Lovibond Glass Standardization

Correspondence Between The Bureau of Standards, The Tintometer, Limited, and The Editor

THE attempts of the Bureau of Standards to serve the vegetable and animal oil and allied industries by evaluating and standardizing Lovibond color glasses for use in determining the colors of oils have formed the basis of a letter addressed to the Editor of *Oil & Fat Industries* by The Tintometer, Ltd., with a request for publication. A copy of this letter was forwarded by The Tintometer, Ltd. to the Bureau of Standards. The Director of the Bureau has kindly furnished *Oil & Fat Industries* with a copy of the Bureau's official letter to The Tintometer, Ltd., commenting on the letter addressed by that firm to the Editor. As the standardization of color reading instruments and methods is of major importance to all manufacturers and dealers in oils and their derived products we publish herewith this correspondence in full:

The Colour Laboratory,
1 The Friary,
Salisbury, England.

The Editor,
Oil & Fat Industries,
136 Liberty Street,
New York, U. S. A.

Sir:

In view of the recent criticisms which have been made concerning The Lovibond Colour Standards by The Bureau of Standards and others, many of which have been published in your Journal, we think the following will be of interest to your readers, and trust you will find room to print it in your Journal.

The Tintometer was invented by the late Mr. Joseph W. Lovibond of Greenwich and Salisbury in about the year 1887. The original Tintometer being fitted with an arbitrary brown series of standards for personal experiments.

The Scale: The success of this Instrument was so encouraging that he then constructed The Permanent Red, Yellow and Blue Scale of standards by which all colours can be matched and recorded.

Source of Light: The Inventor in all his Works, stresses the necessity for using the standards in the apparatus for which they are made, in normal diffused north daylight.

Visual Standard: The Lovibond Colour Scale was intended as a *physical* colour standard, to be used under specified conditions for *visual* comparisons.

Proof of Efficiency: The apparatus has justified its existence and is used universally in a vast number of Industries.

Claims of the Inventor: The Inventor, and the Company manufacturing the apparatus only claim visual uniformity of the standards when used in the apparatus for which they are made, under the prescribed conditions.

The Tintometer Limited do not vouch for the standards when used under any other conditions.

The Causes of Dissatisfaction are invariably due to departure from the specified conditions of use by the employment of unsuitable apparatus illuminated by unstandardized sources of light other than that for which the standards were made.

The Criticisms are based upon: (a) Spectral Transmission of the glasses, *which the makers do not claim to have standardised.* (b) Tests made in apparatus other than that specified by the Inventor. (c) Tests by means of the Martens photometer in which the "effective portion of each glass is symmetrical about the geometric center of that glass." (This is not the part of the glass standardised for use in the Tintometer, and the makers do not claim visual standardisation of the area "about the geometrical center.")

Use of the Standards by artificial Light: If it is impracticable to use diffused north daylight, then some easily standardised artificial light must be adopted in a standard form of instrument, mutually agreed upon, and the standards graded for use in that particular instrument illuminated by that particular form of illumination. Such standards would not be interchangeable in other instruments. Upon these lines The Tintometer Limited have expressed their willingness to co-operate with the Bureau of Standards and extend the same offer to the American Oil Chemists' Society.

Caution: The Tintometer Limited most emphatically caution everyone against the indiscriminate use of the Lovibond Tintometer Standards in apparatus other than that manufactured by The Tintometer Limited, in light other than diffused north daylight.

We are,

Yours faithfully,
THE TINTOMETER LIMITED,
(Signed) C. Headley,
Chairman.

Department of Commerce

Bureau of Standards
Washington

The Tintometer, Ltd.,
(Attn. Mr. C. Headley, Chairman),
Salisbury, England.

Subject: Standardization of Lovibond Glasses by the Bureau of Standards.

Gentlemen:

1. This will reply to your letter of October 1st (received October 26th), transmitting copy of a statement which you are submitting for publication in *"Oil and Fat Industries."*

2. Before taking up details, we consider it opportune to make a few comments relative to your attitude (as manifest in this and previous letters) toward our standardization and calibration of Lovibond glasses. We have already dealt with this matter rather fully in our letters of October 24, 1927 and January 5, 1928 to you; and, in order to avoid unnecessarily lengthy repetition, we request that you read these letters again. However, for the sake of making our position perfectly clear, we state some of the relevant fundamental facts and principles as follows, even at the cost of some tedious repetition:

(1) The lack of uniformity of color among Lovibond glasses having the same nominal value was *not originally discovered* by us but (much to their own cost and inconvenience) by the practical users of these glasses in the vegetable oil industry in America —particularly by the members of the American Oil Chemists' Society.

(2) The *fact* that the actual color differences between glasses having nominally the same value (engraved numbers on the glasses) are large compared to the nominal fineness of grading is patent, obvious, and incontrovertible. No recondite nor elaborate technical investigation is required to discover this fact. This conclusion is *not* necessarily based on measurements of spectral transmission nor any other measurement which might be mysterious or confusing to the layman It may be *seen* by any one having normal color sense by simply *comparing* the glasses side by side in "diffused North Daylight" (or any other illumination fairly representative of daylight).

(3) The investigation and calibration of Lovibond glasses which we are carrying on was *not* undertaken on our own initiative, but only in compliance with the urgent and insistent requests of the users of these glasses in America—particularly the American Oil Chemists' Society (formerly the Society of Cotton Products Analysts). In complying with the requests of a large group of citizens representing an important industry, we are only discharging our duty as the national standardizing agency—a duty which cannot be evaded, particularly since these citizens have shown their sincere interest and good faith by themselves contributing freely both their own time and their own money to this investigation. Except for these circumstances, we would be very glad indeed to be free of investigating and calibrating Lovibond glasses and making reports in regard to them. If you object to having your glasses investigated, we would therefore respectfully suggest that you make your complaint directly to the purchasers and users of the glasses and, if you desire, stipulate in the articles of sale that they are sold only on condition that they shall not be standardized nor calibrated nor certified by any agency except yourselves. Or, if you believe that the calibration could be done more satisfactorily to you by some reputable standardizing agency other than this Bureau, we suggest that you arrange to have the glasses certified by the corresponding British agency, the National Physical Laboratory.

(4) We have no intent nor desire to injure your reputation nor your business. Our sole purpose and endeavor is to tell the truth to those who employ us for the purpose of finding out the truth about these glasses.

(5) We would also emphasize that, far from injuring your business in America, our efforts in standardizing your product contribute very materially to *increasing* your sales. We would recall again that the errors in these glasses were first discovered by their users—not by us. Unless some such standardization as we are carrying on succeeds in restoring confidence in the glasses, it appears highly probable to us that the present users of these glasses will be compelled to abandon them entirely and resort to some more satisfactory method of color grading.

(6) As to your fear that the publication of our findings may injure your reputation, we are of the opinion that nothing could be better adapted to injuring it in this country than the publication of such statements as that which you are requesting the Editor of *"Oil and Fat Industries"* to publish. On the other hand, your cordial encouragement of a plan for having your glasses certified by an independent and impartial standardizing agency would greatly enhance your reputation and confidence in your glasses among American users of them.

3. We shall now make some specific comments upon the statement which you have requested the editor of *"Oil and Fat Industries"* to publish:

(1) The paragraphs headed as follows, while of some historical or other collateral interest, appear to be irrelevent to any discussion of the merits of our work or the correctness of our findings: *"The Tintometer," "The Scale," "Proof of Efficiency."*

(2) Your statement under *"Source of Light"* appears to be in error. We quote from page 10 of Mr. Lovibond's book "Light and Colour Theories" (published by E. and F. N. Spon in 1915) as follows:

"The real difficulty was in obtaining this equivalence, because a balance which transmitted a neutral tint by one light developed colour by another. This necessitated the selection of a standard light. The light finally selected was that of a so-called sea fog, away from the contaminating influence of towns. The white fog of Salisbury Plain was used as being most available."

Some of the comparisons of glasses (about one tenth of total) reported in the article to which you refer *("Oil and Fat Industries,"* Vol. VI, No. 9, p. 27; September, 1929) *were made with natural north sky illumination.* The remainder were made by artificial noon sunlight. When the change of illumination was made, eight glasses (viz.: maker's numerals 1.0, 2.2, 4.0, 5.0, 5.0, 5.7, 6.0, 6.0) were actually checked by *both* illuminations. Check observations to determine the effect of changing the quality of illumination were made by two observers and it was found that the effect was entirely negligible, sensibly the same results being obtained by the two illuminations. That this would be true in comparing *glasses having approximately the same spectral transmission* is indeed obvious, *a priori* without making the test, to any one acquainted with the principles of colorimetry. The exact specification of the quality (spectral distribution of energy) of the illuminant is only of importance in using the glasses to specify the color of something which has a spectral transmission (or reflectance) notably different from the spectral transmission of the glasses.

(3) In comment upon your paragraph *"Visual Standard"* we may say that the comparisons in question were made *visually*. Specifically, the glass to be calibrated was placed so that its color (by north sky or artificial sunlight illumination) appeared in one half of a photometric field. The person making the comparison then selected, by trial, standard glasses to match this color (a brightness match being simultaneously made by adjustment of the Martens photometer). The positions of the standards and the glass under test were then reversed (to eliminate any slight error due to asymmetry of the apparatus or the observer's eye) and the judgment of match made

again. Finally, the glass being calibrated was assigned the grade given by the standard glasses found to *visually* match it. The apparatus as used with north skylight has been fully described in *"Oil and Fat Industries,"* Vol. V, No. 1, pp. 16-19; January, 1928. In changing to artificial noon sunlight the only material change made was to substitute the artificial sunlight for the natural north sky light.

(4) In comment upon your paragraph *"Claims of the Inventor"* we have only to say that the publication to which you refer *("Oil and Fat Industries,"* p. 27, September, 1929) concerns only the color of the glasses, in daylight, as compared by methods which we deem sufficiently sensitive, convenient, and suitable to the making of such comparisons with a high degree of accuracy. However, if the lack of uniformity which we have found and reported is not found by comparing the same glasses, in daylight, by other apparatus and methods of comparison, it will undoubtedly be due to the circumstance that such apparatus and methods are not sufficiently sensitive to disclose the differences in question. Likewise, if two nominally one-gram weights, which we had found to differ by one milligram by carefully comparing them on a sufficiently sensitive balance, were reported to be equal as the result of less careful comparison on a crude balance having a sensitivity of only one centigram, this finding of equality would have no bearing on our report.

(5) In comment upon your paragraph *"The Causes of Dissatisfaction,"* we refer to our comments (3) and (4) just above.

(6) Referring to your paragraph *"The Criticisms . . ."* we submit the following statements:

(a) The findings as to lack of uniformity of glasses bearing the same scale numeral (N), in the paper to which you specifically refer (*"Oil and Fat Industries,"* Vol. VI, No. 9, p. 27; September, 1929) are *NOT* based upon the spectral transmission of the glasses. In fact, the spectral transmission of very few, if any, of these glasses has been determined. (The manner in which this lack of uniformity was found has been described under [3] above.) Data on spectral transmission were used as a convenient and accurate method of establishing our standards so that they would conform to the additivity law; for example, so that the quality of color of two glasses each graded as 1.0 would be the same as the quality of color of one glass graded as 2.0. (Cf. the following publications:—(1) J. O. S. A. & R. S. I., *16*, p. 116; February, 1928; (2) B. S. Res. Paper No. 58, p. 800; April, 1929). However, having established our standards by the use of data on spectral transmission, *we then verified the results by direct visual comparison of the colors of single glasses with the colors of various combinations, and also various combinations one with another, until we were satisfied that our results were in sufficiently close accord with the results of direct visual comparison of colors as colors.* We are certain that, by the use of spectral transmission data, we have established red and yellow standards much more in accord with Mr. Lovibond's ideal than were ever established by any one heretofore.

(b) We believe we have discussed the question of the use of "apparatus other than that specified by the Inventor" at sufficient length above and in our earlier letters to you. In our letter of October 24, 1927 we said: "Unfortunately, a multiplicity of ways of using the glasses to grade oils has grown up in America. Some instruments (with immediately juxtaposed fields) accentuate differences in brilliance (dependent upon the fraction of white light transmitted by the glasses), while others with separated fields, e.g., your own tintometer, obscure brilliance differences and relatively enhance hue differences. The type of comparator to be recommended depends upon the end sought, but, of course, comparable results in grading oil depend upon the use of identical instruments by all users. We are attempting to educate the users on this point. You may be assured that glasses standardized by us will be suitable for use in your 'tintometer' . . . In order that we may show and demonstrate it to users of your glasses, we would be pleased to have you send us an exhibit model of the instrument which you recommend for reading the color of oil (5¼ inches) in terms of Lovibond glasses. It would greatly help the situation to have here, for educational purposes, an exemplar of the instrument approved by you." We particularly invite your attention to the last two sentences of the above quotation from our previous letter. In your letter of November 21, 1927 replying to the above, you said: "We will certainly send an exhibit model of our Tintometer for demonstration purposes." In our letter of January 5, 1928 to you, we said:- "We have not received the exhibit model of the Tintometer which your letter mentions as being sent to us." We now add that we have not yet received it, nor have we received any further advice from you concerning it.

(c) We are quite unable to grasp the significance of your statement that "the makers do not claim visual standardization of the area 'about the geometrical center'." In specifying the particular part of the area of the glass for which the color was reported, we merely took into account that this was (or might well be made) the effective part, and guarded against the fact that the color *might* not be exactly the same over the whole area. If the color is uniform over the whole area, no harm is done. But, if you do not standardize this part, it seems to us incumbent on you to state what part you *do* standardize and not merely state what part you do *not* standardize.

(7) We make the following comments on your paragraph *"Use of the Standards by artificial Light"*:

(a) As indicated above, the exact specification of the quality of daylight used in comparing Lovibond glasses with Lovibond glasses (which is the matter with which we are primarily concerned) is not of great importance, but it would be just as well to establish a standard illumination for this purpose. In using the glasses to grade oil, a more precise specification of the quality of illumination is desirable; and we join with you in urging that a standard be adopted. We recommend for this purpose an artificial light having the quality of the overcast sky. This is substantially equivalent to Mr. Lovibond's recommendation of "sea fog" or "The white fog of Salisbury Plain" ("Light and Colour Theories," p. 10), and also equivalent to your present recommendation of "diffused North Daylight" *provided that the sky is overcast.* However, it is notably different from "diffused North Daylight" if the day is clear and the north sky blue. As a matter of fact, it is obvious on a moment's thought that in recommending natural "diffused North Daylight," you are recommending a very variable standard which changes daily and hourly with the weather.

(8) Any comments which we might make on your paragraph *"Caution"* would involve needless repetition of comments already made above.

4. We now return to the specific questions in your letter of October 1, 1929:

(1) The instrument mentioned in the last paragraph on p. 27, No. 9, Vol. VI of *"Oil and Fat Industries,"* about which you inquire consists essentially of:

(a) A Martens photometer, used as a convenient means of bringing the oil color and the color of the glasses into immediate juxtaposition to facilitate their comparison, and as a means of equating the brilliance of the two, and (if desired) as a means of measuring the white light transmission of the oil relative to that of the glasses.

(b) A series of wheels carrying red and yellow glasses arranged so that, by merely turning the wheels, any combination of glasses required to match the oil may be brought into the field of view. (This, of course, is a mere matter of mechanical convenience in selecting the proper combination of glasses to match the oil. It would save a great deal of time in the handling of glasses and would, to a considerable degree, prevent their becoming soiled, scratched, and broken by accident.)

(c) A suitable tank and support for holding the oil sample.

(d) Two gas-filled tungsten lamps to provide light.

(e) A white lined housing for the lamps.

(f) An optical train which receives light from the interior white wall of the lamp housing and passes it through the oil and the glasses, so that light from the same source illuminates the two halves of the photometer field, that which illuminates one half having passed through the oil while that which illuminates the other half has passed through the glasses.

(g) A Davis-Gibson filter (Cf. [1] Proceedings of the Seventh International Congress, held in London, July, 1928, pp. 161-173; [2] B. S. Tech. News Bulletin No. 138, pp. 143-144, October, 1928; and (3) J. O. S. A. & R. S. I., *16*, p. 332; May, 1918. Copies enclosed.) designed to convert the light from the lamps into artificial daylight of prescribed quality (spectral distribution).

This instrument has not been used except in our preliminary experiments with it. Only one model has been completed; and we are not in position to send you one.

(2) We have done considerable work on the calibration of the glasses which you sent us; but cannot set a definite date for their return. The red glasses have been compared with our red standards by one observer. We intend to have them compared independently by one or two other observers. Spectral transmission measurements have been made on all of the yellow glasses and 18 red glasses; but these data are not final. We would remind you that we only offered to calibrate twenty *red* glasses for you free of charge (paragraph 7, our letter of January 5, 1928). We find that you have sent us 35 red glasses, 30 yellow glasses and 29 blue glasses. We are expediting the calibration of the red glasses. We have never standardized blue glasses because there has been little or no call for us to do so. Since American interests do not demand it of us, it now seems unlikely that we shall undertake to complete a fundamental standardization of the blue glasses. There would seem to be little or no excuse for our doing so except on your request; and we infer from your several letters that you would deprecate and discourage such standardization rather than request it.

(3) In comment upon your statement, "We would appreciate communications concerning our glasses being sent to us direct rather than seeing them by chance in the press," we submit the following statement:

We have taken care to send you our publications, and trust that you have received them, although they have not always been acknowledged by you. The article to which you now refer (*"Oil and Fat Industries"* p. 27, September, 1929) was not an official publication and we had no convenient means of sending it to you. It was not published on our initiative. The material therein was merely sent to Mr. Putland, President of the American Oil Chemists' Society, as a summary of our findings on 1000 glasses which he had submitted for calibration, these glasses being the property of individual members of the society. Mr. Putland evidently thought (quite properly, we believe) that this summary would be of sufficient interest to the members to justify publication in their journal. We are now preparing the same material for official publication with a more detailed treatment of it; but as to the present publication, we obtained our first knowledge of it in the same manner in which you did, namely by seeing it in print when the journal came in our mail. We never had any extra copies of this publication, and so have not been in position to send you one.

Respectfully,
(Signed) L. J. Briggs, Acting Director,
George K. Burgess, Director.

Enclosures:

Davis & Gibson: "Artificial Sunlight . . . ", 7th Intern. Con. of Phot. Davis & Gibson: JOSA & RSI, *16*, p. 332; May 1928. T. N. B., October, 1928.

Wood Rosin

(*From p. 22*)

only grow through the profitable sales of its products. Among the achievements, the most notable is the production of an oil soluble rosin and the medium and pale grades. Included in the many factors contributing to the successful solution of the problems, particularly those involving some of the physical and chemical properties, there is one which I consider, and I believe I express the consensus of opinion of those in our Industry, has lent invaluable assistance, and that factor is the consumer, for with his close cooperation we have been permitted to enter his plants and make a thorough study of our products under actual operating conditions. In this way, we could correctly determine which property or properties were necessary for his particular conditions, and with this authentic data our Research Department could formulate a logical plan to attack the problem. As a result, we have not only been able to raise the grades of our regular products to their present high standards, but have developed special products for special uses. Through cooperative efforts both the consumer and producer share a mutual benefit and now that pale wood rosins are a reality, may your industry and the wood rosin industry join in this cooperative spirit.