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NBS Standards for Opacity Meters

Opacity meters for use in measurement of opacity according to the Official TAPPI Method, T425m-44, "Opacity of Paper", August 1944, give values of opacity in terms of contrast-ratio. In the contrast-ratio method the value of opacity is computed as the ratio of readings of directional reflectance of a sample backed by a black backing to such readings of the same sample backed by a white backing of effective reflectance 0.915 relative to magnesium oxide. The purpose of this Letter Circular is to describe how Davis[1]-type opacity meters, which are the most commonly used type of opacity meter, may be adjusted and calibrated with the help of opacity standards issued by the National Bureau of Standards.

The NBS standards of opacity are 5- by 12-cm rectangles of opal or alabaster glass of assorted thicknesses. These standards have been calibrated according to the Official TAPPI Method for paper. The standards are available in assorted opacities between 0.60 and 0.96. They have been found to be permanent and have the added advantage that when they become dirty they can be cleaned with a mild soap and water.

If the value of opacity for a glass standard as measured with an opacity meter does not agree with the reported value, then the measured value of opacity for paper specimens will not correspond to TAPPI opacity. The opacimeter may then either be readjusted so that it does yield the reported value of opacity for the standard, or a correction may be applied to each measured value of a paper specimen. A series of four glass standards generally is recommended to check the calibration over a wide range of opacities such as from 0.60 to 0.96. Standards should preferably be selected with opacities close to the opacities of the test samples, especially for use in direct comparisons.

1) Adjustment of Light Source.

Check the source of illumination to insure that the incident beam is centered on the aperture of the light box and that the illumination is as uniform as possible over the sample area. The lamp and mirror may need to be aligned with the lens system to center the incident beam on the exit aperture of the light box. The lamp socket and the mirror are secured by screws at their bases; these screws may be loosened during this alignment. While the mirror is being thus aligned, the distance between the lamp and mirror may need to be changed and this can be done at the same time. Once the mirror is in proper adjustment it seldom needs any further adjustment unless it is accidentally moved. The lamp will need further adjustment by raising or lowering or turning the lamp socket and this adjustment will have to be repeated each time a new lamp is inserted in the instrument. To assist in centering the incident light from the lamp in the aperture of the light box,

the light may be allowed to fall on a nearby wall. For correct adjustment the image formed by light from the filament and the image formed by light reflected from the mirror are both in focus, and about equally bright. If a piece of thin paper or translucent glass is then placed over the aperture, it will be noted that the illuminance will be about as uniform as possible and of maximum amount attainable. In addition, the lens nearest to the lamp may need to be moved toward or away from the lamp in order that the illuminated area almost fills the aperture. This may also improve the illuminance of the field. If the illuminated area extends beyond the edges of the aperture, reflections off the edges of the aperture and inside of the light box will raise the zero setting undesirably (a difference of more than 0.1 microampere between the readings of the microammeter when the lamp is off and when the "check of zero setting" is made, as described in the next paragraph, is undesirable).

2) Check of Zero Setting.

The reflectance of the black-cavity backing should be zero, but a reflectance of 0.01 may be tolerated. The cavity lined with black felt or black velvet supplied with instruments of the Davis type has a reflectance much less than 0.01. To check the zero setting of the instrument, place the black cavity over the illuminated spot without any specimen in place and adjust the needle setting to zero by means of the zero adjustment screw.

3) Adjustment and Maintenance of the White Backing.

The adjustment and maintenance of the white backing of the sample are most important. This backing consists of a cover glass and a magnesium-carbonate block in a cylindrical holder (the other end of the holder houses the black cavity referred to above). The magnesium-carbonate block is movable relative to the cover glass. An NBS glass standard may be used as follows for setting the magnesium carbonate to the correct distance from the cover glass so that the effective reflectance relative to MgO is the required 0.915. Place the white backing over the illuminated spot without any specimen in place and adjust the instrument aperture until the microammeter reads 0.915. Place the standard over the illuminated area with the fine-ground side toward the light source and place the white backing against the standard. Compare a reading on the standard with the reported opacity for the standard. If they differ by more than 0.010 the backing should be adjusted until the reported value for the standard is obtained as a reading. The carbonate surface should be fixed at that position in the holder by tightening the set-screw. Then repeat the reading to check the adjustment and also recheck the zero setting discussed in Section (2) above. From time to time, the carbonate surface of the backing may need to be renewed by scraping off the top layers, or the carbonate block may need to be replaced to obtain the correct values of opacity.

In case the value of opacity for the standard differs only slightly (less than 0.010) from the reported value, it may be desirable not to alter the adjustment of the instrument. In that case the instrument reading may be corrected for a sample having a light, nearly white color. Let ΔC_S be the difference between measured and reported value of opacity of the standard; then

the correction, C, to be applied to the measured value for a paper sample is given by $\Delta C = K \Delta C_S$. The variation in K with measured value of opacity is given in the following table:

Measured Value of Opacity	$\Delta C/\Delta C_S = K$	Measured Value of Opacity	$\Delta C/\Delta C_S = K$
1.00	0.0	0.70	1.2
.95	0.5	.65	1.2
.90	0.8	.60	1.2
.85	1.0	.55	1.1
.80	1.1$_5$	.50	1.0
.75	1.2		

If the instrument reading is higher than the reported value of the standard, the corresponding corrections should be substracted from the measured values, but if the reading is lower than the certified value, corrections should be added.

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