International Color Consortium®

White Paper 14

Level: Intermediate

Summary of CIE Publication 163: 'The effects of fluorescence in the characterization of imaging media'

This reportership was established in April, 2001 at the Division 8 meeting held at the University of Derby, UK. It was chartered with assessing the effects of fluorescent substrates on the colorimetric characterization of imaging media. Of particular concern, at the time, was the development of device profiles from colorimetric measurements and the measurement errors that might be introduced into the instrumental assessment of image colour differences and the colour gamut of digital process printing

The addition of fluorescence to either the inks or the substrate greatly increases the level of uncertainty in instrumental readings of the optical properties of printed images. CIE 76-1988 (CIE, 1988) shows that even research and standards laboratories experience a degradation in their reproducibility of up to one order of magnitude (10x), in the readings of total spectral radiance factor of strongly coloured, fluorescent materials. There are no recent studies of this magnitude or reliability but it is the opinion of this Reporter that the state-of-the-art has significantly advanced in the 15 years since the approval of CIE 76-1988. It is therefore recommended that Division 8 send a request to Division 2 to review CIE 76-1988 and establish a Technical Committee to update the contents of that report.

This report contains results from a study of the measurement of total spectral radiance factor of digital halftone printing over a range of substrates exhibiting various levels of fluorescence. Colorimetric properties were computed for CIE Illuminant D50 when the UV component was included and when the UV component was excluded from the measurement source. The results indicate and quantify that the fluorescence of the substrate can be measured in both solid ink areas and halftone ink area with the effect being far larger in the latter. The magnitude of the CIELAB colour differences indicate that a significant lack of reproducibility may be experienced between two imaging centers who attempt to apply colour management principles to their individual measurements of the same image printed on fluorescent substrates or between two laboratories who attempt to quantify the colour differences between images printed on fluorescent stock and measured using instruments with different sources.

The preliminary reports of CIE TC 1-44 "Practical Daylight Simulators for Colorimetry" have shown that significant variability exists among instruments claiming daylight simulations and an even greater difference between instruments with UV-rich pulsed xenon lamps and those with UV-poor incandescent lamps.

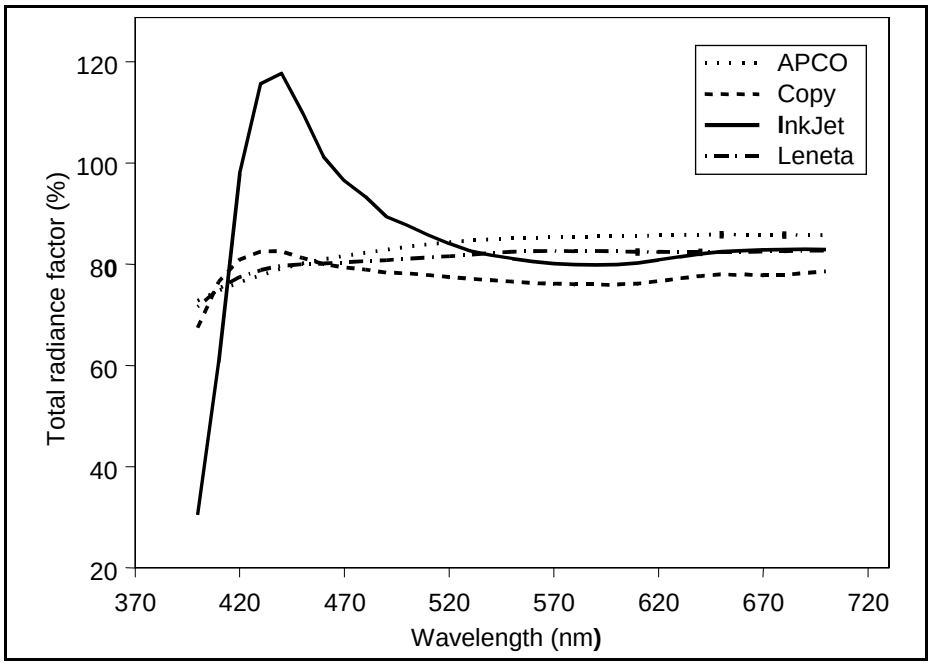

Fig. 1 Total spectral radiance factor of papers used in the study.

Table I – CIELAB Coordinates and Color Differences for Solid (100% coverage) Ink Patches on Experimental Substrates

	UVI			UVX			
	*L**	*a**	*b**	*L**	*a**	*b**	ΔE^*
Inkjet 1 on Copy paper	45,62	49,46	17,90	45,61	49,47	18,09	0,19
Inkjet 1 on Inkjet paper	44,32	55,00	20,22	44,25	54,71	21,50	1,32
Inkjet 2 on Copy paper	40,47	47,90	21,59	40,44	47,87	21,69	0,10
Inkjet 2 on Inkjet paper	41,38	49,87	21,86	41,34	49,72	22,42	0,59
Offset on Apco II/II paper	53,57	64,79	15,71	53,58	64,85	15,76	0,08
Offset on Copy paper	50,20	52,19	16,59	50,19	51,95	16,99	0,46
Offset on Inkjet paper	49,85	55,58	16,37	49,65	54,89	19,59	3,29
Offset on Leneta paper	54,32	62,00	13,42	54,33	62,04	13,57	0,15
Laser on Copy paper	41,26	56,89	23,30	41,25	56,82	23,47	0,18
Laser on Inkjet paper	42,05	59,20	23,41	42,03	59,01	24,31	0,92

These measurements were made with a spectrocolorimeter that has a ultraviolet (UV) rich source and an optional filter than can be inserted between the specimen and the source which removes most of the radiance at wavelengths less than 400nm. The non-fluorescent APCO paper with the very transparent offset ink shows very little difference in the color values between measurements that include the UV radiance (UVI) and the measurements that exclude the UV radiance (UVX). In contrast, the same ink on a highly brightened inkjet paper shows a large color difference.

Table II. CIELAB Colour Differences (UVX-UVI) for Inkjet Paper and Halftone Ink Patches from an Inkjet Printer.

Halftone (%)	Cyan	Magenta	Yellow	Black
5	12,15	12,30	12,05	11,20
10	11,87	12,10	11,41	9,69
15	11,55	11,82	10,86	8,35
20	11,14	11,63	10,37	6,85
30	10,59	10,82	9,22	4,36
40	9,73	10,03	7,73	4,05
55	8,02	8,41	5,74	5,96
75	6,18	6,20	3,49	4,77
100	4,84	4,64	3,08	0,64

The data here show how the magnitude of the color difference increases with the amount of exposed substrate in the measurement port. This error will propagate through into profiles based on sets of halftone combinations, such as an IT8 or ECI target.

The report makes several recommendations. This report shows that varying levels of UV content in the instrument source can have a dramatic effect on the colour measurement of inks over that substrate. As a result of this effect, two strong recommendations and three milder recommendations are made by this reporter.

The main recommendations are to have Division 8 request that Division 2 repeat its earlier study on the assessment of fluorescence and to have Division 8 issue a warning to the digital imaging and graphic arts communities that colour measurements of materials containing fluorescent dyes and pigments will not exhibit the level of reproducibility and accuracy reported in the technical, trade and manufacturer's literature.