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PRE-RELEASE VERSION (FDIS)



Mineral insulating oils in electrical equipment – Supervision and maintenance guidance

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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TITLE:

Mineral insulating oils in electrical equipment – Supervision and maintenance guidance

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MINERAL INSULATING OILS IN ELECTRICAL EQUIPMENT – SUPERVISION AND MAINTENANCE GUIDANCE

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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IEC 60422 has been prepared by IEC technical committee 10: Fluids for electrotechnical applications. It is an International Standard.

This fifth edition cancels and replaces the fourth edition published in 2013. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) This new edition represents a major revision of the fourth edition, bringing this document in line with the latest developments in oil condition monitoring. New interpretation tables have been created, containing limits for oil parameters specific to plant type with suggested corrective actions in the tables and new test methods.
- b) The action limits for all oil tests have been revised and changes made where necessary to enable users to use current methodology and comply with requirements and regulations affecting safety and environmental aspects.

- c) Category O has been removed and is now incorporated within category A.
- d) Online moisture interpretation is now incorporated.
- e) More guidance on oil treatment (including reclamation criteria) is now available.
- f) Guidance has been updated regarding corrosive sulphur.
- g) In addition, this document incorporates changes introduced in associated standards since the fourth edition was published.

The text of this International Standard is based on the following documents:

| Draft | Report on voting |
|------------|------------------|
| 10/XX/FDIS | 10/XX/RVD |

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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INTRODUCTION

Insulating mineral oils are used in electrical equipment employed in the generation, transmission, distribution, and use of electrical energy.

Monitoring and maintaining oil quality is essential to ensure the reliable operation of oil-filled electrical equipment. Codes of practice for this purpose have been established by electrical power authorities, power companies and industries in many countries.

A review of current experience reveals a wide variation of procedures and guidance. It is possible, however, to compare the value and significance of standardized oil tests and to recommend uniform criteria for the evaluation of test data.

If a certain amount of oil deterioration (by degradation or contamination) is exceeded, there is inevitably some erosion of safety margins and the question of the risk of failure should be considered. While the quantification of the risk can be very difficult, a first step involves the identification of potential effects of increased deterioration. The philosophy underlying this document is to furnish users with as broad a base of understanding of oil quality deterioration as is available, so that they can make informed decisions on inspection and maintenance practices.

Mineral oils are valuable resources and should be utilised accordingly. Used mineral oils are, by most regulations, deemed to be controlled waste. If spills occur, this can have a negative environmental impact especially if the oil is contaminated by persistent organic pollutants such as polychlorinated biphenyls (PCBs).

This document, whilst technically sound, is mainly intended to serve as a common basis for the preparation of more specific and complete codes of practice by users in the light of local circumstances. Sound engineering judgement will have to be exerted in seeking the best compromise between technical requirements and economic factors.

Reference should also be made to instructions from the equipment manufacturer.

General caution

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

The handling of mineral oils can be subject to local regulatory requirements and suppliers' safety datasheets.

Environment, health, and safety

This document is applicable to mineral oils, chemicals and used sample containers. The disposal of these items can be subject to local regulatory requirements regarding their impact on the environment.

Attention is drawn to the fact that, at the time of writing this document, some mineral oils in service are known to be contaminated to some degree with other liquids, for example, silicone oils and PCBs.

Because of this, 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. The disposal or decontamination of these oils can be subject to local regulatory requirements. Every precaution should be taken to prevent release of mineral oil into the environment.

Typically, each country has specific regulations around health and safety. Safety Data Sheets (SDS) are normally used by the industry internationally and are usually written in accordance with an international regulation set (such as REACH [1]¹). Please consult the SDS from the suppliers of the insulating product that is used. These documents provide essential information regarding health, safety, and environmental impacts.

¹ Numbers in square brackets refer to the Bibliography.

MINERAL INSULATING OILS IN ELECTRICAL EQUIPMENT – SUPERVISION AND MAINTENANCE GUIDANCE

1 Scope

This document provides monitoring guidance and procedures that are required for the use and maintenance of mineral insulating oils and other hydrocarbon-based liquids in transformers and other electrical equipment, including strategic spares and tanks for holding spare parts and components.

This document is applicable to mineral insulating oils, originally supplied conforming to IEC 60296, in transformers, switchgear and other electrical apparatus where oil sampling is reasonably practicable, and where the normal operating conditions specified in the equipment specifications apply.

This document is also intended to assist the power equipment operator to evaluate the condition of the oil and maintain it in a serviceable condition. It also provides a common basis for the preparation of more specific and complete local codes of practice.

The document includes recommendations on tests and evaluation procedures, and outlines methods for reconditioning and reclaiming oil, and the decontamination of oil contaminated with PCBs.

NOTE The condition monitoring of electrical equipment, for example by analysis of dissolved gases, furanic compounds or other means, is outside the scope of this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IEC 60156, *Insulating liquids – Determination of the breakdown voltage at power frequency – Test method*

IEC 60247, *Insulating liquids – Measurement of relative permittivity, dielectric dissipation factor ($\tan \delta$) and d.c. resistivity*

IEC 60296:2020, *Fluids for electrotechnical applications – Mineral insulating oils for electrical equipment*

IEC 60475, *Method of sampling insulating liquids*

IEC 60666:2010, *Detection and determination of specified additives in mineral insulating oils*

IEC 60814, *Insulating liquids – Oil-impregnated paper and pressboard – Determination of water by automatic coulometric Karl Fischer titration*

IEC 60970, *Insulating liquids – Methods for counting and sizing particles*

IEC 61125:2018, *Insulating liquids – Test methods for oxidation stability – Test method for evaluating the oxidation stability of insulating liquids in the delivered state*

IEC 61619, *Insulating liquids – Contamination by polychlorinated biphenyls (PCBs) – Method of determination by capillary column gas chromatography*

IEC 62021-1, *Insulating liquids – Determination of acidity – Part 1: Automatic potentiometric titration*

IEC 62021-2, *Insulating liquids – Determination of acidity – Part 2: Colourimetric titration*

IEC 62535:2008, *Insulating liquids – Test method for detection of potentially corrosive sulphur in used and unused insulating oil*

IEC 62697-1, *Test methods for quantitative determination of corrosive sulfur compounds in unused and used insulating liquids – Part 1: Test method for quantitative determination of dibenzyl disulfide (DBDS)*

IEC 62961, *Insulating liquids – Test methods for the determination of interfacial tension of insulating liquids – Determination with the ring method*

ISO 2049, *Petroleum products – Determination of colour (ASTM scale)*

ISO 2719, *Determination of flash point – Pensky-Martens closed cup method*

ISO 3016, *Petroleum and related products from natural or synthetic sources – Determination of pour point*

ISO 3104, *Petroleum products – Transparent and opaque liquids – Determination of kinematic viscosity and calculation of dynamic viscosity*

ISO 3675, *Crude petroleum and liquid petroleum products – Laboratory determination of density – Hydrometer method*

ISO 6247, *Petroleum products – Determination of foaming characteristics of lubricating oils*

ISO 9120, *Petroleum and related products – Determination of air-release properties of steam turbine and other oils – Impinger method*

ISO 12185, *Crude petroleum and petroleum products – Determination of density – Oscillating U-tube method*

ASTM D971, *Standard Test Method for Interfacial Tension of Insulating Liquids Against Water by the Ring Method*

ASTM D7042, *Standard Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)*

DIN 51353, *Testing of insulating oils – Detection of corrosive sulphur – Silver strip test*