The Standardization of Lovibond Glasses: Statement from the Color Committee

At a meeting of the Color Committee in New Orleans at the Roosevelt hotel, May 28, 1957, two motions were made and passed that the chairman prepare a statement concerning the fundamental nature and differences in the N and N″ color scales for publication in the Society Journal, and (with assistance as desired) review the question of calibration of Lovibond glasses with a view to recommending a more modern means of calibration.

At a meeting in Cincinnati on September 29, 1957, the following material was approved for publication.

At present A.O.C.S. Procedure Cc 13b-45, revised October, 1955, reads as follows: "Color glasses, red and yellow, of suitable numbers to match the color of the oils to be examined. Red glasses must be standardized by the U. S. Bureau of Standards (Washington, D. C.) or the Electrical Testing Laboratories (East End avenue and 79th street, New York, N. Y.)."

While the method does not specifically so state, glasses standardized by either the Bureau of Standards or the Electrical Testing Laboratories are calibrated in accordance with the N″ or Priest-Gibson scale established by the Bureau. The method by which the N″ scale was established and the procedure for calibrating glasses are given in the following publications:

a) "The Lovibond Color System, a Spectrophotometric Analysis of the Lovibond Glasses," by K. S. Gibson and S. K. Harris; Scientific Papers of the Bureau of Standards, No. 547, February 17, 1927.

b) "Calibration of Sixty-Five 35-Yellow Lovibond Glasses." by Irvin G. Priest, Deane B. Judd, K. S. Gibson and S. K. Harris; Scientific Pa-Paper No. 58, Bureau of Standards Journal of Research, vol. 2, April, 1929.

c) "Statistical Investigation of the Uniformity of Grades of 1,000 Lovibond Red Glasses," by G. R. Walker; Research Paper RP 653, Bureau of Standards Journal of Research, vol. 12, March, 1934.

d) "Standardization of Lovibond Red Glasses in Combination with Lovibond 35-Yellow," by K. S. Gibson and Geraldine Walker Haupt; Research Paper RP 718, Journal of Research National Bureau of Standards, vol. 13, October, 1934.

e) "The Adjustment of Lovibond Red Glasses," by Roger S. Estey, Electrical Testing Laboratories, Oil and Soap, vol. 12, 1935.

These five papers contain a tremendous amount of information concerning the spectrophotometric nature of Lovibond glasses, the methods used in establishing the N″ scale, and the procedure for calibrating glasses in accordance with the proposed scale. To obtain a thorough knowledge of the tremendous amount of work that went into this study, it is necessary for the individual to review these data himself. A short summary of the information given in these papers has been made for those who do not have ready access to the papers or those who do not wish to spend the necessary time to review them

In 1912 the Bureau obtained a set of Lovibond glasses from Lovibond Tintometer Ltd. The N″ scale was established on the basis of 78 calibrated glasses, designated as Bureau of Standards set 9940. The following information is taken directly from "Research Paper 718" mentioned above. "This standardization was carried out at the insistence of those who use such glasses in the grading of vegetable oils. The nature of the standardization was dictated by the following considerations:

a) the glasses of set BS 9940 had previously been accepted at 'standard' by the Interstate Cotton Seed Crushers' Association and by the Society of Cotton Products Analysts (now American Oil Chemists' Society);

b) the set had to be standardized within itself; there was no other standard set with which to compare it;

c) the standardization must be based upon fundamental absolute measurements; it must not be dependent upon the permanence of the glasses or of any other material color 'standards';

d) The numbers assigned to the glasses when standardized must be additive within prescribed tolerances; and

e) the glasses must be combined with some prescribed yellow glasses. Because of the color of vegetable oils the red glasses are always used in combination with Lovibond yellow glasses and, in decisions of greatest importance, in combination with a 35-yellow glass. The standardization described in this paper has been carried out therefore with the respective red glasses combined with a 35-yellow glass. The values obtained are doubtless valid for a considerable range of yellow glasses on both sides of 35Y, but the values do not necessarily hold for the red glasses used alone or with a Lovibond yellow glass of small numeral."

The N″ scale was established in accordance with the considerations given above. Later in this same paper the authors point out that the N″ scale is related to the normal Lovibond scale when only the 20 even-numbered glasses of Bureau of Standards set 9940 are used by the following equation: $N'' = 0.987N + 0.26$. When the first 1,000 glasses graded were compared, the relation between the scales became $N'' = 1.02N + 0.14$. For all practical purposes these equations are identical. The authors point out, "it is in no way surprising that the 20 glasses of the Bureau set, BS 9940, fail to give exactly the same scale and unit that a much larger number of glasses would have given. The slight failure of the Bureau glasses to be accurately representative of the first 1,000 glasses graded has apparently caused no trouble or inconvenience to the oil trade whereas the elimination of the erratic and consistent deviations from additivity that existed among the Lovibond red glasses when combined with 35Y has removed one of the

principal causes of dispute regarding the color grading of cottonseed oils. The Priest-Gibson (N″) scale may now be considered as thoroughly established in America."

Having established the N″ scale, which is definitely linked to the use of a 35-yellow type, the Bureau of Standards and the Electrical Testing Laboratories set up identical procedures for checking glasses submitted to them for standardization. The standardization procedure used is taken as quoted from "Research Paper RP 653," p. 274: ". . . the glass to be tested is compared directly under artificial sunlight illumination with the standard glass or combination of standard glasses. The central portions of each are viewed in juxtaposition in the Martens photometer through the 35Y glass placed over the ocular. A standard glass or combination of standard glasses is selected, giving the best possible match in chromaticity. Since the smallest intervals between the standard glasses in use are differences of approximately 0.1 of an N″ unit, estimates between the tenths are made whenever differences of this small magnitude can be detected. When a combination of two or more standard glasses is necessary to secure the match, the glass being tested is combined with a corresponding number of clear glasses so that the light illuminating one-half of the photometric field passes through as many reflecting surfaces as that illuminating the other half. Three glasses are the maximum number ever used in one-half of the photometric field. By thus limiting the number of standard glasses, errors due to the accumulation of small errors in the standards are prevented. Because of this limitation and the restricted number of standard glasses available, it is frequently necessary, in order to obtain the N″ value for the glass tested, to combine a standard glass with the glass being tested and subtract its N″ value from that of the standard glasses in the other half of the photometric field.

"After the first decision the glass being tested and the standards are interchanged in position and a second decision is made. An average of these two readings is recorded as one determination. The final grade of each glass tested is based upon at least two separate determinations embodying two different combinations of standards. To increase the reliability of the average grade, a third or fourth combination of standard glasses is occasionally used, especially when the glass tested is of nominal grade greater than 10.0 Lovibond units."

The Electrical Testing Laboratories make comparisons against Bureau of Standards glasses set No. 74170, which was calibrated by the Bureau. Since procedures for the standardization of Lovibond glasses were established in 1934 and 1935, many such sets have been standardized for industrial firms. It is expected that numerous other sets have been calibrated visually against these standards. Accordingly it is expected that the Color Committee will recommend that A.O.C.S. Official Method Cc 13b-45 be amended to read as follows:

3. Color Glasses
   Color glasses calibrated to conform to National Bureau of Standards N″ Scale. Glasses may be calibrated by the Electrical Testing Laboratories or may be calibrated by comparison against a standard set calibrated by the Electrical Testing Laboratories or National Bureau of Standards.

The proposed change in the A.O.C.S. Method, if adopted, will not change anything now being done but will bring the method into accord with the facts. Many laboratories now using uncalibrated glasses will be enabled to obtain proper calibration, and a greater uniformity of results between laboratories should be achieved.

After reviewing the work completed by the Bureau of Standards on the calibration of Lovibond glasses and the literature concerning the standardization of new glasses, the committee feels that no additional changes in the method of calibration should be made.

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Color Committee

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Brown-Colored Oxypolymers of Unsaturated Fats[1]

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BROWN OR YELLOW lipide polymers or copolymers have been characteristically associated with both pathological *in vivo* oxidation of unsaturated fats and the advanced stages of oxidative fat rancidity in food products. In the yellow fat disease of vitamin E-deficient mink (14), rats (16), cats (3), chickens (4), pigs (7, 18), and fish (22) these yellow-brown polymers are formed in the adipose tissue. Similar yellow-brown polymers have been found in human atherosclerosis (9), where they appear related to pathological, unsaturated lipide oxidation (8). These polymers are similar to those named "ceroid," which are associated with choline deficiency (2). In the rusting of fish (19) and the yellowing of bacon (5) during refrigerated and frozen storage the color development follows unsaturated fat oxidation and is associated with rancidity.

These naturally occurring oxypolymerizations of unsaturated lipides proceed in the presence of proteins. Furthermore it has been demonstrated that proteins, especially hemoglobin, accelerate polymer formation (2, 10, 21). Also these proteins either copolymerize with the oxypolymerizing lipide or become occluded in it. If the yellow-brown polymers are, in fact, copolymers containing protein, then the mechanism is probably active carbonyl-amine browning (11, 21). By the active carbonyl-amine browning mechanism the carbonyls formed by decomposition of lipide peroxides could react with the amino groups of

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