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IEEE Guide for the Use of Gas-in-Fluid Analysis for Paper and Laminated Paper-Polypropylene Insulated Cable Systems

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IEEE Power and Energy Society

Developed by the
Insulated Conductors Committee

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IEEE

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Abstract: The application of the analysis of gases dissolved in the fluids of fluid-filled cable systems is discussed in this standard with respect to the procedures for sampling, obtaining the dissolved gas data, and analyzing the results.

Keywords: aging, cable diagnostic, DGA, dissolved gas analysis, fluid-filled cable, gas analysis, gas-filled cable, IEEE 1406™, liquid filled cable, pipe-type, remaining life, self-contained, transmission cable

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Introduction

This introduction is not part of IEEE Std 1406-2020, IEEE Guide for the Use of Gas-in-Fluid Analysis for Paper and Laminated Paper-Polypropylene Insulated Cable Systems.

This guide is intended for the engineering specialist interested in the evaluation and maintenance of fluid-filled cable systems. This includes high-pressure fluid-filled (HPFF) and high-pressure gas-filled (HPGF) pipe-type cables, as well as self-contained fluid-filled (SCFF) cables operating at low, medium, or high pressure. The pressurizing medium can be either a dielectric liquid or gas. The primary focus of this document is on testing of liquid-filled systems, with less emphasis on gas-filled systems, since HPGF cables constitute a significantly smaller amount of the total circuit miles of pipe-type cable systems. However, where applicable, the document will identify tests and analyses that can be used on gas-filled systems.

The use of dissolved gas analysis (DGA) began in the 1970s and has become an important tool for those who are responsible for the reliable operation of these cable systems. The technique requires removing a small sample of the pressurizing fluid and analyzing the gases that are present in solution using a gas chromatograph. The results can provide clues as to the amount of thermo-electric aging that the cable system has experienced and how this aging may be progressing in time. DGA can also identify where there may be problems in the system, especially in the vicinity of cable accessories such as splices and terminations.

The technology parallels the application of DGA to transformers as described in IEEE Std C57.104™. Following a historical background discussion, the fundamentals of gas generation in dielectric papers and fluids is presented as the basis for the technology. Guidance is provided so that the user can relate the DGA data with the conditions that may have caused the gas generation.

Guidelines for the application of DGA and the methods used for sampling, analysis, and interpretation of the results are discussed in detail. Descriptions of other ancillary tests that can be done on the same samples to provide additional information as to the state of the cable system are also covered. Procedures are discussed that can be used to lower the dissolved gas content when system operation may be jeopardized. Additionally, a data-reporting format is suggested to aid utilities to trend the condition of their cable system.

The first meeting of ICC Working Group 5–28 “Guide for DGA for HPFF Cables,” chaired by J.S. Engelhardt, was held in April 1982. This ultimately led to the publication of IEEE Std 1406™-1998 “Trial Guide to the Use of Gas-In-Fluid Analysis for Electric Power Cable Systems” in 1998. The re-affirmation requirement for the 1998 document along with the need to better represent the current state-of-the-art led to the formation of ICC C05W “Guide for the use of Gas-in-Fluid Analysis for Electric Power Cable Systems”. The ICC C05W working group first met in Fall 2011 and undertook the revision of the original 1998 guide.

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IEEE Guide for the Use of Gas-in-Fluid Analysis for Paper and Laminated Paper-Polypropylene Insulated Cable Systems

1. Overview

1.1 Scope

The scope of this guide is to furnish an understanding of the conditions that generate gases in paper and laminated paper-polypropylene insulated fluid-filled cable systems; to establish a recommended method for sampling, data collection, analysis; and to identify possible remedial actions for systems with high dissolved gas-in-fluid content.

1.2 Purpose

This guide is intended to provide users of pipe-type cable systems, both high-pressure fluid-filled (HPFF) and high-pressure gas-filled (HPGF), as well as self-contained fluid-filled (SCFF) cable systems with the basis to establish the use of gas-in-fluid analysis for diagnostic purposes, part of condition assessment, and as a maintenance tool.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

ASTM D88, Test method for Saybolt viscosity.[1]

ASTM D445, Test method for kinematic viscosity of transparent and opaque liquids (and calculation of dynamic viscosity).

ASTM D664, Test method for acid number of petroleum products by potentiometric titration.

ASTM D831/D831M, Test method for gas content of cable and capacitor oils.

[1]ASTM publications are available from the American Society for Testing and Materials (http://www.astm.org/).