Generic Fiberglass

Product Selection and Description

Fiberglass batt insulation is made by forming spun-glass fibers into batts. At an insulation plant, the product feedstock is weighed and sent to a melting furnace. The raw materials are melted in a furnace at very high temperatures. Streams of the resulting vitreous melt are either spun into fibers after falling onto rapidly rotating flywheels or drawn through tiny holes in rapidly rotating spinners. This process shapes the melt into fibers. Glass coatings are added to the fibers that are then collected on conveyers. The structure and density of the product is continually controlled by the conveyer speed and height as it passes through a curing oven. The cured product is then sawn or cut to the required size, such as for a batt. Off-cuts and other scrap material are recycled back into the production process.

BEES performance data are provided for fiberglass batt insulation with thermal resistance values of R-13, R-15, and R-19 for a wall application, and R-38 for a ceiling application.

Blown fiberglass insulation is made by forming spun-glass fibers using the same method as for batts but leaving the insulation loose and unbonded. For loose fill fiberglass insulation, BEES performance data are provided for a thermal resistance value of R-38 for a ceiling application.

The tables below specify fiberglass insulation by type and R-value:

Table 1: Fiberglass Batt Mass by Application

Application	***Thickness cm (in)***	***Density kg/m^3 (lb/ft^3)***	***Mass per Functional Unit kg/m^2 (oz/ft^2)***
Wall--R-13	8.9 (3.5)	12.1 (0.76)	1.07 (3.52)
Wall--R-15	8.9 (3.5)	22.6 (1.41)	2.01 (6.58)
Wall--R-19	15.9 (6.25)	7.0 (0.44)	1.11 (3.65)
Ceiling--R-38	30.5 (12.0)	7.7 (0.48)	2.35 (7.71)

Table 2: Blown Fiberglass Mass by Application

Application	***Thickness cm (in)***	***Density kg/m^3 (lb/ft^3)***	***Mass per Functional Unit kg/m^2 (oz/ft^2)***
Ceiling--R-38	37.7 (14.8)	8.8 (0.55)	3.32 (10.9)

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

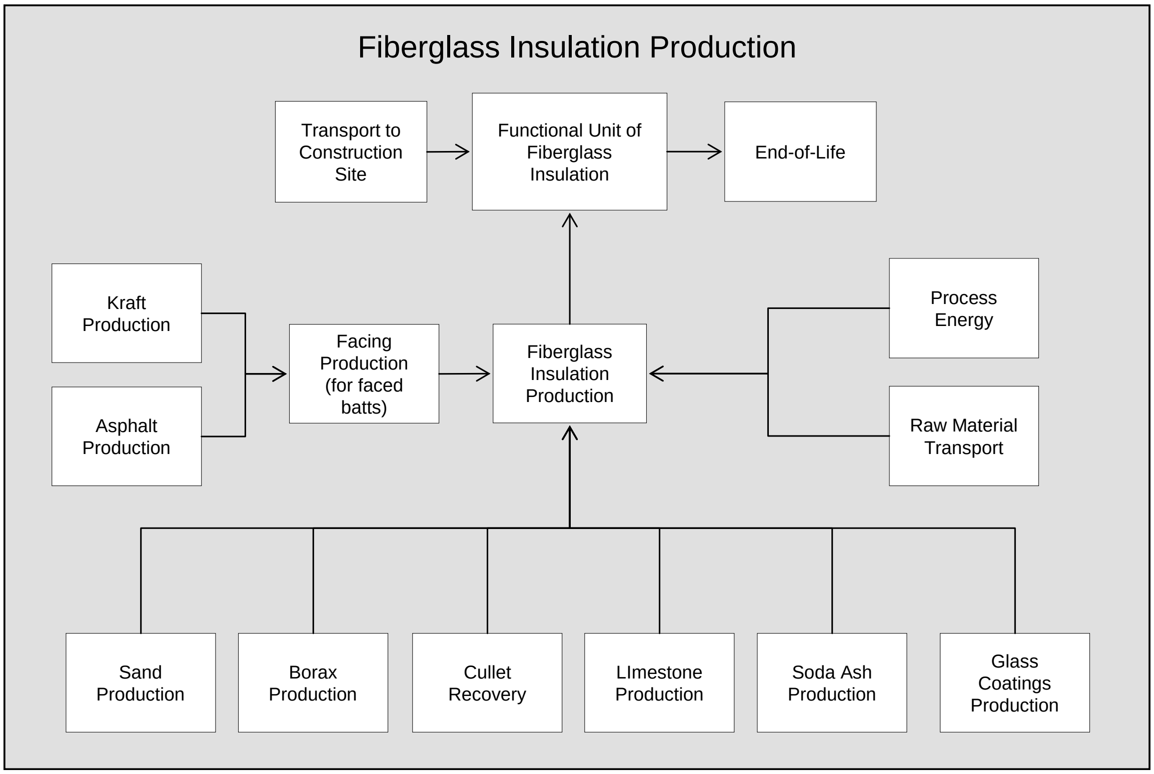

Figure 1: Fiberglass Insulation System Boundaries

Raw Materials
Fiberglass insulation is made with a blend of sand, limestone, soda ash, and recycled glass cullet. Recycled window, automotive, or bottle glass is increasingly used in the manufacture of glass fiber, and it now accounts for approximately 30 % to 50 % of the raw material input. The recycled content is limited by the amount of usable recycled material available in the market – not all glass cullet is of sufficient quality to be used in the glass fiber manufacturing process. The use of recycled material has helped to steadily reduce the energy required to produce insulation products.

The raw materials used to produce fiberglass insulation are show in the following Table.

Table 3: Fiberglass Insulation Constituents

Constituent	***Batt Mass Fraction (%)***	***Loose Fill Mass Fraction (%)***
Soda Ash	9	9
Borax	12	13
Glass Cullet	34	35
Limestone	9	9
Binder Coatings	5	<1
Sand	31	33

The life cycle environmental profiles for the constituents of fiberglass insulation are based on life cycle data from the SimaPro software tool and data from the U.S. LCI Database.

Manufacturing

Energy Requirements and Emissions. The energy requirements for melting the glass constituents into fibers and drying of the completed batt involve a mixture of natural gas and electricity. The energy demands are outlined in the following Table.

Table 4: Energy Requirements for Fiberglass Insulation Manufacturing

Energy Carrier	*MJ/kg (Btu/lb)*
Natural Gas	1.99 (857)
Electricity	1.37 (591)
Total	**3.36 (1448)**

The manufacturing process generates air emissions from the combustion of the fuels used to melt the raw materials and from the drying of the insulation material prior to cutting and packaging. Emissions from fuel combustion are captured in the fuel use data included in the BEES model; additional emissions are listed in the Table below.

Table 5: Emissions for Fiberglass Insulation Manufacturing

Emission	*Bonded Batts g/kg (lb/ton)*	*Unbonded Loose Fill g/kg (lb/ton)*
Particulates	2.380 (4.759)	1.610 (3.220)
VOC	0.759 (1.518)	0.083 (0.165)

Transportation. The raw materials are all shipped to the manufacturing plant via diesel truck. The average shipping distances are as follows:

Table 6: Raw Material Transportation Distances

Constituent	*Distance to Plant km (mi)*
Borax	805 (500)
Soda Ash	805 (500)
Glass Cullet	161 (100)
Limestone	161 (100)
Binder Coatings	322 (200)
Sand	161 (100)

Waste. All waste produced during the cutting and blending process is either recycled into other insulation materials or added back into the glass mix. Thus, no solid waste is generated during the production process.

Transportation

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

Installation

Fiberglass 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 fiberglass batts and loose fill insulation, any waste material is added into the building shell where the insulation is installed - there is effectively no installation waste.

Installing batt insulation is primarily a manual process; no energy or emissions are included in the model. For blown fiberglass insulation, a diesel generator is used to blow the insulation material into the ceiling space. For one h of operation, a typical 18 kW (25 hp) diesel engine can blow 818 kg (1 800 lb) of insulation. 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 fiberglass 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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