SFERA

Solar Facilities for the European Research Area

SEVENTH FRAMEWORK PROGRAMME

Capacities Specific Programme

Research Infrastructures

Integrating Activity - Combination of Collaborative

Project and Coordination and Support Action

Joint Research Activities

Deliverable 12.3 : Transient models that predict temperature variation of absorbers

Workpackage 12: Improving quality and service of CSP infrastructure installations
Task 12.4 : Virtual CSP facilities
Workpackage coordinator organisation name: PROMES-CNRS

First version: February 2011 PROMES-CNRS Model
Updated Version: February 2012 ENEA Model

1. Transient Model for PROMES-CNRS

A computer program (to be available on the website) was developed to predict the temporal variation of an absorber sample located at the focus of a parabola (Figure 2). This computer program aims to help future users of the solar facilities to prepare their experiments, in particular to get a realistic temperature range that their samples can reach during operation as a function of experimental conditions. Indeed, this tool will be available from the virtual facility of the small vertical axis solar furnace at PROMES-CNRS laboratory (Odeillo, France).

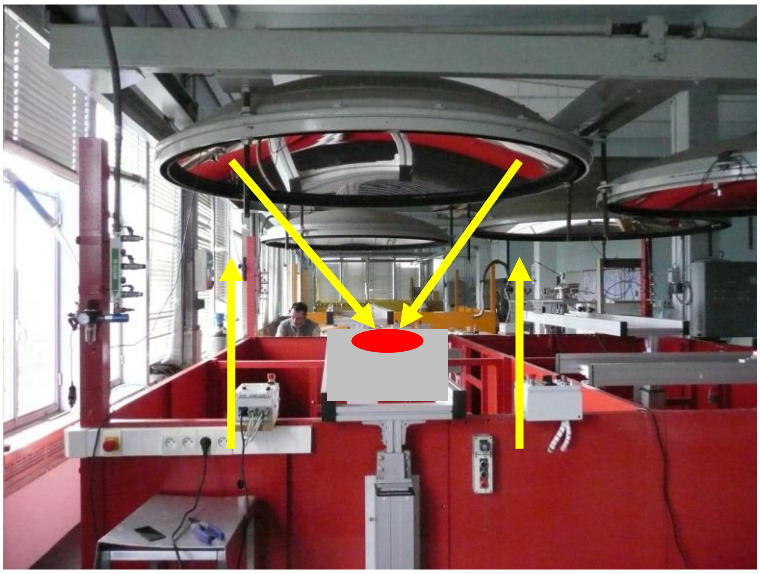

Figure 2. Sketch of the sun rays concentrated on a sample by the parabola – PROMES-CNRS

To predict the temperature distribution in the sample, we first assume the sample as a one-dimensional media which receives on its top surface a uniform solar concentrated flux. These assumptions were selected to compute temperature distribution as fast as possible in an interactive simulation (real time computation). Additional assumptions are made: the ambient temperature is 300K, the sample is supported by a water (300 K) cooled holder or by an insulation material, there is no contact resistance between the plate and the sample, the boundary condition at the irradiated face accounts for radiation and convection losses (see Figure 3). To obtain a result some input data will be necessary and specified by the user:

1. the parabola size will be necessary with the shutter aperture to compute the incident solar flux,
2. the sample thickness (here 1 mm) and its thermo-physical properties will be required (even default ones will be given) such as the thermal conductivity, density, specific heat, sample solar absorptivity and emissivity,
3. the duration of the simulation.

As an example, Figure 4 presents the result of the simulation for a Zirconia sample (ZrO_2, 1 mm thick) placed on a water cooled holder and irradiated by a concentrated solar flux of 15

MW/m² and Figure 5 presents the temperature profile if the back side of the sample is insulated with Alumina (Al_2O_3, 2 mm). This example shows clearly the importance of the sample support on the maximum temperature reached by the sample.

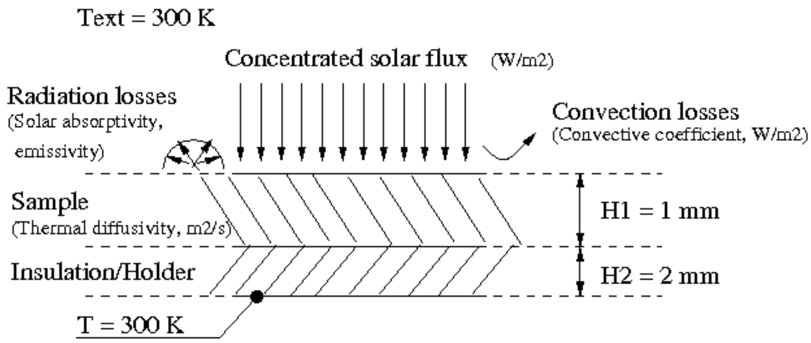

Figure 3. Boundary conditions and parameters needed for the transient heat computation of the 1D geometry constituted of the sample and the insulation / holder

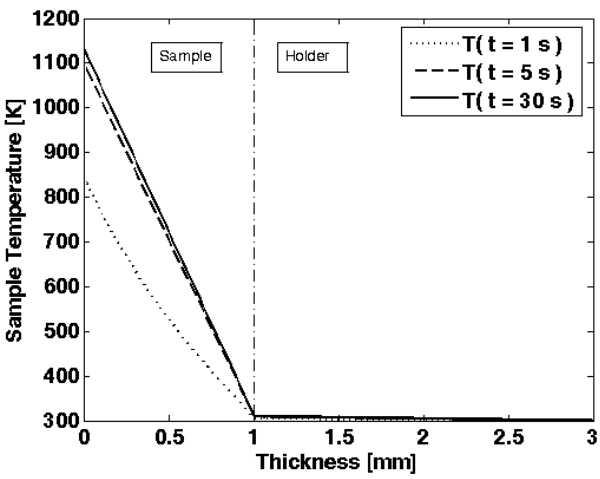

Figure 4. Internal temperature profile of a Zirconia sample (1 mm thick) submited to 15 MW/m2 and supported by a water cooled holder (2 mm Aluminum)

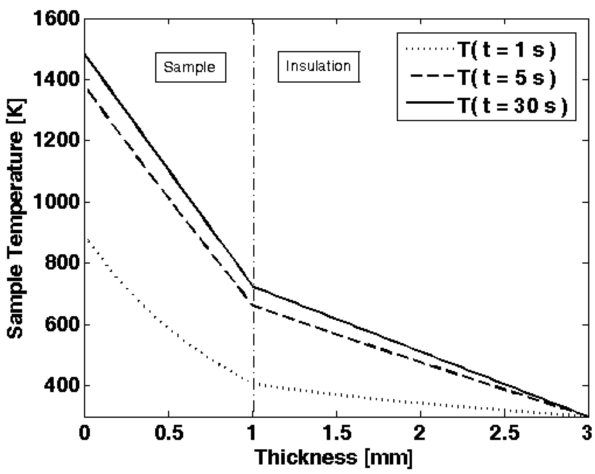

Figure 5. Internal temperature profile of a Zirconia sample (1 mm thick) submited to 15 MW/m2 and supported by an insulator (2 mm Alumina)

2. Transient Model for ENEA

In addition to this computer programm, another simulation programm has been done by ENEA. The executable is availbale on the website plus a full documentation on how to use it here: http://sfera.sollab.eu/index.php?page=joint_wp12_PCS