Steady State Hot Strip Method

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In a transient hot strip (THS) experiment, a thin nickel strip operates as the self-heated thermometer to rapidly measure the thermal conductivity of the surrounding material under test. A major drawback of this simple technique arises from the end-effect, i.e., the non-uniform temperature profile along the long axis of the strip. This deviation of the underlying theory of the method from its practical use can cause a significant increase in uncertainty. The newly developed tandem hot strip sensor overcomes this problem by its in-line layout of two metal strips of different lengths embedded between polyimide foils. This arrangement acts most similar to the two-wire configuration of the transient hot wire method but is considerably more robust.

A tandem hot strip experiment is usually carried out in the transient mode that enables a quick and precise determination of the thermal conductivity of a wide range of different materials. By transient means, however, only single-layer materials can be tested. For each additional layer of a composite wall specimen, so far, there is no appropriate time-dependent solution to the heat conduction equation. But instead, in the steady-state regimen there is a working equation for this class of materials. Due to its very effective end-effect compensation, the embedded tandem sensor can easily be used in this mode too. In contrast to known stationary instruments, the sensor does not need any additional guard heater.

In the special case of a two-layer material, the thermal conductivity of each of its walls can be determined from one single run. While the initial transient part of the output signal of the sensor furnishes the thermal conductivity of the first layer, the second layer's conductivity is derived from the final steady-state part of the signal with the further knowledge of the first layer's parameter.

After a brief presentation of the underlying theory, the paper presents a "two-layer experiment" on a single pipe thermal insulation.