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INTERNATIONAL STANDARD

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

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SOLAR THERMAL ELECTRIC PLANTS –

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

FOREWORD

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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. 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 in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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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 – 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*

ISO 12937, *Petroleum products – Determination of water – Coulometric Karl Fischer titration method*

ISO 15597, *Petroleum and related products – Determination of chlorine and bromine content – Wavelength-dispersive X-ray fluorescence spectrometry*

ISO 20846, *Petroleum products – Determination of sulfur content of automotive fuels – Ultraviolet fluorescence method*

UNE 206015, *Heat transfer fluids for solar thermal power plants with parabolic trough collector technology. Requirements and tests*

DIN 4754-1, *Wärmeübertragungsanlagen mit organischen Wärmeträgern – Teil 1: Sicherheitstechnische Anforderungen, Prüfung* (in German) [*Heat transfer installations working with organic heat transfer fluids – Part 1: Safety requirements, test*]

DIN 51529, *Prüfung von Mineralölen und verwandten Erzeugnissen – Prüfung und Beurteilung gebrauchter Wärmeträgermedien* (in German) [*Testing of mineral oils and related products –* Testing and evaluation of used heat transfer fluids]

DIN 51794-2003-05, *Prüfung von Mineralölkohlenwasserstoffen – Bestimmung der Zündtemperatur* (in German) [Testing of mineral oil hydrocarbons – Determination of ignition temperature]

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 62862-1-1 and the following apply.

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

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

3.1 General definitions

3.1.1
heat transfer fluid
HTF
substances in the liquid or gaseous phase that are used for heat transfer

3.1.2
unused heat transfer fluid
heat transfer fluid which has not been introduced into the heat transfer system, e.g. the solar field

3.1.3
heat transfer fluid in use
heat transfer fluid which has been introduced into the heat transfer system at least once

3.1.4
heat transfer fluid at operating conditions
heat transfer fluid which is operated at the specified working temperature, after reaching a chemical equilibrium state

3.1.5
equilibration
process of reaching equilibrium composition under specific temperature and pressure parameters

Note 1 to entry: In a chemical reaction, equilibrium is the state in which both the reactants and products are present in concentrations which have no further tendency to change with time, so that there is no observable change in the properties of the system. Typically, silicone-based heat transfer fluids at a given temperature and pressure experience changes of their physical properties until a chemical equilibrium is established. Afterwards, the physical properties and chemical composition of the fluid remain stable.

3.1.6
maximum working temperature
maximum bulk temperature of the heat transfer fluid permitted at any location in the heat transfer fluid system

3.1.7
maximum bulk temperature
highest average temperature of the heat transfer fluid in a specified section of the installation

Note 1 to entry: The location of the section of the installation with the maximum bulk temperature is usually directly after the exit of the hot collector outlet or at the exit of a fluid heater.

3.1.8
film temperature
temperature at the contact between heat transfer fluid and heating surface of the solar receiver, heater, or other components

3.1.9
zeotropic mixture
complex mixture with liquid components that have different boiling points

Note 1 to entry: Individual substances in the mixture do not evaporate or condense at the same temperature as a pure substance.

3.2 Relevant physical and chemical properties of heat transfer fluids

3.2.1
appearance
<of heat transfer fluid> parameter describing the purity of a heat transfer fluid, referring to the absence or presence of turbidity, emulsion, particles or visible water in the heat transfer fluid

Note 1 to entry: The appearance and color of a heat transfer fluid can be useful for a comparative assessment. A change in color, or the appearance of particles, may indicate degradation or contamination of the liquid.

3.2.2
composition
<of heat transfer fluid> information on the chemical identity of the medium or its individual components

Note 1 to entry: For complex mixtures information on the chemical identity can be also the chemical family instead of individual compounds. The physical and chemicals properties of the HTF are very relevant for concentrated solar power (CSP) application. These properties and the health, safety and environment (HSE) classification is determined by the type of chemistry of the HTF. The chemical composition of siloxanes can be determined by gas chromatography–mass spectrometry (GC-MS).

3.2.3
water content
<of heat transfer fluid> amount of water in the heat transfer fluid, given on a mass (gravimetric) basis

Note 1 to entry: High water content leads to higher vapor pressure. It may also impact the corrosivity and other parameters like aging rate of an HTF and hydrogen formation rate and thus the concentration of particles or degradation products. Concerning SiHTFs, high amounts of water may also lead to water-induced degradation reactions. In consequence fluid viscosity may increase significantly faster and shorten shelf-life. The occurrence of water in the heat transfer fluid is usually due to a defective point in the heat exchange system.

3.2.4
chlorine content
<of heat transfer fluid> amount of chlorine in the heat transfer fluid, given on a mass (gravimetric) basis

Note 1 to entry: Corrosiveness and the degradation rate of the HTF may increase with increasing chlorine concentration, thus the chlorine content of the heat transfer medium shall be known.

3.2.5
sulphur content
<of heat transfer fluid> amount of sulphur in the heat transfer fluid, given on a mass (gravimetric) basis

Note 1 to entry: The corrosiveness and the degradation rate of the HTF may increase with increasing sulphur concentration, thus the sulphur content of the heat transfer medium shall be known.

3.2.6
acid number
neutralization number
<for water soluble acids> required basic amount (shown in milligrams of potassium hydroxide) to neutralize the acid content in one gram of the heat transfer fluid sample (mg KOH/g HTF)

3.2.7
copper corrosion
corrosion of materials made of copper or copper alloys when exposed to the HTF itself or any other compounds in the HTF

Note 1 to entry: The relative degree of corrosiveness can be determined by the copper strip test.

3.2.8
flash point
minimum temperature at which a flame on the surface of a heat transfer fluid triggers the ignition of the liquid's vapor (°C)

Note 1 to entry: The flash point determines the flammability classification of the liquid and thus the transport regulations (hazardous goods), as well as measures for occupational and plant safety. During operation of a CSP plant the fluid is typically operated significantly above the flash point temperature. Accordingly, the system is designed for it, and all surfaces of the fluid are covered with inert gas (nitrogen).

3.2.9
auto-ignition temperature
temperature at which a heat transfer fluid self-ignites in the presence of air but in the absence of flames or sparks that could trigger combustion (°C)

Note 1 to entry: The auto-ignition temperature of a medium is required to specify equipment suitable for the use in potentially explosive atmospheres (areas prone to leakages). The surface temperatures shall either be limited to a safe value below the auto-ignition temperature, or other measures to prevent fire in accordance with the results of a hazard analysis have to be taken.

3.2.10
heat of combustion
amount of energy released when a unit of mass of a heat transfer fluid is burned in the presence of oxygen (J/kg)