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IEEE Guide for Acceptance and Maintenance of Natural Ester Insulating Liquid in Transformers

IEEE Power and Energy Society

Sponsored by the
Transformers Committee

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(Revision of IEEE Std C57.147-2008)

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Abstract: Assistance to equipment manufacturers and service companies to evaluate the suitability of unused natural ester insulating liquids being received from suppliers is provided in this guide. Information for transformer operators in evaluating and maintaining natural ester insulating liquids in serviceable condition is also provided.

Keywords: dielectric coolant, high fire point liquid, IEEE C57.147™, insulating liquid, less-flammable liquid, natural ester liquid, transformer, vegetable oil

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Introduction

This introduction is not part of IEEE Std C57.147-2018, IEEE Guide for Acceptance and Maintenance of Natural Ester Insulating Liquid in Transformers.

This guide was prepared by the Insulating Fluids Subcommittee of the Transformers Committee of the IEEE Power and Energy Society. The purpose of this guide is to identify standards for acceptance and maintenance of natural ester insulating liquid in transformers. This guide is the first revision of the initial guide published in 2008. Overall, the guide was substantially updated to include the current state of the art for natural ester insulating liquids.

This revision includes updates to follow the current IEEE SA policies, style, and terms appropriate for a Guide. In this revision, where appropriate, the term "fluid" has been replaced with "liquid" to be more descriptive of the application and for consistency of terminology within C57 transformer standards. The normative references have been updated and expanded. Based on available data from testing samples from operating transformers, the normative and informative information on limits for continued service have been expanded. The bibliography has been expanded to provide additional background for the user. Two additional informative annexes were added: Annex C provides discussion on fire safety, environmental and sustainability factors of natural ester insulating liquids; Annex D discusses considerations when applying natural esters to load tap changers (LTCs).

Acknowledgments

Table B.1 and Figure B.1 were modified with permission from Doble Engineering Company, Lewand, L. R., "Laboratory evaluation of several synthetic and agricultural-based dielectric liquids," *Proceedings of the 86th Annual International Conference of Doble Clients*, Doble Engineering Company, Watertown, MA, USA, 2001 [B13].

Figure B.1 was reprinted from IEEE Std C57.106™-2002 [B26].

Figure B.2, Figure B.3, and Figure B.4 were reprinted from McShane, C. P., J. Luksich, and K. J. Rapp, "Retrofilling aging transformer with natural ester based dielectric coolant for safety and life extension," *Proceedings of the IEEE IAS/PCA Cement Industry Technical Conference,* Dallas, TX, USA, May 2003 [B35].

Table C.1 was reprinted with permission from CIGRE Technical Brochure 436, *Experiences in service with new insulating liquids*, © 2010 [B9].

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IEEE Guide for Acceptance and Maintenance of Natural Ester Insulating Liquid in Transformers

1. Overview

1.1 Scope

This guide recommends tests and evaluation procedures, as well as criteria and methods of maintenance, for natural ester-based (e.g., vegetable oil) insulating liquids. Methods of reconditioning, field applications, and diagnostics of natural ester-based insulating liquids are also described.

1.2 Purpose

This guide recommends standard tests and evaluation procedures of natural ester insulating liquids for application in distribution and power transformers and other liquid-filled electrical equipment. Natural ester insulating liquids are also being applied in retrofilling existing liquid-filled equipment. This guide provides recommendations for new and retrofill field applications including: field testing of equipment filled with natural ester insulating liquids, methods of reconditioning and reclaiming natural ester insulating liquids, and the analysis results at which reprocessing or replacement of the insulating liquid is necessary.

1.3 System design

The reliable performance of natural ester liquids in an insulation system depends upon certain basic liquid characteristics that can affect overall apparatus characteristics. Such liquid characteristics are integral to equipment design for which the manufacturer should have final responsibility. The reliable operation of the equipment in service, for which the transformer operator should have final responsibility, also depends on maintaining certain basic liquid characteristics. Adherence to the recommended liquid characteristics can assist in obtaining the desired equipment characteristics. Other tests or verification of the integrity of the insulation system may be necessary.

The essential properties of insulating liquids used in transformers should be maintained if the liquid is to perform its multiple roles as electrical insulation and heat transfer agent. It should have adequate dielectric strength to withstand the normal range of electric stresses imposed in service. It should have a certain combination of thermal conductivity, specific heat, and viscosity so that its ability to transfer heat is sufficient for the particular equipment. It should have a sufficiently high flash point and fire point to meet safety requirements. The natural ester liquid should not be allowed to become so deteriorated or contaminated that it adversely affects other materials in the apparatus.