

Generic Silicone Transfer Oil

Product Selection and Description

Silicone-based transformer fluid is a synthetic transformer oil composed primarily of dimethylsiloxane polymers, and follows a very different series of production steps than does mineral oil-based transformer oil.

Flow Diagram

The figure below shows the elements of silicone transformer fluid production.

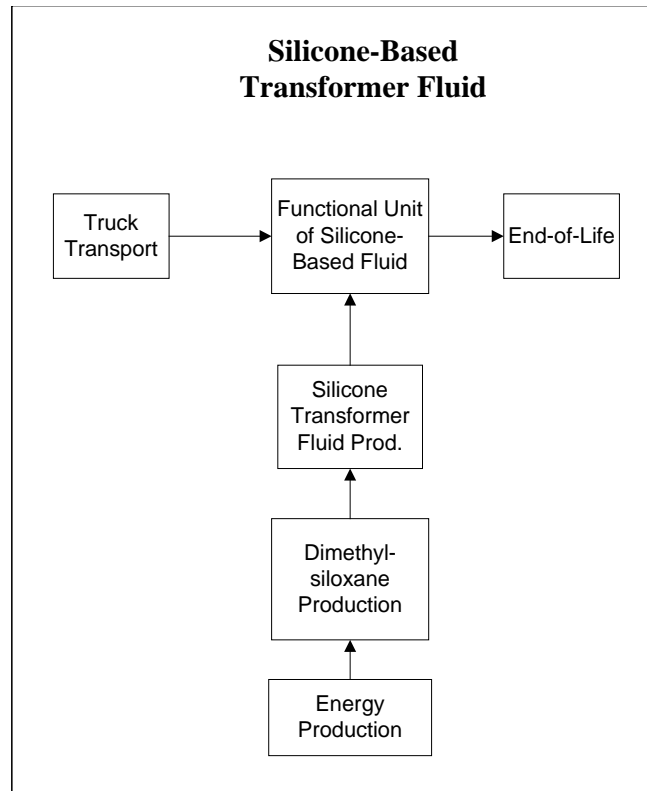


Figure 1: Silicone-Based Transformer Oil System Boundaries

Raw Materials

While silicone-based fluid is produced both in the United States and abroad, the only publicly-available data is European. European data is used to model the main component of the product, cyclical siloxane.¹

Manufacturing

The production of dimethylsiloxane starts with the production of dimethylchlorosilane using chloromethane and silicon. Dimethylchlorosilane undergoes hydrolysis reactions to produce dimethylsilanediol, which undergoes another series of hydrolysis reactions to condense into cyclical siloxane. The average density of the fluid is assumed to be 0.9565 kg/L.²

Transportation

Trucking is the mode of transport used to represent transportation from the transformer oil production plant to

¹ Silicon production: JL Vignes, Données Industrielles, économiques, géographiques sur des produits chimiques (minéraux et organiques) Métaux et Matériaux, pp. 134, ed. 1994, Union des Physiciens; Dimethylchlorosilane production: "Silicones", Rhône-Poulenc département silicones, Techno-Nathan edition, Nouvelle Librairie, 1988; Dimethylsilanediol and cyclic siloxane production: Carette, Pouchol (RP Silicones), Techniques de l'ingénieur, vol. A 3475, p.3.

² From <http://www.clearcoproducts.com/pdf/msds/specialty/MSDS-STO-50-Transformer-Oil.pdf> and http://www.dowcoming.com/applications/product_finder/pf_details.asp?l1=008&pg=00000642&prod=01496204&type=PROD.

the transformer to be filled at point of use. The transportation distance is modeled as a variable of the BEES system.

Use

The amount of oil used in a transformer depends on the size of the transformer. A relatively small-sized (1 000 kV·A) transformer is assumed, which requires about 1.89 m³ (500 gal) of fluid to cool. It is assumed that the use phase of the transformer oil lasts the lifetime of the transformer, approximately 30 years. Included in the 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

End of Life

With periodic reconditioning of silicone-based transformer oil during the 30-year life of the transformer, the oil is in good enough condition for half of it to be further reconditioned and reused in another transformer. The other half is sent back to the manufacturer for restructuring for production into other silicone-based products.⁴ End-of-life options for transformer oil do not include waste disposal, as it is generally a well-maintained product and can be used in other applications. Therefore, none of the product is assumed to be landfilled.

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>.

PRé Consultants: *SimaPro 6.0 LCA Software*. 2005. The Netherlands.

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_pub.html. Energy information on reconditioning was provided during telephone conversations with S.D. Myers, a transformer and transformer fluid contractor, November 2001.

⁴ Information from Dow Corning, <http://www.dowcorning.com>, "Reuse, recycle, or disposal of transformer fluid," 2001.