Design of a 50kW concentrating solar facility for solar fuels production

Dimitrios A. Dimitrakis[1,2], Chrysoula Pagkoura[1], Christos Softas[1], A.G Konstandopoulos[1,2]

[1]Aerosol & Particle Technology Laboratory, CPERI/CERTH, P.O. Box 60361, 57001, Thessaloniki, Greece

[2]Department of Chemical Engineering, Aristotle University, P.O. Box 1517, 54006, Thessaloniki, Greece

Keywords: solar, parabolic, dish, heliostat, thermochemical reactions

Thematic Areas: Energy

In the current work, the design of a solar facility able to achieve high solar concentration on a reactor is presented. This facility aims to support the study of materials and process conditions used/applied during thermochemical cycles performed at elevated temperatures for the production of solar fuels (i.e. production of syngas produced from the combined steam (H_2O) and carbon dioxide (CO_2) thermal splitting). The facility will be used for the evaluation of small-scale samples (e.g. the frontal area of the samples is estimated to be ~1”Ø) at high temperatures ranging between 1000-1400^{o}C.

For the current application, a concentrating solar facility (schematically presented in Figure **1**) was designed. This configuration allows the achievement of very high solar irradiance concentrations, similar to those achieved by parabolic dishes while at the same time tackling the challenging technical aspects (moving parts, sealing etc.) that rise when operating at the temperature ranges of 1000-1400^{o}C.

The proposed facility consists of three main systems: (a) the ‘heliostat field’, which in the current design consists of a single large heliostat, (b) the concentrating optic system, in this case a parabolic dish and (c) the solar receiver-reactor. The operation principle of this system is that initially (stage one) the heliostat field tracks the position of the sun and reflects the solar radiation to the concentrating optic system. At this stage (stage two) concentration of the solar radiation is achieved and is directed (stage three) towards the target/solar reactor which is in turn located at the focal point of the parabolic dish. The heat flux reaching the receiver and consequently the temperatures developed at the focal point, can be regulated by a shutter which is placed between the heliostat field and the concentrating optic system.

In the current work the parameters that led to the final design of the solar facility are presented: the assessment of the available solar potential at the installation point of the solar facility, the dimensioning process of the concentrating optic system, the dimensioning of the heliostat field and the exact positioning of each of the separate components (i.e. heliostat, parabolic dish, shutter and solar receiver). The overall design is based on calculations that all initiated from the required conditions that must apply on the reactor receiver aperture.

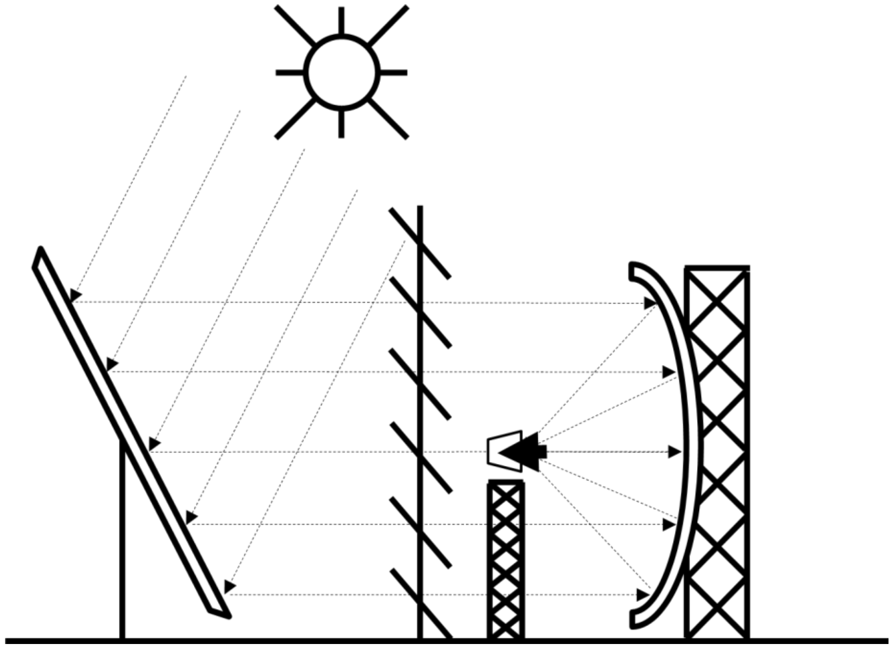

Figure 1: Outline of the solar installation. From left to right: heliostat; shutter for the control of the heat flux, solar reactor-receiver, parabolic dish.