
Analysing Ink Density behaviour on Matt Paper using different Digital Printing Methodologies

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ABSTRACT

In this modern era, print consistency is being considered of greater significance which needs to be frequently evaluated. This print consistency is correlated to various technical aspects while printing, amongst these ink density of secondary colour, play an important role and contribute significantly during printing. Hence it becomes necessary to understand the behaviour of ink density while using different methodologies. This present analysis is to explicate the ink density behaviour and delineate the ink density variations on matt paper using different methodologies during printing.

Keywords: Ink density, Print consistency, Secondary colour, Methodologies, Matt paper

1. Introduction

Solid ink density is the measurement of a solid printed patch on the substrate or paper including the paper density. It is generally related to ink film thickness and helps in controlling dot gain while printing. A densitometer is required for measuring the solid ink density that reads print density. These measurements are used to establish the print quality and its relationship while printing (Jangra et al., 2014). The types of densitometer are classified on the bases of type of substrate they are used for i.e. transparent and opaque. A transmission densitometer is used for transparent type substrates; it measures the amount of light passing through film or any other transparent medium. A reflection densitometer measures the light reflected from an opaque surface, usually paper or any other substrate.

Digital printing is the mode of printing in which digital images are directly printed on a wide variety of substrates. Digital printing has eliminated many of the intermediate steps of conventional printing processes which includes use of chemicals for exposing, developing and image carrier preparation. In the other words no master is required for printing (Mathur et al., 2014). The data of the digital print job is transferred directly to control the imaging unit. Digital printing involves a complete cycle for printing which includes:

- i. Imaging
- ii. Inking
- iii. Toner transfer i.e. Printing
- iv. Toner fixing
- v. Cleaning

Digital Printing (NIP) Process functional components are shown as which elaborates the complete cycle for printing impression on a substrates.

2. Research Objective of Study

The key objective of this research was to explicate the ink density behaviour and delineate the ink density variations during printing on matt paper by using different digital methodologies on various Digital Printing Machines.

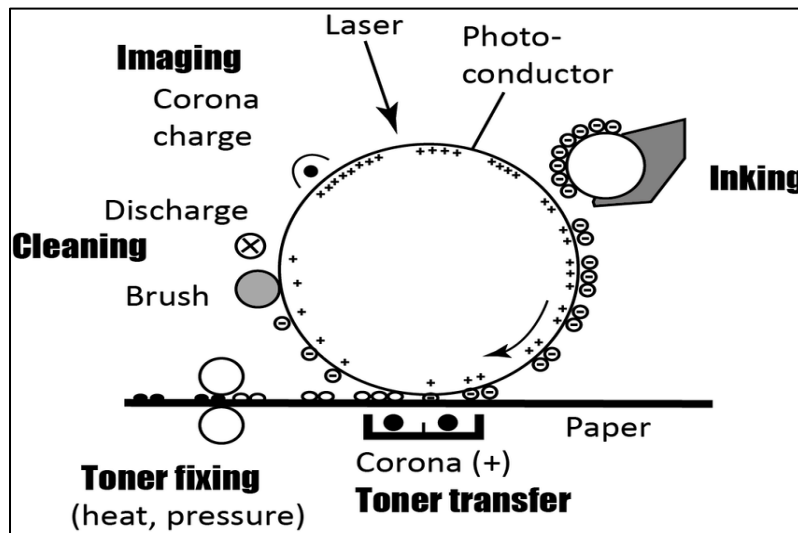


Figure 1: Digital Printing Methodology Process Functional Components (Nguyen et al., 2021)

3. Research Methodology

For carrying out the aforesaid study i.e. analyzing ink density behavior on different methodologies on various digital printing machines, first and foremost a master test chart was developed. Different methodologies taken for carrying out the research work included HP Indigo, Canon, Xeikon, Konica Minolta and Xerox using which the developed master test chart was printed. Calibration process was the foremost and important step before starting the printing of test chart. After that printing was done by using different methodologies by maintaining standard press conditions. After printing the next step was to carry out the colorimetric measurement. The instrument used for measuring colorimetric properties was x-Rite i1 Pro Spectro-densitometer. It is a photoelectric device which is used to measure colorimetric properties of process colour printed on any substrate. The calibration of spectrophotometer was made and then measuring ink densities of each process colour i.e. cyan, magenta, yellow and black. The captured data was tabulated and put on record for further analysis in order to conclude.

4. Data Analysis

In order to accomplish the research work effectively the data was collected which was further analysed to conclude. The info-graphic of the collected data is elaborated as:

Analysis of Ink Density behavior using different methodologies of Digital Printing: Different methodologies for the study includes HP Indigo, Canon, Xeikon, Konica Minolta and Xerox were taken into consideration. The results of ink density on matt paper (130 GSM) for cyan, magenta, yellow and black colour are represented as:

a. **Ink Density of Cyan Colour on Matt Paper:** The observations of ink densities of cyan colour on matt paper using five different methodologies is depicted in figure: 1. The ranges of ink density of Cyan colour was observed in between 1.21 to 1.26; 1.26 to 1.45; 0.80 to 0.95; 1.26 to 1.40 and 1.57 and 1.66 in HP Indigo, Canon, Xeikon, Konica Minolta and Xerox methodologies respectively. Xiecon methodology exhibited the minimum range (0.80 to 0.95) while Xerox methodology exhibited maximum range (1.57 and 1.66) of cyan colour ink density printed on matt paper. The minimum variations were observed in the ink densities of cyan colour in case of HP Indigo methodology, while maximum deviations were observed in case of Canon methodology followed by Konica Minolta methodology

(graph : 1). It is concluded that cyan colour is printed consistently on matt paper by HP Indigo methodology.

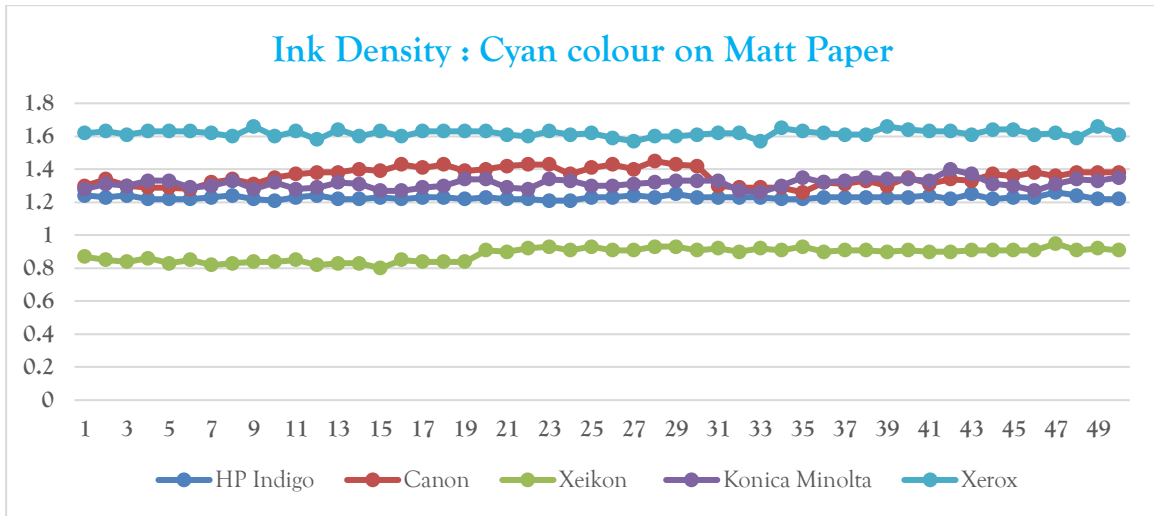


Figure 1: Ink Density of Cyan Colour on Matt Paper

b. Ink Density of Magenta Colour on Matt Paper: Figure 2 depicts the results of magenta colour ink density on matt paper using five different methodologies. Magenta colour ink density ranges 1.14 to 1.18, 1.33 to 1.49, 0.75 to 0.85, 1.36 to 1.46 and 1.32 to 1.54 while using HP Indigo, Canon, Xeikon, Konica Minolta and Xerox methodology respectively. The ink density varies linearly in case of HP Indigo methodology means variation during printing is very low. Minimum range of magenta colour ink density is exhibited by Xeikon methodology and on the other hand Xerox exhibits maximum range of ink density on matt paper. It is also observed from the graph Canon methodology exhibits near the range of Xerox methodology. The range of magenta colour ink density in three methodologies namely Xerox, Konica Minolta and Canon were almost same. Ink density for magenta colour in case of HP Indigo methodology is more as compared to Xeikon and less than other three remaining methodologies.

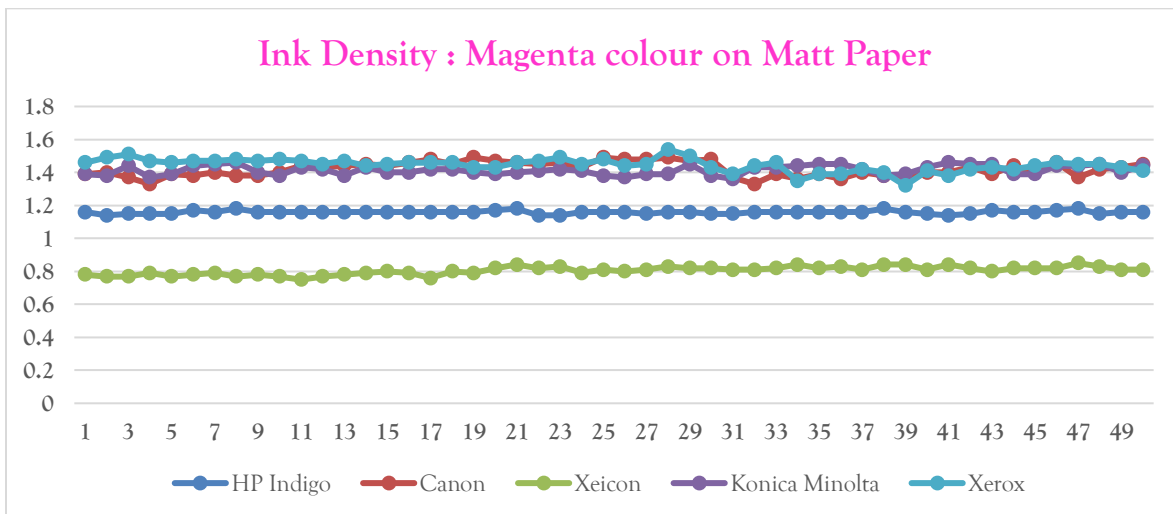


Figure 2: Ink Density of Magenta Colour on Matt Paper

c. **Ink Density of Yellow Colour on Matt Paper:** Five different methodologies exhibited the results for Yellow colour ink densities are depicted in figure no. 3. Ink density range for yellow color ranged 0.75 to 0.78, 1.0 to 1.06, 0.73 to 0.78, 0.85 to 0.90 and 1.06 to 1.10 for HP Indigo, Canon, Xeikon, Konica Minolta and Xerox methodology respectively. The behaviour of yellow ink density by HP Indigo and Xeikon methodology was almost identical and exhibited lowest ink density ranges amongst five methodologies. On the other hand higher range of ink density of yellow colour was exhibited by Xerox methodology. Amongst five methodologies Konica Minolta exhibited medium range of ink density for yellow colour.

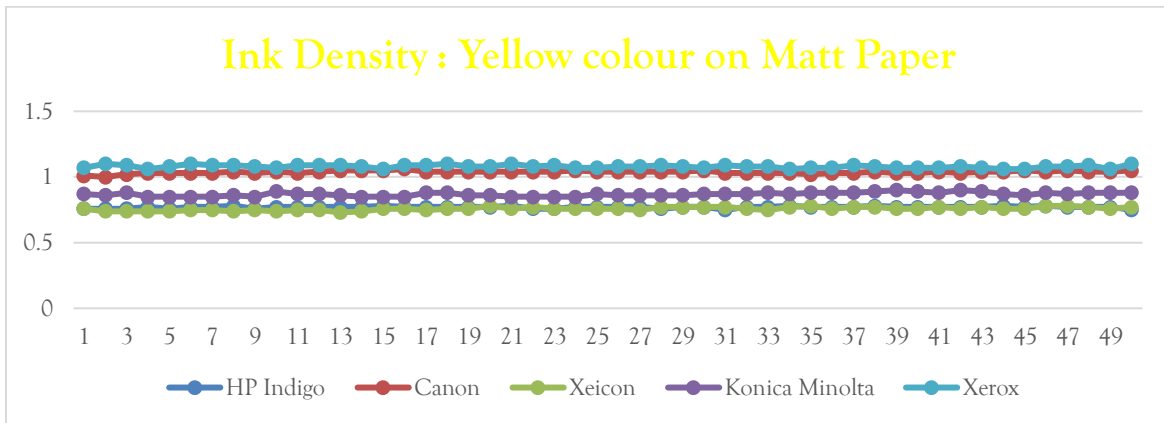


Figure 3: Ink Density of Yellow Colour on Matt Paper

d. **Ink Density of Black Colour on Matt Paper:** The ink densities of black colour in five different methodologies are depicted in figure 4 showed that the ranges of HP Indigo, Canon, Xeikon, Konica Minolta and Xerox methodologies were remained in between 1.46 to 1.53, 1.83 to 2.01, 1.07 to 1.19, 1.62 to 1.77 and 1.72 to 1.80 respectively. It was also observed that Xieikon methodology exhibited the lowest ranges for ink densities i.e. 1.07 to 1.19; followed by HP Indigo i.e. 1.46 to 1.53 while Canon methodology exhibited the highest i.e. 1.83 to 2.01. The behaviour of Canon methodology for black colour was found inconsistent due to deviations while printing on matt paper. Almost similar ink densities were observed in case of Xerox and Konica Minolta (figure : 4).

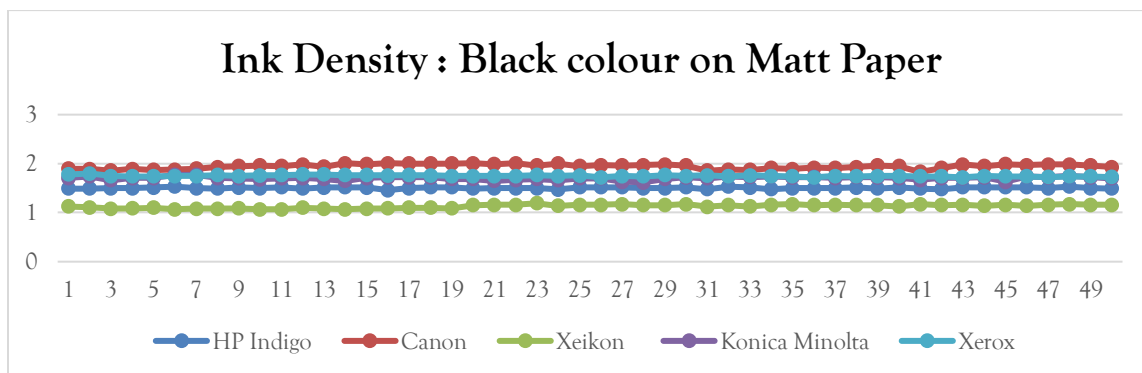


Figure 4: Ink Density of Black Colour on Matt Paper

5. Results and Discussion

The collected data was analyzed in order to conclude. During observation it was found that the values of ink densities were found repeated again and again on matt paper using five different methodologies (HP Indigo, Canon, Xeikon, Konica Minolta and Xerox methodologies) on digital printing. It was also observed that ink densities values recorded were in range with accordance with the standard print quality. The summary of analyzed data of ink density behavior on matt paper for different methodologies is delineated in table 1 as below:

Table 1: Summary of the Ink Density using different methodologies on Matt Paper

Ink Density	Cyan		Magenta		Yellow		Black	
	Mini.	Max.	Mini.	Max.	Mini.	Max.	Mini.	Max.
HP Indigo	1.21	1.26	1.14	1.18	0.75	0.78	1.46	1.53
Canon	1.26	1.45	1.33	1.49	1.0	1.06	1.83	2.01
Xeikon	0.80	0.95	0.75	0.85	0.73	0.78	1.07	1.19
Konica Minolta	1.26	1.40	1.36	1.46	0.85	0.90	1.62	1.77
Xerox	1.57	1.66	1.32	1.54	1.06	1.10	1.72	1.80

Conclusion

This research paper has depicted an overview about the analysis of ink behavior on matt paper using different methodologies in order to study print consistency on different digital printing machine. This paper delineated how ink density behaved with respect to methodologies on matt paper. During observation it was found that ink densities values recorded were found in accordance with the printing standards. On the basis of data analysis, it was revealed that Xeikon methodology exhibited lowest ink density values for all the process colour i.e. cyan, magenta, yellow and black. In contrast exhibited highest value of ink density was exhibited by Canon methodology for black and Xerox methodology for remaining process colour i.e. cyan, magenta and yellow colour.

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