DEGRADATION OF REFLECTIVITY OF PARABOLIC MIRROR CAUSED BY DUST ON ITS SURFACE.

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INTRODUCTION

Accumulation of ambient dust on mirror surfaces of solar concentrators is one of major environmental factors that reduce performance of solar facilities for conversion of sunlight to thermal energy. This effect is particularly crucial in the case of facilities with high concentration ratio. Our goal is to compare several techniques for measurement of this effect and to compare it with a directly measured optical efficiency of a solar concentrator.

METHODOLOGY

Measurements of optical properties of parabolic mirror before and after its exposure to ambient dust have been performed. An individual panel, representing one of 216 segments of a large parabolic dish was used for this goal. It represented by itself an equilateral parabolic triangle with sides equal to 205 cm. Its focal distance was 13.1 m. Mirror specular reflectivity $r$ was equal to 0.94; a single 1mm-thick layer of low iron glass was used as a protective coating. The panel was placed on the ground for a period of 24 days, so being exposed to ambient contaminants -- mainly coarse loess dust of local origin.

The following measurements have been performed after that:
- Reflectivity of mirror surface has been measured directly with a specular reflectometer before and after exposure to ambient dust in order to calculate the rate of reflectivity degradation $\Delta r / r$;
- Microscopic analysis of dust on surface has been performed by means of a computerized optical microscope in order to derive $\Delta s / s$ -- the rate of degradation of clean mirror surface area $s$;
- Sun light, concentrated by this panel, was viewed by means of CCD TV-camera on a white mat screen at the focal distance 13.1 m from the panel. Flux maps produced by the contaminated parabolic mirror and by the same mirror after cleaning were compared. The corresponding quantity $\Delta F / F$ was calculated, where
$F$ is a total amount of light reflected by the white screen. A typical flux distribution on the screen is shown in Fig.1.

![Flux distribution of concentrated solar light on a white mat screen](image_url)

**Figure 1. Flux distribution of concentrated solar light on a white mat screen**

**RESULTS**

The described measurements revealed the following values: $\Delta r / r = 0.249 \pm 0.024$, $\Delta s / s = 0.102 \pm 0.017$, $\Delta F / F = 0.292 \pm 0.033$. These three sets of data were analyzed in terms of extinction efficiency $Q$, in a manner described in [1]. Effective extinction efficiency of ambient dust on the parabolic mirror surface was estimated in terms of $Q_1 = q(\Delta r / r) / (\Delta s / s)$ and $Q_2 = q(\Delta F / F) / (\Delta s / s)$. Multiplier $q$ was introduced into expressions for $Q_1$ and $Q_2$ in order to account for the influence of glazing. Double pass of light through a dust layer on the glass coating leads to an approximate value 0.5 for this multiplier. The measured values for $\Delta r / r$ and $\Delta F / F$ were found to be in a good agreement due to a similar geometry of measurements with a specular reflectometer and with a white screen (but the scales differed by two orders of magnitude!). Two estimates of the same quantity $Q$ from the two experiments, namely $Q_1 = 1.22 \pm 0.23$ and $Q_2 = 1.43 \pm 0.29$, are consistent within the experimental accuracy.

**CONCLUSION**

Three different techniques for measurement of dust influence on specular properties of parabolic concentrator have been performed, using an individual mirror panel of a large parabolic dish. Direct measurements of the intensity of concentrated light confirmed results of measurements with a specular reflectometer. Both measurements are consistent with measurements of particle size distributions on surface by means of the optical microscope.

**REFERENCES**