Quality Assurance of Insulating Materials in Next to No Time

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Fig. 1. Heat flow meter NETZSCH HFM 446 *Lambda*^{S}

Thermal insulation produced so as to be in accordance with current guidelines and regulations can only function correctly if the material properties declared by the manufacturer are regularly checked on a random basis by both the manufacturer (in-plant monitoring) and neutral testing institutes (third-party monitoring). One such material property is thermal conductivity, which can be determined by the methods described in ISO 8301 and ASTM C518.

Standard Method for Quality Assurance

While the standards ISO 8302 and ASTM C177 describe absolute methods employing the guarded hot plate and require – over wide temperature ranges – relatively long measurement times at high measuring precision, the standards ISO 8301 and ASTM C518 cover the heat-flow method.

This method can be traced back to the international thermal conductivity reference materials NIST SRM 1450 and IRMM-440 and is characterized by very efficient measurement times. In addition to this, the instruments can be calibrated for a variety of materials of known thermal conductivity. That's why they have become standard not only in the field of quality assurance but also in research and development.

Materials can be measured directly following production in different plate sizes.

For many years now, NETZSCH has offered measuring instruments which are employed in both material development and quality assurance for the determination of thermal conductivity across a very wide temperature spectrum. Particularly in the field of building materials, where the decisive operating temperatures are around room temperature, the heat-flow method is ideally suited.

In this method, two plates are used to create a temperature gradient through the sample to be measured (see figure 2). Once the heat flow generated through the gradient and the thermal conductivity calculated from it are stable within defined limits, a temperature-dependent thermal conductivity measurement value can be recorded (figure 3).

Intuitive Operating Concept

At NETZSCH, we view ourselves as a solution provider. In recent years, we have worked hard on optimizing our instrument operation through software to provide users with the greatest possible ease in handling routine tasks. For quality assurance in the production of insulating materials, NETZSCH now offers a user-friendly, clear solution in the current HFM 436 *Lambda* and HFM 446 *Lambda*^{S} (figure 1) and the accompanying *SmartMode* software. The clearly structured, touchscreen-capable software runs under all current Windows operating systems and is designed, per present-day expectations, to accept inputs not only via mouse or keyboard but also directly via touchscreen or a Windows tablet PC.

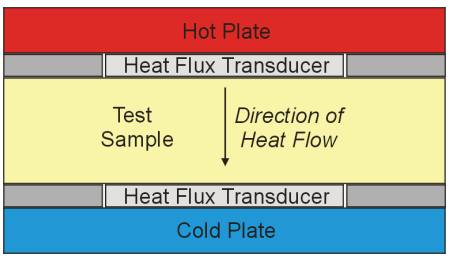

Fig. 2. Measuring principle of a heat flow meter

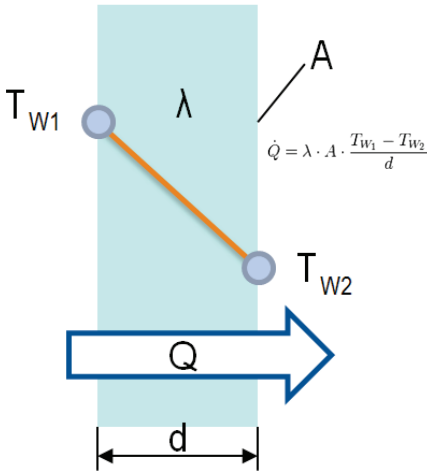

Fig. 3. Schematic of heat transfer through a stationary solid body

The current status of all connected instruments can be seen at a glance (figure 4). Under "Favorites", you can choose recurring measurement definitions (methods) with just one click. The "User Methods" section administers all measurement specifications defined and saved by the user, which are known as 'methods'. You can mark the methods for your Favorites section with just the tap of a finger. The "Wizard" guides you in defining a new method according to your specifications. You just take care of the essentials, such as naming the measurement, designating the material, or specifying your sample's dimensions. After selecting the appropriate calibration, just set the temperature points of interest to you and the measurement can be started. Once a "User Method" is set up, all you still need to do is enter a sample ID and you can start a new measurement within a measurement series in a matter of seconds.

Evaluation of the Measurement Is as Easy as Child's Play

All instrument signals are displayed in clearly-structured graphs during the entire measurement. Information on the current temperatures of both of the plates as well as the sample can be seen at a glance. The current signals of the heat-flow sensors and the currently calculated thermal conductivity can also be seen in the graphs (see figure 5).

At the end of the measurement, the thermal conductivity is presented as a function of temperature in both graphic and tabular form in the "Results" overview.

Just One Click to a Standard-Compliant Report

For your internal documentation, a variety of reporting functions are available. With a single mouse click, you may select from among three predefined templates: either the short report, the expanded report with additional instrument information or the report in accordance with ASTM C518 that – along with general measurement information – also includes information on calibration and measurement uncertainty.

The report is immediately loaded into Word; from there, it can be printed, saved or converted into a PDF. In addition to that, one can export to Excel a complete report depicting, in individually prepared tables, all of the metadata of the measurement along with the measurement results and all graphs. This way, the data can also be very easily embedded into existing QM systems.

Of course, you can also easily customize the report templates to your company's CI.

Statistics: $\lambda_{90/90}$

The integrated $\lambda_{90/90}$ calculation is of particular advantage. The $\lambda_{90/90}$ value is the basis for determination of the declared value of the thermal conductivity within the realm of CE declarations of building materials. It is calculated from a measurement series of at least 10 measurements and states which thermal conductivity values to a probability of 90%, can be achieved for 90% of the output production volume. This value is widespread as a common statistical value in classical quality assurance and is applied in all European production of insulating materials. Aging materials, such as PU foam for example, can additionally be fur-

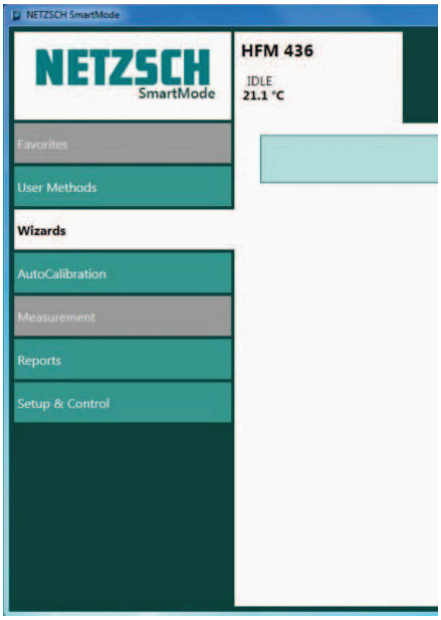

Fig. 4. *SmartMode* – clearly and logically structured

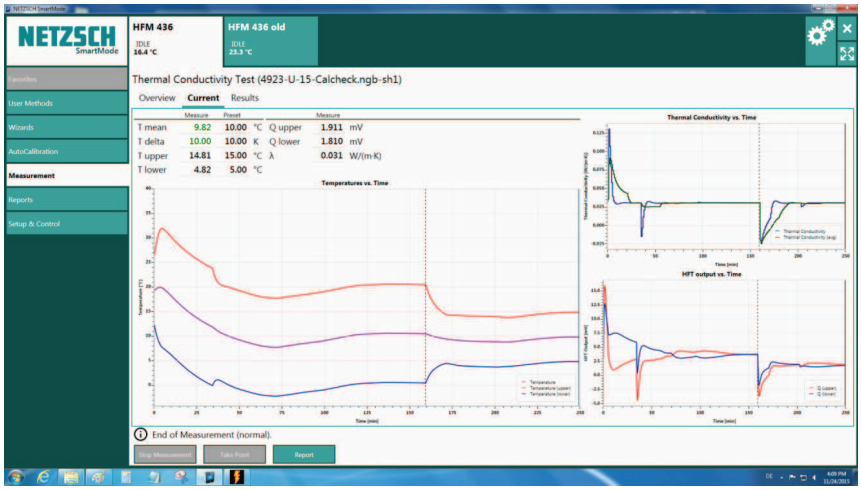

Fig. 5. Presentation of the current measurement – to the report in just one click

nished with the normatively defined extra aging supplements within the scope of the calculation. This makes the NETZSCH HFM instrument series to a very valuable tool in the realm of in-process production control.

Add-Ons and Accessories

Particularly for fiber materials such as glass or rock wool, the thermal conductivity is heavily dependent on the sample's degree of compression. With the optional load device, the thermal conductivity of fiber materials or compressible foams can be measured as a function of compression. To that end, the pressure to be applied to the sample during the measurement can be defined. This allows the true installation situation to be readjusted very easily. Hard samples or samples with rough surfaces and comparatively high thermal conductivities make it particularly challenging to correctly measure the thermal conductivity. While soft or compressible samples most often exhibit good contact with the plates, in hard or rough samples the smallest of gaps may form between the sample and measuring plates. This contact resistance can falsify the measurement result. By means of the optional instrumentation kit consisting of two additional thermocouples and two silicone pads, even samples such as this can be measured correctly. The silicone pads, which are positioned between the sample and plates, allow for good contact and homogeneous heat flow. Additionally, the thermocouples are applied to the lower and upper sample surfaces in order to be able to measure the exact surface temperature of the sample.

For gritty materials or powders, a special measuring framework is available. This can be filled manually and pared back with a ruler. After insertion, the gritty material can be measured just like any other solid sample structure.

With the latest addition to the NETZSCH HFM family, the HFM 446 *Lambda*^{S}, this instrument series has been expanded by a very useful instrument. With a plate size of 200 x 200 mm, this device features very compact dimensions and is particularly well suited for material development in the field of polymers and any kind of foams or materials such as aerogels. The possibility of measuring the specific heat capacity is of special interest. Particularly in the quality assurance of phase-change materials (PCMs) or PCM-containing building materials, the operating ranges and storage capacities of such materials can now be investigated.

Conclusion

With the NETZSCH HFM instrument series and the brand-new *SmartMode* software, your measuring efforts need not extend beyond the essentials of physical handling. Since the introduction of iPad and Co., software masks requiring explanations have become a thing of the past. Take advantage of the intuitive Wizard, create and save your own User Methods and draw from your pool of recurring Favorites with no more than a tap of the finger. Create comprehensive reports for your internal documentation with a single click and benefit from the many years of experience behind our employees' application know-how.