

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Insulating liquids – Determination of the breakdown voltage at power frequency – Test method

Isolants liquides – Détermination de la tension de claquage à fréquence industrielle – Méthode d'essai



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2025 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications, symboles graphiques et le glossaire. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 500 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 25 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Insulating liquids – Determination of the breakdown voltage at power frequency – Test method

Isolants liquides – Détermination de la tension de claquage à fréquence industrielle – Méthode d'essai

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.040

ISBN 978-2-8327-0140-9

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	3
INTRODUCTION.....	5
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	6
4 Electrical apparatus.....	6
4.1 General.....	6
4.2 Voltage regulator	6
4.3 Step-up transformer.....	7
4.4 Switching system	7
4.5 Current-limiting resistors.....	7
4.6 Measuring system.....	7
5 Test assembly	7
5.1 General.....	7
5.2 Test cell.....	8
5.3 Electrodes	9
5.4 Stirring device.....	9
6 Preparation of electrodes.....	9
7 Test assembly preparation.....	9
8 Sampling	10
9 Test procedure	10
9.1 Sample preparation.....	10
9.2 Filling of the cell	10
9.3 Application of the voltage.....	10
10 Report	11
11 Test data dispersion and reproducibility.....	11
11.1 Test data dispersion	11
11.2 Reproducibility	12
Annex A (informative) Improved test method.....	13
A.1 Test procedure for improved test method	13
A.2 Report.....	14
Annex B (informative) Special test method for low volume samples	15
Annex C (informative) Representative material for a performance test	16
Bibliography.....	17
Figure 1 – Example of test cell with spherical electrodes 12,5 mm to 13,0 mm diameter	8
Figure 2 – Example of test cell with partially hemispherical electrodes with 25 mm radius and 36 mm diameter.....	8
Figure 3 – Graphical representation of coefficient of variation versus mean breakdown voltage.....	12
Figure A.1 – Example of a sequence of breakdown shots for determination of the breakdown voltage.....	14

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INSULATING LIQUIDS – DETERMINATION OF THE BREAKDOWN
VOLTAGE AT POWER FREQUENCY – TEST METHOD**

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 60156 has been prepared by IEC technical committee 10: Fluids for electrotechnical applications. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2018. This edition constitutes a technical revision.

This edition constitutes a technical revision and, mainly, confirms the content of the previous edition even if some advances are included. The test method has not been changed for practical reasons, due to the very large number of instrumentations disseminated around the world.

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

Draft	Report on voting
10/1241/FDIS	10/1256/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.

INTRODUCTION

As normally applied, breakdown voltage of insulating liquids is not a basic material property but an empirical test procedure intended to indicate the presence of contaminants such as water and solid suspended matter and the advisability of carrying out drying and filtration treatment.

The AC breakdown voltage value of insulating liquids strongly depends on the particular set of conditions used in its measurement. Therefore, standardized testing procedures and equipment are essential for the unambiguous interpretation of test results.

The method described in this document applies to either acceptance tests on new deliveries of insulating liquids or testing of treated liquids prior to or during filling into electrical equipment, or to the monitoring and maintenance of insulating liquid-filled apparatus in service. It specifies rigorous sample-handling procedures and temperature control that should be adhered to when certified results are required. For routine tests, especially in the field, less stringent procedures may be practicable, and it is the responsibility of the user to determine their effect on the results.

Annex A describes, for comparison, an alternative test method which could be introduced in the future. Annex B describes special test methods, using cells which may include low volume samples. Annex C describes a reference material for a performance test and check according to IEC 60060-3 [1]¹.

¹ Numbers in square brackets refer to the Bibliography.

INSULATING LIQUIDS – DETERMINATION OF THE BREAKDOWN VOLTAGE AT POWER FREQUENCY – TEST METHOD

1 Scope

This document specifies the method for determining the dielectric breakdown voltage of insulating liquids at power frequency. The test procedure is performed in a specified apparatus, where the oil sample is subjected to an increasing AC electrical field until breakdown occurs. The method applies to all types of insulating liquids of nominal viscosity up to 350 mm²/s at 40 °C. It is appropriate both for acceptance testing on unused liquids at the time of their delivery and for establishing the condition of samples taken in monitoring and maintenance of equipment.

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 60475, *Method of sampling insulating liquids*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

4 Electrical apparatus

4.1 General

The electrical apparatus consists of the following units:

- 1) voltage regulator,
- 2) step-up transformer,
- 3) switching system,
- 4) current-limiting resistors,
- 5) measuring device.

Two or more of these units may be integrated in any equipment system.

4.2 Voltage regulator

The test voltage shall be increased with an automatic control of the required uniform voltage rate of rise. The device should not introduce harmonics disturbances (< 3 %) and the AC source should be free from harmonics.