EVALUATION OF OPTICAL PARAMETERS OF A REFLECTIVE COATING IN SECONDARY SOLAR CONCENTRATORS

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A new technique for evaluation of reflective coating's optical parameters in secondary solar concentrators is proposed. The capability of the method has been illustrated by measurement of the optical parameters of a parabola-toric secondary concentrator, designed for the DLR solar furnace. The optico-energetical and spectral characteristics of the illuminated field within the operative zone of the solar furnace are determined in the result of measurements.

Secondary reflectors of different designs (parabola-toric, ellipso-toric, hyperboloidal etc.), intended for variation of illuminated field structure within the operative zone of a solar furnace, are finding extensive application in high-temperature tests. The main function of secondary concentrators is to increase of a light flux density coming from a primary concentrator. They are placed directly within the focal region of the solar furnace, where the illumination level is maximal. This circumstance leads to increased requirements with regard to stability of the reflective coating properties at high temperatures, contamination due to evaporation of materials under investigation and necessity for continuous control of the degradation processes.

The achievable optico-energetical and spectral parameters of the illuminated field within the operative zone of the solar furnace are mainly determined by the condition of a reflective coating of the secondary concentrator. These characteristics may be evaluated directly during exploitation conditions, for which a complex measuring set-up is required, or by numerical calculations using a limited number of optical parameters of the reflective coating. These parameters may be easily determined under laboratory conditions.

For flat samples with reflective coatings there exist reliable methods and corresponding instrumentation, which provide to determine parameters of the composite reflecting surface: reflective, anti-reflective and protective coating layers. Flat sample surfaces may be produced alongside the surfaces formed on the secondary concentrator and employed for working out of technological conditions providing necessary optical parameters of the coating. Nevertheless, it remains necessity to deduce optical parameters of the coatings on already manufactured secondary concentrators, with their significantly curved reflecting surface, taking into account the inhomogeneous thickness of the anti-reflective and protective coatings, as well as possible contamination and degradation of the reflective coating after a series of exploitation cycles.

To illustrate the capabilities of the proposed technique we have measured the optical parameters of the parabola-toric secondary concentrator, designed and manufactured for the DLR solar furnace. Making use of obtained optical parameters of the secondary concentrator, we calculated the spectral characteristics of the illuminated field in the system: heliostat - primary concentrator – secondary concentrator for the DLR solar furnace. The result is presented in the following figure.

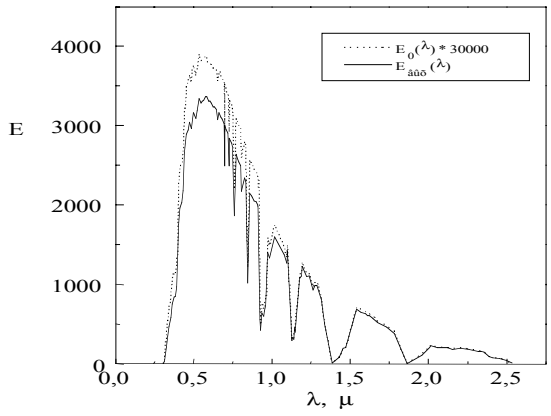

Figure. Spectral content of the radiation at the center of exit aperture of a secondary concentrator (solid line) and 1.5 AM solar spectrum (dots).

An additional optical system is proposed for continuous measurement of a secondary concentrator's reflective coating degradation during its operation with a solar furnace. Parameters of the reflective coating, obtained by the above described technique are used as reference data when output signals from the additional system is processed.

Keywords: Solar furnace, secondary concentrator, reflective coating, degradation control, optical measurements.