The Thermal Conductivity Test Tool λ-Meter EP500*e*

1. General

The Thermal Conductivity Test Tool λ-Meter EP500*e* is a test tool using an Embedded-PC for absolute value measurements based on the **guarded hot plate method according to ISO 8302, DIN EN 1946-2, DIN EN 12667 and ASTM C177 (DIN 52612).**

It is not a heat flow meter and therefore it offers a **higher accuracy** induced by principle compared with other test tools. It is designed **for long-term use** and does **not require re-calibration** even after many years.

The use of modern technologies for designing the sensor plates enables the measurement to be made without the need for a measurement chamber controlled environment, which is standard in other test tools. This makes sample handling easier to manage.

The λ-Meter EP500*e* does not require a controlled measurement environment. The tool can be plugged into a regular power supply and can be used in any room or office. It makes very little noise (like a PC) and dissipates very little heat.

The advanced control algorithm of the test tool calculates the optimal measurement parameters for each measurement and reduces the measurement time to a minimum.

The λ-Meter EP500*e* is a compact desktop tool. The general design is shown schematically in Fig. 1.

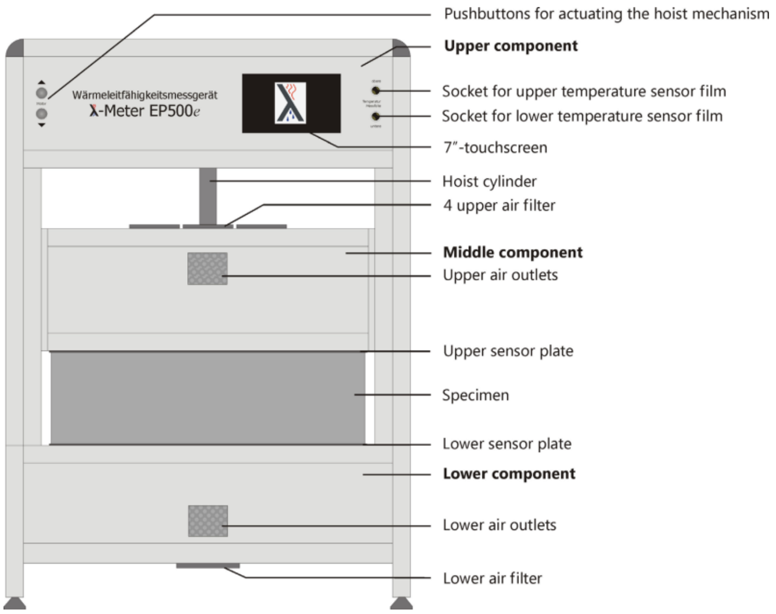

Fig. 1.: Front view of the Thermal Conductivity Test Tool λ-Meter EP500e

The middle and lower components contain the sensor plates. They are constructed in a concentric pattern. The centrepieces of these plates are computer optimised aluminium units, 40 mm in thickness, required for the maintenance of an isothermal temperature. Air-cooled high-performance Peltier modules are responsible for adjusting the temperature of the sensor plates to any temperature between -15°C and 65°C allowing thermal conductivity measurements within the temperature range of 10°C and 40 °C at a temperature difference between the sensor plates of between 5 K and 15 K.

Unlike other test tools, the temperature measurements on both surfaces of a sample are done not spotty with thermocouples, but integrally over the entire measurement surface. This ensures high measurement accuracy especially for non-homogeneous samples.

2. The Thermal Conditions within the Sample

The illustrations shown below (Fig. 2 and Fig. 3) shall illustrate the thermal conditions within a measured specimen for a λ10 measurement of a 120 mm specimen taken with two different conductivity measurement tools, both according to ISO 8302.
The first illustration (Fig. 2) shows the pattern for a conventional guarded hot plate apparatus according to ISO 8302 para. 2.1.3 figure 5 a. The second illustration (Fig. 3) illustrates the temperature field which is created within the λ-Meter EP500e.

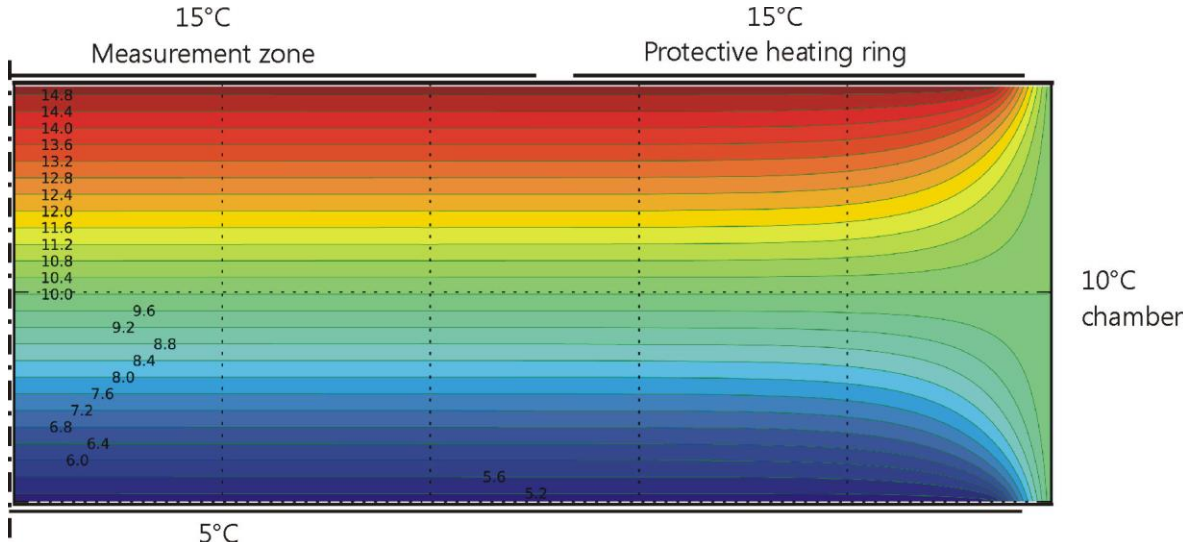

*Fig. 2: Temperature field within the sample in a typical guarded hot plate apparatus with a tempering measurement chamber according to ISO 8302, para 2.1.3., figure **5-a***

An even, one-dimensional and stationary temperature field only exists if the temperature in the lateral zones equals the specimen's mean temperature (see Fig. 2). The alternative set-up (Fig. 3) where additional heating and cooling rings are positioned on either side of the specimen provide a heat barrier and creates such a temperature field that is independent of the lateral conditions (i.e. room temperature), one-dimensional and stationary.

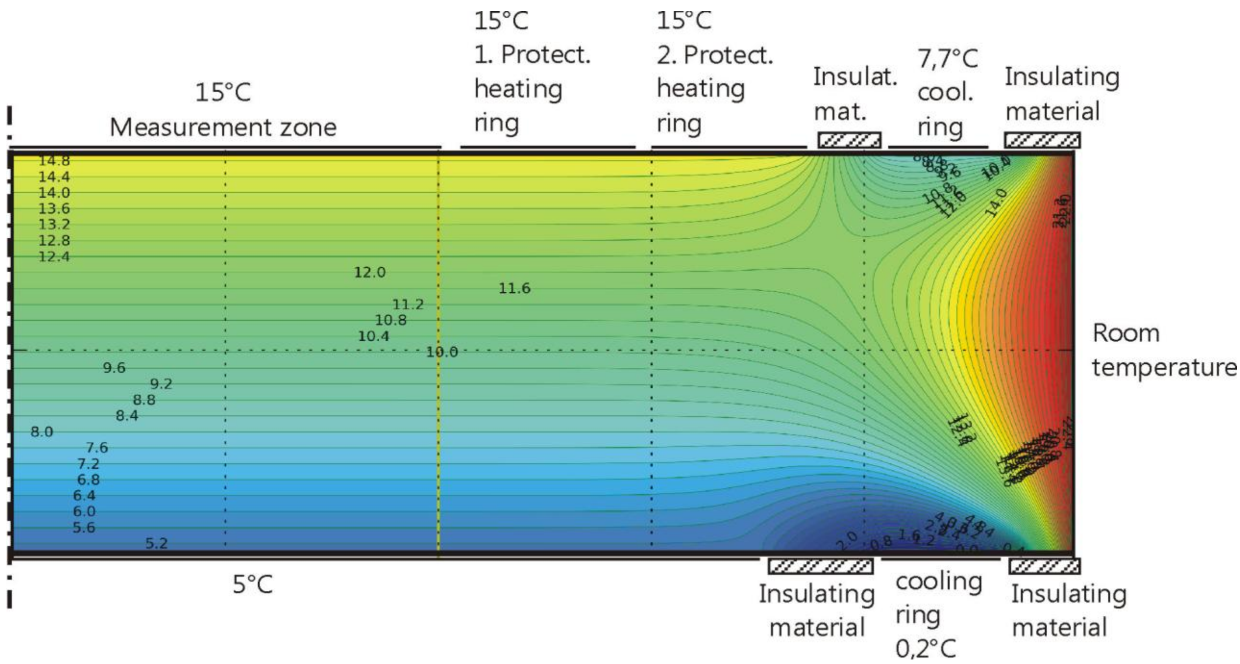

*Fig. 3: Temperature field within the sample in a guarded hot plate apparatus according to ISO 8302, para 2.1.3., figure **5-c**, extended with a second additional protective heating ring and an additional cooling ring*

During a λ10-measurement, the test tool cools down the border area of the sample from both Sides. In this way higher surrounding surface temperatures (room temperature) will not permeate the inside of the specimen. Within the specified ranges of measurement temperature and sample thickness for the test tool, an exact one-dimensional, stationary temperature field will be built up for the range of the measuring heating and protective heating zone. A thermostatic measuring chamber is not necessary for it!

The additional cooling ring in the λ-Meter EP500e functions like a "humidity sink". Air humidity and eventual humidity in the surrounds of the specimen shift towards the cooling ring and is not able to influence the measurement result. Additionally the measurement time will be reduced. This provides a decisive advantage in comparison with conventional guarded hot plate apparatus tools.

An intelligent control mechanism can determine the ideal parameters for a measurement and will reduce runtimes. The Thermal Conductivity Test Tool λ-Meter EP500e can be used in any room and does not require a constant temperature environment.

3. Specimens Dimensions

The Thermal Conductivity Test Tool λ-Meter EP500e can do measurements on samples of 10 mm up to approx. 120 mm in thickness, and with modification from 5 up to 200 mm.
If very thin material (thickness < 10 mm) have to be measured then it is possible to stack multiple samples (that are smooth, flat and parallel) to achieve a thickness of 10 mm or more.
The lower the thickness and the heat capacity of the material to be measured, the quicker the required stationary temperature field can be established, and therefore keep runtimes short.

For insulating materials, sample dimensions of 500 x 500 mm² are recommended. Because the test tool is opened sidewise, one direction of the sample can be longer than the other direction.

The specified measurement zone of the λ-Meter EP500e test tool is 200 x 200 mm².
With a specimen size of 500 x 500 mm², the mean thermal conductivity of the material is determined inside the measurement zone. Material outside this zone has no influence on the measurement. However the outer material is needed for creation and maintenance of thermal conditions required within the measurement zone for a one-dimensional and stationary temperature field (see Fig.4).

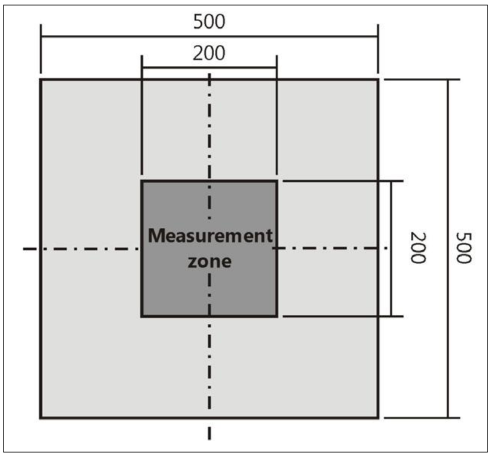

Fig. 4: Sensor plate / Measurement zone of different test tool versions (in mm)

If the material which has to be measured is only available in smaller dimensions, sample pieces that make up the area of the measurement zone, are permissible. The sample can also be composed of smaller pieces which are exactly cut and fitted together without air gaps. For such small samples, a insulated sample jig with internal cut-out of 200mm x 20mm and external dimensions of 500mm x 500mm has to be used.
Material with high thermal conductivity requires a single sample covering the measurement zone.

4. Packaging & Labelling of Samples to be Tested

For solid materials, the samples need to be protected from other samples and hard surfaces. Where the material is heavy such as with concrete or light weight concrete, the samples need to packed into wooden boxes, protected inside the box with bubble wrap or corrugated cardboard, using strong reinforcing battens and screws on the wooden box.

Where the material is light such as with foam, the samples can be packed into cardboard boxes, provided there are thin layers of ply protecting each side of the set of samples.

Each sample needs to be labelled, or marked so that there is clear identification of each piece. Ideally there should be a descriptive list of the samples included with the box, containing –

a) Name of manufacturer
b) Web site of the manufacturer
c) Copy of technical specification, if any
d) Sample number
e) Location from the pallet or roll or bale
f) Nominal thickness
g) Nominal density
h) Given thermal conductivity or R-Value for a given thickness
i) Person who took the samples
j) Date when the samples were taken
k) Any other useful information about the nature of the materials / samples.

Samples need to be 500mm x 500mm.

The address for testing is:

BEAL Testing Service
2A Plimmerton Drive, Plimmerton, Porirua, 5026.
For a map of the location, refer the contact page on www.beal.co.nz

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