To see what you don‘t see

UV LIGHT IS INVISIBLE. • Nonetheless it influences the final appearance of printed products. Therefore it is vital to know the final viewing conditions where the products are meant to be used. As this is rarely possible the printing industry established standardized viewing conditions which are used for the visual appraisal of original and production.

This viewing condition is the simulation of illuminant D50 with a correlated colour temperature of 5003 Kelvin and an illuminance of 2000 lux. The detailed requirements are specified in ISO 3664. In addition to visual appraisal the quality of colour reproduction is also controlled using colour measurement throughout the complete industry. The golden rule is: “Measure as we see”.

The printing industry uses a geometry of 45:0 or 0:45 respectively which reflects the geometry of the visual assessments of the products. Also D50 is used as reference illuminant. The illuminating light source that is used in the colour measurement devices differs from D50. Gas-filled tungsten lamps are used in most instruments. The colour values are calculated for the reference illuminant D50 using the reflection factor.

Strictly speaking this violated the golden rule “Measure as we see”, but using a known white tile for calibrating the instrument allows the system to “neutralize” the readings. This works well for object colours and is known as measurement mode M0 in ISO 13655:2009, which is the relevant ISO standard for measurements in the graphic arts industry.

AND THEN THERE WAS THE “BLUE LIGHT”. For several years the use of brightened papers in the graphic arts industry has increased significantly. Optical brighteners are fluorescing substances.

Fluorescence is the name given to the property of a substance where energy is absorbed in the invisible UV wavelength range but emitted in the visible range of the spectrum. One could say that invisible light is made visible through fluorescence (Fig. 1).

Figure 1: Papers with different amounts of fluorescent whitening agents are emitting visible light caused by UV excitation.

This can be visualized using a Donaldson-matrix (Fig. 2). Every point in this matrix indicates the amount of emitted energy for every wavelength (wavelength shown on x-axis) using a colour scheme from dark blue (= no energy) to bright red (= a lot of energy). The y-axis indicates the absorption wavelength range. For a paper without any brighteners one would see a diagonal line of emission which indicates pure reflective properties. The bright blue area indicates the fluorescence, which is energy that is not emitted at its irradiation wavelength, caused by optical brighteners.

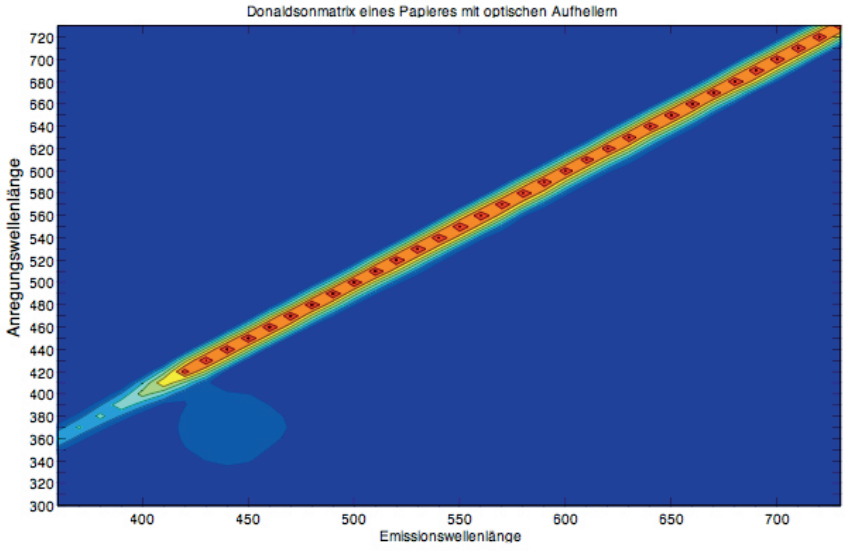

Figure 2: Graphical image of the Donaldsonmatrix of a brightened paper. Consider the bright blue are below the diagonal line. Light energy between 340nm & 380nm (y–axis) is emitted between 420nm & 460nm (x–axis).

This effect varies with the energy which is irradiated at the absorption or activation wavelength of the brightener. It's is dependent on the amount of UV light energy. To put it another way a brightened paper can look yellowish in absence of UV light (Fig. 3. paper on the right).

Figure 3: Papers in a UV-free artificial light environment. The brighteners are not excited. The pure reflective paper shade can be seen.

FROM VISUAL APPRAISAL TO MEASUREMENTS. When conducting colour measurements on papers containing optical brighteners the emission in the visible wavelength range is dependent on the UV energy of the light source used in the measurement device. The golden rule "measure as you see" is violated as soon as the amount of UV energy in the measurement device differs from the amount of UV energy in the desired viewing environment. This leads to problems for the graphic arts industry which has been measuring fluorescing papers for a number of years. The colour values reported by instruments of mode "M0" (undefined UV content in the light source; mostly tungsten is used) do not correlate with the visual appearance very well. This is not only caused by a variation of UV energy in the measurement devices. (Fig. 4).

The relevant ISO standard defining the viewing conditions for visual appraisal in the graphic arts industry ISO 3664 allowed a large deviation regarding the agreement of UV content in the viewing cabinet and illuminant D50. Even cabinets containing no UV energy could conform to the standard.

Figure 4: Papers in a daylight simulator with UV content. The brighteners are excited and cause a change of the paper colour.
Papers with a huge amount of FWAs (3rd from r.t.l.) are „glowing" blueish.

In addition to using undefined UV energy for measurements the industry also used undefined UV content for the visual assessment. The result when assessing samples whose appearance differ with varying UV content has been experienced by the industry for years. A colour match “by the numbers” could lead to a disastrous result in a visual assessment.
A practical problem in today‘s workflows is caused by ISO 12647-7, the relevant standard for proof prints. It contains a criteria which can lead to problems when proofing substrates con–tain fluorescent whitening agents. If an ISO 12647-7 conforming proofing substrate is used for simulating a production stock containing a lot of fluorescing whitening agents, users run into gamut problems on the lightness axis. This is due to the necessity of simulating the blueish paper colour of the production stock by adding an ink layer onto the proofing substrate which also darkens the proof.

SOLUTIONS. In the year 2009 the ISO standard for visual appraisal was revised. The most signifi-cant change was made for the criteria that judges the UV wavelength range. New cabinets have to have a much better agreement when compared to the UV content of D50. As a consequence of the increasing usage of fluorescence in graphical papers the measurement standard ISO 13655:2009 was adapted by defining a measurement mode M1. This mode should ensure a similar excitation of optical brightening agents to D50 and thus allows a colorimetric judgment of papers containing optical brighteners. The derived colour values show a better correlation to the visual assessment in an environment showing a good D50 simulation.

It can be shown that the consideration of the final viewing conditions during colour measurements leads to better visual correlation. If the viewing environment is a good D50-simulation measure-ment mode M1 is the candidate to choose.
Best practices for finding suitable pairs of proofing and production stocks are still missing. Work has already been carried out in some groups and institutes to obtain these.
For viewing conditions that differ from D50 (e.g. POS, trade fairs…) the spectral measurement of the final viewing condition (including UV!) using a light measurement device shows great potential. It enables the objective quality control for the golden rule „measure as we see“ where products are intended to be used with special lighting at the POS in general. When considering the future usage of LED light sources the advantage will increase still further.

SUMMARY. Standard operating procedures for handling different amounts of fluorescent whitening agents in todays graphical papers are still missing and they need to be included into the relevant ISO standards. Viewing conditions and colour measurement are increasingly expected to show better agreement and are, therefore, fundamental to the objective judgment of most colour phenomenons in the graphic arts industry.

Devices for M1

The first M1 devices from Konica Minolta (FD-5 and FD-7) are available. The Konica Minolta FD-7 serves as light measurement device in addition which allows considering the actual viewing condition.

About Konica Minolta Sensing Europe B.V.:

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Our colour management solutions are essential to control and monitor quality in many areas of manufacturing, such as automotive, coatings, plastic, construction materials, food, chemicals and pharmaceutics. In the innovative area of Light & Display technology, Konica Minolta Colour Analysers enjoy an "industry standard" position. Our 3D digitisers are widely used in applications such as medicine, cultural heritage and academic education and research. Konica Minolta Sensing will continue to innovate, utilising the latest high–accuracy sensing technology providing solutions which meet the ever–changing needs in diverse fields.

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