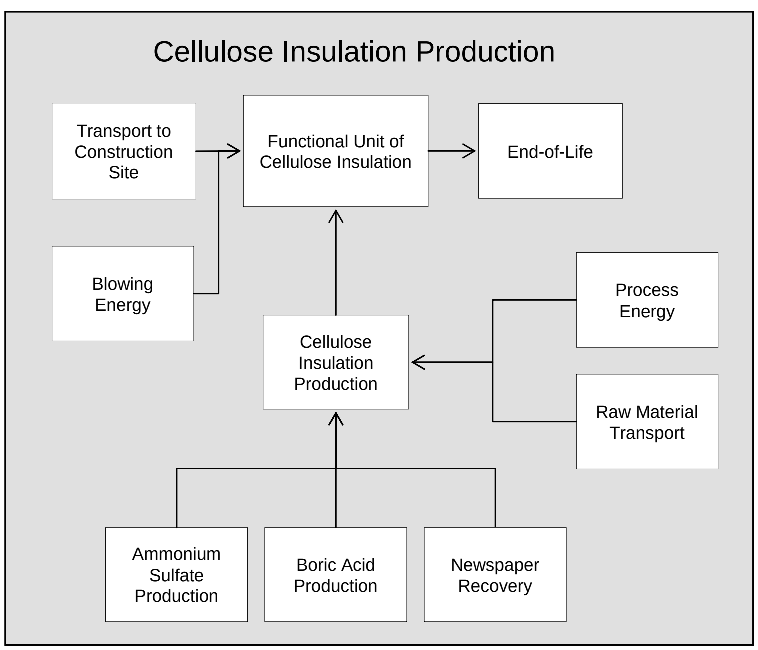

Figure 1: Cellulose Insulation System Boundaries

Raw Materials

Cellulose insulation is essentially shredded recovered wastepaper that is coated with fire retardants. The mix of these materials is provided in the following Table; while the relative proportions of the fire retardants vary among manufacturers, they are assumed to be mixed in equal proportions for BEES.

Table 2: Cellulose Insulation Constituents

Constituent	*Mass Fraction (%)*
Recovered Newspaper	85
Ammonium Sulfate	7.5
Boric Acid	7.5

BEES recovered newspaper data includes burdens from wastepaper collection, sorting, and subsequent transportation to the insulation manufacturer. Since it is a recovered product, burdens from upstream production of the pulp are not included in the system boundaries.

Ammonium sulfate is assumed to be a co-product of the production of nylon (caprolactam). The boric acid flame retardant is assumed to be produced from borax. Data for both materials, representing the early 2000s, is European.

Manufacturing

Energy Requirements and Emissions. There are no wastes or water effluents from the process of manufacturing cellulose insulation. The process includes shredding the wastepaper and blending it with the different fire retardants. Manufacturing energy is assumed to come from purchased electricity, as shown below.

Table 3: Energy Requirements for Cellulose Insulation Manufacturing

Energy Carrier	*MJ/kg (Btu/lb)*
Electricity	0.35 (150)

Transportation. The raw materials are all assumed to be shipped 161 km (100 mi) to the manufacturing plant via diesel truck.

Waste. All waste produced during the production process is recycled back into other insulation materials. Therefore, no solid waste is generated during the production process.

Transportation

Transportation of cellulose insulation by heavy-duty truck to the building site is modeled as a variable of the BEES system.

Installation

Cellulose insulation has a functional lifetime of more than 50 years – there is no need to replace or maintain the insulation during normal building use. During the installation of loose fill insulation, any waste material is added into the building shell where the insulation is installed, so there is effectively no installation waste.

For loose fill insulation, a diesel generator is used to blow the insulation material into the space. For one h of operation, a typical 18 kW (25 hp) diesel engine can blow 818 kg (1 800 lb) of insulation. The emissions and energy use for this generator are included in the system boundaries for this product. No other installation energy is required.

Use

While not accounted for in BEES, it is important to consider thermal performance differences when assessing environmental and economic performance for insulation product alternatives. Thermal performance affects building heating and cooling loads, which in turn affect energy-related LCA inventory flows and building energy costs over the 50-year use stage. Since alternatives for ceiling insulation all have R-38 thermal resistance values, thermal performance differences are at issue only for the wall insulation alternatives.

End of Life

While cellulose insulation is mostly recyclable, it is assumed that all of the insulation is disposed of in a landfill at end of life.

References

Life Cycle Data

Energy Information Administration, *Short-Term Energy Outlook—November 2006* (Washington, DC: U.S. Department of Energy, 2006), Table WF01.

National Renewable Energy Laboratory (NREL): *U.S. Life-Cycle Inventory Database*. 2005. Golden, CO. Found at: http://www.nrel.gov/lci/database.

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Petersen, S., *Economics and Energy Conservation in the Design of New Single-Family Housing (NBSIR 81-2380)* (Washington, DC: National Bureau of Standards, 1981).

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Industry Contacts

Daniel Lea, Cellulose Insulation Manufacturers Association (July 2007).