Feedback control of thermal systems using heat flux sensors

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Abstract

In many applications in the field of feedback control of thermal systems not the absolute value of temperature but the temperature gradient or a temperature distribution is the control variable. Usually, temperature sensors are placed at different positions inside these systems to measure temperature differences to determine temperature gradients. Since these temperature sensors are independent of each other, their respective characteristics can vary over time in different directions and magnitudes (sensor drift). Hence, the applied controller can produce a temperature gradient which differs from the desired value since the temperature differences are not measured correctly. To overcome this, a heat flux sensor (HFS) can be used instead of several temperature sensors. A HFS can be designed in a way, that the sensor drift can be expected to equal zero. HFS can be used in different applications in feedback control (Fig. 1).

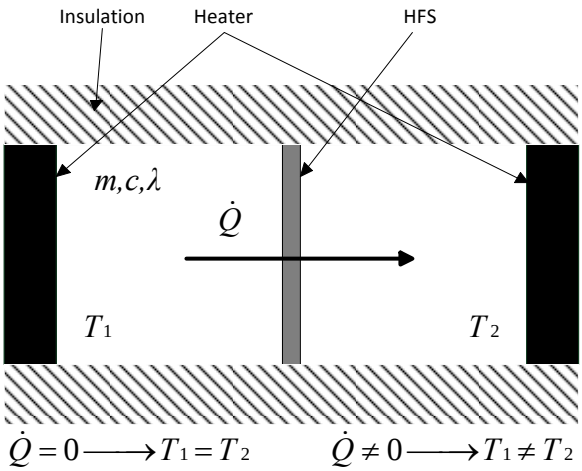

Figure 1: Scheme of HFS with two heaters and two bodies with temperatures T_1 and T_2 and heat flux $\dot{Q}$ between them.

One application is to use HFS to control heaters in a manner, that a desired heat flux of known magnitude and direction is established between two bodies or parts of one body. Another application is to control the heaters in a manner, that the heat flux equals zero. Here, the temperature difference between both sides of the HFS equal zero, too. This principle can be used to build an adiabatic system,

comparable to a calorimeter. Besides different designs of HFS and their advantages and disadvantages, this principle will be showed at the thermal issues workshop using the example of a dry block calibrator for temperature sensors.