IEC 62961

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

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

Isolants liquides – Méthodes d'essai pour la détermination de la tension interfaciale des isolants liquides – Détermination par la méthode à l'anneau

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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INSULATING LIQUIDS – TEST METHODS FOR THE DETERMINATION OF INTERFACIAL TENSION OF INSULATING LIQUIDS – DETERMINATION WITH THE RING METHOD

FOREWORD

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The text of this standard is based on the following documents:

FDIS	Report on voting
10/1062/FDIS	10/1066/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

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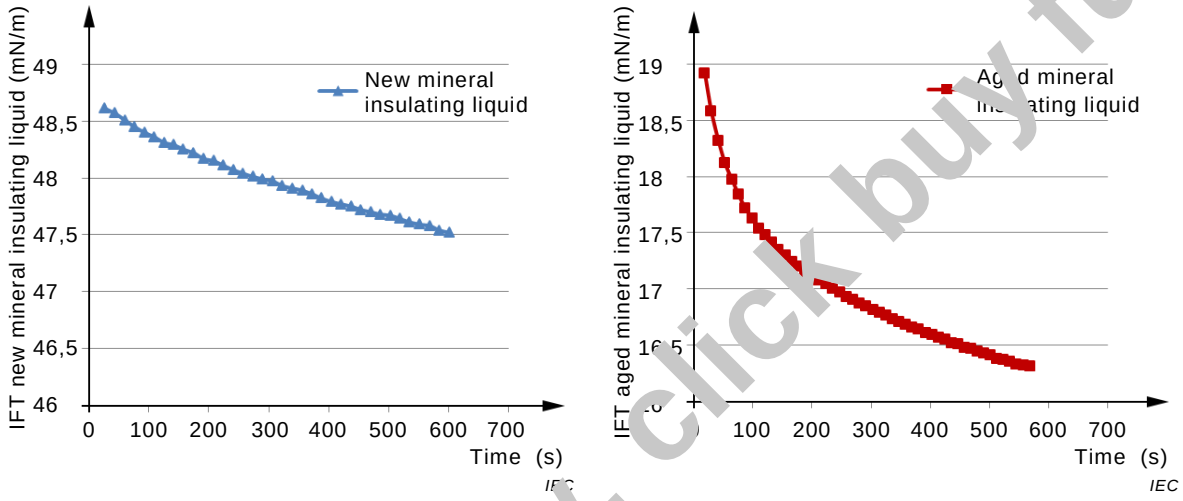
INTRODUCTION

Interfacial tension (IFT) of insulating liquid against water has been used for a long time as a criterion for ageing evaluation. Statistical values that are used as orientation values and for their interpretation have been published in IEC 60422 [1] [1].

The interfacial tension of insulating liquids changes with time depending on the type and nature of the ageing products. This process is more pronounced with aged than with new insulating liquids. It is well known that the interfacial tension of insulating liquids depends on the interfacial concentration of the surface active amphiphilic aged products at the time of measuring (dynamic interfacial tension), see Figure 1. The adsorption procedures, and thus the attaining of a state of equilibrium, can take several minutes or even hours. With the so-called static measuring methods – e.g. the Du Noüy ring [2]– measurements are repeated on the same sample surface until no further change occurs.



a) Typical development of interfacial tension values of a new inhibited mineral insulating liquid

b) Typical development of interfacial tension values of a service aged mineral insulating liquid

Figure 1 – Typical development of interfacial tension values of new and service aged mineral insulating liquids

[1] Numbers in square brackets refer to the Bibliography.

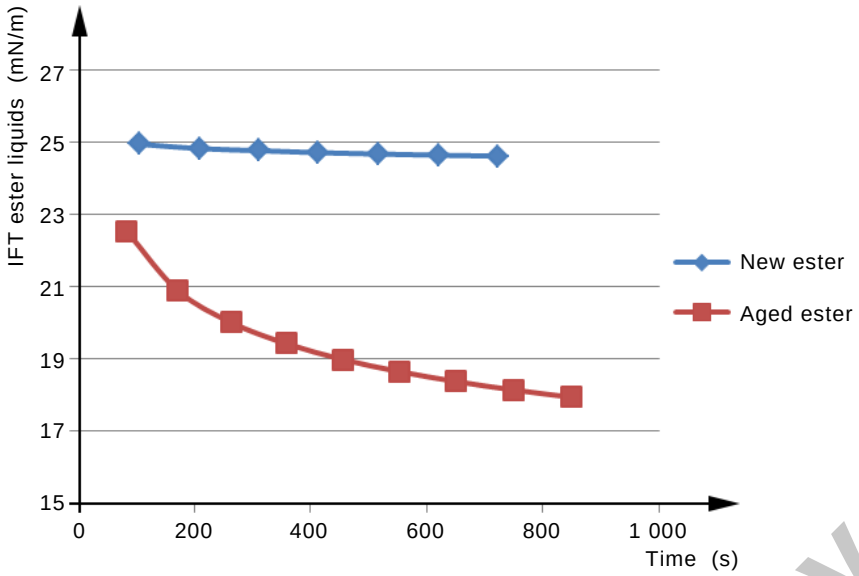


Figure 2 – Typical development of interfacial tension values of a new and a service aged ester insulating liquid

The interfacial tension of insulating liquids measured by the existing method ASTM D971 [3], working in non-equilibrium modus, provides only a single value within quite a short time (60 s) and hence might be quite different from the static interfacial value, particularly in the case of aged insulating liquids. In addition, the error of the time measurement might become a more important aspect than the performance of the measurement itself. These weaknesses of ASTM D971 could be generally compensated by replacing it with EN 14210 [4]. However, for the practical work in the laboratory, the requirement of repeating tests until "static" conditions are obtained can increase the test time dramatically.

The scope of this document is to find a compromise between the less accurate but fast ASTM D971 method and the precise but time consuming EN 14210 procedure. Experience of the round robin tests shows clearly that the slope of the time-dependent interfacial tension curve decreases significantly over a period of 180 s in the case of both mineral insulating liquids (Figure 1 a), Figure 1 b)) and insulating synthetic and natural esters (Figure 2). A measurement is carried out after a surface age of approximately 180 s in order to obtain a value that provides a more realistic expression of the real interfacial tension, and that is less sensitive to the timing of the measurement taken, and does not overly increase the test time.

The proposed surface age of 180 s allows the distinction between differently aged ester liquids, which is not possible with ASTM D971.

The drop volume method for the determination of interfacial tension can deliver similar results as the ring method if adapted concerning the surface age. This method is described in Annex A.

Experience and results of round robin tests have shown that the deviation of tests repeated after 10 min is less than 1 mN/m per min. Such tests can be necessary in case of further comparative investigations of aged mineral and ester insulating liquids, and are described in Annex B.

INSULATING LIQUIDS – TEST METHODS FOR THE DETERMINATION OF INTERFACIAL TENSION OF INSULATING LIQUIDS – DETERMINATION WITH THE RING METHOD

1 Scope

This document establishes the measurement of the interfacial tension between insulating liquid and water by means of the Du Noüy ring method close to equilibrium conditions. In order to obtain a value that provides a realistic expression of the real interfacial tension, a measurement after a surface age of approximately 180 s is recorded.

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.

ISO 862, *Surface active agents – Vocabulary*

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

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

EN 14370, *Surface active agents – Determination of surface tension*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 862 and the following apply.

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

3.1
interfacial tension
tension at the interface between two phases

Note 1 to entry: The SI unit of interfacial tension is the Newton per metre (N/m). In practice, the submultiple millinewton per metre (mN/m) is used.

4 Principle

The maximum force, F, necessary to pull or to force a ring of perimeter πD out of the interface between insulating liquid and water in the direction of the insulating liquid is measured. The interfacial tension, σ, is obtained by calculation, where the following approximate equation (1) serves as the base: