ON THE MEASUREMENTS OF SOLAR RADIATION INTENSITY IN THE SPECTRAL REGION OF SHORT WAVELENGTHS ($\lambda < 425$ m μ)

By

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Summary

A filter, composed of 80% Lead Oxide, has been manufactured and tested at the National Research Centre. It transmits uniformly all the solar radiation for wavelengths higher than the long-wave limit of violet and ultraviolet radiation ($\lambda < 425$ m μ).

The filter is similar to any of the Standard Schott filters such that it can be used in conjunction with any type of actino- such that it can be used, in conjunction with any type of actinometer, to measure the solar radiation above and below 425 m μ

1. Introduction

The measurements of solar radiation and its spectral distribution is becoming desirable in many applications in biology, agriculture and industry (1). Evidently the ideal method is to undertake these measurements spectroscopically for the different wavelengths. Such method is quite delicate and is used only for investigations where maximum accuracy in the interpretation of measurements is required. In practice relatively simple processes are used such as the use of actinometers which integrate the radiation in the whole solar spectrum or in certain spectral regions, when the actinometers are provided with carefully calibrated filters.

Many types of coloured glasses, having different selective absoption characteristics, are available for use as optical filters in the spectral regions in the ultraviolet, the visible and near infrared. Filters Nos. OG_1, RG_2 and RG_8 manufactured by Schott

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Jéna (2) are used for the measurements of the solar radiation in the spectral regions from 525 to 2800 mμ , from 630 to 2800 mμ and from 710 to 2700 mμ respectively.

For the measurements of the solar radiation in the violet and ultaviolet region, filters GG_{18}, GG_{13}, GG_{22} and WG_1 are recently manufactured by Schott, which transmit uniformly all the solar radiation for wavelengths higher than 400 mμ. The difference between the two actinometric readings with and without the filter gives the amount of the ultraviolet radiation.

In Egypt preliminary data on violet and ultraviolet solar radiation, whose upper wavelengths limit is less than 425 mμ have been obtained using a new filter manufactured and tested at the National Research Centre.

2. The New Filter

Besides the use of the Schott filters OG_1, RG_2 and RG_8 which are the only available filters in our laboratory, attention has been paid to find a new filter which can shut-off all the ultraviolet radiation and at the same time, transmit uniformly the rest of the solar spectrum. To this end, spectrophotometric examination on various glass filters have been carried out. Flint filters have not proved suitable as their short wave cut-off were always below 325 mμ. On the other hand, when examining the transmission curves (between 200 & 700 mμ) of Crown glass samples with different Lead Oxide concentrations, studied at the Glass Technology Unit, N. R. C. it has been found that a filter with 80% Lead Oxide concentration may satisfy our requirements.

A new melt, having the same composition of this type of glass was made, cut and polished to form filters similar to the standard filters manufactured by Schott. These filters which have different thicknesses were then examined spectroscopically for wavelengths up to 2800 mμ, and at different temperatures.

It was found that :

1. The short wave cut-off is at the long wave limit of the violet radiation.

2. This position shows no shift with increasing temperature (± 10°C).
3. The percentage transmittance, as shown in figure 1 (curve A) is constant in the main transmission region up to 2.7 μ. It is equal to 87% when the thickness of the filter is 1 mm.

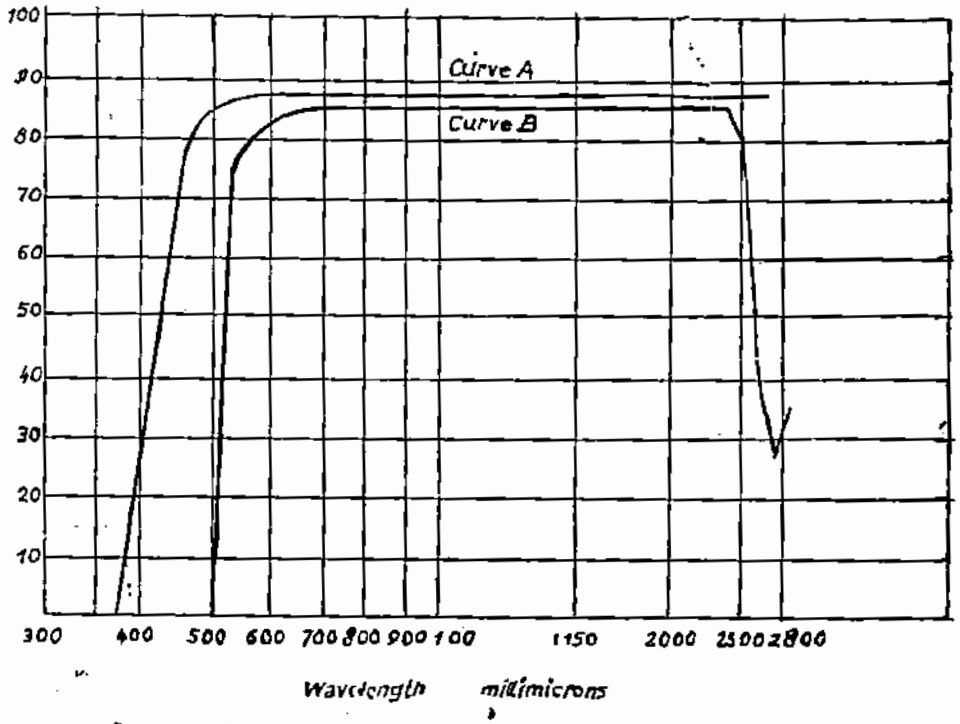

FIG. 1 Variation of the percentage transmittance with wavelength for the new filter and the Schott Filter OG$_1$

4. As thickness of the filter increases, its transmittance decreases slightly. It reaches 85% when the thickness is 2.10 mm.
5. As the temperature of the filter increases by 10°C, its transmittance decreases by 0.2%.
6. For wavelengths higher than 2.7 μ , a rapid decrease in the transmittance is noticed, but it is of no importance as the solar intensity in this range is very small and depends mainly on atmospheric humidity.

3. Energy Transmitted by the New Filter

The ultraviolet solar radiation can be measured with this filter when it is used in conjunction with a pyrheliometer or actinometer. The difference between the two actinometric readings taken alternately and rapidly with and without the filter is proportional to the solar radiation in this spectral region. In many applications it is convenient to know this amount in energy units. This is done as follows :

1. Calculate the reduction factor F_A of the filter; i.e. the factor which allows for the measurement of the transmitted energy with an ideal filter of 100% transparency. ($F_A = \frac{100}{87}$ from curve A).
2. Obtain curve B, as shown in figure 1, to represent the percentage transmittance of the standard Schott filter OG_1, noting that the same spectrophotometers should be used as in the case of curve A. The transparency for OG_1 as obtained from curve B is 85% and the corresponding reduction factor is $F_B = (100/85)$.
3. Mount the two filters on a Linke and Feussner actinometer, and notice the actinometer readings d_A and d_B when adjusting the two filters separately and rapidly. The ratio between the energy transmitted by the new filter to that by OG_1 is given by : $d_A F_A / d_B F_B$, and the amount of radiation transmitted by OG_1 (d_B x Davos Reduction Factor DR_1). In other words the actinometer deflection when using the new filter should be multiplied by (87/85) DR_1 to give the radiation it transmits in energy units. It should be noted that the measured energy includes correction for the losses due to reflection at the surfaces of the filter.

Measurements of the ultraviolet radiation have been obtained with this filter, at the National Research Centre, since February 1962. A Linke and Feussner actinometer No. 113 has been used (1 scale division of its millivoltmeter corresponds to 0.018 cal. cm^{-2} min^{-1}). As of measurements obtained, table 1 is given. It assembles the data observed on three days when the sky conditions are clear. (On May 28th and 29th the sky was perfectly blue).

Table 1. — Hourly measurements of the intensity of the ultraviolet and total solar radiation (cal cm^{-2} min^{-1}) taken at normal incidence for clear sky conditions.

Date	Time	Air mass	Deflection of Actinometer		Intensity of		Ratio %
			Without filter	With-filter	Ultra-violet Radia-tion	Total Radi-ation.	
3/4/62	09	1.58	63.0	49.0	0.20	1.13	18
	10	1.29	66.0	50.0	0.24	1.19	20
	11	1.15	71.5	54.9	0.24	1.29	19
	12	1.10	72.0	55.0	0.25	1.30	19
	13	1.13	72.5	55.0	0.26	1.31	20
	14	1.24	68.0	52.8	0.22	1.22	18
	15	1.47	65.0	50.0	0.22	1.17	19
	16	1.98	58.5	45.5	0.19	1.05	18
	17	3.32	44.0	35.0	0.12	0.79	15
28/5/62	08	1.73	54.5	41.9	0.20	0.98	20
	09	1.34	58.5	44.2	0.21	1.05	20
	10	1.14	62.5	47.2	0.22	1.13	20
	11	1.04	64.9	48.9	0.24	1.17	20
	12	1.01	65.0	49.0	0.24	1.17	20
	13	1.04	66.0	50.0	0.24	1.19	20
	14	1.13	60.3	45.8	0.22	1.09	20
	15	1.32	58.0	44.5	0.20	1.04	19
	16	1.68	52.0	40.5	0.17	0.94	19
	17	2.50	38.7	30.0	0.13	0.70	18
29/5/62	08	1.72	49.0	37.0	0.18	0.88	20
	09	1.34	58.3	45.0	0.20	1.05	19
	10	1.14	61.0	46.2	0.22	1.10	20
	11	1.04	62.8	48.0	0.22	1.13	20
	12	1.01	60.0	45.5	0.22	1.08	20
	13	1.04	60.0	45.5	0.22	1.08	20
	14	1.13	57.5	43.3	0.21	1.04	20
	15	1.17	55.0	42.0	0.19	0.99	20
	16	1.68	46.0	35.5	0.15	0.83	19
	17	2.49	33.0	26.0	0.10	0.59	17

These observations obtained show that the ultraviolet radiation constitutes about 20% of the total incident radiation when the air mass $m \leq 2$ (three or four hours before and after solar noon) and decreases considerably for higher air masses.

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