

# Analyzing behavior of Solid Ink Density in Sheet-Fed Offset and Digital Printing

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**Abstract**— Print quality is correlated to numerous aspects associated with printing technology. Amongst them solid ink density play a crucial role and contribute significantly while printing. Print quality has been considered of greater significant and most frequently evaluated now a days. So it becomes inevitable to understand how ink density behaves on different types of substrates. In this modern era, both sheet-fed offset and digital printing have emerged as most dominating printing technologies facilitate working on large variety of substrates. This present analysis system is used to delineate the ink density variations occurred during printing. The key objective of this research paper is to elucidate the behavior of solid ink density on coated and uncoated paper in sheet-fed offset and digital printing.

**Key words:** Print Quality, Ink Density, Sheet-Fed Offset Printing, Digital Printing, Printing Technology

## I. 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. 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.

### A. Sheet-Fed Offset Printing

'Ink and water do not mix' - this is the principle on which offset printing underlies. The principle of sheet-fed offset printing process is derived from the Planography printing process. As the word planography conveys the meaning that the printing and non-printing area lie in the same plane, similarly sheet-fed offset printing process consists of both the plane i.e. printing and non-printing area in the same plane. Both the surfaces are separated chemically by use of the natural principle, 'Water repels grease and grease repels water.' Planographic printing process is generally a chemical process in which image and non-image area are separated by the use of certain chemicals in such a way that image area is ink receptive and non-image area is water receptive. The transfer of ink from one image area of the plane is controlled by maintaining the balance of water and ink. During printing the inked image is transferred from plate to rubber blanket and then subsequently on to printing substrate with the help of suitable impression pressure. Therefore this printing process is coined as the name offset printing process.

### 1) The Advantage of Offset Printing

These includes

- Printing of long run job is economical.
- It is suitable for solid and line job printing comparative to other printing processes.
- Better print quality can be achieved even on rough and cheap papers.
- Printing process provides better line and halftones print work.
- High efficiency in terms of production.

### B. Digital Printing Process

Digital printing describes the process of transferring a document on a personal computer or other digital storage device to a printing substrate by means of a device that accepts text and graphic output. In digital printing process information is reduced to binary code or 'digitized,' to facilitate its storage and reproduction. Digital printing has steadily replaced lithography in many markets, especially at the consumer and business level as a result of its substantially lower production costs.

### 1) The Advantage of Digital Printing

Digital printing widens a number of advantages over the traditional printing process resulting benefits not only in terms of time and efficiency, but in terms of colors also.

- Digital printing uses electronic patterns therefore designs can be changed instantly without cost. This enables in terms cost-effective in short print runs.
- Digital printing is more economical involving less waste of the materials.
- It is also a faster process means it is time effective.
- Digital print quality often deals in high quality as compared to traditional printing including color matching and range.
- Provide variable data printing facility.

## II. OBJECTIVES OF STUDY

The key objectives of this research are to elucidate on the following aspects of solid ink density on coated and uncoated paper in Sheet-fed Offset and Digital printing:

- To analyse Solid Ink Density in Sheet-fed Offset and Digital Printing
- Comparative analysis between Sheet-fed Offset and Digital Printing

## III. RESEARCH METHODOLOGY

In order to analyze the behavior of solid ink density in sheet-fed offset and digital printing, this research work was carried out. Sheet-fed offset and digital printing jobs were analyzed time to time. The instrument used was densitometer. Densitometer is basically a photoelectric device used for measuring ink density printed on any substrate. Nature of working of any densitometer depends

upon the type of material either opaque or transparent, it is designed to measure. According densitometer can be classified into two different categories i.e. reflection type and transmission type. During research reflection type densitometer for opaque materials was used for measuring solid ink density. Various steps involved while measuring solid ink density:

- Taking the printed sample of digital or sheet-fed offset printing.
- Calibrating of the densitometer.
- Measuring solid ink density of each color i.e. cyan, magenta, yellow and black.
- Noting down the data i.e. value of the solid ink density.

For measuring solid ink density densitometer - GRETAG MACBETH, D - 19C series was used. The data was collected from Thomson Press (Okhla and Faridabad), Thomson Sheet-fed Printing: Mitsubishi Diamond 3000L and Digital Printing: HP 5500. So collected data was analyzed and then the difference in ink density of the two different processes i.e. sheet-fed offset and digital printing was recorded.

#### IV. DATA ANALYSIS

The data was collected during research. The data so collected was compiled and analyzed in order to accomplish the research effectively. By using this statistical data, the interpreted results were expressed in graph and figure. The following aspects were taken into consideration during analysis:

- Analysis of Solid Ink Density in Sheet-fed Offset and Digital Printing
- Comparative analysis between Sheet-fed Offset and Digital Printing

These various aspects from research point of view are delineated as below:

##### A. Analysis of Solid Ink Density in Sheet-fed Offset and Digital Printing

“Oil and water do not mix with each other,” this is the principle on which Offset Printing underlies. Digital printing is a method of printing by which a digital image is directly printed on a variety of substrates. The results of solid ink density on coated and uncoated paper (130 GSM) for cyan, magenta, yellow and black color in sheet fed offset and digital printing are delineated as below:

##### 1) Solid Ink Density of cyan color on coated and uncoated paper in sheet fed offset and digital printing

The average values of observations of Solid Ink Density (SID) of cyan color on coated paper and uncoated paper are presented in figure 1. The mean values of SID at Thomson press-Mitsubishi Diamond 3000L were found in the range of 0.98 to 1.72, in case of sheet fed offset printing used for printing the various jobs on coated paper. While the mean values of SID at Thomson press-HP 5500 was found in the range of 1.33 to 1.52 on coated paper in digital printing. In contrast, the average values of observations of SID of cyan color on uncoated paper as expressed in figure 1; the mean values were found in the range of 1.26 to 1.80 in sheet fed offset printing on Thomson press-Mitsubishi Diamond 3000L i.e. sheet fed offset printing machine used for printing the various jobs. While the mean values of SID in digital printing on Thomson press-HP 5500 digital printing

machine was found in the range of 1.16 to 1.28 on uncoated paper.

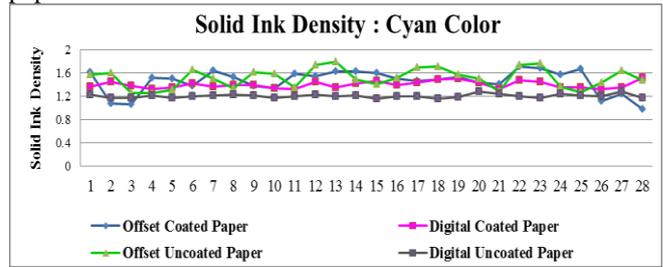


Fig. 1: Solid Ink Density (SID) of cyan color on coated and uncoated paper in sheet fed offset and digital printing

##### 2) Solid Ink Density of magenta color on coated and uncoated paper in sheet fed offset and digital printing

The results (average values) of observations of Solid Ink Density (SID) of magenta color on coated and uncoated paper are depicted in figure 2.

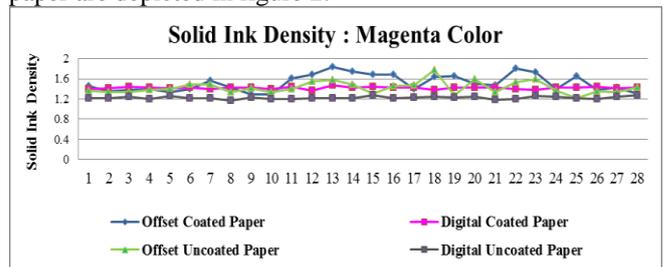


Fig. 2: Solid Ink Density (SID) of magenta color on coated and uncoated paper in sheet fed offset and digital printing

During research, the mean values of SID on coated paper were found in the range of 1.29 to 1.83 in sheet fed offset printing used for printing various jobs. While the mean values of SID in digital printing were found in the range of 1.36 to 1.47 on coated paper. In contrast, the average values of observations of Solid Ink Density (SID) of magenta color on uncoated paper were found in the range of 1.22 to 1.78 in sheet fed offset printing on Thomson press-Mitsubishi Diamond 3000L. While the mean values of SID in digital printing on Thomson press-HP 5500 digital printing machine used for printing the various jobs was found in the range of 1.17 to 1.27 on uncoated paper. From the above mentioned SID values of magenta color on coated and uncoated paper, it was observed that there was a only a considerable variations during digital printing and more variations took place in sheet fed offset printing process e.g. sheet-fed offset solid ink density range varies from 1.29 to 1.83 on coated paper and on uncoated paper it is 1.22 to 1.78. It means digital printing spills a desirable control on print ink density on the substrate as compared to sheet-fed offset printing.

##### 3) Solid Ink Density of yellow color on coated and uncoated paper in sheet fed offset and digital printing

The results (average values) of observations of Solid Ink Density (SID) of yellow color on coated paper and uncoated paper are expressed in figure 3. For the various printing jobs, in case of sheet fed offset printing the mean values of SID of yellow color were found in the range of 0.91 to 1.69 on coated paper. While in digital printing the mean values of SID were found in the range of 1.29 to 1.52 on coated paper. In contrast for the uncoated paper, the mean values of SID were found in the range of 0.97 to 1.46 in sheet fed offset printing and in digital printing the range found was from 1.21 to 1.35 for yellow color. The observations depicted that

the average values of Solid Ink Density (SID) took place slight variations in case of digital printing process. Comparatively more variations took place in sheet fed offset printing process.

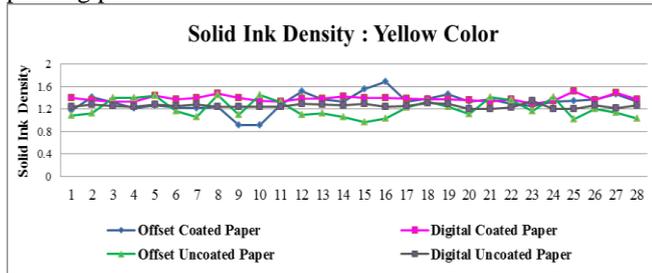


Fig. 3: Solid Ink Density (SID) of yellow color on coated and uncoated paper in sheet fed offset and digital printing  
4) Solid ink Density of black color on coated and uncoated paper in sheet fed offset and digital printing:

The results of observations of Solid Ink Density (SID) of black color on coated paper and uncoated paper are shown in figure 4.

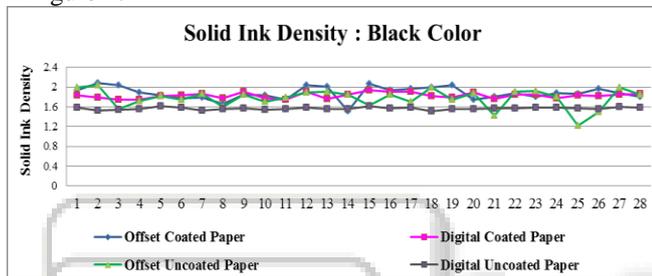


Fig. 4: Solid Ink Density (SID) of black color on coated and uncoated paper in sheet fed offset and digital printing  
The data expressed in figure 4 depicted that the mean values of solid ink density were found in the range of 1.51 to 2.08 in sheet fed offset printing on coated paper while printing various jobs. And the mean values of SID in digital printing were recorded in the range of 1.74 to 1.94 on coated paper. On the other hand in case of uncoated paper, the average values of observations of Solid Ink Density (SID) of black color on uncoated paper were found in the range of 1.22 to 2.03 in sheet fed offset printing and in digital printing range found was recorded from 1.51 to 1.61 while printing various jobs. From the above mentioned solid ink density values of black color on coated and uncoated paper; the range of average values of solid ink density were higher in case of coated paper as compared to uncoated paper, because of its more smoothness property. In digital printing process, there is a consistency while printing the jobs and slight variations take place comparatively sheet-fed offset printing.

**B. Comparative analysis between Sheet-fed Offset and Digital Printing**

In this modern era both sheet-fed offset and digital printing are most dominating printing processes offering high print quality. Therefore comparative study between these two printing processes becomes inevitable. During the research the results of the data collected depicted that in case of sheet-fed offset printing the range of solid ink density found for cyan, magenta, yellow and black color was 0.98 to 1.72, 1.29 to 1.83, 0.91 to 1.69 and 1.51 to 2.08 respectively on coated paper. In digital printing range observed on coated paper was 1.33 to 1.52, 1.36 to 1.47, 1.29 to 1.52 and 1.74 to 1.94 for cyan, magenta, yellow and black color respectively. In addition to this, the value of solid ink density on uncoated

paper found for cyan, magenta, yellow and black color was 1.26 to 1.80, 1.22 to 1.78, 0.97 to 1.46 and 1.22 to 2.03 respectively during printing various jobs on sheet-fed offset. In digital printing density on uncoated paper found was 1.16 to 1.28, 1.17 to 1.27, 1.21 to 1.35 and 1.51 to 1.61 for cyan, magenta, yellow and black color respectively.

**V. RESULTS AND DISCUSSION**

The data was collected and analyzed to conclude. During the analysis it was found that values of ink density were repeated again and again while printing either sheet-fed offset or digital printing on two different types of substrates i.e. coated paper and uncoated paper. It was also observed that these values were in accordance with the standard print quality range. The result observed was that there was a large variation in case sheet-fed offset printing comparatively that of digital printing due to the nature of respective printing methodology. Summary of the analyzed data of solid ink density on coated and uncoated paper in Sheet-fed offset and Digital Printing is delineated in table 1 and 2 respectively as below:

Solid Ink Density on Coated Paper in Sheet-fed offset and Digital Printing		
Cyan Color Solid Ink Density		
Solid Ink Density	Sheet-fed Offset	Digital Printing
Max. Value	1.72	1.52
Min. Value	0.98	1.33
Magenta Color Solid Ink Density		
Solid Ink Density	Sheet-fed Offset	Digital Printing
Max. Value	1.83	1.47
Min. Value	1.29	1.36
Yellow Color Solid Ink Density		
Solid Ink Density	Sheet-fed Offset	Digital Printing
Max. Value	1.69	1.52
Min. Value	0.91	1.29
Black Color Solid Ink Density		
Solid Ink Density	Sheet-fed Offset	Digital Printing
Max. Value	2.08	1.94
Min. Value	1.51	1.74

Table 1: Summary of the Solid Ink Density on Coated Paper Sheet-fed Offset and Digital Printing

Solid Ink Density on Uncoated Paper in Sheet-fed offset and Digital Printing		
Cyan Color Solid Ink Density		
Solid Ink Density	Sheet-fed Offset	Digital Printing
Max. Value	1.80	1.28
Min. Value	1.26	1.16
Magenta Color Solid Ink Density		
Solid Ink Density	Sheet-fed Offset	Digital Printing
Max. Value	1.78	1.27
Min. Value	1.22	1.17
Yellow Color Solid Ink Density		
Solid Ink Density	Sheet-fed Offset	Digital Printing

Max. Value	1.46	1.35
Min. Value	0.97	1.21
Black Color Solid Ink Density		
Solid Ink Density	Sheet-fed Offset	Digital Printing
Max. Value	2.03	1.61
Min. Value	1.22	1.51

Table 2: Summary of the Solid Ink Density on Uncoated Paper Sheet-fed Offset and Digital Printing

## VI. CONCLUSION

This research paper has presented an overview about the analysis of the behavior of printed solid ink density in sheet-fed offset and digital printing on different modes of substrates i.e. coated and uncoated paper. This paper elucidated how ink density behaved on coated and uncoated paper in sheet-fed offset and digital printing. On the basis of data analysis, it was depicted that there was higher difference between maximum and minimum value of solid ink density while sheet-fed offset printing. On the other hand the range of ink density recorded in digital printing had marginal difference on coated and uncoated paper. Also there was always consistency during digital printing. It means digital printing spills a desirable control on print ink density on the substrate as compared to sheet-fed offset printing. In case of offset printing there are more chances of variations reason being the principle of offset printing, 'Ink and Water balance' i.e. Chemical separation of image and non-image area is responsible for this. Some other factors contributing to variations included fountain solution characteristics, ink properties and blanket characteristics. In other words it was revealed that the digital printing produced the consistent print ink density control on the substrates comparatively sheet-fed offset printing.

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