

## COMPARATIVE PRINT QUALITY ANALYSIS OF DRY ELECTROPHOTOGRAPHY (DEP) AND INKJET PRINTING PRESSES ON PRIMARY AND SECONDARY PAPERS

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### ABSTRACT

To address the ever-evolving demands of both printers and customers, a variety of printing processes have emerged within the printing industry. Among these, digital printing has notably gained rapid popularity in recent times. Within the realm of digital printing, two significant methods are employed for printing on cellulosic substrates: Dry Electro-photography (DEP) and Inkjet technologies. This paper aims to conduct a comparative analysis of the print quality achieved through Dry Electro-photography (DEP) and Inkjet technologies on both primary and secondary papers, utilizing the Human Standard Observation Method. The process involved designing a comprehensive test chart in Corel Draw Graphic Suite 20, which encompassed diverse test image components such as line drawings, continuous tones, and solid images. This test chart was subsequently printed using locally available Dry-toner Electrophotographic and Inkjet printing presses. The evaluation of print quality took into account factors like Solid Ink Density (SID), Dot Gain, and Print Contrast. The assessment of print quality enlisted the participation of Standard Human Observers who had successfully passed the Munsell Test. The results, averaged from twenty observers, were then analysed and presented for further discussion and interpretation.

**KEYWORDS:** - DEP (Dry Electro-photography), Inkjet Printing, Print Contrast, Solid Ink Density (SID), Dot Gain, Digital Printing process, Primary Papers, Secondary Papers, Print Quality, Densitometer

### INTRODUCTION

Dry Electro-photography (DEP) represents a digital printing technique wherein ink, in dry powder form, is conveyed onto a photoconductive drum. This ink is subsequently fused onto the substrate utilizing heat and pressure, thereby imprinting the desired image onto materials like Cellulose Papers (Barney Smith, E. H., 2010). Conversely, the Inkjet printing process employs a printhead for imprinting. This printhead stands as a pivotal component, housing minuscule nozzles responsible for expelling ink droplets onto the target surface. As the printhead undergoes motion, it receives directives from the printer's control system, dictating the timing and placement of ink droplet ejections. With the heating of the nozzles within the printhead, the ink transforms into vapor, creating tiny bubbles. These bubbles exert pressure, propelling individual ink droplets out through the nozzles and onto the intended substrate. The resolution and quality of the resulting image are determined by factors such as droplet size and their concentration in a given area (M. Hwsam & B. Volfango, 2020).

Numerous research endeavors have already explored the distinctions between the Dry Electro-photography (DEP) and Inkjet printing processes in terms of print quality. These studies have examined various attributes of print quality, including Solid Ink Density (SID), Dot Gain, and Print Contrast, specifically on both primary and secondary papers. These attributes hold considerable potential in aiding printers to conduct a meaningful comparison of print quality between the aforementioned printing techniques, encompassing their application on both primary and secondary paper substrates.

The production of primary papers is typically a multifaceted and resource-demanding procedure that encompasses the transformation of raw materials like wood, cotton, and various plant-derived fibers into premium-grade paper items. As a result, primary papers exhibit a superior level of quality.

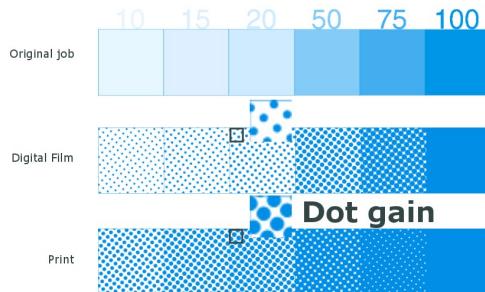
Secondary papers are predominantly manufactured using recycled paper, synthetic materials, and other economical fibers. This category of papers is characterized by a lower level of quality compared to primary papers. However, the quality of secondary papers can be improved by incorporating surface agents or other types of additives. It's worth noting that secondary papers are more affordable in comparison to primary papers (Samani, N., 2023).

### **RESEARCH OBJECTIVE**

In the contemporary landscape, both Dry Electro-photography (DEP) and Inkjet printing processes have gained significant traction, capturing market share, particularly for short-run jobs. However, a notable concern has emerged among printers and customers regarding the perceived disparities in print quality between Dry Electro-photography (DEP) and Inkjet printing presses. To gain a comprehensive understanding of print quality, samples from both printing methods have been generated, and their attributes quantified using a densitometer. This analysis focuses on key print-quality aspects including Solid Ink Density, Dot Gain, and Print Contrast, facilitating a thorough comparison of print quality on primary and secondary papers. The fundamental aim of this paper is to assess and contrast the print quality achieved through Dry Electro-photography (DEP) and Inkjet printing technologies on both primary and secondary papers, employing densitometric measurements as a guiding metric.

### **RESEARCH METHODOLOGY**

Utilizing line drawings, continuous tones, solid images, and tint patches of cyan, magenta, yellow, and black, a comprehensive master test chart was meticulously devised. This test chart was subsequently employed for printing purposes, employing both the Dry Electro-photography (DEP) and Inkjet printing presses available within the local market. The evaluation process encompassed the assessment of print-quality attributes, in accordance with ISO 13660 standards, which encompassed Solid Ink Density, Print Contrast, and Dot Gain (Figure 1).



**Figure 1. Dot gain (ESKO, 2012)**

The assessment of these print-quality attributes was conducted through the utilization of a densitometer. A densitometer is an instrument designed for gauging the density of materials, typically employed for measuring the optical density of ink, pigments, films, and other printed substances. Its significance extends across multiple sectors, including printing, photography, and film production, wherein precise density and colour measurement holds paramount importance (Pritchard, 2010). A total of 20 measurements were acquired from a sheet produced via the Dry Electro-photography and Inkjet printing presses.

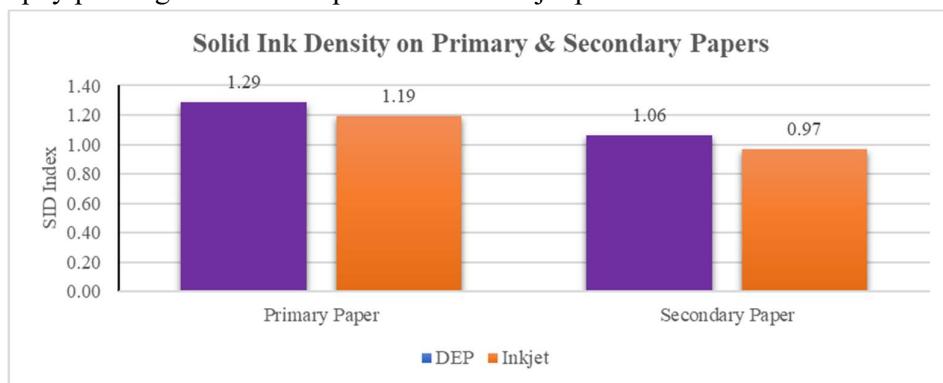
The average of 20 values was taken and calculated along with standard deviations. With the help of tables and bar charts the data was analysed for the results and discussions.

#### DATA COLLECTION & ANALYSIS

**Table 1. Print-quality (Solid Ink Density) on DEP & Inkjet printing presses**

	Primary Paper	Secondary Paper
DEP	1.29	1.06
Inkjet	1.19	0.97
SD1	0.0108	0.0079
SD2	0.0112	0.0076

It is observed in the table 1, that the Solid Ink Density values of Dry Electro-photography are (1.29 and 1.06) higher than values of Inkjet printing press (1.19 and 0.97) on primary and secondary papers. SD-I is representing the values of standard deviation in Dry Electro-printing data and SD-II represents the standard deviation in the Inkjet printing press as well. The collected data shows that the solid ink density of the prints is on the higher side in Dry Electro-photography printing Press as compare with the Inkjet press.



## Figure 2. Comparative analysis of Print-quality (Solid Ink Density) on DEP and Inkjet presses

Figure 2 is a graphical representation of collected data one of the most valuable attributes of print-quality check. And it is found that the solid ink density values of DEP (Dry Electro-photography) on primary and secondary papers are higher than those of Inkjet printing press.

Table 2. Print-quality (Print Contrast) on DEP & Inkjet printing presses

	Primary Paper	Secondary Paper
DEP	36.33	35.30
Inkjet	36.17	34.71
SD1	1.0135	1.1170
SD2	1.0309	0.8538

Table 2 represent the print-quality contrast values are on the higher side in Dry Electro-photography i.e., 36.33 and 35.30 on primary and secondary papers respectively but on the other hand these values are 36.17 and 34.71 in Inkjet printing press. Standard deviation is ranged between 1.0135 to 1.1170 in case of Dry Electro-photography printing press and in case of Inkjet printing press it is ranged between 1.0309 to 0.8538.

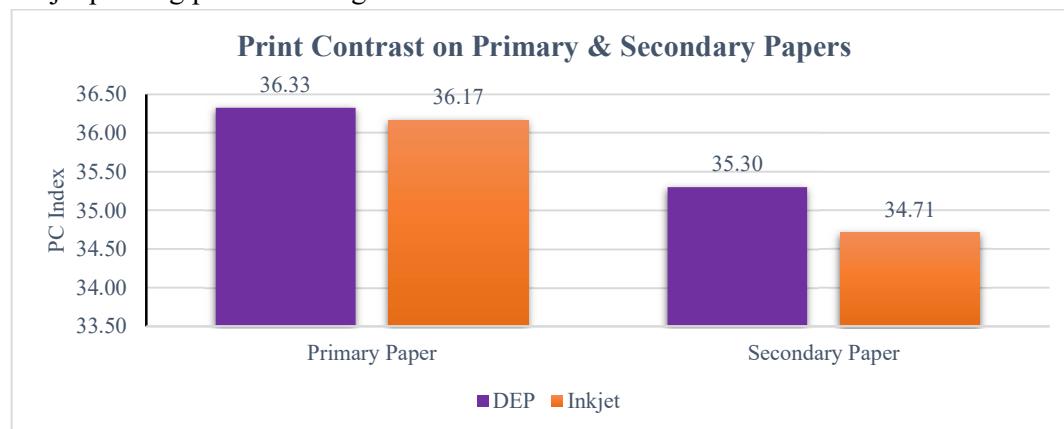


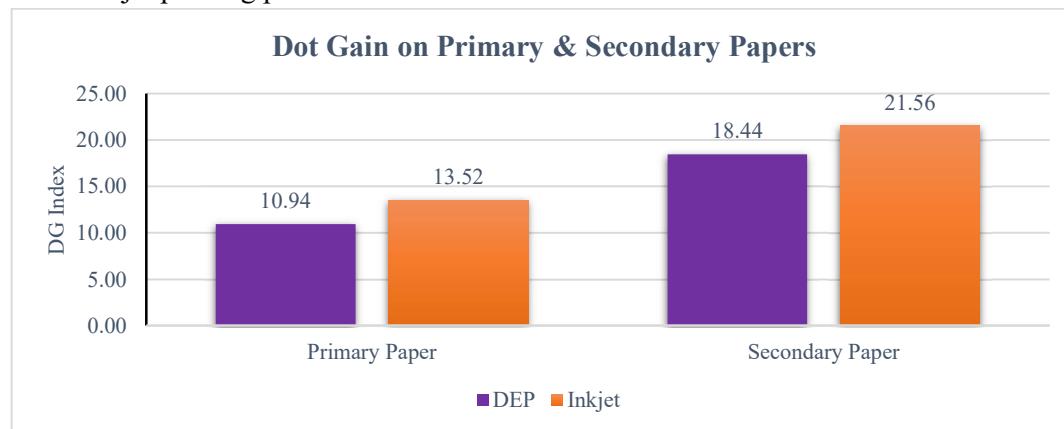
Figure 3. Comparative analysis of Print-quality (Print Contrast) on DEP and Inkjet presses

Figure 3 illustrates that the print contrast exhibited higher values when utilizing the dry electro-photography printing press on both primary and secondary papers, in contrast to the Inkjet printing press.

Table 3. Print-quality (Dot Gain) on DEP & Inkjet printing presses

	Primary Paper	Secondary Paper
DEP	10.94	18.44
Inkjet	13.52	21.56
SD1	1.0116	1.0264
SD2	1.0114	1.0068

Dot gain is playing a major role in print-quality attributes and when this attribute was compared on dry electro-photography and inkjet printing presses it was found that the result based on the types of papers. It was represented in the table 3 that in case of the DEP press the values of print contrast on lower side i.e., 10.94 and 18.44 on primary and secondary papers compared with the inkjet printing press.



**Figure 4. Comparative analysis of Print-quality (Dot Gain) on DEP and Inkjet presses**

Comparative analysis of dot gain is represented in figure 4 and it was found that on the secondary paper the values of dot gain was higher in both DEP and Inkjet printing press, same the values are on the higher peak in case of primary paper.

## RESULTS & DISCUSSION

### Solid Ink Density Analysis

Density of the printed ink is considered as one of the most important print qualities. Density of the printed ink of the printed substrates are generally measured by reflective density, and is calculated from the amount of light that is reflected from the substrate (paper, film, etc.) and the ink. As a general rule, the increase in ink thickness or the concentration of the printed ink, more incident light is absorbed, and less is reflected back, the higher the density value and vice-versa. When it was compared on the DEP and Inkjet printing presses data which was represented in table 1 and it was found that the solid ink density was on higher side in case of DEP press on primary and secondary papers.

### Print-contrast Analysis

Print contrast is another print quality factors that essentially affects the final print output, and it is basically an objective characteristic of printing relating to the amount of shadow detail rendered by the process. While it was compared in DEP and Inkjet printing presses on the primary and secondary papers as represented in table 2 it is found that the values of print-contrast are on higher side in case of dry electro-photography printing press.

### Dot gain Analysis

It is described as the effect of halftone dots growing in area between the original film and the printed sheet. Most of the printers look dot gain as one of the serious problems and that cannot

be taken care. In table 3 dot gain was compared in DEP and Inkjet printing presses on primary and secondary papers. It was found that the dot gain was on higher side in Inkjet printing press on both primary and secondary papers.

## CONCLUSION

The following points are concluded on the basis of results and discussions.

1. Solid Ink Density is found more on DEP press as compared with the Inkjet printing presses on primary and secondary papers.
2. Print Contrast was found more in the case of Dry Electro-photography printing press as compared to the Inkjet presses on primary and secondary papers.
3. Dot Gain was found more on Inkjet printing press as compared with Dry Electro-photography (DEP) printing press on both primary and secondary papers.

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