

The American Oil Chemists' Society

Notes and Correspondence

Standardization of Lovibond Glasses

(Investigation in Cooperation with
A. O. C. S.)

Report for February, 1928

(Names in parentheses after sub-
titles and at ends of paragraphs in-
dicate individuals principally re-
sponsible for the work described)

1. *Adoption of a Working Stand- ard 35-Y.*

Considerable effort has been made to find a single glass which might be taken as a perfect standard 35-Y to be used in testing other glasses by direct comparison with it in the Martens photometer. This search has not met with complete success. These glasses depart from ideal in hue as well as in saturation. A glass may grade 35-Y so far as saturation is concerned and still be reddish or greenish relative to the standard. It may, for example, be equivalent to 35-Y O. 1-R. Failing to find a perfect standard in *one* glass, we have sought to make a standard 35-Y of *two* glasses. By carefully noting the errors of several glasses and the effects of combining them, we have found such a combination suitable to serve as a standard 35-Y (scale of Priest and Gibson derived from B.S. 9940), in so far as saturation and hue are concerned. (The transmission is, of course, not correct, but this is of no consequence in the way we use the standard.) This combination consists of the following two glasses:—

35-Y B.S. 10289 C

1-Y B.S. Test 41960.

This combination was arrived at

as follows:—(1) It was noted that the true yellow numeral for the first named glass was 34.03 but that it was *greenish*. (2) It was noted that the true yellow numeral for the second named glass was 1.025, but that it was *reddish*. (3) This suggested that the combination might approximate closely to 35 and be neither green nor red relative to the standard. (4) The yellow numeral and the dominant wave length for this combination were computed from the previously determined spectral transmission of these glasses. The combination was found, by this computation, to be equivalent to

35. 1-Y 0.00-R.

The departure of 0.1-Y from 35.0-Y is of no practical consequence as 0.1-Y is entirely inappreciable by direct comparison of colors at about 35-Y. The fact that the red error is zero is the important consideration.

This combination served a very useful purpose in the final tests made on the 35-Y glasses submitted last August by the A.O.C.S. (Priest and Gibson).

II. *Continuation of Investigation of the 35-Y Glasses Submitted by A.O.C.S. in August, 1927.*

Investigation of the Lovibond 35-Y glasses, mentioned in the report for January, has been continued as follows:—

(1) Complete spectral transmission data have been obtained on the following glasses: A.O.C.S. Nos. 71, 75, 76, 101, 103, 114, 135, 165. The complete data on these glasses were taken because the preliminary partial data indicated that

these glasses were close to true 35-Y, and it was desired to test them more accurately in the hope of finding a particularly accurate 35-Y. The required computations are only about half finished and the results will be reported next month. (Gibson & Brown)

(2) Determination of the dominant wave lengths by direct comparison with a working standard glass has been completed. (Priest & Riley)

(3) Direct comparison of colors in the Martens photometer has given results in accord with the numerals found by Priest's empiric formula for the yellow numeral on scale of Priest and Gibson, viz:—

$$\text{Numeral} = -37 \log_{10} \left\{ \frac{T_{480}}{T_{550}} \right\}$$

(Cf. Report for January.) This conclusion was reached by testing the correlation between Judd's observations on relative saturation and the computed numerals. (Judd & Priest)

(4) The true value of each glass in *yellow and red* has been finally arrived at by computation supplemented by direct observation, the steps being as follows:—

(a) The yellow numeral was computed, by Priest's formula, from measured values of transmission for wave lengths 480 and 550 millimicrons. (Cf. Report for January.)

(b) Standard yellow glasses were applied to neutralize the difference between these computed values and 35; and the resulting combinations were viewed in the Martens photometer, using as working standard 35-Y, the combination mentioned under I above.

(c) Red standard glasses were selected by trial to produce a perfect match in hue, and it was noted

that in nearly all cases a saturation match was obtained. (Judd & Priest)

(5) All glasses received in August, 1927, which had not been previously returned, were returned (by Mr. Priest) to Mr. Trevithick, in New York, February 23, 1928.

(6) Preparation of report on these glasses is in course.

III. Temperature Coefficient of Color of Lovibond 35-Y Glass.

As is well known the color of a glass is not entirely independent of its temperature. With this in mind it has seemed desirable to determine the magnitude of this effect. Accordingly, the spectral transmissions for 35-Y have been determined at 15° and 35° C, a range intended to cover all ordinary conditions of use. From these data, the corresponding changes in sunlight transmission, dominant wave length, purity and Lovibond yellow numeral have been computed.

The sunlight transmission decreases with increase in temperature while the dominant wave length and purity both increase. The decrease in transmission is only 0.00047 per degree centigrade and is therefore quite negligible for practical purposes.

The change in purity is found to be 0.00026 per degree centigrade and is also negligible for practical purposes, even for most extreme variations of laboratory temperatures (say 15° C departure from average). It is true that the corresponding change in Lovibond numeral on the yellow scale is 0.136 per degree centigrade. That is, a change of 10°C really changes the yellow numeral by 1.4. This, however, is an inappreciable amount in color.

The change in dominant wave

length is found to be 0.020 millimicron per degree centigrade. A change of 10°C will accordingly change the dominant wave length by 0.2 millimicron which is equivalent to 0.1-R on the Lovibond scale. In more specific terms:—If two 35-Y glasses were exactly matched at 20°C and one of them were raised to 30°C while the temperature of the other remained at 20°, it would be necessary to add 0.1 R to the one at 20° in order to restore the hue match. (Gibson)

We have as yet no information as to corresponding changes in red glasses nor in cotton seed oil. It is, however, proposed to determine similar temperature coefficients for the glass combination 35-Y 7.6-R and for oil of this color. If it is found that the colors of the oil and this combination of glasses vary *together* with temperature the changes will be of no practical interest in color grading oil. If, on the other hand, the dominant wave lengths of oil and glasses should change in opposite directions with temperature, or if one should change much more than the other for the same temperature change, it is apparent that due account of this effect will have to be taken in reporting the color of oil.

IV. *Further Calibration of Bureau of Standards Set of Lovibond Yellow Glasses* (B. S. 9940).

In order to complete the calibration of fractional yellow glasses (numerals less than unity) in the set B.S. 9940, measurements on the spectral transmissions of these glasses have been started. Measurements have been made on the following glasses (designated by maker's numerals as marked on the glasses):—0.90, 0.80, 0.70, 0.60, 0.50. The data obtained so far

are not complete nor final. (Gibson & Brown)

V. *Sensibility to Change in Yellow at 35-Yellow on the Lovibond Scale.*

Observations made in connection with the calibration of sixty-five 35-Y glasses enable us to make what is believed to be a fair preliminary estimate of the order of magnitude of the difference in yellow just perceptible with certainty (with brilliance equated). This estimate is one to three units. Although the experiment by the method of right and wrong answers has not yet been made, these data indicate that the smallest difference for which a good observer would answer correctly 10 times in 10 trials would lie between one and three units. (Judd)

VI. *Approximate Empiric Equivalence of Small Differences in Red and Small Differences in Yellow at 35-Yellow on the Lovibond Scale.*

The following observations as to substitution of red for yellow result from the experiments made in calibrating sixty-five 35-Y glasses. If two nominal 35-Y glasses do not match *exactly* it often happens that an approximate match can be made by trial by adding either *red* or *yellow* to one or the other. It is difficult to decide which to add or whether some of both should be added. The practical equivalence appears from experience to be that 0.1 R may be substituted for 5-Y. (Judd)

VII. *Review and Reduction of Earlier Data on Bureau of Standards Lovibond Red Glasses* (B.S. 9940).

The review and reduction of earlier data by Dr. Frehafer, as mentioned in the report for January, has been continued. The com-

putations were nearly finished by the end of February, but not in form for final discussion. (Gibson & Riley)

VIII. *Further Data on Bureau of Standards Lovibond Red Glasses (B.S. 9940).*

The spectral transmissions of the following glasses (designated by maker's marked numerals) in set B.S. 9940 have been determined:— 3.7 and 1.85. (Walker)

IX. *Design of Apparatus for Artificial Daylight Illumination to be Used with the Martens Photometer in Grading Glasses and in Testing Color Sense.*

In order that observation may be made under constant conditions apparatus is being designed to provide a constant artificial daylight illumination to be used with the Martens photometer. (Priest & Walker)

X. *Progress on Routine Calibration of Red Glasses Submitted by A.O.C.S. (Walker)*

1. Fourteen red glasses (A. O. C. S. Nos. 201-214 inclus.) received January 16, were graded, reported and returned. (Date of report, February 10. Date of shipment to Mr. Putland, February 10.)

2. Nineteen red glasses (A. O. C. S. Nos. 215, 217, 222, 223, 225, 226, 229, 232, 234, 236, 257, 258, 273, 275, 279, 281, 282, 285.) received January 30, have been graded, reported, and returned. (Date of report, February 10. Date of shipment to Mr. Putland, February 10.)

3. Ten red glasses (special form, 16 mm disks) received January 30, were graded by February 16. Issue of report and return of glasses were delayed because of delay in receiving information as to identification numbers to be assigned to these glasses. (The re-

port dated March 1, was mailed March 3, and the glasses were shipped to Law and Co., March 2.)

4. Twenty-five red glasses (A. O. C. S. Nos. 218, 254, 255, 289, 294, 296, 302, 306, 307, 308, 309, 315, 320, 321, 330, 331, 341, 342, 346, 351, 352, 353, 356, 358, 359) were submitted February 17. The grading of these was nearly completed February 29.

XI. *Report on Tests of Color Sense Made at Memphis, May, 1927.*

This report (by Priest) was mailed to the Editor of OIL AND FAT INDUSTRIES December 29 for publication. It developed during February that some revision would be desirable before publication. Mr. Priest conferred with Mr. Trevithick and Mr. Lee in New York February 23, and February 27, relative to such revision. The report is now being revised and it is expected that it will be published in OIL AND FAT INDUSTRIES for March or April. An abstract of this report (under the title, "Perception of Slight Color Differences") was published in the "Tech. News Bulletin of the Bureau of Standards" for January, 1928.

XII. *Reprints of Report by Judd and Walker on "A Study of 129 Lovibond Red Glasses with Respect to the Reliability of their Nominal Grades."*

This report, first published in OIL AND FAT INDUSTRIES, January, 1928, has been separately reprinted. A limited number of these separate reprints are available for free distribution. Address:—

Colorimetry Section,
Bureau of Standards,
IRWIN G. PRIEST,
Chief, Colorimetry Section.

SAMPLE REPORT

Bureau of Standards and American Oil Chemists' Society

Investigation of the uniformity of Lovibond glasses in use in the U. S.

Report on Calibration of Red Glasses Submitted by the A. O. C. S.

Date submitted

Lovibond Numeral as submitted (engraved on the glass)

Method of calibration used to obtain correct numeral

Method used to measure transmission

The following "Correct Numerals" relate to grading by hue. They are given in terms of the additive standards established by Priest and Gibson in May, 1927.

The "Transmission Error" is $(T_a - T_n) / T_n$, where

T_a is sunlight transmission of a combination consisting of the test glass and a 35-Y glass;

T_n is sunlight transmission of a combination consisting of the same 35-Y glass and a normal red glass having the numeral assigned to the test glass in this report.

Table with 6 columns: A. O. C. S. No., Other Marks Engraved on the Glass, Date of Calibration, Correct Numeral, Transmission Error, Remarks. The table contains multiple empty rows for data entry and a 'Mean' row at the bottom.

The errors in the "Correct Numerals" given above are believed to be less than 0.1.

Report Sheet No.
Washington
(Date)

Certified by
Research Associate of the A. O. C. S.
at the Bureau of Standards.