

# INTERNATIONAL STANDARD



**Solar thermal electric plants –  
Part 1-6: Silicone-based heat transfer fluids for use in line-focus concentrated  
solar power applications**



**THIS PUBLICATION IS COPYRIGHT PROTECTED**  
**Copyright © 2024 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.

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

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://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](http://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 It also gives information on projects, replaced and withdrawn publications.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](http://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](http://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](mailto:sales@iec.ch).

**IEC Products & Services Portal - [products.iec.ch](http://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](http://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.

# INTERNATIONAL STANDARD



---

**Solar thermal electric plants –  
Part 1-6: Silicone-based heat transfer fluids for use in line-focus concentrated  
solar power applications**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

---

ICS 27.160

ISBN 978-2-8322-8825-2

**Warning! Make sure that you obtained this publication from an authorized distributor.**

## CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references .....	6
3 Terms and definitions .....	7
3.1 General definitions.....	7
3.2 Relevant physical and chemical properties of heat transfer fluids.....	8
4 Classification of heat transfer fluids .....	12
4.1 General.....	12
4.2 Mineral oil fluids.....	12
4.3 Synthetic fluids .....	12
4.4 Synthetic heat transfer fluids based on polydimethylsiloxanes (silicone, SiHTF).....	12
4.5 Organic synthetic heat transfer fluids based on biphenyl / diphenyl oxide (BP/DPO).....	12
4.6 Molten salt.....	12
5 Specified fluid properties and test methods .....	12
5.1 General.....	12
5.2 List of technical requirements and evaluation of the quality of unused heat transfer fluids.....	13
5.3 List of additional fluid properties and test methods for silicone-based heat transfer fluids for general layout at operating conditions .....	14
5.4 List of fluid properties and test methods for heat transfer fluids in use .....	14
6 Inspection interval and sampling.....	15
6.1 Inspection interval.....	15
6.2 HTF sampling .....	16
6.3 Gas-sampling.....	16
6.4 Labeling of the samples .....	17
7 Reporting.....	18
8 Marking, labelling and accompanied documents .....	19
9 Mixing.....	19
10 Recycling and disposal.....	20
11 Replacement and reuse .....	20
Annex A (informative) Determination of the degree of thermal degradation of polydimethylsiloxane-based heat transfer fluids .....	21
A.1 Overview.....	21
A.2 Meaning of symbols M, D, T.....	21
A.3 Principle .....	21
A.4 Technical equipment.....	23
A.5 Safety remarks.....	24
A.6 Reagents .....	24
A.7 Procedure.....	24
A.7.1 Sample preparation .....	24
A.7.2 Measurement procedure .....	24
A.8 Evaluation.....	25
A.8.1 Analysis of results .....	25
A.8.2 Calculation of the degree of degradation .....	26
A.8.3 Assessment of the result .....	27

A.9	Accuracy	27
A.9.1	General	27
A.9.2	Addition of TM <sub>3</sub> as external standard	27
A.9.3	Repeatability	27
A.9.4	Reproducibility	27
A.10	Example with TM <sub>3</sub> as reference substance	27
Annex B (informative) Safety instructions and recommendations for handling polydimethylsiloxane-based heat transfer fluids at temperatures up to 450 °C		29
B.1	Safety information	29
B.2	Safety instructions and recommendations	29
B.2.1	General recommendations	29
B.2.2	Hazardous ingredients of polydimethylsiloxane-based heat transfer fluids under operating conditions	30
B.2.3	Exposure controls and personal protection	30
B.2.4	General protection and hygiene measures	31
B.2.5	Personal protection equipment	31
B.2.6	First aid measures after contact	31
B.2.7	Firefighting measures	32
Bibliography		33
Figure 1 – Example of an aluminum bottle for sampling (new)		16
Figure 2 – Example of a cylinder mounted with two valves (before use) e.g. for sampling at 425 °C and 20 bar		17
Figure A.1 – Representation of the molecular structure of M-, D-, and T-units in polydimethylsiloxanes (PDMS)		21
Figure A.2 – Representation of the molecular structure of polydimethylsiloxanes (PDMS, left) and the thermally induced cyclization reaction of linear polydimethylsiloxanes		22
Figure A.3 – Thermally induced disproportionation of D-units in linear polydimethylsiloxanes, into T and M units		22
Figure A.4 – Theoretical model for describing the long-term increase in viscosity of polydimethylsiloxane-based fluids by thermal aging		23
Figure A.5 – Representation of a <sup>29</sup> Si NMR spectrum indicating the different shift regions		26
Figure A.6 – <sup>29</sup> Si NMR spectrum (99,3 MHz, CD <sub>2</sub> Cl <sub>2</sub> ) of TM <sub>3</sub> with TMS as internal standard		28
Table 1 – Properties and test methods for unused heat transfer fluids		13
Table 2 – Additional fluid properties at specified operating conditions		14
Table 3 – Test methods for heat transfer fluids in use (basic program)		15
Table 4 – Test methods for heat transfer fluids in use (additional program)		15
Table A.1 – Shift regions and assignment		25
Table B.1 – Possible hazardous ingredients of polydimethylsiloxane-based heat transfer fluids in use		30
Table B.2 – The product can contain the following substances of very high concern (Regulation (EC) No. 1907/2006 (REACH), Article 57) in amounts ≥ 0,1 %		30

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## SOLAR THERMAL ELECTRIC PLANTS –

Part 1-6: Silicone-based heat transfer fluids for use in  
line-focus concentrated solar power applications

## 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 Publications"). 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 far 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 62862-1-6 has been prepared by IEC technical committee TC 117: Solar thermal electric plants. It is an International Standard.

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

Draft	Report on voting
117/199/FDIS	117/202/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](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at <http://www.iec.ch/standardsdev/publications>.

A list of all parts in the IEC 62862 series, published under the general title *Solar thermal electric plants*, can be found on the IEC website.

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](http://webstore.iec.ch) in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

**IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

## SOLAR THERMAL ELECTRIC PLANTS –

### Part 1-6: Silicone-based heat transfer fluids for use in line-focus concentrated solar power applications

#### 1 Scope

This part of IEC 62862 specifies the technical requirements (safety and physical parameters), test methods, inspection rules and intervals, sampling, judgment, marking, labelling and accompanying documents, packaging, transportation and storage, recycling and disposal of silicone-based heat transfer fluids (SiHTF) for use in line-focusing solar thermal power plants.

The application of polydimethylsiloxane-based heat transfer fluids for this type of installation is covered in this document. Owing to their chemical nature and composition, the introduction of new test methods to determine the applicability and the thermal stability of SiHTF is included in 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 TS 62862-1-1, *Solar thermal electric plants – Part 1-1: Terminology*

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

ISO 2160, *Petroleum products – Corrosiveness to copper – Copper strip test*

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 3405, *Petroleum and related products from natural or synthetic sources – Determination of distillation characteristics at atmospheric pressure*

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

ISO 6618, *Petroleum products and lubricants – Determination of acid or base number – Colour-indicator titration method*

ISO 11885, *Water quality – Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES)*

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