Study of the Heater Plate Flatness Affecting the Thermal Conductivity Measurement using Guarded Hot Plate Technique

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Guarded hot plate (GHP) method widely used to the thermal conductivity measurement of insulating materials is introduced and tested at CMI (Czech Metrology Institute) within the project of the European Metrology Research Programme SIB52 Thermo. The material (specimen) is inserted between two heater plates. The temperature difference of a hot and a cold plate as well as the knowledge of the heat flow through the specimen and a thickness of the specimen enable to calculate the value of the specimen thermal conductivity according to Fourier´s law. However, several problems have to be solved to ensure the heat flow through the specimen is unidirectional and perpendicular to the heater plates. As the title of GHP suggests, the central part of hot plate with desired temperature and input heater power is surrounded by the guard plate to protect unidirectional flow in the central part of specimen. As regards the measurement of thermal conductivity of solid materials, one of the important design requirements for the GHP apparatus is a sufficient flatness of heater plates. The deviations from the plane cause insufficient contact with the specimen leading to the disruption of desired unidirectional heat flow. Therefore, the temperature profile of the specimen has to be calculated under different conditions of the plate flatness. With respect to the temperature range within the GHP can operate (up to 800°C) the calculation is provided also with the contribution of the radiation which becomes more significant with the increasing temperature. Above 300°C the combined model consisted of the conduction and the radiation part has to be taken into acount. The output of this work is the mathematical model considering the aspects which can contribute to the inhomogeneity of the specimen temperature profile and the comparison with the experimental results.