SOLAR POWER ARRAY FOR THE CONCENTRATION OF ENERGY

Technical Report Covering
Task 2

Task 2

Modifications to a Specular Photometer

MASTER

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This report describes design, fabrication, and calibration which have been completed for the modified specular photometer shown in Sheldahl Drawing No. SD1773 and the attached photographs.

The basic instrument is designed to examine the reflection or transmission of solar materials by measuring the amount of radiation which is reflected or transmitted by the material into a given acceptance aperture. The design objective for the modified specular photometer described was to increase the utility of the instrument as a device for the evaluation of solar materials by increasing the available parameter ranges to include those defined by the sun and the earth's atmosphere.

These parameters and the relevant modifications are discussed in the following paragraphs.

The original specular photometer was equipped with a white light source and a photomultiplier tube giving an integrated response peaking at 0.57 microns. Since the wavelength band associated with this peak includes only about 15 percent of the energy in the Air Mass 2 solar spectrum, the specular photometer was modified to include sources and detectors which would cover the entire spectrum. The Air Mass 2 spectrum results when solar radiation passes through the equivalent of two layers of the earth's atmosphere, and extends from 0.3 to 2 microns; that is, from the ultraviolet through the visible (0.4 to 0.7 micron) to the near infrared.

To examine this spectrum, an Oriel Model 7240 grating monochromator is placed between the light source and the collimator to provide a parallel beam of light of a narrow wavelength band. The monochromator is equipped with two gratings so that it covers the Air Mass 2 spectrum from 0.3 to 2 microns. Corning glass filters are used to filter out higher order diffracted radiation so that only the wavelength of interest is present in the beam (otherwise radiation at shorter wavelengths than that desired would also be present). The radiation source is a 250 watt tungsten halogen lamp with a quartz envelope and a color temperature of 3000°K which provides radiation of wavelengths down to 0.3 micron.

The collimator and telescope are fitted with achromatic lenses for use in the visible portion of the spectrum, and have adjustable focus controls for the infrared. These lenses have been focussed using auto-collimation, and provide a high quality image.

The radiation described above is detected using a 1P28 photomultiplier for the ultraviolet-visible region of the spectrum, and a lead sulfide cell for the infrared. These detectors are attached directly to the integrating sphere, eliminating the fiber optics losses of the earlier specular photometer.

Beyond extending the spectral range of the instrument the specular range was also increased. The previous instrument could examine radiation reflected into a total subtended angle of 2 to 18 milliradians (the angle subtended by the sun is about 9 milliradians).

The modified instrument detects radiation scattered into a range of 1 to 100 milliradians allowing examination of a wide range of specularity. It can accurately examine very diffuse reflectors, and covers the previously inaccessible range between the old instrument and Sheldahl's Beckman DK-2A spectrophotometer. This extended range is achieved using a combination of short and long focal length telescopes equipped with small and large variable apertures which cover the ranges of 1 to 22 and 5 to 100 milliradians, respectively. The latter range is particularly useful, and is wide enough to avoid frequent interchange of the telescope.

To accommodate the large aperture of the short focal length telescope (about 1-inch diameter) a larger 6-inch diameter integrating sphere was made. This sphere was turned from solid blocks of aluminum and spray coated with barium sulfide as a white diffuse reflector. The aperture settings were calibrated using drill blanks, hole gauges, and a micrometer.

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