International Journal of Scientific Research in Science and Technology
Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)
doi : https://doi.org/10.32628/IJSRST229544

Effect of Ink Transfer on Color Values in Lithographic Printing

Tran Thi Thu Trang, Luu Bach Hiep, Hoang Thi Kieu Nguyen
School of Chemical Engineering, Hanoi University of Science and Technology, Hanoi, Vietnam
Nguyen.hoangthikieu@hust.edu.vn

Article Info
Volume 9, Issue 5
Page Number : 235-239
Publication Issue
September-October-2022
Article History
Accepted : 10 Sep 2022
Published : 25 Sep 2022

ABSTRACT

The effect of ink transfer on color parameters of primary and secondary solid inks was investigated for a commercial lithographic printing system. The ink transfer is evaluated through color density values and ink trapping factors. The results indicate that the targeted color values can be obtained by density control. The standard color values according to the ISO 12647-2:2013 are set up in relation to the ink densities.

Keywords : Lithographic Printing, Ink Trapping, Ink Density, ISO 12647-2

I. INTRODUCTION

In the process of multi-color offset printing, a paste ink of a given color – yellow, magenta, cyan, and black (CMYK) is transferred from the ink fountain through the series of inking rollers, the image areas of the plate (image carrier), the blanket, and to the paper. This ink transfer determines the dot size, ink trap, and ink film thickness, primarily in tonal and color variations. Density measurements of solid ink CMYK patches are used to monitor the ink film thickness applied during a press run. The ink density values influence dot gain, print contrast, and apparent trap [1, 2].

Ink trapping is defined as the amount of the second ink transferred on top of the first ink during the multi-color printing process [3]. In the printing process of pasty inks, such as lithography, the upper ink layers are never trapped with the whole layer thickness compared to printed directly on paper. Hence, the ink trapping is evaluated or measured in terms of percentage. A high percentage is "good" because it gives the desired color. A low percentage, which gives uneven or off-color, is "poor". A poor percentage narrows the printable color gamut and may cause image problems [4].

In multi-color lithographic printing with CMYK inks, the CMYK ink densities must be in balance. If ink densities are not in harmony, the color (hue) of the Red, Green and Blue (two color overprints) will shift. This balance depends on both ink film thickness and ink trapping. Therefore, monitoring solid ink density during a press run is essential when comparing any printed material in terms of quality [1]. However, in almost standards, the colors of solids are standardized by CIELab values, for example, ISO 12647 [5]. A matching ISO 12647 solid color can be archived with very different densities that induce different dot gain curves. Therefore, the standard color values should be connected to color densities in

every printing process.

In our study, the effect of ink transfer on the color values of printed images was investigated. A relationship between ink densities and CIE Lab values of solid colors according to ISO 124647-2 was established for a commercial offset printer.

II. METHODS AND MATERIAL

A. Experiment

The experiment was carried out in CTP workflow. The test form (Fig. 1) was output by using AM technology with a resolution of 175lpi. Heidelberg SM 74-2 colors printing machine, as shown in Fig. 2

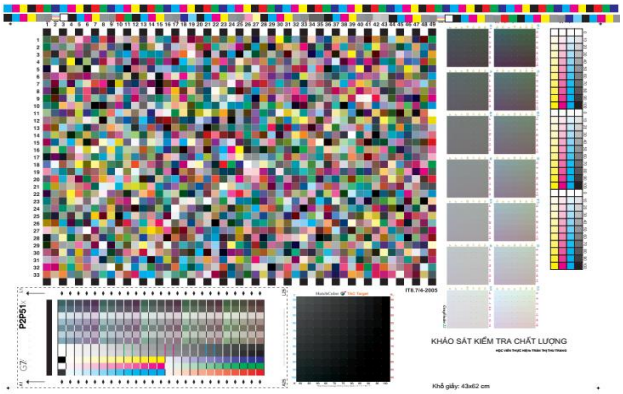


Figure 1: The CMYK test target

Figure 2: Offset printing machine SM74 – 2012

Offset printing Nippon speed (Cyan - C, Magenta - M, Yellow – Y) inks and Coated paper 100 g/m² were used. The printing process was carried out with the ink sequence Black - Cyan – Magenta – Yellow and a speed of 10.000 sph. The variation in the average and range solid ink density values (CMYK) of the printed sheets during the printing process was less than 0.1.

B. Density and ink trapping measurement

The ink trapping was calculated between the density of the first and second color sequence and the trapping of overlap two colors in wet-on-wet ink transfer as the formulas of Preucil [6]

$$FA(\%) = \frac{D_{12}-D_1}{D_2} \qquad (1)$$

Here, D_1 is the solid tone density of the first-down ink, D_2 is the solid tone density of the second-down ink, and D_{12} is the density of the overprint solid.

The dry densities are measured by an X_Rite SpectroDensitometer 504, Inc.Grandville, MI

C. CIE Lab value and color difference measurement

The color values were quantified numerically by the CIE LAB color model. The CIE Lab values were calculated by an X_Rite SpectroDensitometer 504, Inc.Grandville, MI. In the CIELAB color model, two colors can be compared and differentiated. These color differences are expressed as ΔE_{00} (Delta E or Difference in Color Sensation). The following equation is used to calculate the ΔE_{00}[7]

III.RESULTS AND DISCUSSION

A. Effect of ink layer thickness

The values of optical density of the full-tone area are listed in Table I. The optical density is proportional to the ink layer thickness. Thicker ink layers have higher values of optical density. The effect of ink densities (C, M, Y, K) on its color values is reported in Table I and Fig. 3.

TABLE I

COLOR VALUES (CMYK) OF THE PRINTS COMPARED TO THE STANDARD

Sample	Dc	L	a	b	ΔE_{00}
1	1.52	44.58	-35.75	-29.60	3.65
2	1.50	46.08	-36.09	-29.74	2.37

3	1.49	46.20	-36.07	-29.97	2.23
4	1.46	47.30	-35.59	-29.23	1.46
5	1.42	47.34	-36.26	-28.87	1.77
6	1.40	47.68	-36.29	-27.74	2.07
Sample	Dm	L	a	b	ΔE_{00}
1	1.49	40.12	60.65	0.40	2.32
2	1.46	40.88	62.82	-0.62	2.85
3	1.40	41.32	61.46	-0.08	2.64
4	1.38	42.28	59.71	-0.09	2.91
5	1.35	42.55	61.11	-0.35	3.02
6	1.32	43.13	59.95	-2.82	4.45
Sample	Dy	L	a	b	ΔE_{00}
1	1.18	75.94	-7.40	77.56	2.51
2	1.13	77.71	-7.31	80.23	1.75
3	1.10	78.25	-5.83	76.21	2.55
4	1.09	78.13	-6.23	75.33	2.73
5	1.04	78.56	-6.12	74.39	3.02
6	1.01	79.20	-6.51	73.05	3.50
Sample	Dk	L	a	b	ΔE_{00}
1	1.76	13.81	-0.37	8.67	4.76
2	1.75	13.92	2.39	1.41	2.86
3	1.74	13.96	1.28	5.89	3.01
4	1.73	14.36	0.59	7.47	3.96
5	1.72	14.68	-0.35	9.71	5.50
6	1.70	17.06	-0.40	9.79	5.90

The obtained results show that the investigated ink densities seem to have a limitation where the saturation is almost unchanged. However, there is a slight shift in the hue. With Cyan ink, the hue angle shifts about 3° toward Blue as density increases. The same shift is observed with M ink towards Red. However, for yellow and black, the hue changes caused by density increase are significantly more, about 10°.

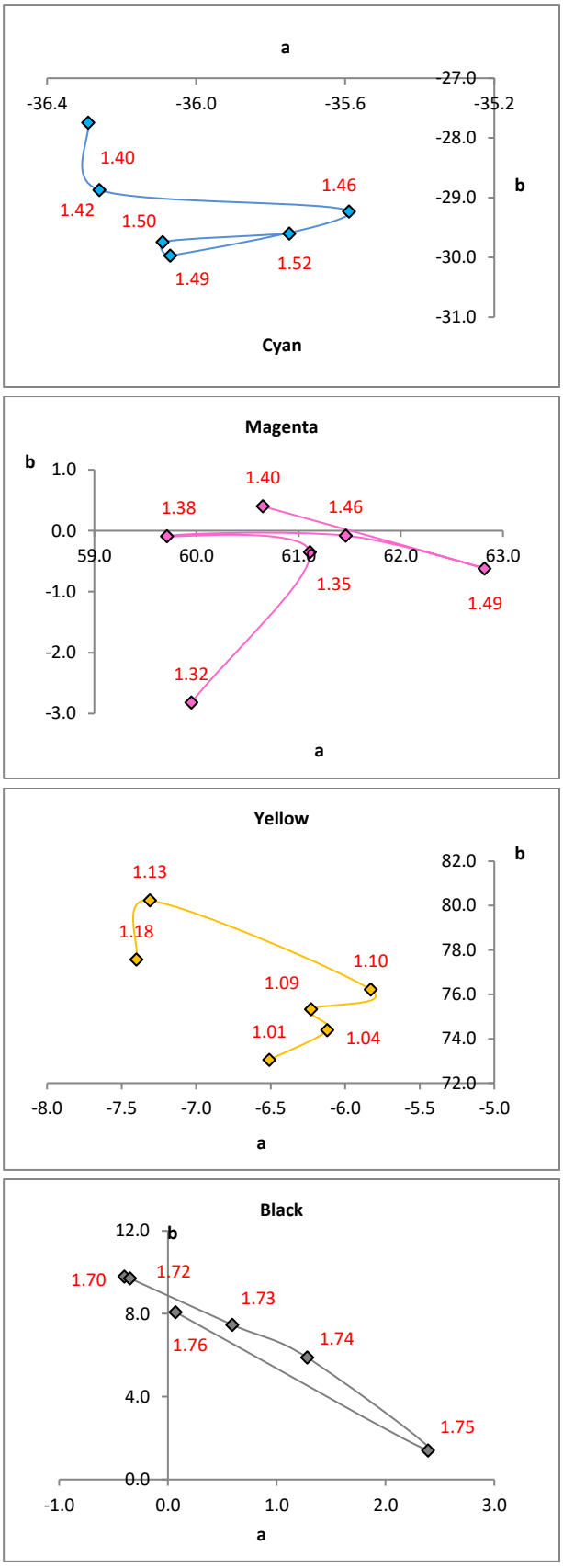


Figure 3: CIE Lab values of CMYK inks with various densities (red number)

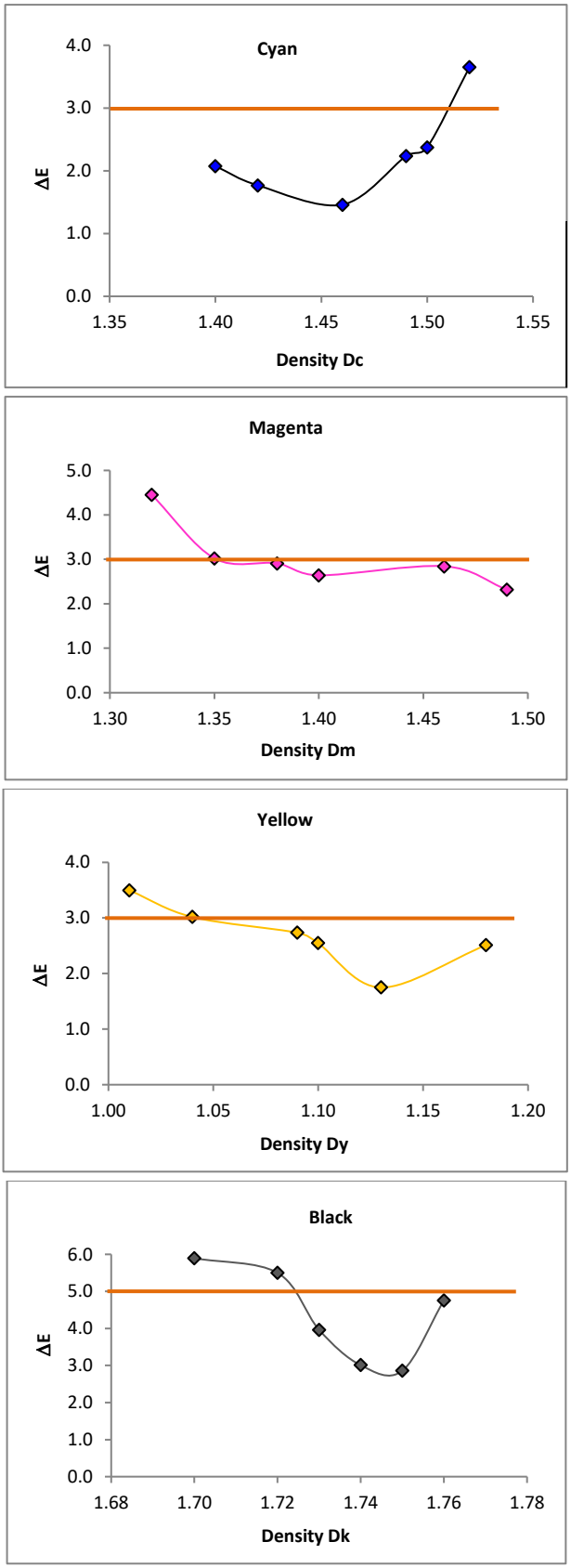


Figure 4: Color difference in solid colors of the print and ISO standard 12647-2 as a function of ink density

Color (CMYK) differences of the printed CIELab values vs. ISO 12647-2 standard CIELab values [5] are reported at various CMYK densities in Table I and Fig.4.

The density ranges corresponding to the standard color values ($\Delta E_{00} \leq 3.0$) are 1.40 – 1.51, 1.37 - 1.49, 1.07 – 1.13, 1.73 – 1.76 for C, M, Y, K ink, respectively.

B. Effect of ink trapping

In this series of experiments, the ink trapping coefficients of C-M, M-Y, and C-Y overprints were investigated at the wet-on-dry trapping processes. The calculated ink trapping coefficents are reported in Table II.

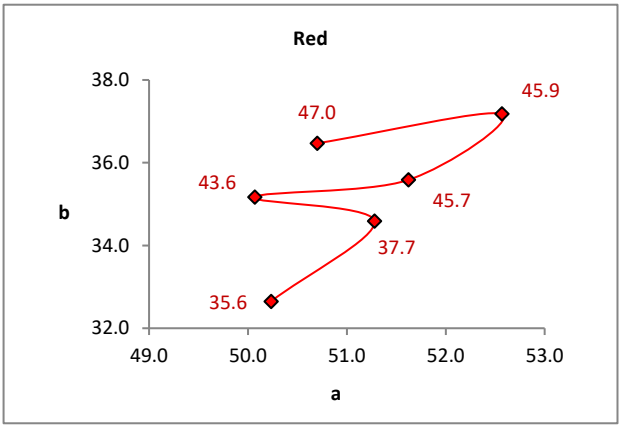
TABLE III

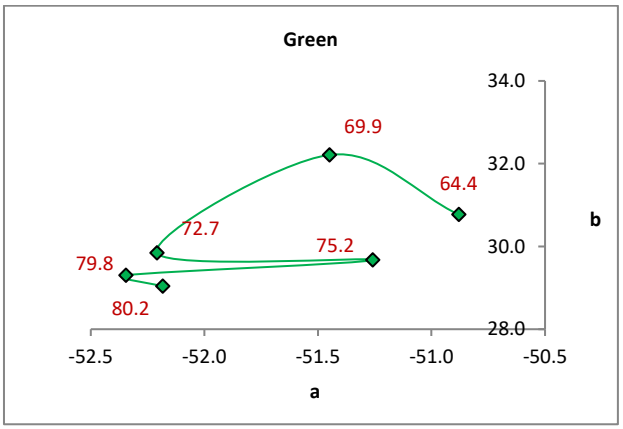
INK TRAPPING FA(%) OF TWO INK OVERPRINTS

Sample	D_1	D_2	D_{12}	FA(%)
C-M overprint				
1	0.64	1.49	1.38	49.66
2	0.61	1.46	1.40	54.11
3	0.61	1.40	1.41	57.14
4	0.59	1.38	1.47	63.77
5	0.59	1.35	1.52	68.89
6	0.59	1.32	1.51	69.70
C-Y overprint				
1	0.51	1.18	1.27	64.41
2	0.48	1.13	1.27	69.91
3	0.48	1.10	1.28	72.73
4	0.47	1.09	1.29	75.23
5	0.47	1.04	1.30	79.81
6	0.48	1.01	1.29	80.20
M-Y overprint				
1	0.97	1.50	1.20	35.57
2	0.95	1.5	1.21	37.67
3	0.92	1.53	1.21	43.57
4	0.91	1.54	1.21	45.65
5	0.91	1.53	1.21	45.93
6e	0.87	1.50	1.21	47.73

The results show that the ink trapping coefficient depends significantly on the thickness of the first-down ink layer. In all investigated inks, the ink trapping coefficient increases gradually from sample 1 to sample 6 with decreasing color density of the fist-down ink solids. The result is attributed to the fact that the thicker the previous ink layer, the longer it takes to dry, and the harder it is to transfer the overprinting ink.

With the high ink trapping coefficient, the high amount of ink transfer causes the hue of overprint colors to shift towards the tint of the second color (Fig. 5). However, a suitable range of values allows the overlapping color to be achieved according to the standard specified in Table III with $\Delta E_{00} \leq 4.2$.





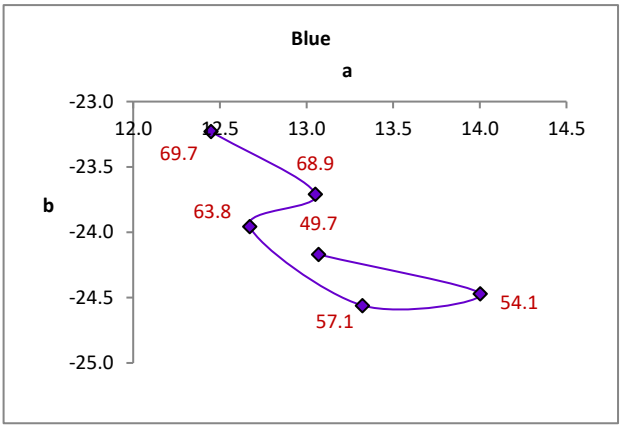


Figure 5: CIE Lab values of RGB overprints with various ink trapping coefficients (red number)

TABLE IIIII
COLOR VALUES (RGB) OF THE PRINTS COMPARED TO THE STANDARD

Sample	FA (B)	L	a	b	ΔE_{00}
1	49.66	20.19	13.07	-24.17	3.48
2	54.11	21.26	14.00	-24.47	3.44
3	57.14	21.55	13.32	-24.56	3.20
4	63.77	22.58	12.67	-23.96	3.54
5	68.89	22.74	13.05	-23.71	3.79
6	69.70	23.21	12.45	-23.23	4.05
Sample	FA (G)	L	a	b	ΔE_{00}
1	64.41	41.42	-50.88	30.77	3.16
2	69.91	43.81	-51.45	32.21	3.19
3	72.73	44.23	-52.21	29.85	2.51
4	75.23	45.21	-51.26	29.68	3.26
5	79.81	45.50	-52.35	29.30	3.16
6	80.20	46.20	-52.18	29.04	3.69
Sample	FA (R)	L	a	b	ΔE_{00}
1	35.57	39.04	50.70	36.47	2.94
2	37.67	40.71	52.57	37.17	2.64

3	43.57	41.43	51.62	35.58	3.42
4	45.65	42.33	50.07	35.17	3.90
5	45.93	42.83	51.28	34.59	4.39
6	47.73	43.77	50.23	32.65	5.55

IV. CONCLUSION

The effects of ink film thickness and ink trapping on the color values of solid color were investigated for a commercial lithographic printing system. The results indicate that these factors significantly influence the hue of printed image color. The CIE Lab values of the ISO 12647-2 standard can be controlled by ink density in the printing room.

V. REFERENCES

[1]. H. Naik Dharavath. Analysis of Newsprint Color Reproduction within the Newspaper Association of America Solid Ink Density and Color Gamut Standards, Journal of Industrial Technology, 2006, 22(4)

[2]. Dogan Tutak , Huseyin N. Beytut, Arif Ozcan, Investigation of the effects of different ink density values on color gamut in offset printing, Journal of Graphic Engineering and Design, 2018,6

[3]. Robert Chung and Fred Hsu. Test Targets, Rochester Institute of technology, 2008

[4]. S. D. Warren company, Wet ink trapping, Bulletin 4, 1998

[5]. International standard ISO 12647-2:2013

[6]. Bernd Th. Grande, Ink trapping in offset printing, 2012

[7]. Gaurav Sharma, Wencheng Wu, Edul N. Dalal, The CIEDE2000 Color-Difference Formula: Implementation Notes, Supplementary Test Data, and Mathematical Observations, COLOR research and application, 2005, 30(1)

Cite this article as :

Tran Thi Thu Trang, Luu Bach Hiep, Hoang Thi Kieu Nguyen, "Effect of Ink Transfer on Color Values in Lithographic Printing", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 9 Issue 5, pp. 235-239, September-October 2022. Available at doi : https://doi.org/10.32628/IJSRST229544

Journal URL : https://ijsrst.com/IJSRST229544