

Highly Concentrated Solar Radiation Measurement By Means of an Inverse Method

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Abstract

This work focuses on the numerical analysis conducted on the prototype sensor for the measurement of highly concentrated radiative heat fluxes based on an inverse heat transfer method realized at the ENEA Portici Research Center in collaboration with the DETEC department of the University of Naples Federico II. Figure 1 shows a picture of the sensor. It consists of a metallic target made of AISI 316 stainless steel, a zirconia thermal insulating support, and a metallic support. The estimates of highly concentrated radiative heat fluxes on the target surface are obtained by implementing the inverse heat transfer method based on the Levenberg-Marquardt algorithm which permits to compute the radiative boundary condition on the exposed surface of the target by means of the temperature measurements on the hidden bottom surface of the target performed using three type "K" thermocouples.

As concerns the numerical analysis, a large number of simulations have been carried out in order to evaluate the correlations between the uncertainty relative to the sensor measurements and the following factors: uncertainty relative to the emissivity of the target exposed surface, synchronization error, and thermocouples measurements error. Indeed, the unsteady temperatures field inside the prototype has been simulated using COMSOL's 2D axisymmetric physics while the implementation of the inverse method algorithm has been carried on by using a home code written with MATLAB®. In this work the numerical procedure implemented for the resolution of the inverse problem is detailed and the results of the numerical analysis conducted on the prototype sensor are illustrated and analyzed. Furthermore, the results of the experimental validation of the prototype is reported and discussed.

Figures used in the abstract

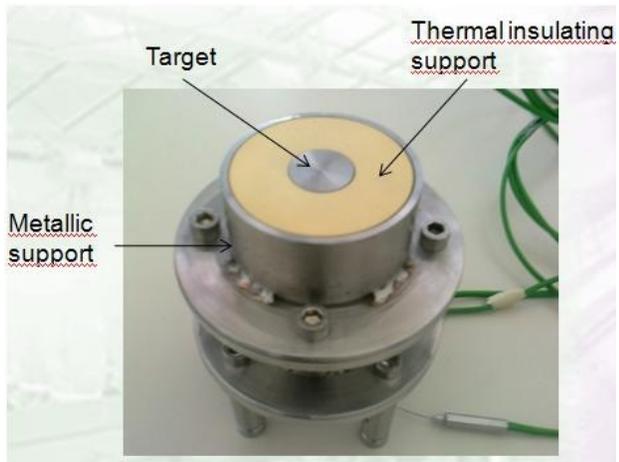


Figure 1: Highly concentrated radiative heat flux sensor.