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Magazine of photometry and colorimetry

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MINOLTA

CM-3610d and CM-3630: new system generation for paper characteristics

Paper: patience is rewarded

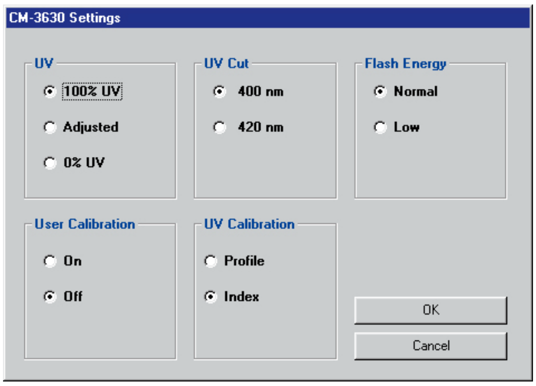
The paper industry has been concerned with the optical aspects of paper practically since the time of Gutenberg. After all, every customer has different requirements when it comes to characteristics such as colour, whiteness, opacity and gloss. Thus maximum opacity prevents the print showing through to the other side of the paper. Or the greater the whiteness, the better the contrast of the print and the reproduction of finest nuances of colour.
The importance of these optical properties is indicated by the fact that they are strictly defined between the paper manufacturers and customers in the form of quality and associated price specifications. So the paper engineer must know what factors influence these parameters during production and must apply appropriate test techniques for quality control.

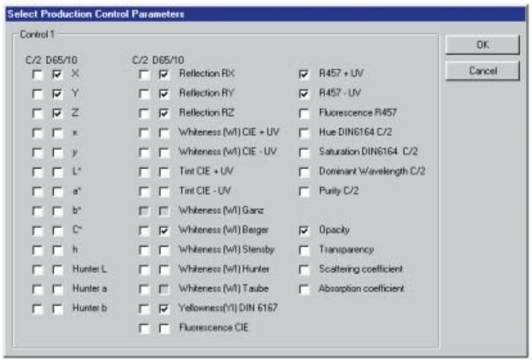
Standards to ISO and DIN

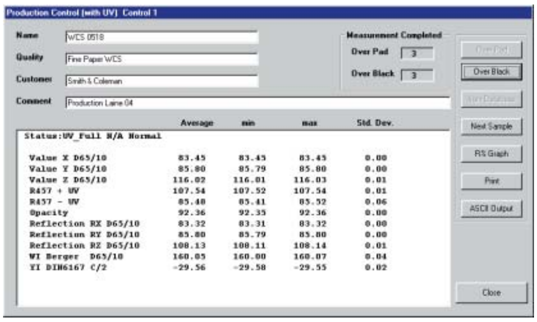
Colorimetric instruments were first used in the cellulose and paper industry in the 1950s, when they were matched to the requirements of paper and cardboard manufacture. At that time, three-filter meters with steady burning lamps were mainly used. A blue edge filter (R457) was used to measure the brightness (whiteness) and a green filter to measure the opacity and reflection (Y). These instruments have now been superseded by powerful spectrophotometers equipped with xenon flashlights and UV calibration units.
In the paper industry, various standards define both the technical requirements on the instruments and the measurement specifications. This includes (in accordance with their importance in Europe) ISO standards 2469 and 2470 as well as DIN standards 53145-1 and 53145-2. Tough demands are made on the agreement between the measuring instruments in order to satisfy the need for exchanging absolute values between manufacturer and customer.

A small difference produces big effects

The two DIN standards permit both d/0° and d/8° instrument geometry (diffuse illumination with observation under 0° or 8°). In contrast, the ISO standards specify the d/0° geometry as mandatory. This small difference can lead to significant effects in practice if different paper surfaces produce different results when measured with different geometries. That is why the ISO standards specify the design of the gloss trap and the size of the measuring aperture (> 30 mm) in addition to the instrument geometry.
In practice, this specification requires coordination between manufacturers and customers in order to exclude misunderstandings due to poor data compatibility. The two new spectrophotometers CM-3610d and CM-3630 from







Minolta satisfy the requirements of ISO and DIN standards with respect to both d/8° (CM-3610d) and d/0° geometry (CM-3630). The customer then has a choice between two instruments both of which form a powerful quality-test system for paper characteristics in conjunction with the PaperControl software.

The MIOS innovative optical system from Minolta

In both models, the user benefits from the exclusive and patented MIOS technology presented for the first time in the CM-3600d model. It includes the numerical UV control (NUVC) which minimises the work involved in UV calibration and measurement of optically brightened specimens, thus bringing enormous handling benefits. Instead of complex mechanical systems which are liable to wear (filters with stepper motors), Minolta uses two xenon flashlights (with and without UV blocking filters respectively) as well as an algorithm to determine the virtual filter position for the required UV emission. The calibration is extremely fast and reliable, either for whiteness to CIE or for the Ganz/Griesser method.

The CM-3610d with its d/8° geometry offers another patented highlight, namely numerical gloss control. Instead of a motor-powered gloss trap, two flashes are used to simultaneously calculate measurements with gloss inclusion (SCI) and gloss exclusion (SCE) in a few seconds. Three alternate apertures of 4, 8 and 25 mm diameter respectively are available for specimens of different size. The CM-3630 operates rigorously to the ISO standard with gloss exclusion and a fixed measuring-aperture size (30 mm). Flashlights capable of more than a million flashes and no mechanical parts guarantee maximum operational reliability and minimum wear. An accessory for measuring opacity is available for both models: a practical specimen holder which allows measurements via white (batch) and black (single sheet) in a simple way.

PaperControl software: routine measurements made simple

The optical characteristics of paper are routinely measured in shifts. This calls for simple operation, matching to the production line, automated wherever possible and with rigorous logging of the measured data. The PaperControl software running under Windows was developed in close cooperation with customers in the paper industry. The user can create various test programs from more than twenty colour systems, white and yellow-level formulas as well as special paper characteristics. This minimises the number of operating steps for production control and maximises convenience. The measured data can be automatically stored or exported to an external process-control system.

Detailed information on these new instruments may be obtained under code number 61.

The optional opacity tool for fast measurements over pad and black.

Step by step to the right

A choice made simple

Selecting the right colour measuring system is critical for the quality of future colour communication. However, the confusing diversity of instruments available on the market makes it much more difficult to make an optimum choice. The following step-by-step procedure simplifies the process.

Initial situation

1. Analyse the working environment in terms of the applicable colorimetry standards and the customer or supplier requirements: define the colour tolerances, test procedures for incoming goods, test methods for subcontractors, colour specifications of the finished products, etc.
2. Assess the current operational situation:
- What methods are used to define colour standards and tolerances?
- How is colorimetric data processed?
- How are the parameters affecting colour transformations determined?
- How are colour-testing methods implemented at each process stage?
- Acquire an understanding of the factors liable to influence colour changes.
- Monitor key factors: consistency of raw materials, pretreatment, laboratory dyeing, production process, subcontracting, finishing.
3. Evaluate the strengths and weaknesses of colour management and determine the cost-reduction potential which can be achieved by more efficient working practice.

Solutions

The best solution offers the closest match between the capabilities of the system and the actual requirements (performance level, precision and operating conditions).

Performance and precision

The requirements on performance and degree of precision depend principally on the application. Typical applications include R&D, the definition of standards and tolerances, colour matching and correction, quality control and incoming tests in the laboratory as well as production or process control.
All these applications can be networked. Thus a new colour recipe can be calculated in the laboratory with a colour matching system, then sent to the production department for quality control and possibly recipe correction before being stored in the customer file with the production statistics. This sequence affects the choice of instruments, as identical reading should be obtained even on different models.

System requirements and properties

- Graphical display
- Colorimetric systems and equations for colour deviation
- Standard illuminants and observer function
- Instrument geometry

- UV emission facility
- Spectral range
- Wavelength interval
- Photometric range
- Size of measuring aperture
- Repeatability
- Inter-instrument agreement

Because different suppliers sometimes use different specification units and methods for testing their instruments, the user is recommended to perform his own tests. The most reliable indicator of inter-instrument agreement is the maximum deviation value on BCRA ceramic tiles.

Rapid advances thanks to new technologies

Digital technology permits innovations and cost savings with no loss in quality, performance, functions or reliability. Minolta's new laboratory spectrophotometers of the CM-3600 series offer the best proof of this: numerical gloss control (simultaneous SCI and SCE readings instead of a mechanically driven gloss trap) and numerical UV control (eliminating time-consuming UV calibration using moving filters operated by stepper motors). All benchtop models from Minolta guarantee identical readings irrespective of the size of the measuring aperture and can be networked with portable models of the CM-500 series.

Operating requirements profile

- What must be checked on the product at each stage?
- Portable or benchtop system?
- Test and sampling procedures or on-line?
- Operator functions and qualification levels?

Analysis of market offers

- Seek a solution which meets all your requirements without compromising.
- Assess the capabilities of the total solution (instruments, accessories, software, service).
- Assess the capabilities of your suppliers with respect to colorimetric quality.

As a leading supplier of optical precision instruments, Minolta offers a wide selection of colorimetric solutions in portable and benchtop models. This broad range ensures optimal matching to specific requirements throughout the entire chain from production process to finished product.

Ten main reasons for choosing a portable spectrophotometer of the CM-500 series

Often copied, never equalled

For many years, the portable spectrophotometers from Minolta have been the accepted reference standard with respect to optical quality and long-operating life. Their uncompromising design ensures optimum compliance to standards and compatibility with laboratory instruments, thus guaranteeing full agreement with the colour communication of your suppliers and customers. The CM-500 series has proved itself thousands of times over in numerous industrial sectors throughout the world.

1. **Genuine spectrophotometer to DIN and ISO standards.**
2. **Illumination with xenon flashlight for high luminous power and thus optimal repeatability, especially for dark colours.**
3. **Reference beam path for maximum repeatability and monitoring of the spectral energy for every reading (lamp degradation has no adverse effects).**
4. **Best absolute accuracy proved by independent tests (e.g. National Physical Laboratory in England).**
5. **Optimum matching to your application thanks to a wide range of models (various measuring geometries and apertures).**
6. **Minimum directional dependence when measuring structured specimens such as embossed plastics or textiles.**
7. **Best internal agreement of readings between instruments of the same type.**
8. **Outstanding agreement between portable and benchtop equipment ensures identical results in laboratory and production applications.**
9. **Always ready to use thanks to battery, accumulator or mains operation as desired.**
10. **In successful use thousands of times around the world – for your application too.**

PS: Fast and competent consulting, training, hotline and maintenance services.

The new luxmeter series T-10

A change of generations

The presentation of the new generation of T-10 luxmeters continues a success story which began in 1981 with the models of the T-1 series. Luxmeters from Minolta have made a name for themselves as high-class, rugged and extremely handy instruments for measuring luminous intensity throughout the world – among architects, engineers as well as manufacturers of lighting installations and lamps.

Among the decisive factors for their success were not only their outstanding price-performance ratio, but above all their multi-functionality, a special T-1M model with a small flexible measuring probe as well as an interesting range of accessories. Customers requirements are continuously increasing, especially as regards the subsequent processing of measured data on the computer. Recent applications include cases where the luminous intensity at several points on large surfaces is of simultaneous interest.

Evolution instead of revolution: the T-10 basic model

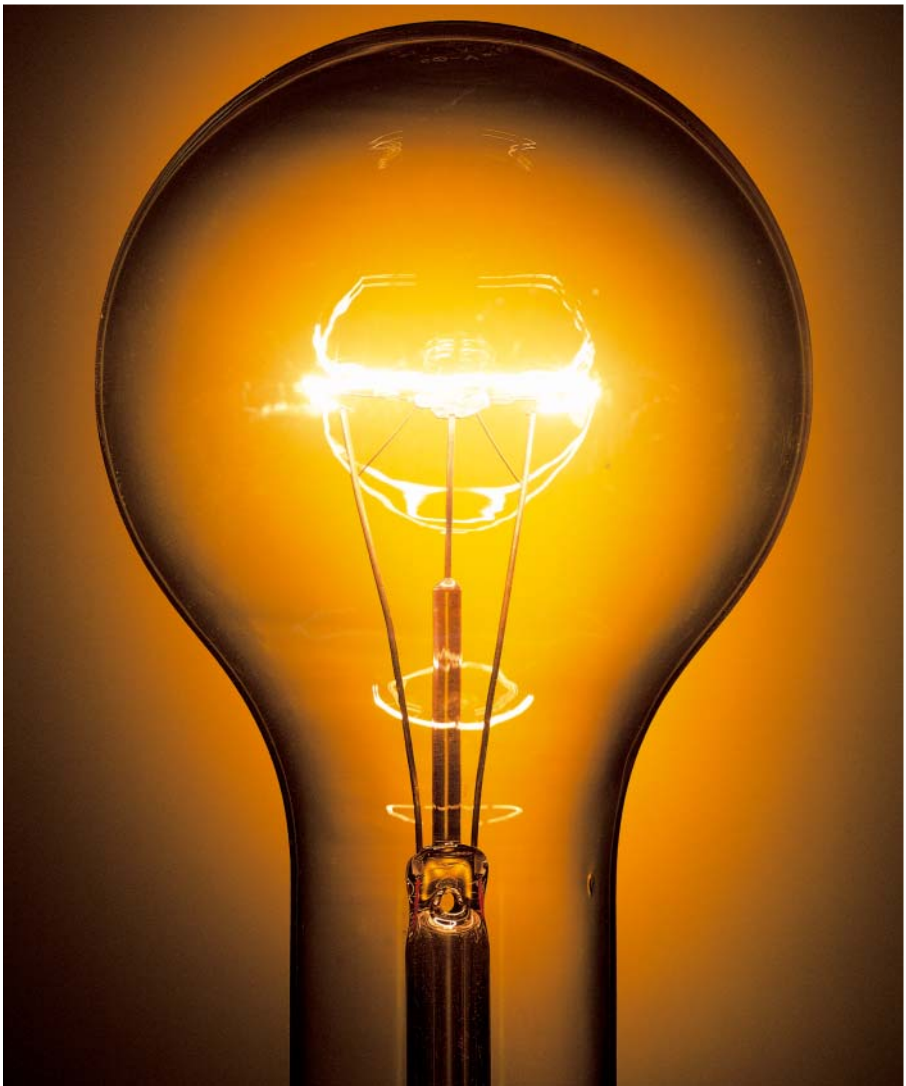
In developing the new generation of instruments, the engineers at Minolta worked according to the motto: evolution instead of revolution. Handiness and simple operation have been retained. The basic functions, namely normal luminous intensity, difference measurements in lux or as a percentage of a stored reference value, and time-integrated luminous intensity in lux-hours, are now assigned to three function keys. Another six function keys for storing reference values as well as for entering colour-correction factors are accommodated under a slider designed to prevent operational errors.

The zero calibration is now performed automatically after the instrument is switched on. The measurement range (0.01–299 900 1x or 0.001–29 990 fcd) was significantly increased thanks to the use of new luminosity compensation filters so that there was no need to develop a successor to the previous T-1H model. Matching the brightness sensitivity curve to CIE as well as the cosine correction satisfy quality class B (to DIN 5032, Part 7) as before. But the T-10 can also be calibrated to other standard light sources via the colour-correction factor.

Faster, more diverse, more sophisticated
All models now have a large LCD display with up to four digits and automatic background illumination with low ambient brightness. Thanks to state-of-the-art microelectronics, the power supply from only two 1.5 V (AA) dry cells allows continuous measurements of up to 72 hours. An AC-Adapter is naturally also available, especially recommended when multiple heads are connected. The previous cables have now been replaced by standard commercial LAN cables (10Base-T) up to 50 meters in length, so that the measuring head can be used separately from the display unit.
The adapters and connection cables available as accessories can be used to connect up to 30 measuring heads together and control them from a single display unit, for example to monitor the homogeneity of illumination in a room. Thanks to the RS-232C interface and the optional T-A30 Windows software, comprehensive data evaluations can be performed with numerous graphical displays such as table or trend graphs. Automatic measurements can also be made at suitably selected intervals. An analog data output is also available for connecting an external line recorder. The measuring-gate time can be changed via a small switch in order to measure intermittent light sources such as fluorescent tubes.

The T-10M models for special applications
The special T-10M model is ideally suited for performing measurements at locations which are difficult to access, such as the interiors of architects' models. It has the same features and functions as the model T-10, but is distinguished by a small measurement head only 14 mm in diameter and a highly flexible cable 1 meter in length. The T-10M also allows several measurement heads to be connected together; models T-10 and T-10M may even be used in conjunction. For stationary external applications under humid climatic conditions or for use in the fishery and aquatic sectors, models T-10Ws and T-10WL are optionally available with watertight measuring probes and cable lengths of 5 or 10 meters.

A detailed brochure on the T-10 series may be obtained under code number 62.



Measuring and controlling colour and brightness in pasta

Colours al dente

Information on the CR-300 series may be obtained under code number 63.

The appearance of food products is of major importance. The food industry is well aware that the eye is also involved in the eating process. So there is intense interest in this phenomenon and new forms and colours are constantly being sought. But the industry also invests considerable sums to ensure that the typical properties of successful products remain constant.
Lovers of Italian pasta prefer the traditional amber-coloured variety. This quality feature is associated principally with carotene, a pigment which is present naturally in cereals (mostly durum wheat grits) and is genetically determined. Special techniques are used to control parameters such as pressure, humidity and temperature as well as the ratio between yellow and brown pigments and enzymatic oxidation reactions. The brightness of the superfine flour depends essentially on the grinding process – thus bran can darken the product.

Colorimetry evaluates the colour of pasta…

Colorimeters such as the Chroma meters of the CR-300 series allow all colour variants to be evaluated simultaneously. These instruments are well suited for analysing durum wheat products as they are equipped with a xenon flashlight which offers a close approximation to the spectral distribution of standard daylight of type D65. The measured data is output in the CIELAB 76 (L*a*b* and L*C*h) colour system.

The colour coordinate L* represents a brightness parameter in the range from black (0) to white (100), whereas the coordinate a* specifies the differences between red and green tones: positive values of a* show the presence of reddish colour components. The coordinate b* describes the differences between the blue and green tones and is thus a direct indicator of a yellow coloration. The b* value shows a close correlation with the quantity of carotene pigments.

…and of the raw materials

Colorimetry may also be applied to raw materials, in this case durum wheat. The b* values measured for the sieved and milled grain are lower than those obtained for the superfine flour but show a close correlation with the latter. Suitable regression equations allow the values for the superfine flour to be determined in advance on the basis of the results obtained for the milled grain.
Colorimetry also allows the durum wheat to be classified quickly and objectively during its processing on the basis of the parameter “colour”. The product can then be stored in qualitatively homogenous batches so that high-quality durum wheat grain is available to the processing industry.

Dr. Daniela Sgrulletta, the author of this article, works at the Experimental Institute for Cereal Culture (Istituto Sperimentale per la Cerealicoltura) in Rome (isc@flashnet.it).

The CM-3800d: state-of-the-art technology for measuring absolute fluorescent colour

A shining example

In recent decades, manufacturers have been confronted with ever faster-changing fashion trends, customer requirements and the fickle taste of the public. Today, fluorescent components play a central role in the development of new colours and special colour effects.
Optical whitening agents are a vital ingredient in the manufacture of white materials or paper. Thus the brightening effect used to enhance the degree of whiteness of shirts results from the absorption of UV light by optical brighteners, which then emit it as visible blue light. This property means that the degree of reflection of fluorescent colours depends on the way the specimen is illuminated. Hitherto, conventional spectrophotometers merely allowed the reflection to be measured as a function of the instrument's light source. As a result, fluorescent

colours usually had to be evaluated visually – a procedure which requires a great deal of expertise and experience, especially in quality control.

An evident need for innovation

Minolta now presents the CM-3800d. This model allows the exact measurement, evaluation and control of fluorescent colours for textiles and other applications such as paper, enamels and paints. The CM-3800d contains a sphere with a diameter of 15.2 cm which permits the specimen to be illuminated diffusely from all sides in an optimal way. The readings then no longer depend on the surface conditions: the CM-3800d supplies measured data with optimum repeatability even for embossed or textured fibres and fabrics. The secondary illumination associated with a d/8° measuring geometry plays no role thanks to a very low ratio of sphere surface to the apertures (0.3%).

Rapid measurement mode

The core feature of the CM-3800d is the double monochromator system. A grating in front of the xenon lamp splits the light from the illumination source up into monochromatic rays (with a pitch of 10 nm) which illuminate the specimen.
The light emitted by the specimen and reflected at the sphere wall is recorded by a polychromatic sensor which calculates the spectral values. Thanks to 38 spectral sensors, the light emitted by the specimen is received simultaneously, thus dramatically reducing the measuring time compared with the conventional method (in which a single sensor evaluates the individual wave ranges in succession). The unique technology of the CM-3800d offers numerous new options: the readings of the fluorescent and non-fluorescent components of a specimen can be output separately, fluorescent colours can be matched and calculated for various light types, reference standards can be established for optically brightened specimens…

Minolta and Nisshinbo

The CM-3800d incorporates quality control software from Nisshinbo, an industry leader with extensive experience in the sectors of textiles, automobiles, paper, chemistry and machines. This strong partnership provides tomorrow's technologies for today's requirements in colour measurement.

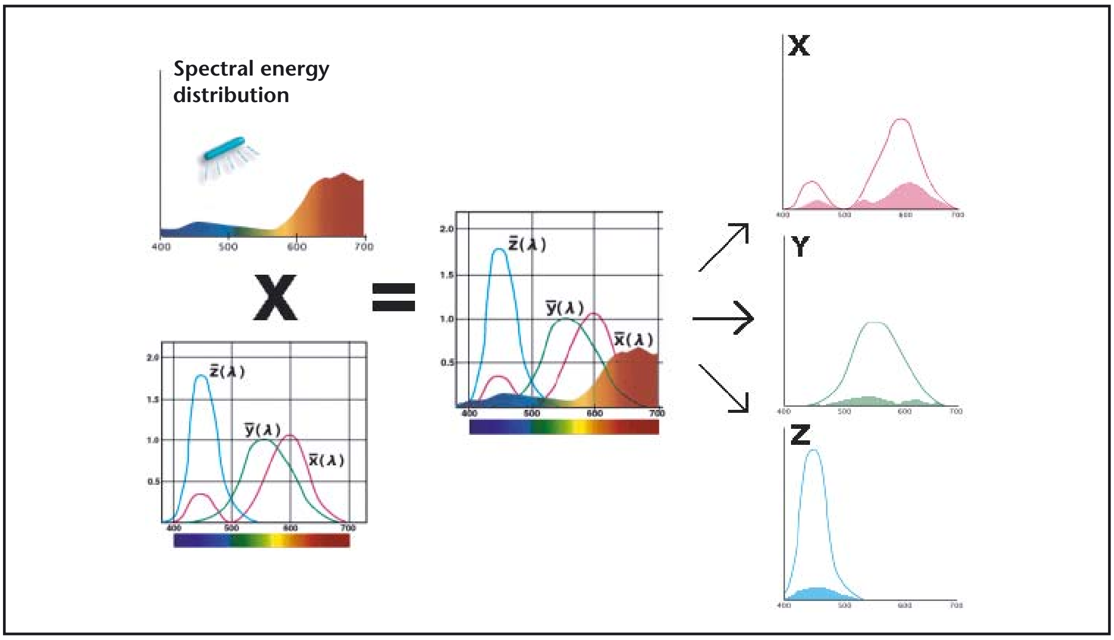
Fluorescent colours: certainly not to be overlooked.

Fine lingerie: a typical application for optical brighteners.

A brochure on the CM-3800d may be obtained under code number 64.

Three-sector colorimeters and spectroradiometers

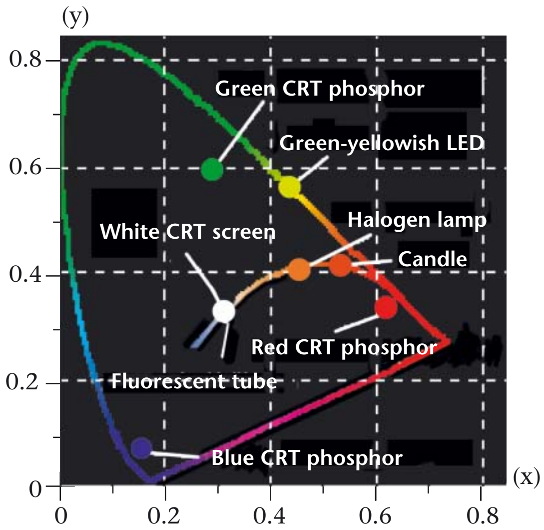
The spectrum of illumination



The principle of colour perception: the integration of the spectral energy distribution of the light source (top left) over the standard colour-mixture curves (bottom left) leads to the standard valences X, Y and Z (right), the basis of every colour space.

High cost-effectiveness thanks to lower power consumption, long service life, minimal heat generation, better matching to daylight – at first sight, fluorescent tubes appear to have nothing but advantages. However, discharge lamps reveal their shortcomings when it comes to measuring the colour of their light: instruments which give perfect readings for classical halogen searchlights suddenly begin to display incorrect values. The reason: incandescent lamps belong to the class of continuous radiation sources, whereas luminescent tubes (and other discharge lamps) are discontinuous.

Luminescent tubes show clear peaks in the visible part of the spectrum. These are known as spectral lines, so that the term «line spectrum» is also used. Although usually superposed by a continuous spectrum, the characteristic lines are still present.



Standard chromaticity diagram for a normal observer with the Planckian locus and the colour locations of several light sources.

Line spectrum or colour temperature

In thermal radiators such as candles, incandescent bulbs or halogen lamps, the light is produced exclusively by the heating of the incandescent filament. This generates a continuous flat spectral-energy distribution. As the name implies, the light colour can be expressed in these cases as a temperature in degrees Kelvin. The colour temperature T is then referred to the temperature of a (standardised) black body which would produce the same light colour. Thus standard light of type D65 has a colour temperature of 6500 K, which corresponds to average daylight and is perceived by the eye as white light. If all the colour locations of the black body are plotted in the chromaticity diagram, the Planckian locus is obtained, going from red via yellow and white to blue. All thermal radiators lie on or close to this curve.

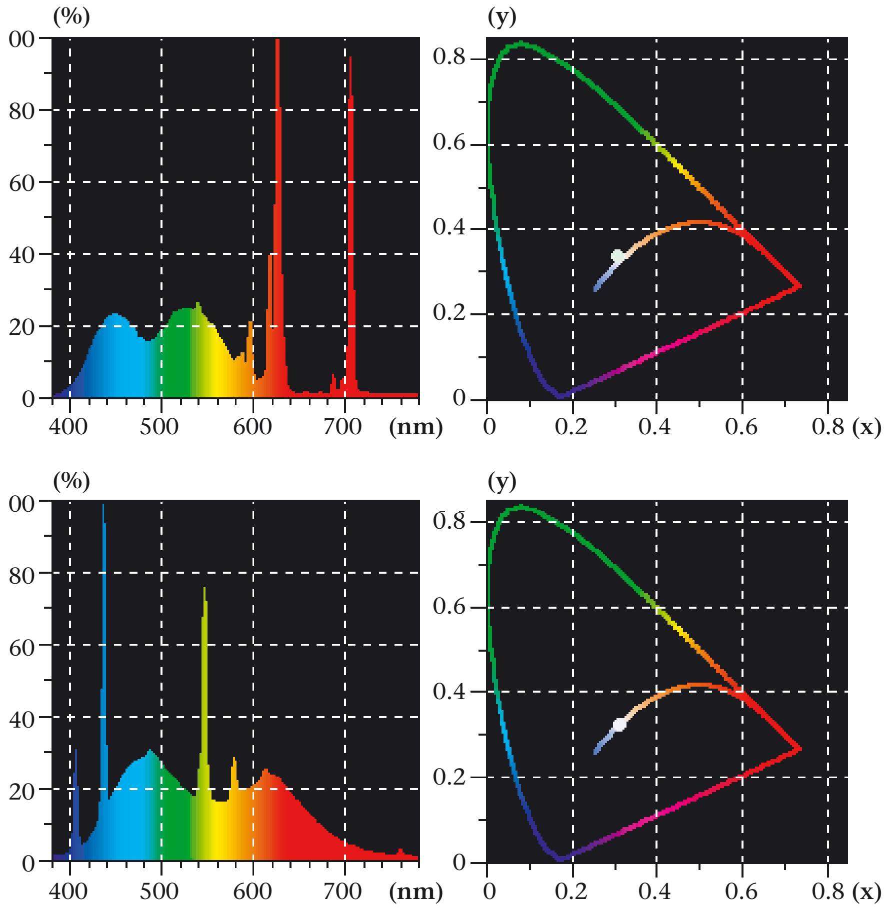
The specification of a colour temperature is meaningful only if the light source lies on or very near to the Planckian locus. It loses its meaning as it becomes further removed from it or as the colour of the light source must be characterised with increasing precision. It is fundamentally pointless to try and characterise a green LED with a colour temperature. However, a colour temperature which lies closest to the colour location is often specified for mixed light. The same applies to the light from many discharge lamps, which represents a mixture of the individual spectral lines and the superposed continuous spectrum. Colour temperatures are particularly inadequate for characterising deviations towards green or purple. In these cases, the x or y values of the colour location as well as the brightness Y (Lv) of the light source must be specified. Advanced meters such as the Chroma meters xy-1, CL-100 or CS-100 from Minolta measure all three characteristic values for a light source in order to determine the colour location.

Three-filter instruments or spectroradiometers?

Instruments designed for measuring the colour light make use of three filters whose spectral sensitivity is matched to the standard colour-mixture curves. These comprise high-quality photodiodes with series-connected filters. The terms «three-filter» or «three-range» meters are therefore also used. The incident light is converted by the photodiodes into signals which directly yield the standard colour values X, Y and Z. However, matching to the standard CIE colour-mixture curves can be achieved only with finite accuracy. Deviations occur in the defined curves and in the sensitivity curves in the measuring instrument. These differences can be neglected as long as the light to be measured exhibits a continuous energy output over the entire spectrum (thermal radiator). However, the error may be significant if steep edges occur in the spectrum or in individual lines (fluorescent tubes). Three-filter instruments are not usually suited to measure discharge lamps, light sources with spectral lines or with narrow spectral energy distributions (LEDs).
In addition to the simple and low-cost spectroradiometers in three-filter technology, other models are also available which measure the spectral energy distribution of the light source as a physical parameter. Thus the CS-1000 from Minolta measures the light with a pitch of 0.9 nm and also records very fine spectral lines. The colour values are determined by calculating the spectral curve with the standard CIE colour-mixture curves.

Calibration of three-filter instruments on discharge lamps

Non-thermal radiators can be measured with precision only by means of the spectral procedure; they are standard equipment in the optical laboratories of the lamp manufacturers.



However, spectroradiometers have disadvantages for the TV and video industry, as they are still significantly larger, heavier and more expensive than three-filter meters.
The Chroma meters xy-1, CL-100 and CS-100 are calibrated at the works to the Minolta standard with respect to standard illuminant A, thus ensuring their celebrated high measurement accuracy for incandescent lamps, halogen searchlights and sunlight. The CL-100 and CS-100 models can also be calibrated to the user's own standard (fluorescent tubes, HMI radiators, etc.). Conversion between the user's and the Minolta standard (standard illuminant A) is possible at any time by switching over the calibration setting. For the user calibration, the lamp's colour coordinates Y_xy must be known. As a rule, the manufacturers of such lamps supply data sheets specifying these values. For the calibration, the colour values of the selected light source are entered into the Chroma meter. The accuracy is usually also sufficient if the calibration cannot be performed under laboratory conditions.

Approximately 6500 Kelvin in both cases and yet completely different: a white monitor and a Biolux daylight fluorescent tube from Osram. The spectral curves are shown on the left, the position of the colour location in the standard chromaticity diagram on the right.

Information on optical meters from Minolta may be obtained under code number 65.

CR-A71 liquid test adapter for the CR-300 Chroma meter

Fast, simple, clean

There are numerous reasons for the world-wide reference status of the Chroma meter from Minolta in the food industry: its simple operation and rugged construction – but above all its broad range of useful accessories. Routine measurements for the quality testing of food can be performed more quickly and simply when less effort is required for preparing the specimens. Thus, cleaning should be as simple as possible, particularly in the case of pasty or liquid specimens.

Minolta has developed the CR-A71 liquid test adapter for this purpose. It is particularly well suited to measuring non-transparent liquids such as milk products, ketchup or un-filtered fruit juices in conjunction with the CR-300 Chroma meter. The measurement head is screwed together tightly with the tube mount. A commercial reagent glass containing the specimen is placed into the tube for measurement so that the specimen never comes into contact with the measuring head. In other words: no cleaning is necessary. Another advantage of the well-matched team comprising the CR-300 and the CR-A71 is the perfect repeatability of the measured data thanks to the fixed position of the measuring head.

International trade fair programme

Where you can meet the experts from Minolta:

8–11	March	KMO	Plastics	Bad Salzuflen/Germany
11–15	April	Anuga Food Tec	Food	Cologne/Germany
11–15	April	Scanplast	Plastics	Gothenburg/Sweden
25–27	April	Asian Paper	Paper	Singapore
25–28	April	Instrurama	Quality Control	Brussels/Belgium
8–12	May	Macropack	Packaging	Utrecht/Netherlands
8–13	May	Plast	Plastics/Rubber	Milan/Italy
16–20	May	Control	Quality Control	Sinsheim/Germany
22–27	May	Achema 2000	Chemical	Frankfurt/Germany
30–3	June	IMB	Confection	Cologne/Germany
19–23	June	NPE	Plastics	Chicago, IL/USA
20–23	June	Instruments, System + Automation	Quality Control	Mines/Malaysia
27–29	June	Zellcheming	Pulp+Paper	Baden-Baden/Germany
25–27	July	Siggraph	Computer Graphics	New Orleans, LA/USA
18–20	September	AATCC	Textiles	Winston-Salem, NC/USA
19–21	September	Eurocoat	Paint/Coatings	Turin/Italy
27–29	September	RETEC	Plastics	TBA

Masthead

Publisher
Minolta (UK) Ltd.
Rooksley Park, Precedent Drive
Milton Keynes, Buckinghamshire
MK13 8HF, England
Phone 01-908 200 400
Fax 01-908 618 662

Minolta Camera Benelux
Branch Office Belgium
Kontichsesteenweg 38
2630 Aartselaar
Belgium
Phone 03-877 24 21
Fax 03-877 13 72

Edited by:
Andreas Ullrich
Minolta (Schweiz) AG

Beat Gloor
text control, Zürich

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MINOLTA

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Publisher
Minolta GmbH
European Headquarter
Kurt-Fischer-Str. 50
D-22923 Ahrensburg
Germany

Phone 0049-4102-701
www.minoltaeurope.com

Your local distributor:

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