



COMPARATIVE ANALYSIS OF PRINT QUALITY ON SILVER COATED SUBSTRATE USING TONER BASED AND LIQUID BASED DIGITAL PRINTING

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Abstract

Printing is the technical reproduction technology in which Printing ink is applied or filled-up on the printing substrates and information is transmitted in repeatable form as per the image carrying medium. digital is the fastest growing processes in the field of printing and packaging. The current era of the printing and packaging industries is demanding very rapid production and better-quality production. digital printing fulfills all these demands in the printing and packaging industrial segment. Study of digital in the form of print quality comparison is essential for printing and packaging. For better production as per the product quality needs of industries, study of the print quality parameters is also essential. This research project deals with the study of the print quality parameters and printing processes such as digital Dry toner and Digital liquid toner.

Keywords: Printing technology, print quality, $L^*a^*b^*$ values, and tonal value increases.

I. Introduction

The technique of replicating digitally based images or documents directly onto different substrates while utilizing inkjet or laser printing technology is referred to as digital printing. Digital printing, as opposed to conventional printing techniques, which require creation of physical printing plates or screens, enables on-demand, high-quality, and customizable printing without the need for protracted setup times. Digital printing involves less press setup and has built-in multicolor registration. This gets rid of a lot of the front-end laborious procedures, enabling quick responses and just-in-time print delivery. One benefit of Digital printing is speed. There are consequently high expectations placed on each link in the production and distribution chain, as well as interactions between papers and different digital printing technologies.[1]The printing and packaging industries widely usedigital printing processes. The printing and packaging industries generally use silver film sheets for their attractive look and special security purposes. The Dry and Liquid Digital machines can both print on silver substrate substrates. But the silver film is laminated with the paperboard for the base.

Print Quality: A color's $L^* a^* b^*$ & TVI values are critical in determining its quality and standard. The lab values help to measure the colour equivalent or similarity in color. The lab values can be determined through the spectrophotometer. The colour lab values help to measure the difference between two adjacent colors. The lab values are essential for the formulation of the delta E. The delta E represents full colour analysis of the colorimetric values. In this research, the lab values and Tonal value increase are measured for the Dry and liquid toner digital processes. The comparison between the Dry and liquid toner digital processes with respect to the lab values and Tonal Values is discussed in this research work.

$L^* a^* b^*$ Values

Colour science and digital imaging employ the colour space model known as LAB^* values, also called CIELAB values. A color's lightness (L^*) and position on the a^* and b^* colour axes are both used to define it.[2]

The L^* value, which ranges from 0 to 100, describes how bright a colour is. Absolute black is represented by a value of 0, and absolute white by a number of 100. Higher values go towards white on the vertical L^* axis, while lower values move towards black.



The color's location on the red-green and yellow-blue colour axes, respectively, is determined by its a^* and b^* values. The a^* axis's values on a scale from -128 to 127 indicate how green or red the sample is, respectively. Additionally, the b^* axis spans from -128.

Tonal Value: The variety of tones or tints in a picture, piece of art, or visual composition is referred to as its tonal values. When we speak of increasing tonal values, we are referring to the image's general range of dark and bright tones, which results in more contrast and a larger range of shades. [3] Enhancing highlights and shadows, altering brightness and contrast, playing with exposure settings, and other methods can all be used to increase tonal values. An image can appear more dynamic and visually arresting, with a higher sense of depth and dimension, by enhancing tonal values.

Silver Substrate: A new material that has attracted a lot of attention in the printing and packaging industries is silver film printable substrate. It is a well-liked option for numerous applications because it provides a distinctive blend of aesthetic appeal, adaptability, and functionality.[4] This substrate has a distinctive and striking aesthetic due to its shiny silver appearance. The silver film printable substrate is made to work with a variety of printing techniques, including both digital and traditional printing techniques. Its smooth surface enables great ink adhesion, producing prints with superb colour and resolution. As a result, it can be used to create images, labels, packaging, and other marketing materials that are visually appealing.[5]

II. Research Objective

The two primary goals of this study project are described below:

- The analysis of Dry toner & liquid toner Digital print $L^* a^* b^*$ values.
- A review of digital print Tonal values increase for dry toner and liquid Digital.

III. Research Methodology

To accomplish the above-mentioned objectives, we start by taking 100 sheets of the silver film substrate which is gummed or laminated with paperboard for base. Then we print 50 sheets with the Dry toner Digital printing and 50 with Liquid ink based digital printing for comparison between the Dry toner and liquid toner Digital printing. With the use of graphic software, a master chart was created and printed in high resolution using a digital device. The master chart was sent to the Dry and liquid toner digital printing machine system and prepared the CMYK colors prints. The spectrophotometer was used to examine both prints, and lab results were recorded. In accordance with the requirements of the research project, the lab values were recorded and studied.

IV. Data Collection and Analysis

L* a* b* Values

The average, maximum & minimum L* a* b* Values for the substrate, cyan, magenta & yellow color printed by both Dry and liquid Digital printing is given as:

Comparison between Dry toner and liquid toner digital substrate, cyan, magenta, yellow and black color Lab values										
		<i>Dry</i>	<i>Liquid</i>	<i>Dry-Liquid</i>	<i>Dry</i>	<i>Liquid</i>	<i>Dry-Liquid</i>	<i>Dry</i>	<i>Liquid</i>	<i>Dry-Liquid</i>
		l*	l*	D-L	a*	a*	D-L	b*	b*	D-L
SUBSTRATE	Average	87.615	86.3144	1.3	-1.457	-1.73	0.27	-0.69	-2.74	2.05
	Maximum	88.88	87.65	1.23	-1.35	-1.66	0.31	-0.18	-2.4	2.22
	Minimum	87.04	84.89	2.14	-1.58	-1.95	0.37	-0.97	-3.04	2.05
CYAN	Average	43.4271	62.59	-19.16	-29.12	-19.08	10.04	-50.164	-29.685	-20.47
	Maximum	50.84	63.83	-12.99	-26.113	-18.15	-7.96	-43.97	-28.91	-15.06
	Minimum	41.29	60.75	-19.46	-34.96	-19.61	15.35	-52.12	-30.51	-21.61
MAGENTA	Average	42.12	47.98	-5.86	69.31	63.1	6.21	-1.897	-6.69	4.793
	Maximum	44.99	48.98	-3.99	71.06	63.865	7.19	0.333	-6.038	6.371
	Minimum	40.69	46.81	-6.12	66.05	62.058	3.99	-4.099	-7.12	3.021
YELLOW	Average	82.56	81.71	0.85	-8.66	-9.58	0.92	91.41	68.03	23.38
	Maximum	83.6	82.83	0.77	-6.68	-9.17	2.49	94.76	70.864	23.896
	Minimum	81.49	80.1	1.39	-9.28	-9.99	0.71	82.73	65.855	16.875
BLACK	Average	13.19	26.73	-13.54	-0.3	0.819	1.119	-1.115	0.33	-1.445
	Maximum	23.32	28.55	-5.23	0.49	1.584	-1.09	-0.01	0.915	-0.925
	Minimum	0.116	24.78	24.664	-1.04	0.2506	-1.29	-3.06	-0.258	-2.8



Comparative analysis between the Dry and Liquid digital print $L^*a^*b^*$ values of the cyan, magenta, yellow and black colors:

The Average, maximum and minimum difference between the longitude or lightness or darkness of the substrate was recorded as 1.3, 1.23 & 2.14 respectively. The Average, maximum and minimum difference between the longitude latitude or Red/Green Value of the substrate was found 0.27, 0.31 & 0.37. The Average, maximum and minimum difference between the altitude or Blue/Yellow Value of the substrate was inspected or recorded as 2.05, 2.22, 2.05.

The Average, maximum and minimum difference between the longitude or lightness or darkness of the cyan color was recorded as -19.16, -12.99, -19.46 respectively. The Average, maximum and minimum difference between the longitude latitude or Red/Green Value of the Cyan color was found -10.04, -7.06, -15.35. The Average, maximum and minimum difference between the altitude or Blue/Yellow Value of the cyan color was inspected or recorded as -20.47, -15.06, -21.61.

The Average, maximum and minimum difference between the longitude or lightness or darkness of the magenta color was recorded as -5.86, -3.99, -6.12 respectively. The Average, maximum and minimum difference between the longitude latitude or Red/Green Value of the magenta color was found 6.21, 7.19, 3.99. The Average, maximum and minimum difference between the altitude or Blue/Yellow Value of the magenta color was inspected or recorded as 4.793, 6.371, 3.021.

The Average, maximum and minimum difference between the longitude or lightness or darkness of the yellow color was recorded as 0.85, 0.77, 1.39 respectively. The Average, maximum and minimum difference between the longitude latitude or Red/Green Value of the yellow color was found 0.92, 2.49, 0.71. The Average, maximum and minimum difference between the altitude or Blue/Yellow Value of the yellow color was inspected or recorded as 23.38, 23.89, 16.875.

The Average, maximum and minimum difference between the longitude or lightness or darkness of the Black color was recorded as -13.54, -5.23, -24.66 respectively. The Average, maximum and minimum difference between the longitude latitude or Red/Green Value of the Black color was found -1.11, -1.09, -1.29. The Average, maximum and minimum difference between the altitude or Blue/Yellow Value of the Black color was inspected or recorded as -1.44, -1.925, -2.88. The relation between dry toner and liquid toner digital prints' data conclusion is provided below:

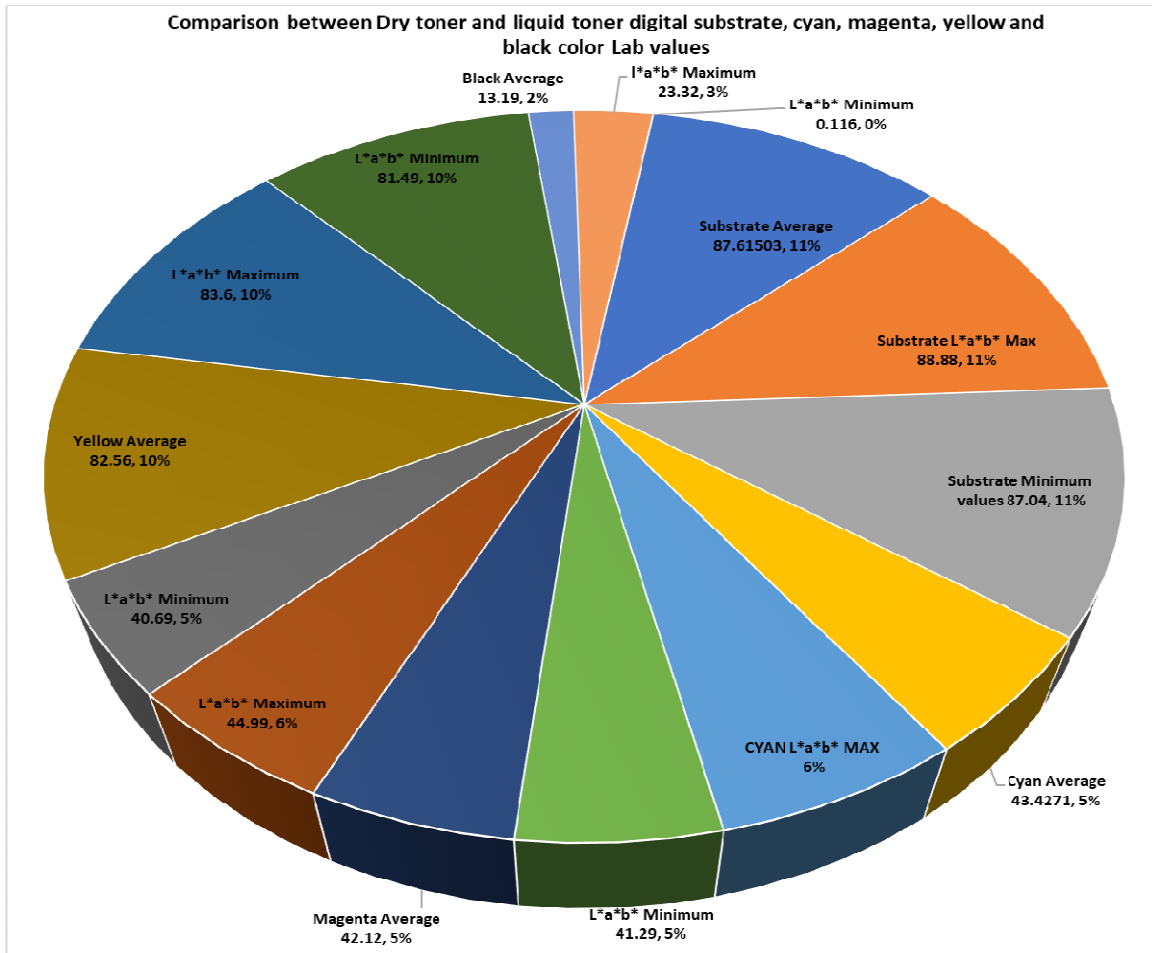


Figure 1 comparison between of Dry and liquid tonner digital printing L, a, b Values



Tonal value Increase (TVI)

Tonal value increase of randomly chosen 10 sheets printed dry toner Digital printing each.

Table 1. TVI(Tonal Value Increase) of Dry Toner digital Printing Substrates

S. No.	On 100%				On 75%				On 50%				On 25%			
	C	M	Y	K	C	M	Y	K	C	M	Y	K	C	M	Y	K
1	1.85	1.65	1.68	1.66	16.1	17.7	23.2	20.8	22.4	33.0	37.8	36.4	6.2	9.1	14.2	23
2	1.66	1.41	1.5	1.56	15.3	17.9	23.6	20.7	19.9	23.9	37.3	33.9	5	9.8	14.8	19
3	1.87	1.6	1.67	1.86	15.3	17.8	23.4	21.8	21.1	28.8	37.6	37.3	5.9	6.9	11.9	22
4	1.86	1.62	1.68	1.87	14.7	16.2	22.8	20.6	23.1	33.0	38.7	36.9	6.8	10	13	24
5	1.79	1.65	1.63	1.69	14.8	18.1	23.4	20.8	23	33.1	38.6	35.6	7	9.4	14.6	24
6	1.79	1.58	1.55	1.87	15.2	17.7	24.4	21.4	21.5	29.9	38.3	36.9	6.6	10.6	15.3	24
7	1.82	1.67	1.72	1.92	15.1	18.5	22.5	21.1	22	33.0	37.4	36.8	6.7	8.4	13.3	22
8	1.88	1.61	1.59	1.87	15.6	18.4	24.1	21.1	21.3	33.0	38.5	37.1	6	8.4	12.9	23
9	1.77	1.56	1.65	1.73	14.8	17.9	23	20.9	21.5	33.1	36.4	38.1	5.7	10.7	13.9	24
10	1.71	1.49	1.53	1.7	16.2	19	22.1	20	23.1	33.1	38.7	37.3	7.9	10.6	14.7	25
Average	1.84	1.58	1.62	1.77	15.3	17.9	23.3	20.9	21.9	33.0	37.9	36.6	6.38	9.39	13.86	23



Tonal value increase of randomly chosen 10 sheets printed dry toner Digital printing each

TVI (Tonal Value Increase) of Liquid digital Printing Substrates

S.No.	On 100%				On 75%				On 50%				On 25%			
	C	M	Y	K	C	M	Y	K	C	M	Y	K	C	M	Y	K
1	0.76	1.2	1.01	1.25	22.8	9.3	12.4	7.7	29	11	15.6	10.3	16.6	8.5	12.2	7.9
2	0.78	1.23	1.05	1.3	22.6	9.5	12.7	7.9	30.6	11.3	17.1	12	19.3	9.7	13	12
3	0.78	1.22	1.03	1.32	22.4	8.8	12.2	7.4	29.8	11.2	16.5	11.5	18.2	9.1	11.6	9.4
4	0.76	1.21	0.93	1.24	22.9	8.4	14.5	5.6	28.8	11.1	17.3	8.7	14.4	5.8	8.9	5.9
5	0.74	1.22	1.01	1.27	23.6	8.2	11.3	5.7	29.6	11.1	15.1	8.8	15.7	6.1	7.7	6
6	0.74	1.23	1.01	1.26	23.9	8.5	11.8	6.5	29.6	11.2	16.3	10.3	15.6	7	9.2	8.2
7	0.75	1.25	1.02	1.27	23.6	9.1	11.6	6.1	29.7	11.2	15.6	10.2	16.5	8.2	9.2	8.1
8	0.75	1.24	1.01	1.22	23.3	8.6	11.6	6.9	30.3	11.2	16.1	10.2	17.9	7.5	9.5	8.2
9	0.75	1.24	1	1.28	23.5	8.4	12.4	5.6	29.3	11.2	15.5	9.2	15.2	6	8.2	7.2
10	0.75	1.22	1	1.25	23.9	8.3	11.4	5.3	27.9	11.1	14.9	7.2	13.8	5.8	7.6	6.6
Average	0.76	1.226	1.007	1.277	23.31	8.71	12.27	6.47	29.55	11.22	15.84	9.84	16.33	7.37	9.71	7.99

Comparative analysis between the offset and digital prints Tonal Value Increase (TVI) for CMYK colors:

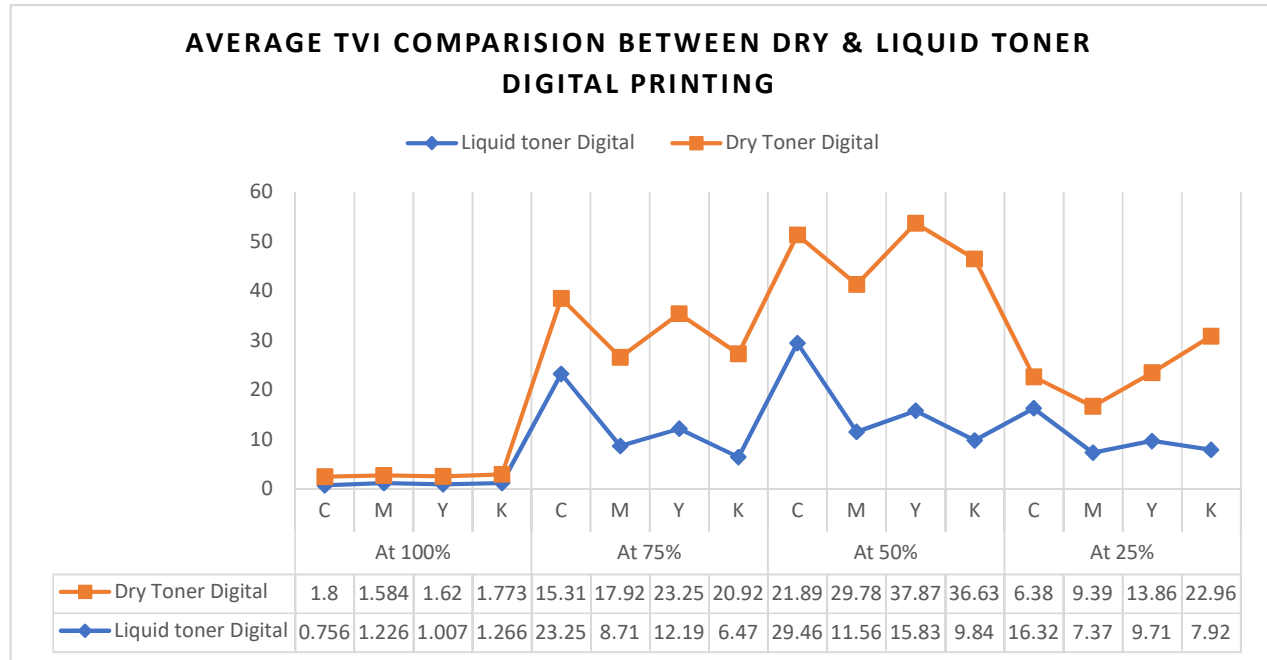


Figure 2 Average TVI Comparison between Dry & Liquid toner digital printing.

The average difference between the Tonal Value Increase of Cyan color on 100% for dry & liquid Digital printing was recorded as 1.8 & 0.756 respectively. The average difference between the Tonal Value Increase of Magenta color on 100% for dry & liquid Digital printing was recorded as 1.584 & 1.226 respectively. The average difference between the Tonal Value Increase of Yellow color on 100% for dry & liquid Digital printing was recorded as 1.62 & 1.007 respectively. The average difference between the Tonal Value Increase of Black color on 100% for dry & liquid Digital printing was recorded as 1.773 & 1.266 respectively.

The average difference between the Tonal Value Increase of Cyan color on 75% for dry & liquid Digital printing was recorded as 15.31 & 23.25 respectively. The average difference between the Tonal Value Increase of Magenta color on 75% for dry & liquid Digital printing was recorded as 17.92 & 8.71 respectively. The average difference between the Tonal Value Increase of Yellow color on 75% for dry & liquid Digital printing was recorded as 23.25 & 12.19 respectively. The average difference between the Tonal Value Increase of Black color on 75% for dry & liquid Digital printing was recorded as 20.92 & 6.47 respectively.

The average difference between the Tonal Value Increase of Cyan color on 50% for dry & liquid Digital printing was recorded as 21.89 & 29.46 respectively. The average difference between the Tonal Value Increase of Magenta color on 50% for dry & liquid Digital printing was recorded as 29.78 & 11.56 respectively. The average difference between the Tonal Value Increase of Yellow color on 50% for dry & liquid Digital printing was recorded as 37.87 & 15.83 respectively. The average difference between the Tonal Value Increase of Black color on 50% for dry & liquid Digital printing was recorded as 36.63 & 9.84 respectively.

The average difference between the Tonal Value Increase of Cyan color on 25% for dry & liquid Digital printing was recorded as 6.38 & 16.32 respectively. The average difference between the Tonal Value Increase of Magenta color on 25% for dry & liquid Digital printing was recorded as



9.39 & 7.37 respectively. The average difference between the Tonal Value Increase of Yellow color on 25% for dry & liquid Digital printing was recorded as 13.86 & 9.71 respectively. The average difference between the Tonal Value Increase of Black color on 25% for dry & liquid Digital printing was recorded as 22.96 & 7.92 respectively.

V. Result and Conclusion

The dry and digital both are the high-quality printing processes. No one person can define easily which one process is better in the quality. According to our research results Color variation in liquid based digital having less, Liquid toner Digital having higher L^* , a^* , b^* , Values as compared to the Dry toner for the Cyan, magenta, yellow and black color and Dry toner digital having higher increase in the tonal values as compared with the Liquid toner. Basically, if we keep image quality, durability & versatility on different substrate then dry toner is more suitable. On other hands the for achieving a glossy appearance or printing on specific media is crucial the liquid toner digital printing is preferred. The data conclusion of the comparison between dry and liquid toner digital print is discussed above in this research report.

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