Oil-filled electrical equipment - Sampling of gases and analysis of free and dissolved gases - Guidance

EESTI STANDARDIKESKUS
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NATIONAL FOREWORD

See Eesti standard EVS-EN 60567:2011 sisaldab Euroopa standardi EN 60567:2011 ingliskeelset teksti.	This Estonian standard EVS-EN 60567:2011 consists of the English text of the European standard EN 60567:2011.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 16.12.2011.	Date of Availability of the European standard is 16.12.2011.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

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Oil-filled electrical equipment - Sampling of gases and analysis of free and dissolved gases - Guidance

(IEC 60567:2011)

Matériels électriques immergés - Echantillonnage de gaz et analyse des gaz libres et dissous - Lignes directrices (CEI 60567:2011)

Ölgefüllte elektrische Betriebsmittel – Probennahme von Gasen und Analyse freier und gelöster Gase – Anleitung (IEC 60567:2011)

CENELEC

European Committee for Electrotechnical Standardization
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Foreword

The text of document 10/849/FDIS, future edition 4 of IEC 60567, prepared by IEC/TC 10 "Fluids for electrotechnical applications" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60567:2011.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2012-08-24
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2014-11-24

This document supersedes EN 60567:2005.

EN 60567:2011 includes the following significant technical changes with respect to EN 60567:2005:

Since the publication of EN 60567:2005, CIGRE TF.D1.01.15 has made progress in several areas of dissolved gas analysis (DGA), notably

a) oil sampling,

b) laboratory analysis and solubility coefficients of gases in non-mineral oils,

c) calibration of the headspace gas extraction method,

d) more sensitive detectors for chromatography,

e) preparation of air-saturated standards and

f) evaluation of gas monitor readings.

These advances are included in EN 60567:2011.

Sampling of oil for DGA from oil-filled equipment has been moved from EN 60567 to EN 60475 as reflected in the revised title of this standard.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 60567:2011 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

[1] ISO/IEC 17025 NOTE Harmonized as EN ISO/IEC 17025.

[2] ISO 3675 NOTE Harmonized as EN ISO 3675.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60296	-	Fluids for electrotechnical applications - Unused mineral insulating oils for transformers and switchgear	EN 60296	-
IEC 60475	2011	Method of sampling insulating liquids	EN 60475	2011
IEC 60599	-	Mineral oil-impregnated electrical equipment in service - Guide to the interpretation of dissolved and free gases analysis	EN 60599	-
ISO 5725	Series	Accuracy (trueness and precision) of measurement methods and results	-	-
ASTM D2780	-	Standard Test Method for Solubility of Fixed Gases in Liquids	-	-

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INTRODUCTION

Gases may be formed in oil-filled electrical equipment due to natural ageing but also, to a much greater extent, as a result of faults.

Operation with a fault may seriously damage the equipment, and it is valuable to be able to detect the fault at an early stage of development.

Where a fault is not severe, the gases formed will normally dissolve in the oil, with a small proportion eventually diffusing from the liquid into any gas phase above it. Extracting dissolved gas from a sample of the oil and determining the amount and composition of this gas is a means of detecting such faults, and the type and severity of any fault may often be inferred from the composition of the gas and the rate at which it is formed.

In the case of a sufficiently severe fault, free gas will pass through the oil and collect in the gas-collecting (Buchholz) relay if fitted; if necessary, this gas may be analysed to assist in determining the type of fault that has generated it. The composition of gases within the bubbles changes as they move through the oil towards the gas-collecting relay.

This can be put to good use, as information on the rate of gas production may often be inferred by comparing the composition of the free gases collected with the concentrations remaining dissolved in the liquid.

The interpretation of the gas analyses is the subject of IEC 60599.

These techniques are valuable at all stages in the life of oil-filled equipment. During acceptance tests on transformers in the factory, comparison of gas-in-oil analyses before, during and after a heat run test can show if any hot-spots are present, and similarly analysis after dielectric testing can add to information regarding the presence of partial discharges or sparking. During operation in the field, the periodic removal of an oil sample and analysis of the gas content serve to monitor the condition of transformers and other oil-filled equipment.

The importance of these techniques has led to the preparation of this standard, to the procedures to be used for the sampling, from oil-filled electrical equipment, of gases and oils containing gases, and for subsequent analysis.

NOTE Methods described in this standard apply to insulating oils, since experience to date has been almost entirely with such oils. The methods may also be applied to other insulating liquids, in some cases with modifications.

General caution, health, safety and environmental protection

This International Standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of the standard to establish appropriate health and safety practices and determine the applicability of regulatory limitations prior to use.

The insulating oils which are the subject of this standard should be handled with due regard to personal hygiene. Direct contact with the eyes may cause irritation. In the case of eye contact, irrigation with copious quantities of clean running water should be carried out and medical advice sought. Some of the tests specified in this standard involve the use of processes that could lead to a hazardous situation. Attention is drawn to the relevant standard for guidance.

Mercury presents an environmental and health hazard. Any spillage should immediately be removed and be properly disposed of. Consult local regulations for mercury use and handling. Mercury-free methods may be requested in some countries.

Environment

This standard is applicable to insulating oils, chemicals and used sample containers.

Attention is drawn to the fact that, at the time of writing of this standard, many insulating oils in service are known to be contaminated to some degree by PCBs. If this is the case, safety countermeasures should be taken to avoid risks to workers, the public and the environment during the life of the equipment, by strictly controlling spills and emissions. Disposal or decontamination of these oils should be carried out strictly according to local regulations. Every precaution should be taken to prevent release of insulating oil into the environment.

OIL-FILLED ELECTRICAL EQUIPMENT – SAMPLING OF GASES AND ANALYSIS OF FREE AND DISSOLVED GASES – GUIDANCE

1 Scope

This International Standard deals with the techniques for sampling free gases from gas-collecting relays from power transformers. Three methods of sampling free gases are described.

The techniques for sampling oil from oil-filled equipment such as power and instrument transformers, reactors, bushings, oil-filled cables and oil-filled tank-type capacitors are no longer covered by this standard, but are instead described in 4.2 of IEC 60475:2011.

Before analysing the gases dissolved in oil, they are first extracted from the oil. Three basic methods are described, one using extraction by vacuum (Toepler and partial degassing), another by displacement of the dissolved gases by bubbling the carrier gas through the oil sample (stripping) and the last one by partition of gases between the oil sample and a small volume of the carrier gas (headspace). The gases are analysed quantitatively after extraction by gas chromatography; a method of analysis is described. Free gases from gas-collecting relays are analysed without preliminary treatment.

The preferred method for assuring the performance of the gas extraction and analysis equipment, considered together as a single system, is to degas samples of oil prepared in the laboratory and containing known concentrations of gases (“gas-in-oil standards”) and quantitatively analyse the gases extracted. Two methods of preparing gas-in-oil standards are described.

For daily calibration checks of the chromatograph, it is convenient to use a standard gas mixture containing a suitable known amount of each of the gas components to be in a similar ratio to the common ratios of the gases extracted from transformer oils.

The techniques described take account, on the one hand, of the problems peculiar to analyses associated with acceptance testing in the factory, where gas contents of oil are generally very low and, on the other hand, of the problems imposed by monitoring equipment in the field, where transport of samples may be by un-pressurized air freight and where considerable differences in ambient temperature may exist between the plant and the examining laboratory.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60296, *Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear*

IEC 60475:2011, *Method of sampling insulating liquids*

IEC 60599, *Mineral oil-impregnated electrical equipment in service – Guide to the interpretation of dissolved and free gases analysis*

ISO 5725 (all parts), *Accuracy (trueness and precision) of measurement methods and results*

ASTM D2780, *Standard Test Method for Solubility of Fixed Gases in Liquids*

3 Sampling of gases from gas-collecting (Buchholz) relays

3.1 General remarks

It is important to bear in mind that receiving a qualitative and a representative sample is crucial for obtaining a reliable diagnosis of the electrical equipment. Even the most sophisticated extraction or diagnosis methods cannot overcome faulty samples.

Gas samples from relays should be taken from the equipment with the minimum delay after gas accumulation has been signalled. Changes in composition caused by the selective re-absorption of components may occur if free gases are left in contact with oil.

Certain precautions are necessary when taking gas samples. The connection between the sampling device and the sampling vessel shall avoid the ingress of air. Temporary connections should be as short as possible. Any rubber or plastic tubing used should have been proved to be impermeable to gases.

Gas samples should be properly labelled (see Clause 4) and analysed without undue delay to minimize hydrogen loss (for example, within a maximum period of one week).

Oxygen, if present in the gas, may react with any oil drawn out with the sample. Reaction is delayed by excluding light from the sample, for example, by wrapping the vessel in aluminium foil or suitable opaque material.

Of the three methods described below, the syringe method is recommended. The other two methods are alternatives to be used exclusively in case of serious hindrance.

Sampling into a sampling tube by liquid displacement using transformer oil as a sealing liquid is simple, but the different solubilities of the gas components may need to be taken into account if the gas quantity is such that some oil remains in the tube.

The vacuum method requires skill to avoid contaminating the sample by leakage of air into the system. It is particularly true where the gas to be sampled may be at less than atmospheric pressure (for example, some sealed transformers).

3.2 Sampling of free gases by syringe

3.2.1 Sampling equipment

NOTE Figures in brackets refer to those circled numbers in the relevant figure.

See Figure 1. The equipment shall be as follows:

a) Impermeable oil-resistant plastic or rubber tubing (3) provided with a connecter to fit onto a suitable sampling connection of the gas-collecting relay. To avoid cross-contamination, the tubing should be used only once.

b) Gas-tight syringes of suitable volume (1) (25 ml to 250 ml). Medical or veterinary quality glass syringes with ground-in plungers may be suitable; alternatively, syringes with oil-proof seals may be used. The syringe should be fitted with a cock enabling it to be sealed. It is often convenient to use the same syringes for both gas sampling and for oil sampling (see 4.2.2 of IEC 60475:2011).