

ABB BIOTEMP

BIOTEMP, produced by ABB, Inc., is an insulating dielectric fluid used in transformers. BIOTEMP is made from various raw vegetable oils, depending on the most ideal market conditions at the time. The most common oils used in this product include sunflower, safflower, and soybean. BIOTEMP is modeled for BEES assuming use of sunflower oil.

A relatively small-sized (1 000 kV·A) transformer is assumed for BEES, which requires about 1.89 m³ (500 gal) of fluid to cool. The functional unit for BIOTEMP, as for all BEES transformer oils, is the use of 1.89 m³ (500 gal) of transformer fluid to cool a 1 000 kV·A transformer for a period of 30 years.

Flow Diagram

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

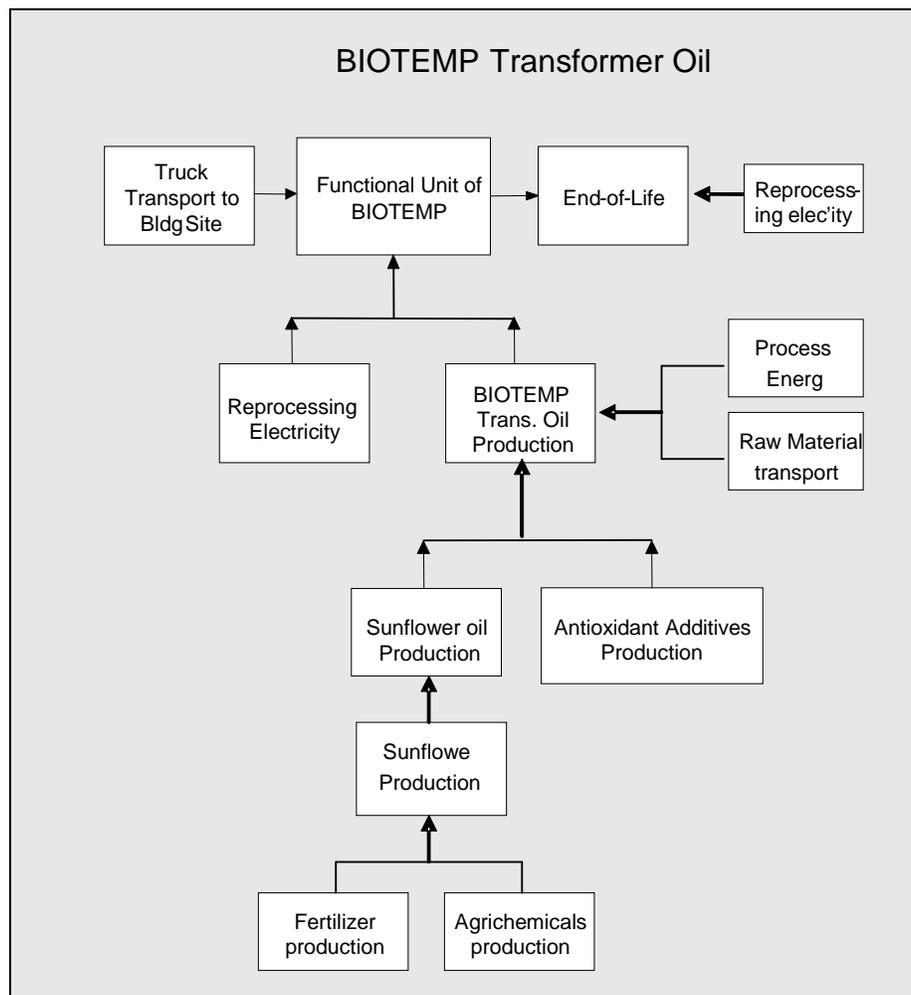


Figure 1: BIOTEMP Transformer Oil System Boundaries

Raw Materials

BIOTEMP consists of a high oleic vegetable oil, for BEES a sunflower-based oil, and a small quantity of antioxidant additives, in the proportions shown below.

Table 1: BIOTEMP Transformer Oil Constituents

Constituent	Mass Fraction (%)
High oleic sunflower oil	98.4
Antioxidant additives	1.6

Data on high oleic sunflower oil covers both sunflower production and production of the oil from sunflower seeds. Sunflower production is modeled as a U.S. average using data aggregated from various sources.¹

Production of oil from sunflower seeds is modeled based on soybean crushing and crude oil production data, adjusted using mass balance information pertaining to sunflowers.²

The specific antioxidants are phenol- and amine- based, and are not further specified to protect manufacturer confidentiality. These are modeled, though, and the life cycle data for the production of phenol and amine as base materials in the additives comes from the general contents of the SimaPro LCA database.

Manufacturing

Energy Requirements and Emissions. At manufacturing, energy is used to heat and filter the raw vegetable oil, blend in the antioxidants, and run the blended compound through a vacuum process. The electricity required for these processes amounts to 1.8 MJ (0.5 kWh) per kilogram of product. Electricity is modeled using the U.S. average electric grid from the U.S. LCI Database.

Transportation. Truck transportation to the BIOTEMP facility for sunflower oil is assumed to cover 5 230 km (3 250 mi), and for the additives is assumed to cover 1 127 km (700 mi).

Waste. Manufacturing waste includes spent filter cartridges. Approximately 0.003 kg (0.007 lb) of spent cartridges result from 1 kg of BIOTEMP production; this is sent to a landfill.

Transportation

Heavy-duty trucking is used to represent transportation from the BIOTEMP production facility to the transformer to be filled at the point of use. The transportation distance is modeled as a variable of the BEES system.

Use

For BEES, BIOTEMP transformer oil is used in a transformer with a capacity of 1.89 m³ (500 gal). Any type of transformer oil needs to be reconditioned or reclaimed over the life of the transformer: transformer aging, thermal problems, or electrical problems can generate dissolved gas, which results in deterioration or contamination of the fluid. Included in the BEES use phase modeling is the electricity required to recondition the oil when dissolved gas analysis tests indicate the need. Reconditioning is assumed to occur every five years.³ The transformer itself is assumed to have a lifetime of 30 years.

¹ Schmierer, J. et al., SF-SV-04 (Sacramento Valley: University of California Cooperative Extension, 2004). Found at: http://www.agecon.ucdavis.edu/uploads/cost_return_articles/sunflowersv2004.pdf; National Sunflower Association, 2005. Found at: <http://www.sunflowernsa.com/growers/default.asp?contentID=72>; Thomas Jefferson Agricultural Institute, Columbia, MO, 2005. Found at: <http://www.jeffersoninstitute.org/pubs/sunflower.shtml#Fertility>; U.S. Geological Survey, "National Totals By Crop and Compound: Sunflower," . Found at: <http://ca.water.usgs.gov/pnsp/crop/sunflower.html>; Ontario Ministry of Agriculture, Food, and Rural Affairs, "Herbicide recommendations for sunflower," (November 2002). Found at: <http://www.omafra.gov.on.ca/english/crops/pub75/12sunflo.htm>.

² Sheehan, J. et al., NREL/SR-580-24089 (Washington, DC: US Department of Agriculture and US Department of Energy, May 1998).

³ Information on dissolved gas analysis testing can be found in the U.S. Bureau of Reclamation (USBR) website's Facilities Instructions Standards and Techniques (FIST) document, <http://www.usbr.gov/power/data/fist/fist3-30>. Energy information on reconditioning was provided during telephone conversations with S.D. Myers, a transformer and transformer fluid contractor,

End of Life

At the end of the 30-year life of the transformer, BIOTEMP is modeled the same as most other transformer oils in BEES: at year 30, BIOTEMP is assumed to be further reconditioned and reused in another transformer, with reconditioning electricity included in the end-of-life modeling. BIOTEMP is 97 % to 99 % biodegradable.

References

Life Cycle Data

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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Sheehan, J. et al., *Life Cycle Inventory of Biodiesel and Petroleum Diesel for Use in an Urban Bus*,

NREL/SR-580-24089 (Washington, DC: U.S. Department of Agriculture and U.S. Department of Energy, May 1998).

Industry Contacts

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