



TEMPOS

thermal conductivity, resistivity, diffusivity & specific heat measurements

overview

- Thermal Conductivity
- Thermal Resistivity
- Thermal Diffusivity
- Specific Heat



The TEMPOS is a fully portable field and lab thermal properties analyzer developed out of 30+ years of research experience on heat and mass transfer in soils and other porous materials. Tested against known standards, the TEMPOS uses the transient line heat source method to measure thermal conductivity, resistivity, diffusivity, and specific heat.

The TEMPOS Thermal Properties Analyzer Kit is manufactured by the world leading technology company, METER Group, formally Decagon. METER Group are the experts in analyzing thermal properties of soils. They have even produced sensors for [NASA's Phoenix Mars Lander](#) analyzing the thermal and moisture properties of soils on Mars!

accurate

The compact TEMPOS controller is much more than a simple readout for time and temperature. A proprietary algorithm fits time and temperature data with exponential integral functions using a nonlinear least squares method. This fully mathematical solution delivers thermal conductivity/resistivity to within $\pm 10\%$.

The TEMPOS corrects for temperature drift. Temperature changes of a thousandth of a degree per second—the sun warming the soil, or someone walking into the lab—destroy the accuracy of thermal properties calculations. Unlike other thermal needle systems, the TEMPOS corrects for linear temperature drift that cause erroneous readings.

Complies with ASTM, and IEEE Standards

The TEMPOS complies fully with ASTM D5334-14 and the IEEE updated 442-03 to IEEE 442/D3 in 2017.

a video introduction to the TEMPOS

why are thermal properties important?

Thermal properties tell scientists important things about soil or other porous materials. Thermal conductivity is the ability of a material to transfer heat. Thermal resistivity, the inverse of conductivity, illustrates how well a material will resist the transfer of heat. Volumetric heat capacity is the heat required to raise the temperature of unit volume by 1°C , and thermal diffusivity is a measure of how quickly heat will move through a substance.

who should measure thermal properties, and why?

Thermal property measurements are needed in varying industries and research

fields. One example is underground power cable design. Electricity flowing in a conductor generates heat. Any resistance to heat flow between the cable and the ambient environment causes the cable temperature to rise. This can harm the cable and may even cause power outages in large sections of major cities. When cables are buried, soil forms part of the thermal resistance, and thus soil thermal properties become an important part of cable design.

Other popular applications for thermal property measurements include thermal conductivity of concrete, thermal conductivity of nanofluids, thermal resistivity of insulating material, and thermal properties of food. Unique applications range from measuring human tissue to adobe houses.

the transient method

The standard technique for measuring thermal properties is called the steady state technique (guarded hot plate method). The steady state technique requires a needle to be heated until it comes to a steady state, at which time it measures the temperature gradient and determines the thermal properties of the measured material.

The transient line heat source method differs in that heat is only applied to the needle for a short amount of time, and temperature is measured as the material heats and cools. The steady state technique is a good fundamental method because it uses the simplest equation. However, it takes a full day to make a measurement because of the wait for steady state. In addition, when measuring a porous material that contains moisture, the heat flow will make moisture will move away from the heated area and condense on the cold area. Thus, the thermal properties of the material will change.

This means there's no way to measure the properties of moist, porous materials with the steady state method. The transient line heat source method, however, is able to measure the thermal properties of moist, porous materials, and it can even measure thermal conductivity and thermal resistivity in fluids.

references

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Bertermann & Schwarz, 2017. Laboratory device to analyse the impact of soil properties on electrical and thermal conductivity. *International Agrophysics*, 31, 157-166. [Weblink](#).

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Mengistu et al, 2017. The effect of soil water and temperature on thermal properties of two soils developed from aeolian sands in South Africa. *Catena*, 158, 184-193. [Weblink](#).

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specifications

feature	specification
accuracy	
Thermal Conductivity/Resistivity	± 5 to $\pm 10\%$
Specific Heat	$\pm 10\%$
Thermal Diffusivity	$\pm 10\%$
measurement range	
Thermal Conductivity	0.02 to 4 Wm ⁻¹ C ⁻¹
Thermal Resistivity	0.25 to 50mC W ⁻¹
Specific Heat	0.5 to 4 MJ m ⁻³ C ⁻¹
Thermal Diffusivity	0.1 to 1.0 mm ² s ⁻¹
general specifications	
Measurement Speed	1, 2, 5, & 10 min. read times depending on measurement type
Data Storage	4,095 readings, flash memory
Compliance to Standards	ASTM Standard D5334-08 and IEEE Standard 442-1981
Operating Environment	-50° to 150°C
Power Supply	4 x AA Batteries



feature	specification
Auto Read Mode	Users can collect unattended data at user-defined intervals in the auto-read mode
Display	Liquid Crystal Display (LCD) 7.5 cm x 4 cm
Case Dimensions	15.5 cm x 9.5 cm x 3.5 cm
Calibration	Each KD2 Pro comes factory calibrated and includes performance verification standards KS-1 Thermal Conductivity/Resistivity sensor (for liquids) TR-1 Thermal Conductivity/Resistivity sensor (for solids) SH-1 Dual-Needle Thermal Diffusivity and Specific Heat sensor (for solids) User's manual Pelican carrying case Readout stand Performance verification standards Thermal grease Drill bit for drilling pilot holes in materials Concrete pilot pin KD2 Pro download utility RS232 cable
Included Accessories	

manual & docs

- [TEMPOS Manual January 2019](#)
- [Thermal properties measurements in rock and concrete](#)

related products

- [Soil moisture content meters](#)
- [Infrared temperature sensor](#)
- [Temperature sensors](#)