Hukseflux
Thermal Sensors

Thermal conductivity selection guide

Choose the right measuring system or sensor for your application

Hukseflux is a leading manufacturer of thermal conductivity measuring systems and sensors. This brochure offers general guidelines for choosing the right system or sensor for your application. Cannot find what you are looking for? Ask us for alternatives. Hukseflux also offers material characterisation testing services.

Figure 1 *Example of an application of Hukseflux thermal conductivity measuring systems: thermal route survey*

Figure 2 *Example of materials of which thermal properties can be determined with Hukseflux measuring systems and sensors: common samples are plastics, paints, composites, pastes and fluids*

The right instrument for your application

Hukseflux offers a wide range of products for material characterisation and measurement of thermal conductivity. Areas of expertise are "thermal needle probes" for measurement of soil thermal conductivity / resistivity and equipment for testing plastics and similar materials such as paints, glues, plastic films and composites.

We can offer assistance in choosing the right instrument. But first, you should ask yourself the following questions:

- what material should be analysed?
- what are the conditions, for instance concerning temperature and pressure?
- what specimens are available?
- are there standards for my application?
- what level of accuracy do I need?

Contact Hukseflux

Hukseflux is able to offer highest quality products at an acceptable price level. If we cannot offer you an acceptable solution ourselves, we will tell you who can. Please contact us for further assistance.

Thermal conductivity measuring system

Measurand	thermal conductivity thermal resistivity contact resistance thermal resistance
Materials	soils, composites, paints, plastics, fluids, powders, pastes, glues, foodstuff, building envelopes
Standardisation	ASTM, IEEE
Commercial options	-purchase -rent -outsource to our material characterisation laboratory -expert training

Hukseflux
Thermal Sensors

Thermal needle probes: use in soils plus a variety of other applications

Hukseflux sells a range of measuring systems which include "thermal needle probes". The main application is testing of soils. Thermal needle probes have the advantage that specimen size is not critical. All systems comply with ASTM D5334 - 14, D5930 - 17 and IEEE 442-2017 standards.

Table 1 *Comparison of systems that employ thermal needle probes*

MEASURING SYSTEMS INCLUDING THERMAL NEEDLE PROBES				
Model	**TPSYS20**	**TPSYS20**	**FTN02**	**MTN02**
Comment	TPSYS20 may be used with TP02 as well as with TP08 needles		FTN02 and MTN02 have the same type of handheld control and readout unit CRU02. A combined system can be purchased as TNS02	
Needle model	**TP02** [1]	**TP08** [1]	**TP09**	**TP07**
Main users	Researchers Commercial soil test labs for soil dryout testing	Researchers Commercial soil test labs for soft sediment core testing	Commercial soil test labs for field testing	Commercial soil test labs for mixed lab / field testing
Main application	High-accuracy laboratory experiments on soils, powders, foodstuff	Experiments on small specimens	Soils: outdoor route surveys at 1.5 m depth	Mixed lab / field use Field use near surface
Measurement range [2]	0.1 to 6 W/(m·K)	0.1 to 6 W/(m·K)	0.1 to 6 W/(m·K)	0.1 to 6 W/(m·K)
Power	External 12 VDC See options	External 12 VDC See options	Battery pack	Battery pack
User interface	External PC, web browser See options	External PC, web browser See options	LCD included	LCD included
Robustness for field surveys	+	+	++++	+++
Field surveys at 1.5 m	+ From trench only	+ From trench only	++++ Using ground drill	+ From trench only
Accuracy	++++	+++	++	++
Small specimen size	++	++++	+	++
Fast measurement	++++	++++	+	++
Low dependence on specimen thermal equilibrium	++++	+	++	++
Low temperature rise during heating	++++	+++	+	+
Wide temperature range [3]	++++	++++	+	+
Other less common applications	Fluids (viscous), Walls, Snow, Frozen soils, Glues, Building envelopes	Fluids (viscous), Snow, Frozen soils, Glues		Soil dryout experiments
Guiding tubes [4]	**GT02**	**GT01**	**N/A**	**GT03**
Calibration reference cylinders[5]	**CRC01**	**CRC01**	**CRC05**	**CRC04**
Options	Keyboard Display	Keyboard Display		

1. TP02 and TP08 are also available as separate probes for use with the user's own electronics, for instance Campbell Scientific CR1000X
2. systems may be used outside their rated measurement range, but will then offer a lower accuracy than specified
3. temperature ranges may be extended upon request
4. guiding tubes are supplied in sets of 5 pieces. They essentially create a needle with a larger diameter. The heating time when using needles with guiding tubes is 50 % longer than without. Guiding tubes are often used in cements and soil dryout experiments. Guiding tubes can also be used cast in inside plastics, glues, etc. This may be easier than specimen preparation for THASYS, which often is too costly or impossible
5. a low-cost approach to calibration is to use glycerol with plastic fibres as calibration reference material. However, Calibration Reference Cylinders offer a formal traceability to international standards which glycerol does not offer

Table 2 *Example of thermal sensors (TP01 is a modification of the thermal needle in a flat foil) developed at the request of our customers*

EXAMPLES OF CUSTOM-MADE THERMAL SENSORS		
Model	**TP01**	**TP03**
Application	Long-term monitoring of soil thermal conductivity; typically incorporated in a meteorological system	Ocean sediment temperature and thermal conductivity measurement; To be incorporated into user's own mounting structure
Advantages	Fully water-proof; Simplified signal processing; IP67 protection class; Low price	Water pressures up to 300 bar Rated tip force up to 300 x 10^3 g
Comment	Foil type sensor. Geometry adapted to the requirements of long-term monitoring.	Very short thermal needle. Dedicated calibration by the customer required to compensate for sub-optimal length-diameter ratio
Less common applications	Estimate of soil thermal diffusivity heat capacity and thermal effusivity Use as surface mounted sensor Monitoring trends in soil moisture	

Non-invasive thermal properties measuring system: STPSYS05

STPSYS05 is a non-invasive, easy-to-use and affordable system for measuring the thermal conductivity at the surface of a solid specimen.

Table 3 *Surface thermal properties measuring system*

MEASURING SYSTEM FOR SURFACE THERMAL PROPERTIES MEASUREMENT	
Model	**STPSYS05**
Application	Specimen testing in material science labs, quality control and verification of consistency of materials, educational purposes; use in student labs
Advantages	Affordable; non-invasive and single-sided testing; IP67 protection class; Fast to work with, easy-to-analyse steady-state measurement of thermal conductivity
Comment	Can also be purchased as a sensor only (STP05).

Plastics, paints, composites, thermal interfaces and glues: THASYS and THISYS

THASYS and THISYS systems are specifically designed for measurements on plastics and composites. The systems are for use in the "through-plane" and "in-plane"directions respectively. THASYS offers superior accuracy because the measurement method makes it insensitive to errors due to contact resistance.

Table 4 *Comparison of the THASYS and THISYS measuring systems*

MEASURING SYSTEMS FOR PLASTICS AND COMPOSITES		
Model	**THASYS**	**THISYS**
Main application	Through-plane measurements of plastics and composites Thermal interface materials	In-plane (2-axis average) measurements of anisotropic plastics and composites
Measurement range	Typically 0.1 to 2 W/(m·K)	Typically 0.2 to 100 W/(m·K)
Compliance with standards	ASTM 1114-98	N/A
Preferred specimen dimensions	H by (70 by 110) x 10^{-3} m (may be stacked); H = specimen thickness	H by (70 by 110) x 10^{-3} m (may be stacked): H = specimen thickness
Specimen thermal resistance requirements [1]	H/λ = (0.5 to 5) x 10^{-3} m^2·K/W λ = specimen thermal conductivity in the through-plane direction	H.λ = (1 to 5) x 10^{-3} W/K λ = specimen thermal conductivity (2-axis average) in the in-plane direction
Number of specimens required per material	2 (minimum), or more when stacked	1 (minimum), or more when stacked
Other less common applications	Determination of plane to plane contact resistances, Fluids (low viscosity) [2], Estimate heat capacity	Thin metal foils

1. systems may be applied outside their rated measurement range. This will lead to higher measurement uncertainties than specified.
2. the rated viscosity range using a fluid cell is 0.3 to 5000 x 10^{-3} Pa·s. If the viscosity of your liquid is out of this range, contact Hukseflux for other solutions.

Walls and building envelopes: TRSYS01

For on-site measurement of the thermal resistance or h-value thermal insulation of walls and building envelopes we offer TRSYS01. The system complies with ISO 9869 and ASTM C1155 / C1046.

Equipment rental

In case you only need a system like FTN02, MTN02 or TRSYS01 for one project, consider renting a system. Rental costs for one month are in the order of 20 % of purchasing costs of a system. Please ask for our rental agreements. See the brochure on system rental.

Expert training for system operators

Although in general the systems can be operated by following manuals and standards, we can provide you with expert training. Training vastly improves the level of service to the third party, the efficiency of working with the equipment and reduces the uncertainty of the end result.

FTN02
Field thermal needle system for thermal resistivity / conductivity measurement

THISYS
Apparatus for thermal conductivity measurement of thin samples

STPSYS05
Surface thermal properties measuring system

TRSYS01
High accuracy thermal resistance measurement system with 2 measurement locations

Figure 3 *Overview of a selection of Hukseflux thermal conductivity measuring systems and sensors*

Figure 4 *TRSYS01 system in use for building envelope thermal resistance measurement*

See also

Besides the possibility to purchase and rent thermal conductivity instruments, Hukseflux offers material characterisation services using our laboratory.

About Hukseflux

Hukseflux Thermal Sensors makes sensors and measuring systems. Our main area of expertise is measurement of heat transfer and thermal quantities such as solar radiation, heat flux and thermal conductivity. With our laboratory facilities, we provide testing services including material characterisation and calibration. Hukseflux is ISO 9001 certified. Hukseflux products services are offered worldwide via our office in Delft, the Netherlands and local distributors.

Need for support in your selection process?
E-mail us at: info@hukseflux.com