# THW-L1 Transient Hot-Wire

Thermal conductivity, thermal diffusivity, and specific heat instrument for primary measurement of **liquids, pastes, and powders**.

Conforms to ASTM D7896-19

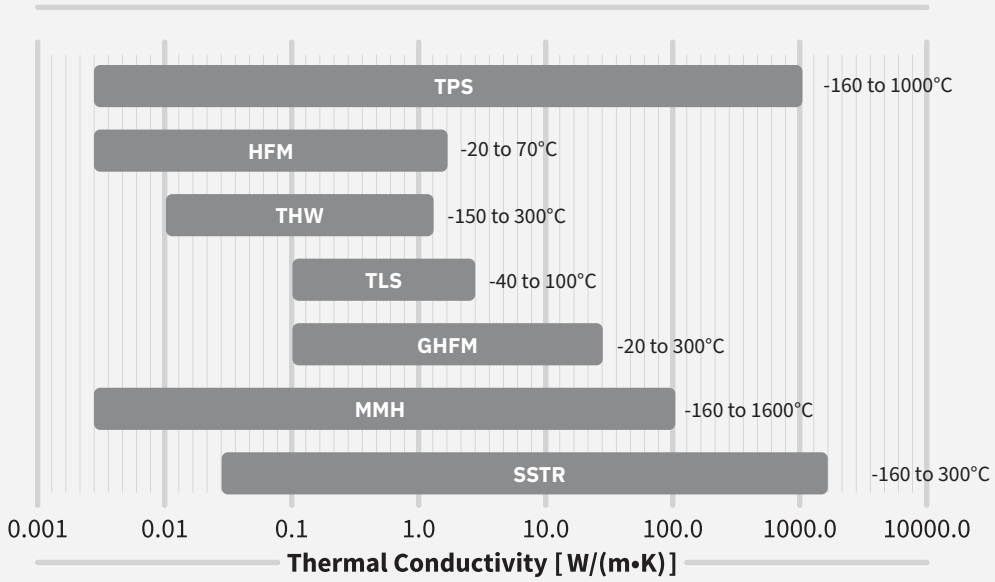

Liquids

Pastes

Powders

Thermtest™ INSTRUMENTS

Thermtest.com




Thermtest INSTRUMENTS

**THERMAL CONDUCTIVITY**:
**HFM-100** (Heat Flow Meter)
**THW-L1** (Transient Hot Wire)
**GHFM-01** (Guarded Heat Flow Meter)
**MMH-1600** (Monotonic Heating)
**SSTR-F** (Steady State Thermoreflectance)

Thermtest PORTABLE

**TLS-100** (Transient Line Source)
**THW-L2** (Transient Hot Wire)
**TPS-EFF** (Transient Plane Source)
**GHFM-02** (Guarded Heat Flow Meter)
**MP-2** (Measurement Platform)

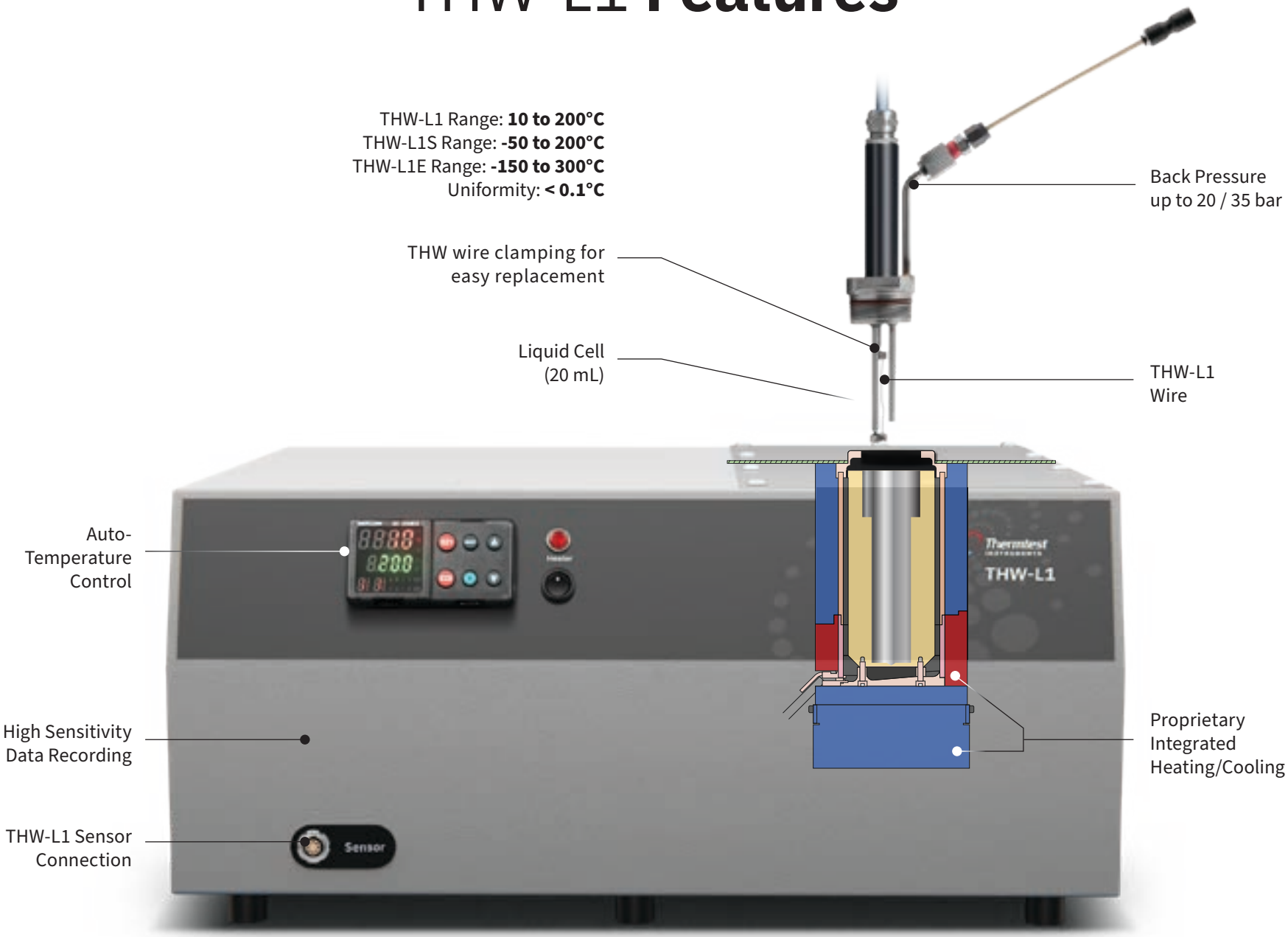
Thermtest has been advancing the measurement of thermal conductivity, thermal diffusivity, and specific heat since 2005. With more than 2000 satisfied customers worldwide, our unique combination of advanced thermal conductivity instrumentation for the laboratory, portable meters for the field, and accessories enables us to provide ideal solutions to fit any material testing application and budget.


# **THW-L1** Transient Hot-Wire

The THW-L1 following ASTM D7896-19, is widely used for the accurate measurement of thermal conductivity, thermal diffusivity, and specific heat of liquids and pastes. This versatility is greatly expanded with the addition of Thermtest's proprietary Temperature Platform (TP) which is appreciated by academic and commercial users alike.

The Transient Hot-Wire (THW) has been used for the testing of liquids for more than 30 years, making it one of the most published methods for measuring thermal conductivity of liquids available.

# THW-L1 **Features**



# Featured **Transient Hot-Wire Capabilities**

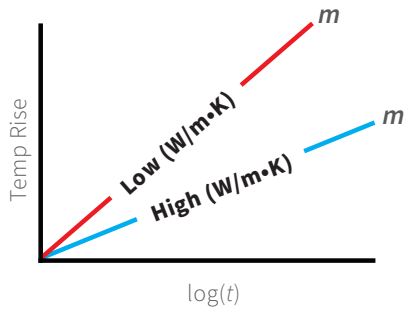
The Transient Hot-Wire (THW-L1) Liquid Thermal Conductivity Meter is an advanced measurement system for primary measurements of thermal conductivity, thermal diffusivity, and specific heat instrument for measurement of liquids and pastes in accordance with ASTM D7896-19. The THW-L1 was designed with speed and operational simplicity in mind. With a single measurement of 1 second in duration, small volumes of Liquids, Pastes, and Powders can be accurately and precisely measured for thermal conductivity, thermal diffusivity, and specific heat. The THW-L1 utilizes a non-stationary measurement approach and rapid test times to limit convective effects for samples with a wide range of viscosities. The THW sensor consists of a thin heating wire 40 mm in length and is completely inserted into the sample to be tested. The sensor wire is heated using a constant current source *(q)* and the temperature rise is recorded by monitoring the change in electrical resistance of the wire. The slope *(m)* from the plot of temperature rise vs. logarithm of time is used in the calculation of thermal conductivity *(λ)*. For liquid samples of high thermal conductivity, the lower the slope. For liquid samples of low thermal conductivity, the higher the slope.

$$\lambda = \frac{q}{4\pi m}$$

$\lambda$ = thermal conductivity (W/m•K)

$q$ = heating power (W/m)

$m$ = slope




- **Follows international standard ASTM D7896-19**
- **Automated, powerful, and accurate**
- **Minimum effects of convection**
- **Cell Pressure up to 35 bar**
- **Integrated temperature control**
- **Unique wire clamping for easy replacement**

## THW-L1 Specifications

| | |
|---|---|
| Materials | Liquids, Pastes, and Powders |
| Measurement Capabilities | Bulk Properties |
| Thermal Conductivity | 0.01 to 2 W/m•K |
| Additional Properties | Thermal Diffusivity & Specific Heat |
| Viscosity Range | 0.001 to 10,000,000 cP |
| Measurement Time | 1 second \| < 5 seconds |
| Repeatability | ± 1% |
| Accuracy* | ± 2% |
| Temperature Range† | -150 to 300°C |
| Pressure | Up to 35 bar |
| Smallest Volume | 20 mL |
| Standards | ASTM D7896-19 |

†Based on THW-L1 model used

*All performance data is verified with ASTM Type II Water (IAPWS)

# Transient Hot-Wire **(THW) Models**

| **Models** | **THW-L1** | **THW-L1S** | **THW-L1E** |
|---|---|---|---|
| **Materials** | Liquids, Pastes, and Powders | Liquids, Pastes, and Powders | Liquids, Pastes, and Powders |
| **Measurement Capabilities** | Bulk Properties | Bulk Properties | Bulk Properties |
| **Thermal Conductivity** | 0.01 to 2 W/m•K | 0.01 to 2 W/m•K | 0.01 to 2 W/m•K |
| **Additional Properties** | Thermal Diffusivity & Specific Heat | Thermal Diffusivity & Specific Heat | Thermal Diffusivity & Specific Heat |
| **Viscosity Range** | 0.001 to 10,000,000 cP | 0.001 to 10,000,000 cP | 0.001 to 10,000,000 cP |
| **Measurement Time** | 1 second \| < 5 seconds | 1 second \| < 5 seconds | 1 second \| < 5 seconds |
| **Repeatability** | ± 1% | ± 1% | ± 1% |
| **Accuracy*** | ± 2% | ± 2% | ± 2% |
| **Temperature Range** | 10 to 200°C | -50 to 200°C | -150 to 300°C |
| **Pressure** | Up to 20 bar | Up to 20 bar | Up to 35 bar |
| **Smallest Volume** | 20 mL | 20 mL | 20 mL |
| **Standards** | ASTM D7896-19 | ASTM D7896-19 | ASTM D7896-19 |
| **External Cooling Apparatus Required** | No | Yes | Yes |

*All performance data is verified with ASTM Type II Water (IAPWS)

# Portable **THW Models**

| **Models** | **THW-L2** | **THW-L3** | **THW-S** |
|---|---|---|---|
| **Materials** | Liquids, Pastes, and Powders | Liquids, Pastes, and Powders | Insulation, and Soft Materials |
| **Measurement Capabilities** | Bulk Properties | Bulk Properties | Bulk Properties |
| **Thermal Conductivity** | 0.01 to 2 W/m•K | 0.01 to 1 W/m•K | 0.01 to 2 W/m•K |
| **Additional Properties** | No | No | No |
| **Viscosity Range** | 0.001 to 10,000,000 cP | 0.001 to 10,000,000 cP | N/A |
| **Measurement Time** | 1 second \| < 5 seconds | 1 second | 1 to 5 seconds |
| **Repeatability** | ± 2% | ± 2% | ± 2% |
| **Accuracy** | ± 5% | ± 5% | ± 5% |
| **Temperature Range** | -50 to 100°C | 10 to 40°C | 10 to 40°C |
| **Pressure** | Ambient | Ambient | N/A |
| **Smallest Volume** | 15 mL | 15 mL | **Min. Sample Size**: 50 mm x 10 mm |
| **Standards** | ASTM D7896-19 | ASTM D7896-19 | N/A |
| **External Cooling Apparatus Required** | Yes | Yes | N/A |

# Optional THW-L1 **Sample Cells**

## Paste and PCM Cell

Special Phase Change Materials (PCM) with easy to load access.  Unique spring design allows sample expansion and contraction, while ensuring sample is in constant contact with THW wire during measurement.

## Observation Cell

THW-L1 observation sample cell is used for liquids, powder, and paste testing. The cell has convenient glass ports for observing what is happening with your sample. Typical applications are phase separation, boiling or particle settling to name a few.

## Ambient Density Powder Cell

The THW-L1 Ambient density Powder Cell is suitable for basic powder sample testing and ambient pressure.

## Variable Density Powder Cell

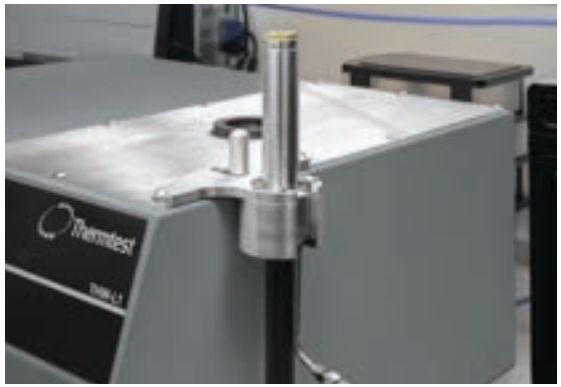
THW-L1 test cell with screw-type compression system for varying the density of powder samples, can also be used to ensure powders stay in contact with THW wire.

# Optional THW-L1 **Accessories**

## Vertical Cell Mount

Convenient THW cell mount that can be attached to your THW-L1 for vertical sample loading. Ideal for the Paste/ PCM and all Powder Cells.


Vertical cell mount attached without sample.




Vertical cell mount with sample loaded.

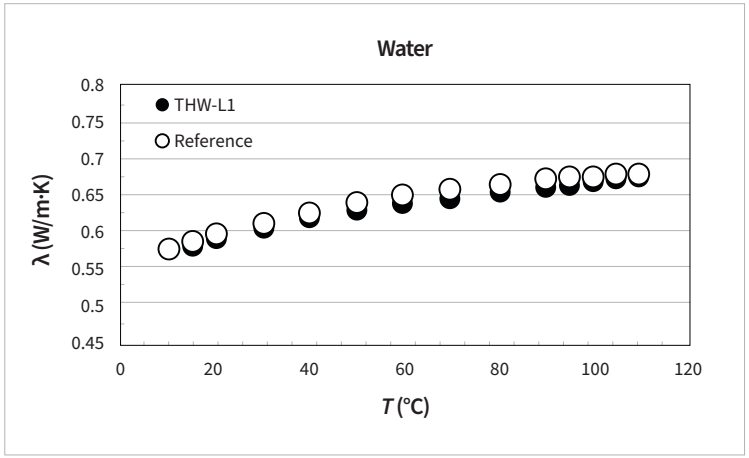
## Cooling Options

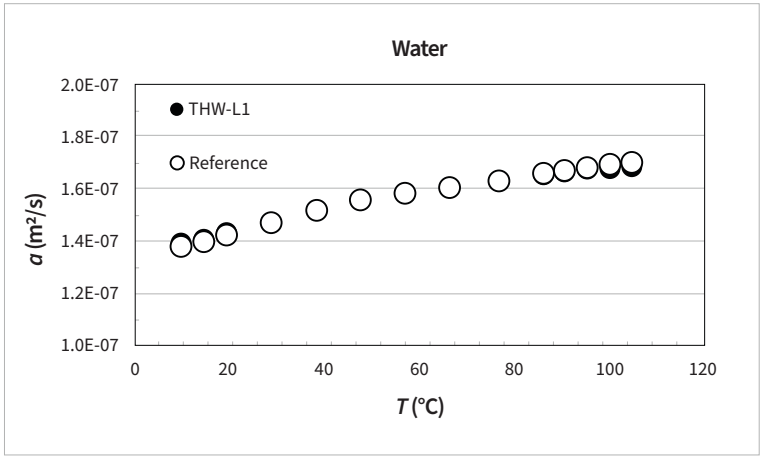
- Economy Circulator: Down to 0°C
- THW-L1 Circulator: Down to -15 / -35 / -50°C
- THW-L1E Only: Down to -100 / -150°C

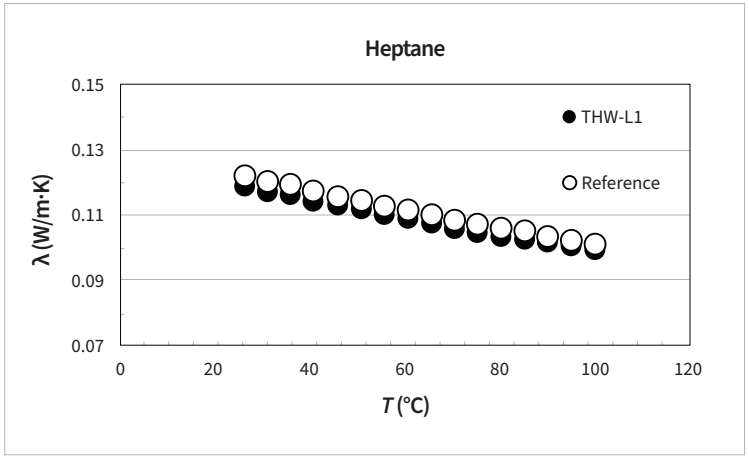
# THW-L1 Applications

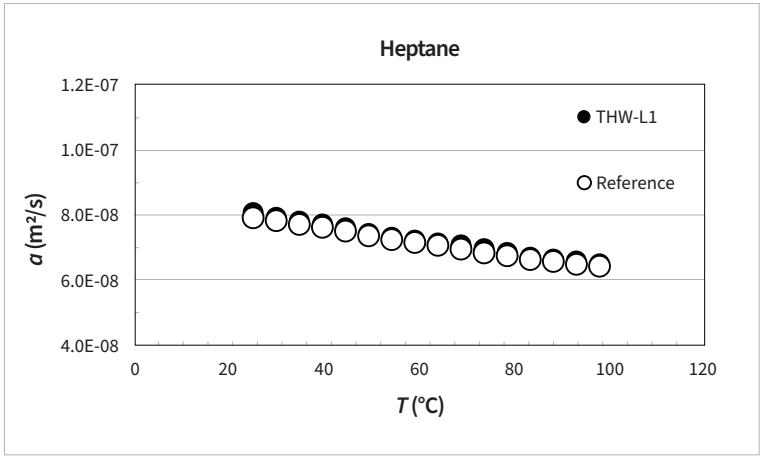
## Thermal Conductivity

## Thermal Diffusivity




Low back pressure was applied to the fluids, to allow measurements over their boiling point.

**Thermal Conductivity** deviations from reference values:
Water < 2%
Heptane < 3%

**Thermal Diffusivity** deviations from reference values:
Water < 2%
Heptane < 2%

**Calculated Specific Heat Capacity** deviations from reference values:
Water < 2%
Heptane < 5%

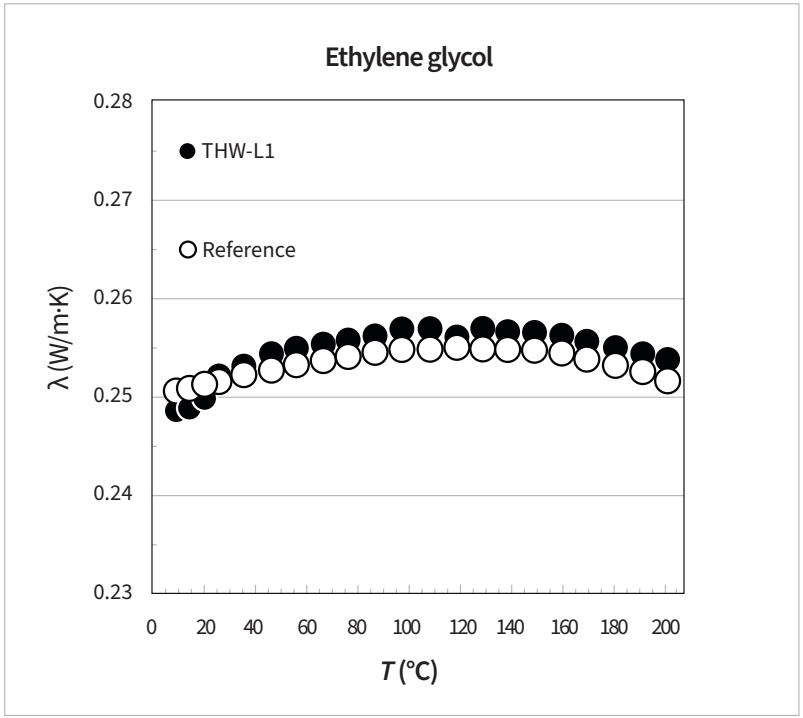
Output results of THW-L1 are thermal conductivity, thermal diffusivity, and calculated specific heat

Citation:

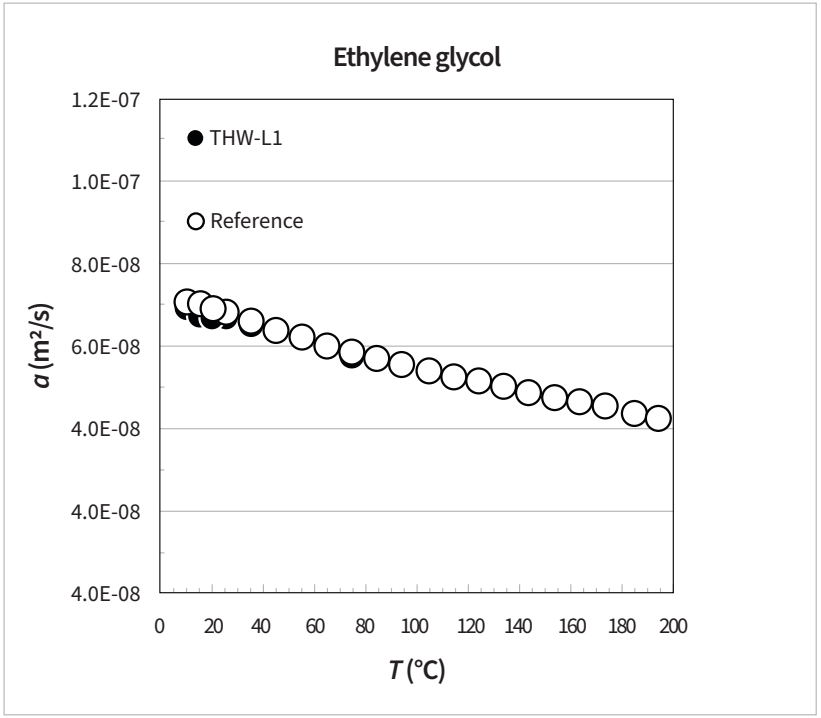
Lemmon, E.W., Bell, I.H., Huber, M.L., McLinden, M.O. (2018). *NIST Standard Reference Database 23: Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0.* National Institute of Standards and Technology, Standard Reference Data Program, Gaithersburg.

# THW-L1 Applications

## Thermal Conductivity




## Thermal Diffusivity




Low back pressure was applied to allow measurements over their boiling point.

**Thermal Conductivity** deviations from reference values: Ethylene glycol < 1%

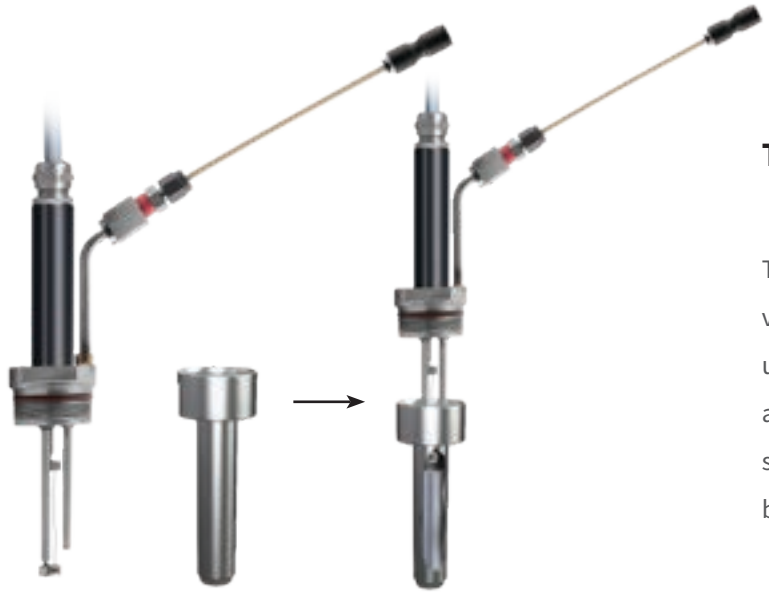
**Thermal Diffusivity** deviations from reference values: Ethylene glycol < 1%

**Calculated Specific Heat Capacity** deviations from reference values: Ethylene glycol < 2%

Citation:

Lemmon, E.W., Bell, I.H., Huber, M.L., McLinden, M.O. (2018). *NIST Standard Reference Database 23: Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0.* National Institute of Standards and Technology, Standard Reference Data Program, Gaithersburg.

# Sample Measurement



## 1 The Sample

The liquid is poured into the sample cell, the required volume is 20 mL. The THW-L1's ability to limit convection, using short test times, allows accuracy measurements of a large range of samples, widely varying viscosities. The sample cell can then be back filled to pressures up to 35 bar, for testing liquids past their boiling points.

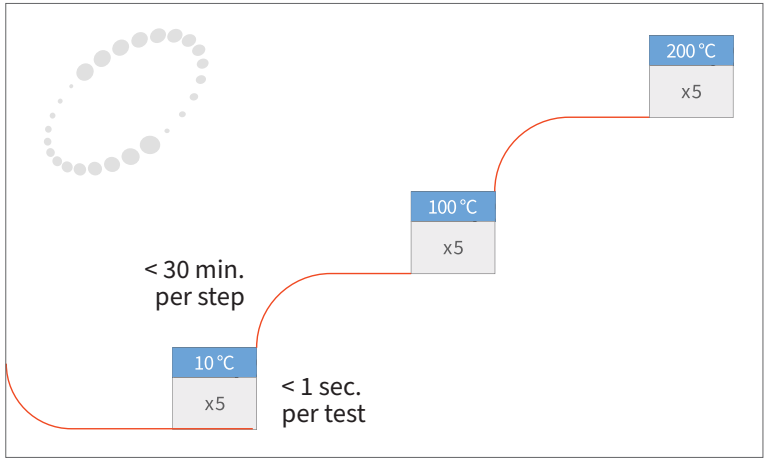
1 min.

## 2 Insert Sensor

For testing with temperature, the liquid cell is inserted into the integrated temperature platform.

< 1 min.

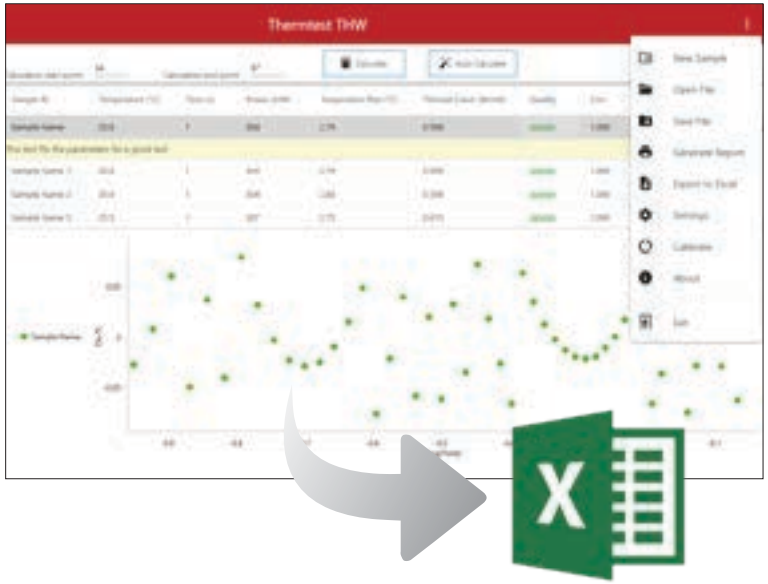
# Efficiency with Ease




## 3 Run Experiment

The THW-L1 Software automatically controls isothermal steps of temperature from -150 to 300°C.

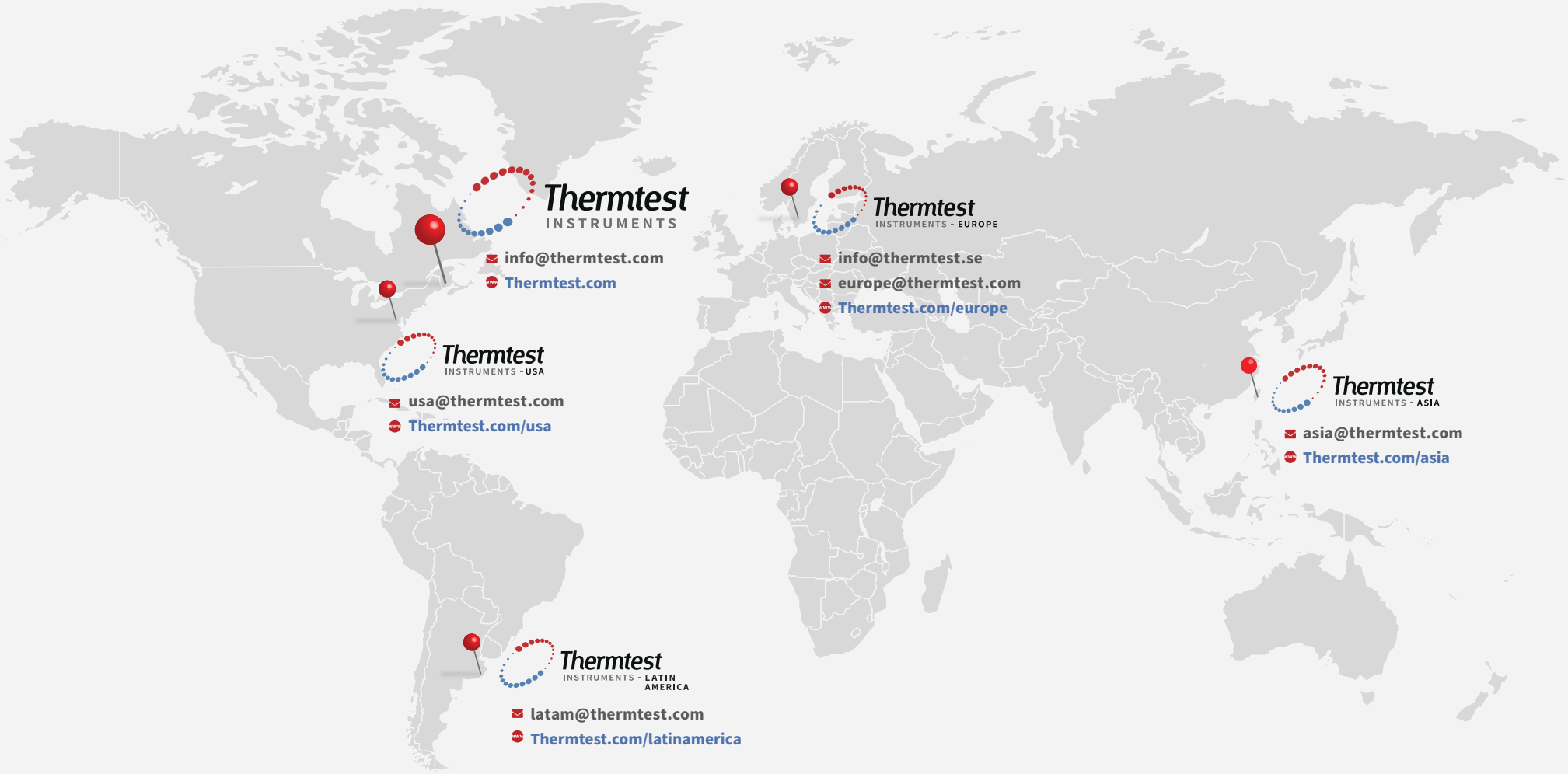
< 1 min.




## 4 Exporting Results

Smart THW-L1 Windows Software verifies quality of results and recommends changes if needed. Results report can be generated, saved, and exported to excel. For convenience results may also be emailed.

1 min.

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