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REPORT ON THE TESTING OF INDIGO ON WOOLLEN AND OTHER MATERIALS.

By PROFESSOR ARTHUR G. GREEN and PROFESSOR WALTER M. GARDNER.

To the Indigo Dye Committee of the Textile Institute.

GENTLEMEN,—

Herewith we beg to present an account of the investigations undertaken at your request for the purpose of establishing improved analytical methods for the testing of indigo-dyed or reputed indigo-dyed woollen and union fabrics. The necessary investigations have proved to be far more difficult and laborious than was at first anticipated, for which reason we have been unable to report to you at an earlier date. The details of the experimental work and the particulars of the analytical processes are contained in the account annexed hereto, and we propose only to summarise here the general conclusions and results to which in our opinion they have led.

As we pointed out in our previous report, the methods of analysis hitherto published afford no reliable means of estimating the quantity of indigo on a cloth in the presence of other dyestuffs, and no method has yet been proposed for determining the quantity of the concomitant dyestuff. In the interests of the textile and dyeing trades, and of the public in general, it is of great importance to be able not only to accurately estimate the quantity of indigo on any given material, but also to be in a position to ascertain what proportion of the total colour depth is due to indigo. It would then be possible to fix trade standards and define within what limits certain designations can be legitimately applied.

The results of our investigation may be summarised as follows:

1. The known methods of analysis have been subjected to critical examination and comparison, and the causes of error and uncertainty ascertained.
2. By means of improvements in the apparatus for extraction and in other details of manipulation, the usual method of estimating indigo by extracting with glacial acetic acid has been perfected and rendered reliable for most purposes, heavy and dense cloths excepted.
3. A new method of analysis, making use of pyridine as the extracting medium has been worked out. This is found to be rapid, convenient of application, and to give accurate results upon

both light and heavy cloths, whilst the results are unaffected by the presence of other dyestuffs. We therefore recommend this method for adoption as the standard method of indigo analysis upon all descriptions of materials.

4. It has been found that the majority of dyestuffs which are employed together with indigo as topping or bottoming colours may be separated from the indigo and left on the fibre more or less unaltered by extracting the indigo either with glacial acetic acid or by dry pyridine under the conditions employed for analysis. Although most dyestuffs are affected (often completely removed) by one or other of these solvents, few are attacked by both. The residual colour, after removal of the indigo, can then be identified qualitatively and its fastness to washing and light investigated, a matter of great importance in enabling a judgment to be formed of the quality of the original shade.

5. In some cases in which the foregoing method of investigating the concomitant dyestuff cannot be employed owing to the latter being stripped both by acetic acid and by pyridine, it has been found possible to leave it more or less unchanged by employing benzaldehyde as the solvent for the indigo. This substance dissolves indigo from the fibre very rapidly, at the same time reacting with it chemically, and in a very large number of cases leaves the concomitant dyestuff more or less unaltered. The method is especially recommended for rapid qualitative investigations.

6. A still more satisfactory method of separating indigo from other dyestuffs, which appears to be capable of general application, has been found in the use of a mixture of cresol with a hydrocarbon solvent. This is especially suitable for employment when the residual dyestuff has to be estimated quantitatively.

7. For the purpose of ascertaining the percentage colour-effect due to indigo when other dyestuffs are present, two methods have been devised, both of which make use of the tintometer for colour measurement. For light and medium shades it is proposed to construct a curve showing the relationship between percentages of indigo (when no other colour is present) and the depth of shade expressed in tintometric units. Given this curve, it would then be possible to ascertain, for the cloth under investigation, how much indigo would have been required to give the depth, if no other dyestuff were used, and to express the actual amount of indigo present as found by analysis, as a ratio of this quantity, which ratio is called the "colour-effect due to indigo." In dealing with light and medium shades, the method appears to be fairly accurate, but is less accurate or unsuitable for heavy shades (over 2.5 per cent indigo).

8. A method of more general applicability for heavy navy blues consists in determining the depth of shade of the residual colour after removing the indigo by extraction with a suitable solvent (glacial acetic acid, dry pyridine, or cresol-mixture), selecting that

which has least effect upon the residual colour. By making use of a curve constructed as described above, the depth of the residual colour can be translated into indigo equivalents, and this, added to the quantity of pure indigo actually present, as determined by analysis, should give the equivalent of the shade in pure indigo; from which the percentage colour-effect due to indigo can be calculated. From the results so far obtained, we believe that this method in practised hands will be found susceptible of satisfactory general employment.

It has been pointed out in the description of the work which follows, that for measuring the "percentage colour-effect due to indigo," it is necessary that each observer should construct his own curve, for this will vary somewhat according to the light employed, the instrument used, the time of the year, and the eyesight of the individual. For the purpose of constructing such curves, a series of standard shades of pure indigo-dyed cloth are required containing accurately determined quantities of indigo. It is recommended that the Textile Institute should prepare for sale a pattern-card containing a series of such standard patterns with the percentage weight of indigo attached.

In conclusion we desire to express our thanks to Dr. L. L. Lloyd and Mr. G. H. Frank, who, with the assistance of Mr. F. L. Barrett and Mr. A. E. Battle, have carried out the experimental part of this investigation. We also wish to recognise the great obligations we are under to Mr. Oliver Marsden, who at much expense and personal sacrifice of time, has supplied the large quantities of specially-dyed material required, given much valuable advice and assistance, and evinced an untiring interest in the work throughout. We are also indebted to Messrs. B. Vickermann and Sons for kindly supplying a series of indigo-dyed serges and of patterns showing the individual colours employed therein.

Signed,

ARTHUR G. GREEN,
WALTER M. GARDNER.