



WP4.D3 / REPORT ON PROPERTIES AND STANDARD TESTS OF SOLAR FLUIDS **FINAL DRAFT**

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SUMMARY

Overview of important fluid properties, existing standards and product declaration of manufacturers.

FLUID PROPERTIES

List of fluid properties relevant for solar thermal applications.

PRODUCT DECLARATIONS AND STANDARDS

Existing standards for the determination of fluid properties. Reference made by manufacturers to existing standards in product datasheets.

SUMMARY

In central and northern Europe, solar collectors are usually filled with an antifreeze fluid to prevent bursting of pipes and other containments during cold periods. This report gives an overview of fluid properties that are of significance for solar thermal systems, standards for the determination of these properties and an overview over current product declarations by the manufacturers of solar fluids.

Fluid properties

Table 1 gives an overview of relevant properties for solar fluids.

Property	Relevance
Freezing point / setting point	Freeze protection (protection against bursting of pipes)
Boiling point	Upper temperature limit of collector operation
Viscosity	Pressure drop in tubes (parasitic energy used for circulation of the fluid), heat transfer
Thermal conductivity / diffusivity / specific heat	heat transfer
Density	heat transfer / calculations
Corrosivity / pH / Reserve alkalinity	Compatibility with containment material used in the installation / durability of the installation
Durability / lifetime of the antifreeze	Maintenance cost / risk of failure because of fluid deterioration and/or material corrosion
Index of refraction	Concentration measurements of water/glycol mixtures
Self ignition temperature / flash point	Fire and explosion safety
Toxicity / ecotoxicity / environmental degradation	Safety of DHW-Systems / ecological product labelling / disposal
Embodied energy	Life cycle assessment

Table 1: Relevant properties of solar fluids

Product declaration by manufacturers and cited standards

Not all manufacturers provide the same data about their products, and standards used for the determination of these data are not always the same (Table 2). It is worth noting that for thermal conductivity, specific heat and toxicity values are usually published without a reference to a standard.

Parameter	Standard used by manufacturers	Other standards
❖ Freezing point	ASTM D1177	
❖ Setting point	DIN 51583 ¹ , DIN ISO 3016	
❖ Boiling point	ASTM D1120	
❖ Viscosity	DIN 51562	
❖ Thermal conductivity / diffusivity		ASTM D2717, ASTM E1952
❖ Specific heat		ASTM E1269)
❖ Density	ASTM D4052, ASTM D1122, DIN 51757	
❖ Corrosion	ASTM D1384	ASTM E745, ASTM E712
❖ pH	ASTM D1287, DIN 51369	
❖ Reserve alkalinity	ASTM D1121	
❖ Stability, lifetime of the anti-freeze	no data published	no standard available
❖ Index of refraction	DIN 51423, DIN 51757	
❖ Self ignition temperature	DIN 51794	DIN 51758 ² , DIN 51376 ³ , DIN EN ISO 2592
❖ Flash point		
❖ Toxicity	data w/o reference	
❖ Ecotoxicity	data w/o reference	
❖ Environmental degradation	OECD 301	
❖ Embodied energy	no data published	no standard available

Table 2: Data published by manufacturers and test standards cited in product datasheets.

No values are usually published for the lifetime of a solar fluid, since the lifetime is always strongly related to specific parameters of an installation / application. Influencing parameters are for example maximum collector temperature during stagnation, frequency of stagnation, emptying behaviour of the collector array, metals encountered in the fluid containments, pressure of the system etc. Even for a given set of influencing parameters, there is no standard method for the determination of the fluid lifetime. Most manufacturers give upper temperature limits for the use of their products. These upper temperature limits are usually much lower than

¹ The Norm DIN 51583 has been withdrawn and replaced by DIN EN 23015

² The Norm DIN 51758 has been withdrawn and replaced by DIN EN ISO 2719

³ The Norm DIN 51376 has been withdrawn and replaced by DIN EN ISO 2592

temperatures encountered during stagnation of glazed flat plate collectors, and considerably lower than stagnation temperatures of vacuum tube collectors.

Embodied energy, which is usually defined as energy used for production and disposal of a product, cannot be found in current datasheets of solar fluid manufacturers. Embodied energy is used for life cycle assessments (LCA) of solar thermal systems and is thus an important figure for the determination of ecological advantages of one system over another. Subtask 9 of this workpackage discusses standards for LCA and related topics, and therefore we will not focus further on embodied energy in this Workpackage.

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Annex A: Product declaration by manufacturers in detail

	CLAR	BASF	TYFO	DOW	THER	FRAG
Freezing point	ASTM D1177	ASTM D1177	ASTM D1177	data w/o std	data w/o std	
Setting point	DIN 51583 ⁴	DIN 51583 ¹ DIN ISO 3016				
Boiling point	ASTM D1120	ASTM D1120	ASTM D1120	data w/o std		ASTM D1120
Viscosity	DIN 51562	DIN 51562	DIN 51562	data w/o std		DIN 51562
Thermal conductivity / diffusivity	data w/o std	data w/o std	data w/o std	data w/o std		data w/o std
Specific heat	data w/o std	data w/o std	data w/o std	data w/o std		data w/o std
Density	DIN 51757	DIN 51757 ASTM D4052	ASTM D1122	data w/o std	data w/o std	ASTM D1122
Corrosion	ASTM D1384	ASTM D1384	ASTM D1384			ASTM D1384
pH	DIN 51369	ASTM D1287	ASTM D1287	data w/o std	data w/o std	ASTM D1287
Reserve alkalinity	ASTM D1121	ASTM D1121	ASTM D1121	data w/o std		ASTM D1121
Lifetime of the anti-freeze						
Index of refraction	DIN 51423	DIN 51423	DIN 51757	data w/o std		DIN 51757
Self ignition temperature	DIN 51794	DIN 51794	DIN 51794	data w/o std		
Flash point	DIN 51758	DIN 51758	DIN ISO 2592	data w/o std		DIN 51376
Toxicity	data w/o std	data w/o std	data w/o std	data w/o std		
Ecotoxicity	data w/o std	data w/o std	data w/o std	data w/o std		
Environmental degradation	data w/o std	OECD 301 A	OECD 301 A	OECD 301 E, OECD 301 F		

CLAR = Clariant, BASF = BASF, TYFO = TYFOROP, DOW = DOW; THER = THERMOCHEMA, FRAG = FRAGOL

data w/o std = data is published, but with no standard test method cited

empty cell = no data could be found on readily available datasheets

Annex B: Literature

/ASTM D1120/	ASTM D1120-94(2004) Standard Test Method for Boiling Point of Engine Coolants
/ASTM D1121/	ASTM D1121-98(2003) Standard Test Method for Reserve Alkalinity of Engine Coolants and Antirusts
/ASTM D1122/	ASTM D1122-97a(2002) Standard Test Method for Density or Relative Density of Engine Coolant Concentrates and Engine Coolants By The Hydrometer
/ASTM D1177/	ASTM D1177-94(1998)e1 Standard Test Method for Freezing Point of Aqueous Engine Coolants
/ASTM D1284/	ASTM D1287-91(2002) Standard Test Method for pH of Engine Coolants and Antirusts
/ASTM D1384/	ASTM D1384-04 Standard Test Method for Corrosion Test for Engine Coolants in Glassware
/ASTM D2717/	ASTM D2717-95(2000) Standard Test Method for Thermal Conductivity of Liquids
/ASTM D4052/	ASTM D4052-96(2002)e1 Standard Test Method for Density and Relative Density of Liquids by Digital Density Meter
/ASTM E1269/	ASTM E1269-05 Standard Test Method for Determining Specific Heat Capacity by Differential Scanning Calorimetry
/ASTM E1952/	ASTM E1952-01 Standard Test Method for Thermal Conductivity and Thermal Diffusivity by Modulated Temperature Differential Scanning Calorimetry
/ASTM E712/	ASTM E712-80(2003) Standard Practice for Laboratory Screening of Metallic Containment Materials for Use With Liquids in Solar Heating and Cooling Systems
/ASTM E745/	ASTM E745-80(2003) Standard Practices for Simulated Service Testing for Corrosion of Metallic Containment Materials for Use With Heat-Transfer Fluids in Solar Heating and Cooling Systems
/Cla03/	Antifrogen N – Sicherheitsdatenblatt gemäss 2001/58/EG, Clariant GmbH, 18.06.2003
/Cla04/	Antifrogen N – Frost- und Korrosionsschutzmittel für Kühl- und Wärmepumpenanlagen sowie Warmwasserheizungen, Leckanzeigeflüssigkeit , Clariant - Division Functional Chemicals, Juli 2004
/DIN 51369/	DIN 51369, Ausgabe:1981-07 Prüfung von Kühlschmierstoffen; Bestimmung des pH-Wertes von wassergemischten Kühlschmierstoffen
/DIN 51423/	DIN 51423, Ausgabe:1975-03 Prüfung von Mineralölen; Messung der Brechzahl
/DIN EN 23015/	DIN EN 23015, Ausgabe:1994-05 Mineralölerzeugnisse; Bestimmung des Cloudpoints (ISO 3015:1992)
/DIN EN ISO 2592/	DIN EN ISO 2592, Ausgabe:2002-09 Mineralölerzeugnisse - Bestimmung des Flamm- und Brennpunktes - Verfahren mit offenem Tiegel nach Cleveland (ISO 2592:2000)

/DIN EN ISO 2719/	DIN EN ISO 2719, Ausgabe:2003-09 Bestimmung des Flammpunktes - Verfahren nach Pensky-Martens mit geschlossenem Tiegel (ISO 2719:2002); Deutsche Fassung EN ISO 2719:2002
/DIN ISO 3016/	DIN ISO 3016, Ausgabe:1982-10 Mineralölerzeugnisse; Bestimmung des Pourpoints
/DIN51562/	DIN 51562, Ausgabe:1999-01 Viskosimetrie - Messung der kinematischen Viskosität mit dem Ubbelohde-Viskosimeter
/DIN51757/	DIN 51757, Ausgabe:1994-04 Prüfung von Mineralölen und verwandten Stoffen; Bestimmung der Dichte
/DIN51794/	DIN 51794, Ausgabe:2003-05, Prüfung von Mineralölkohlenwasserstoffen - Bestimmung der Zündtemperatur
/DOW04/	Dowcal 10 Heat Transfer Fluid - EG-Sicherheitsdatenblatt- 15/11/04
/DOWxx/	Dowcal 10 - Inhibited Ethylene Glycol-based Heat Transfer Fluid – Product information, The Dow Chemical Company, CH-153-314-E-1101
/FRA02/	Ucotherm W-VR – Gebrauchsfertige, verdampfungssichere Spezial-Wärmeträgerflüssigkeit für Solaranlagen auf Basis 1,2 Propylenglycol, Fragol Schmierstoffe G.m.b.H, 01/02