PARABOLIC TROUGH COLLECTOR EFFICIENCY IMPROVEMENT ACTIVITIES

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Parabolic Trough Collector Systems are currently known to be the most cost effective and closest to the market technology for solar electricity generation. From 1984 to 1991 the well known SEGS-plants were installed in the Californian desert with a total electric power of 354 MW. Cylindrical parabolic mirrors concentrate solar radiation on to a black absorber tube transforming radiation into heat. A thermal oil inside the tube transports energy to a heat exchanger, which is connected to a conventional steam generating circuit. To minimise thermal losses the absorber tube is enveloped by an evacuated glass tube.
However, further cost reductions are necessary to make this technology competitive in a liberalised energy market. This paper presents results of a three year project, funded by the German government, focussing on optimisation of single collector components. Results of four activities are presented in this paper:

FLUX MEASUREMENT
To characterise the optical performance of a trough collector, a measurement system was developed, which allows non contact characterisation of the flux density distribution on the outer surface of an absorber tube of trough system in operation. The paper presents results of several measurement campaigns performed at collector modules from the HELIOMAN- and the LS3-type. Furthermore fundamental problems occurring during optical measurements in parabolic trough collectors are discussed. The system consists of two CCD-sensors, a PC integrated frame grabber, an OPTIMAS evaluation code and a simple ray tracing code to theoretically reconstruct the measured distributions.

SECONDARY REFLECTOR
In the past various concepts of secondary concentrating reflectors were developed. In this project a very simple plain secondary reflector was designed, constructed and tested on the PAREX test facility – a two axis tracking modified Helioman – at DLR, Cologne. The reflector is made from anodised aluminum and fixed between absorber tube and glass envelope in the opposite of the cylindrical parabolic main reflector. This configuration allows a reduction of the absorber tube diameter resulting in minor heat losses and material savings without reducing the total energy yield. . A second advantage of this arrangement is the more homogeneous irradiation profile over the absorber tube circumference. The results of a September/October 1999 measurement campaign are reported here.

REPLACEMENT OF BROKEN GLASS ENVELOPES
In practice evacuated glass envelopes surrounding the black absorber tubes often are damaged, caused by mechanical or thermal stresses. Additional thermal losses cause a significant decrease of the collector efficiency. It is not economic to directly replace destroyed modules, because many of them are welded together to built one loop. For repair the whole loop has to be shut down. Replacement is carried out only when a larger number of modules in one loop are destroyed.
An equipment has been developed consisting of two half pipes, which can be easily mounted into the field. Theoretical calculations show that heat losses of the equipment are less than losses of a broken receiver, which lost its vacuum. A first version was tested in 1998 on the Plataforma Solar de Almería in the south of Spain, difficulties occurred have been described on the Jerusalem ISES conference. In September 1999 a second optimised version was tested on the PSA. Results are reported here.

ADVANCED MIRROR CHARACTERISATION

In co-operation with NREL and CIEMAT advanced mirror material optical characterisation is performed. Latest results of a promising aluminium mirror as well as newer a thin-glass material are presented.