DESCRIPTION OF A METHOD OF CONTROL FOR GLASS LENSES USED AS A PROTECTION MEDIUM AGAINST RADIATION

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1. INTRODUCTION

The need for protecting our sight against radiations has been shown on many occasions. This need is particularly obvious in the case of exposures to heat or light sources with a high intensity.

Glass protection lenses are submitted to the spectrophotometric measurement obtained in the three spectral zones: infrared, visible and ultraviolet. As it is not possible to obtain a photometric measurement nor test photometrically a very opaque sample, one must reduce the thickness of the material by destructive techniques, in order to obtain plates in which the transmission factors are at least equal to 5% in the spectral regions with maximum opacity. The values obtained by calculation can refer to any thickness of lense. In practice, these plates can only be obtained by glass manufacturers, or from highly specialized laboratories; the normal user would find it impossible to obtain them. Because of this, the control of glass protection lenses would be reduced to those with a high transparency, which are precisely those of least interest from a practical point of view.

In the present work, a method of measurement is described which permits the determination of the optical density of a glass lense, at each wavelength, by measuring successively a glass lense of a known opacity against others of increasing opacities; in this way their protection capacity can be deduced.

To finalize and check the method, glass lenses normally used for industrial protection were employed.

2. DEFINITIONS AND DESIGNATION

The glass lenses are classified relating the percentage of visible light transmitted and a number, N, denominated "degree of protection", using the expression:

$$N = \frac{7}{3} \log \frac{1}{T} + 1 \qquad \text{or} \qquad N = \frac{7}{3} D + 1$$

in which T is the average transmission in the visible band of the spectrum expressed as a fraction of 1, and log 1/T is the optical density, D, of the lense.

TABLE 1

nm	800	750	700	650	600	550	500	450	400
1/0	116	092	070	054	042	032	032	042	050
2/0	128	102	078	064	050	044	044	058	070
(1+2)/0	244	194	148	118	090	076	076	100	120
4/0	-	-	230	176	136	122	126	160	196
5/0	-	-	280	230	176	152	156	190	210
4/(1+2)	128	108	084	062	052	048	048	056	082
4/2	240	200	154	166	090	080	080	094	128
5/2	-	262	204	164	130	110	110	130	150
5/(1+2)	202	172	134	110	090	080	080	087	100
6/2	270	228	188	186	168	156	168	200	234
5/4	076	067	053	050	040	032	030	032	020
6/4	032	032	039	071	080	080	090	104	110
7/4	102	092	090	120	128	122	134	156	166
8/4	174	154	140	166	170	152	168	190	210
6/5	-044	-036	-014	023	042	050	060	072	094
7/5	024	024	040	076	088	092	104	128	160
8/5	100	088	090	124	130	126	140	170	198
7/6	070	060	050	052	048	044	046	056	062
8/6	144	124	102	104	092	080	082	100	106
8/7	076	065	053	052	044	038	038	046	060

TABLE 2

nm	800	750	700	650	600	550	500	450	400	Steps to obtain the absolute value
1	116	092	070	054	042	032	032	042	050	(1/0)
2	128	102	078	064	050	044	044	058	070	(2/0)
4	-	-	230	176	136	122	126	160	196	(4/0)
4	368	302	232	180	140	124	124	152	198	(4/2)+(2/0)
4	372	302	232	180	142	124	124	156	202	(4/1+2)+(1+2/0)
5	-	-	280	230	176	152	156	190	210	5/0
5	-	364	282	228	180	154	154	188	220	(5/2)+(2/0)
5	446	366	282	228	180	156	156	187	220	(5/1+2)+(1+2/0)
6	398	330	266	250	218	200	212	258	304	(6/2)+(2/0)
6	-	-	269	247	216	202	216	264	306	(6/4)+(4/0)
6	-	-	266	253	218	202	216	262	304	(6/5)+(5/0)
7	-	-	320	296	264	244	260	316	362	(7/4)+(4/0)
7	470	394	322	300	268	246	258	308	364	(7/4)+(4/2)+(2/0)
7	-	-	320	306	264	244	260	318	370	(7/5)+(5/0)
7	-	388	322	304	268	246	258	316	380	(7/5)+(5/2)+(2/0)
7	468	390	316	302	266	244	258	314	366	(7/6)+(6/2)+(2/0)
7	-	-	319	299	264	246	262	320	368	(7/6)+(6/4)+(4/0)
8	542	456	372	346	310	276	292	342	408	(8/4)+(4/2)+(2/0)
8	-	452	372	352	310	280	294	358	418	(8/5)+(5/2)+(2/0)
8	542	454	368	354	310	280	294	358	410	(8/6)+(6/2)+(2/0)

Optical density x 100

3. EXPERIMENTAL

3.1. Material:

The spectrophotometric measurements have been obtained with a BECKMAN spectrophotometer, ACTA C III model, adjusting the power to each wavelength in which the measurement was made, quick answer time, with the digital calibrated for three absorbancy units.

The lenses used, in increasing opacity, were supplied by various commercial firms.

3.2. Measurement technique used:

As the optical density is an additive magnitude, it is possible to carry out the determination step by step. A glass lense with a high opacity, whose photometric measurement cannot be made directly because of the aforementioned obstacles, can be made, nevertheless, with a very simple device. If one mounts the lense to be measured in the measuring beam, and one places another less opaque lense in the beam of reference, the value obtained will be the difference of their optical densities in that wavelength.

So, if one uses a lense of a known density and a series of lenses with an increasing opacity, between the opacity of the known lense and that of the lense to be measured, the density of this lense can be measured, applying the method of successive steps, according to the secuence:

$$D_C = D_{C/B} + D_{B/A} + D_{A/O}$$

$D_{B/A}$ = Difference between the optical densities of the A and B lenses.

The number of intermediate steps will depend on the nature of the lense to be studied and on the glass family available.

3.3. Experimental Results:

The optical density values obtained at different wavelengths for the families of lenses studied are shown in Table 1. In each case, the lenses used for the determination are indicated by two numbers separated by a line. In the upper half the degree of protection of the lense placed in the sample department (S) is shown, and in the lower half, of the lense placed in the beam of reference (R). "/O" indicates that in the corresponding department no lense was placed.

In the following Table, number 2, the optical densities for the different wavelengths have been resumed and arranged; these were calculated by the technique of successive steps. The step sequence followed is shown in the third column.

4. DISCUSSION OF THE RESULTS OBTAINED AND CONCLUSIONES:

4.1. Following the method described in the preceding paragraphs, the optical density of any lense at any wavelength can be obtained, and therefore it is possible to identify the characteristic absorption curve of the lense to be studied by a non-destructive method.

4.2. The results we obtained are independent of the intermediate lenses used, providing that the difference in the optical density between the lenses placed in the sample beam (S) and the reference beam (R) are maintained below a certain value, which will be conditioned by the characteristics of the spectrophotometer used.

4.3. The consistency in the results which were obtained indicates a high precision, since the small differences observed in some cases are within experimental error.

4.4. The application of the successive steps method which we propose, permits the examination of a material which is going to be used for protection in a certain industrial operation to see if it complies with the minimum requirements demanded by the different international standards.