Section: Research Paper

Hue difference on Super Print substrate: Study of various Digital Printing Methodologies

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ABSTRACT: Colour differences exhibited while printing is represented in terms of ΔE Value in CIE Lab Colour Space. Delta E (ΔE) measurement plays a crucial role while evaluating printed colour accuracy. Therefore, ΔE is used as standard measurement process to quantify the difference between two colour that appears on any printed or digital screen. CIE Lab offers Red-Green and Yellow-Blue colour on 'a' and 'b' axis respectively where human eye is more sensitive due to highly saturated areas while 'L' axis represents lightness-darkness where eye is less sensitive resulting which colour difference is not sufficiently considered in ΔE. In order to mitigate this issue is ΔH is adopted to describe hue difference. This analysis is confined to depict ΔH variation on Super Print media using various digital printing methodologies.

Keywords: CIE Lab Colour Space, ΔE Value, Super Print, Hue difference, Printing methodologies

Introduction

CIE L*a*b* Colour Space describes the colour difference by ΔE Value which is crucial for evaluating colour accuracy in printing. But this ΔE Value difference (distance between the coordinates of Lab Colour space) is partially suitable in order to evaluate gray balance. Hue difference delta H for primary colour and gray scale is included in ISO 12647-7. Colour difference calculated in CIE L*a*b* Colour space provides the Euclidean difference (as shown in figure 1) which means the difference between two points in 3-D Colour space. Human eye sensitivity varies more to less while perceiving colour. Colour in highly saturated areas lies along colour code axis (a* and b* axis) are assessed strongly where human eye is particularly sensitive.

In the other words colour difference calculated in CIE L*a*b* Colour space efficient too much in highly saturated areas and very week in gray areas, means gray areas colour difference is not sufficiently considered while calculating ΔE. Therefor ΔH is used for describing hue difference.

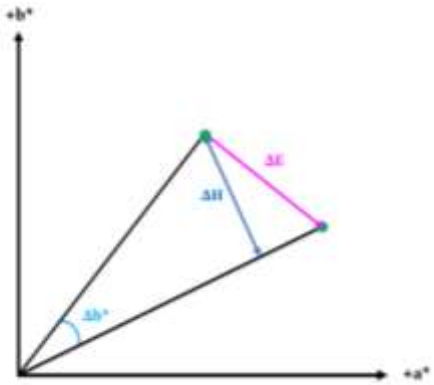

*Figure 1: Concept of ΔE and ΔH using CIE L*a*b* Colour space*

Numerous printing methodologies are available now-a-days which offers verities of advantages over conventional printing methodologies. These digital printing methodologies are known for their versatility and flexibility. Digital printing enables digitized information printed on media by using some sequential steps which includes: imaging, inking (toner or liquid based), transferring (printing), toner fixing and cleaning.

Research Objective

The objective of this research work is to study ΔH (Delta H) Value i.e. hue difference exhibited on Super Print substrate using different digital printing methodologies.

Materials and Methodology

The research for studying ΔH (Delta H) Value i.e. hue difference exhibited on Super Print substrate using different digital printing methodologies was carried out in numerous sequential steps which are enlisted as below:

a. **Master Test Chart:** Test Chart was developed consisting various technical elements so that required technical parameter from printing point of view can be measured.
b. **Selection of Printing Methodology:** Five different digital printing methodologies were selected which included HP Indigo, Canon, Xeikon, Konica Minolta and Xerox.
c. **Selection of Media:** Super Print paper was used as media on which printing was done.
d. **Printing of Test Chart:** Developed test chart was printed using selected methodologies under standard printing conditions. Calibration of machine was made before printing on selected media.

e. **Colorimetric Measurement:** Making the colorimetric measurement using particular standardized photoelectric device i.e. x-Rite i1 Pro Spectro-densitometer. The data so recorded was tabulated in order to analyse and conclude.

Data Analysis

In order to accomplish the research work effectively the data was collected which was further analysed to conclude. The info-graphic elaboration of the collected data for different methodologies which includes HP Indigo, Canon, Xeikon, Konica Minolta and Xerox on Super Print paper substrate is represented as:

a. **ΔH (Delta H) Value for Cyan Colour:** The ΔH values of cyan colour in five different methodologies are depicted in figure 2 showed that the ranges of HP Indigo, Canon, Xeikon, Konica Minolta and Xerox methodologies were remained in between 4.6 to 5.6; 2.3 to 3.9; 1.7 to 2.9; 0.4 to 1.9; 0.3 to 2.3 respectively. It was also observed that HP Indigo methodology exhibited the highest ranges for ΔH values i.e. 4.6 to 5.6; while Konica Minolta methodology exhibited the lowest ΔH values i.e. 0.4 to 1.9 followed by Xerox methodology having ΔH values in the range 0.3 to 2.3. Konica Minolta methodology behaviour for ΔH values was haphazard in nature while HP Indigo and Xeicon methodology exhibited somewhat linearly.

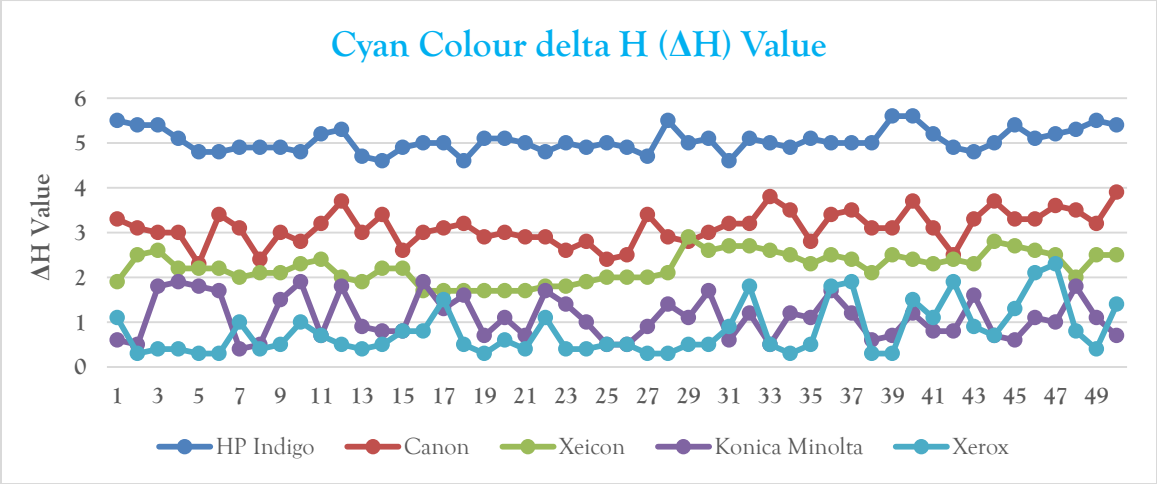

Figure 2: Cyan Colour (ΔH) on Super Print Paper

b. **ΔH (Delta H) Value for Magenta Colour:** The observations of ΔH values of magenta colour on Super Print paper substrate using five different methodologies is depicted in figure 3. The ranges of ΔH values of magenta colour was observed in between 0.6 to 1.6; 1.2 to 2.1; 2.4 to 3.8; 4.5 to 6.3 and 2.1 to 4.3 while using HP Indigo, Canon, Xeikon, Konica Minolta and Xerox methodologies respectively. During observation it was found that HP Indigo methodology exhibited the lowest ranges for ΔH values i.e. 0.6 to 1.6; while Konica Minolta methodology exhibited the highest ΔH values i.e. 4.5 to 6.3 on super print paper substrate for magenta colour.

During observation it was revealed that the nature of Xerox methodology for ΔH (Delta H) Value was haphazard as shown in figure 3. It was also observed that ΔH Values at many points were coincided in case of Xerox and HP Indigo methodology.

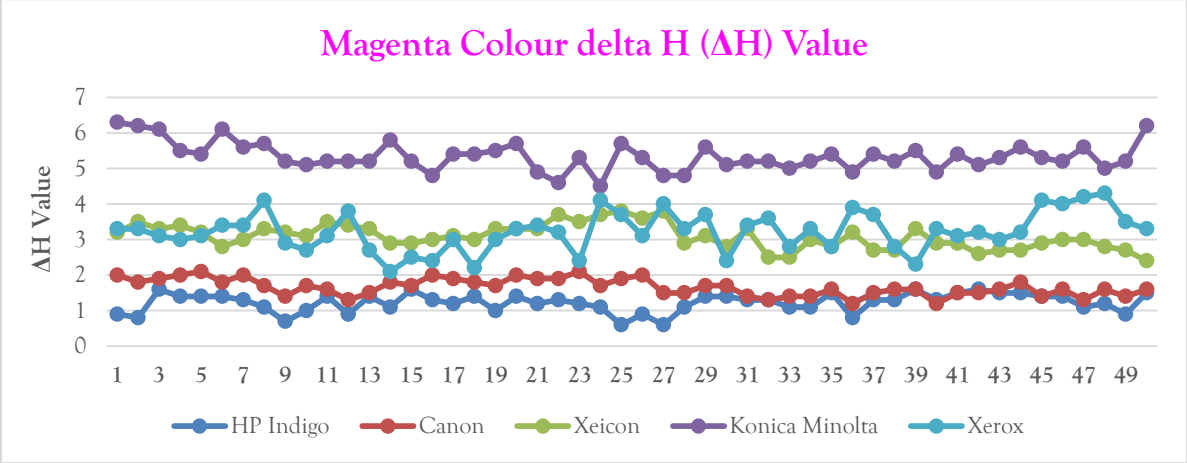

Figure 3: Magenta Colour (ΔH) on Super Print Paper

c. ΔH (Delta H) Value for Yellow Colour: Five different methodologies exhibited the results of ΔH values for yellow colour are depicted in figure 4. The ΔH value exhibited by different methodologies namely HP Indigo, Canon, Xeikon, Konica Minolta and Xerox yellow colour were found in the range 1.1 to 1.7; 1.7 to 2.6; 1.5 to 2.3; 0.4 to 1.7 and 1.4 to 2.6 respectively. Observations have revealed that the lowest value of ΔH value for yellow colour was found 0.4 to 1.7 in case of Konica Minolta methodology, while Canon methodology exhibited the higher value 1.7 to 2.6 followed by Xerox having range 1.4 to 2.6 on super print paper substrate. The nature of all methodologies except HP Indigo had shown haphazard trend for ΔH values of yellow colour. Some linear mode was perceived in case of HP Indigo digital printing methodology.

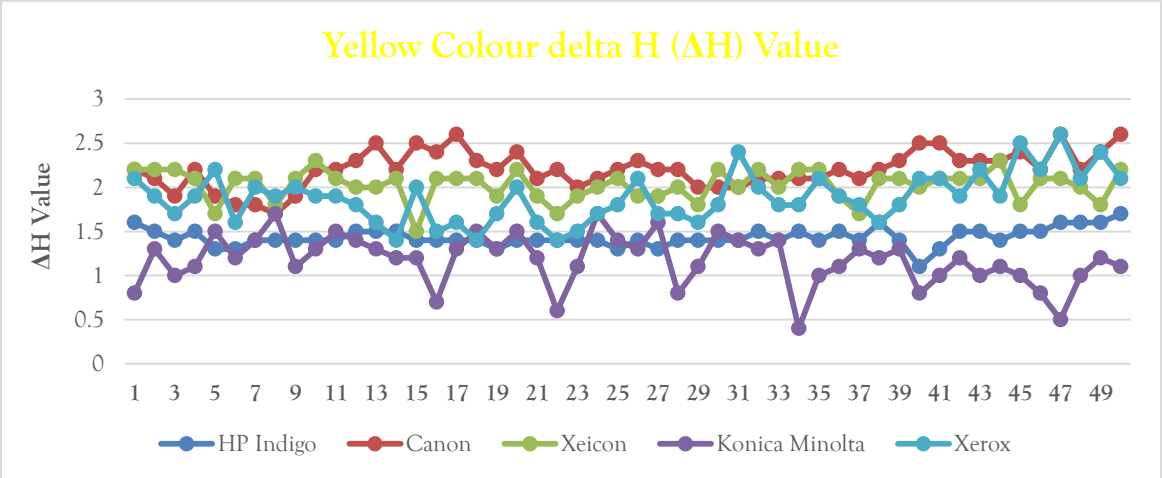

Figure 4: Yellow Colour (ΔH) on Super Print Paper

d. ΔH (Delta H) Value for Black Colour: Figure 5 depicts the results of ΔH values of black colour on Super Print paper substrate using five different methodologies. The ΔH value of black colour was found in the range 0.4 to 0.7; 0.5 to 1.7; 2.2 to 2.9; 1.2 to 2.3 and 0.7 to 2.2 while using HP Indigo, Canon, Xeikon, Konica Minolta and Xerox methodology respectively. The lowest range of ΔH values of black colour was exhibited by HP Indigo methodology i.e. 0.4 to 0.7 and on the other hand Xeikon exhibited the highest range i.e. 2.2 to 2.9 of ΔH values of black colour followed by Canon methodology having range 1.2 to 2.3 of ΔH values of black colour on super print paper substrate. Linear behaviour was observed in case of HP Indigo and Xeicon as compared to remaining three methodologies i.e. Canon, Konica Minolta and Xerox for ΔH Value of black colour.

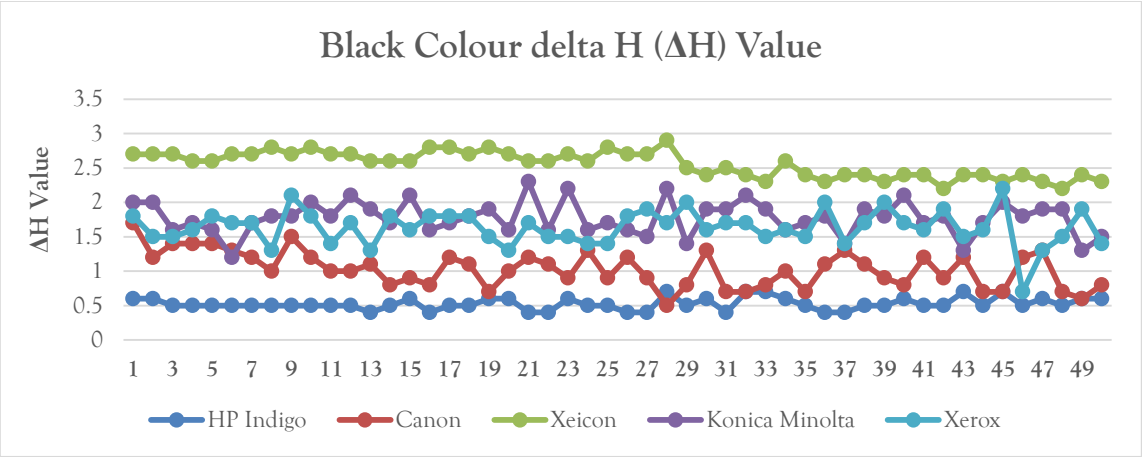

Figure 5: Black Colour (ΔH) on Super Print Paper

Results and Discussion

This research article has delineated a broader view for analyzing the behavior of delta H i.e. ΔH value on super print paper substrate using various different digital printing methodologies which includes HP Indigo, Canon, Xeikon, Konica Minolta and Xerox methodologies. The summary of ΔH (delta H) value on super print paper substrate using various digital printing methodologies is tabulated in table 1.

ΔH (Delta H) Value	Cyan		Magenta		Yellow		Black	
	Mini.	*Max.*	*Mini.*	*Max.*	*Mini.*	*Max.*	*Mini.*	*Max.*
HP Indigo	4.6	5.6	0.6	1.6	1.1	1.7	0.4	0.7
Canon	2.3	3.9	1.2	2.1	1.7	2.6	0.5	1.7
Xeikon	1.7	2.9	2.4	3.8	1.5	2.3	2.2	2.9
Konica Minolta	0.4	1.9	4.5	6.3	0.4	1.7	1.2	2.3
Xerox	0.3	2.3	2.1	4.3	1.4	2.6	0.7	2.2

Table 1: ΔH (Delta H) Value on Super Print Paper using different digital printing methodologies

Conclusion

During observation it was noticed that the values of delta H (ΔH) colour shifts were found not only repeated over again and again, but also in accordance with print quality standards on Super Print Paper using different digital printing methodologies. On the basis of observation, two possible interpretations of the data were obtained. The first strategy involved analyzing the delta H colour shifts caused by various digital printing methodologies. Another strategy was contrasting several digital printing processes for each colour. First approach revealed that HP Indigo and Canon exhibited lowest ΔH value for Black colour. Xeikon, exhibited lowest ΔH value for Yellow colour. Konica Minolta exhibited lowest ΔH value for both Cyan and Yellow colour. Xerox exhibited lowest ΔH value for Cyan colour. In contrast, HP Indigo and Canon exhibited highest ΔH value for Cyan colour. Xeikon Konica Minolta and Canon exhibited highest ΔH value for Magenta colour. On the other hand, another perspective shown that Xerox, HP Indigo, Konica Minolta and HP Indigo exhibited lowest ΔH value Cyan, Magenta, Yellow and Black respectively. While HP Indigo, Konica Minolta, Canon and Xeikon exhibited highest ΔH value Cyan, Magenta, Yellow and Black respectively.

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