AUTOMATIC COLORIMETER FOR PALM OIL

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Colour is an important indication of product composition, purity and degree of deterioration. It is a quick check on degradation and the suitability and stability of the product for a particular use. In the case of vegetable oils, it is necessary to monitor each stage of the refining process to determine whether the correct colour has been obtained, as each type of oil will have its own 'sell-by' colour specification. Hence, colour measurement is used for quality checks, production control and inspection of final product for conformance to predetermined colour tolerances and compliance with customer specifications.

METHODS OF COLOUR MEASUREMENT

Instrumental techniques are used to measure colour. Basically, there are three different methods to assess colour of liquid samples, namely:

- visual colour matching;
- tristimulus method; and
- spectral method.

VISUAL COLOUR MATCHING

Manually operated visual instruments have held the monopoly on colour measurements for almost a century. Conventional methods of colour measurement are by visual comparative techniques. The product to be measured is compared against reference solutions (*e.g.* iodine, Hazen or Gardner colour standards) or coloured glass (Lovibond method). These methods tend to give poor reproducibility and are not useful for research because the data are subjective and depend on the colour vision and judgement of the observer. Vegetable oil colour is usually measured using the Lovibond® Tintometer and reported as Lovibond units of red and yellow plus blue or neutral if used. This technique involves matching the colour of light transmitted through a specified depth of oil with the colour of light transmitted from the same source through a set of coloured glass slides. Colour reading is thus subjective and depends on the analyst's judgement as well as on the type and model of colorimeter used. The Lovibond glasses consist of a series of filters

The automatic Colorimeter.

whose transmissions do not correspond to the primary colour sensitivities of the eye. The accuracy of visual measurement with the Tintometer is limited by the fact that colour of the matching field can be varied only by the discrete steps of the different glass slides in the series. As expected, the laboratory-to-laboratory variation in Lovibond colour measurement is large. Notwithstanding this limitation, Lovibond colour standards are accepted throughout much of the vegetable oil trade as a proven means of assigning colour values.

Visual methods are not always acceptable to researchers as the measurements are operator dependent. For objective and unbiased assessment, automated colorimeters are needed. These are usually bulky spectrophotometers designed to measure the transmitted colour of optically clear liquids. For obvious reasons, the precision of colour measurements with automatic colorimeters is better than those from manual instruments. However, the global acceptance of visual methods is such that these automatic instruments require correlation with existing visually obtained colour data before they can be used confidently.

TRISTIMULUS METHOD

Colour measurement can be also made in terms of CIE (Commission Internationale de l' Éclairage) which specifies a colour by three quantities - X, Y and Z - called the tristimulus values. These values represent the amounts of the three primary colours - red, green and violet/blue —

that are required for a standard observer to obtain a match. In the tristimulus method, the light beam transmitted through the sample is dispersed into its red, green and blue components after passing through colour filters adapted to the colour sensitivity of the eye. The resulting intensity is measured by photodetectors. The CIELAB L*a*b* is one of the systems which measures colour based on the tristimulus method.

SPECTRAL METHOD

In this method, light is dispersed into its spectral proportions with a concave grid and the transmittance of the sample is measured at intervals of 10 nm. The standard tristimulus values X, Y and Z are then calculated from the chosen standard illuminant, standard spectral functions and the transmittance.

COLOUR SCALES OF THE PALM OIL COLORIMETER

The use of CIE for colour measurements calls for a change in the colour scale for vegetable oils and fats from arbitrary red and yellow units to one of the CIE absolute international units, *e.g.* CIELAB L*a*b*. This may be difficult given the monopoly of the former in colour communication of vegetable oils. The standard use of red, yellow and blue colour measurements of palm oil makes it extremely difficult to replace by better and more accurate colour systems.

The practical advantage in retaining the expression of colour in red and yellow Lovibond units in the development of the automatic colorimeter is that the whole palm oil industry is familiar with the Lovibond unit. Both developed and developing nations in all parts of the world understand the colour language of Lovibond red and yellow units. Retaining the use of the arbitrary Lovibond colour scale will minimize changes in worldwide communication of colour data. Therefore, the units used for measurement of colour using our prototype is also expressed as Lovibond Red and Yellow units.

MEASURING PRINCIPLES

Light emitted by three LEDs (red, green and blue) is passed through a 1 inch glass cell containing the oil sample. The transmitted light is detected by a photodiode. The measured transmitted light intensity is then correlated to the Lovibond colour scale of red and yellow units.

FEATURES

Colour measurement using the colorimeter is simple involving three short steps of inserting the glass cell containing the sample into the sample chamber, pressing a button to initiate the measurement and taking the results in Lovibond Red and Yellow units displayed by the LCD. An exceptionally large number of colour determinations can be carried out in a short time as less than 5 s is required per analysis. Unlike most of the bulky automatic colorimeters marketed currently, the instrument is portable and compact, weighing a mere 1.1 kg.

ADVANTAGES

The colorimeter is specially designed for colour analysis of palm oil according to the Lovibond scale. It replaces the conventional visual grading method with instrumental measurement that is user-friendly, speedy and reproducible. The time and tedium taken to carry out a colour match is reduced while prolonged viewing periods that cause eye fatigue and erroneous results are eliminated. The benefits of automatic reading are tremendous, considering the time saved in a refinery where hourly and even half hourly colour measurements are required as feedback for process control and optimisation.

CONCLUSION

The automatic colorimeter for palm oil colour measurement was developed in response to the need to eliminate subjectivity in visual assessment. It is a more efficient instrument for routine colour measurement and paves the way for the introduction of on-line monitoring of colour to estimate the progress in refining and processing. The instrument also offers a ready and relatively inexpensive solution to the problem of colour matching based on approximations or intelligent guesswork.

SPECIFICATIONS

Light source	:	Super bright red, green and blue LEDs
Detector	:	Silicon photodiode
Display	:	2 x 40-character, LCD
Measurement time	:	< 5 s by a single key press
Colour system	:	Lovibond Red and Yellow units
Repeatability	:	± 0.1 Lovibond Red unit
Dimensions (w x l x h)	:	172 mm x 205 mm x 75 mm
Weight	:	1.1 kg
Sample holder	:	Accepts 1-inch Lovibond cell
Instrument housing	:	High impact polystyrene
Electronics	:	Microcontroller
Power requirements	:	+12 V/1 A power pack

Specifications and design are subject to change without prior notice.

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