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EFFECT OF PRINTING SUBSTRATES SURFACE CHARACTERISTICS ON PRINT QUALITY (PRINT CONTRAST) IN CONTINUOUS INKJET AND DROP-ON-DEMAND (PIEZOELECTRIC) INKJET PRINT ENGINES

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ABSTRACT

Inkjet Printing is one of the latest techniques which belong to digital printing. Inkjet Printing is the technology which uses droplets of ink to be ejected from the nozzles to spray on the image areas of the paper. Print contrast is the print quality parameter which focuses on correct rendering of details in shadow areas. This paper focuses on finding the effect of printing substrates surface characteristics on print quality (print contrast) in Continuous Inkjet and Drop-on-Demand (Piezoelectric) Inkjet Print Engines on coated (matte and gloss) and uncoated paper stocks. A test chart was prepared with the help of predetermined number of tint patches and it was printed with the help of Continuous Inkjet and Drop-on-Demand (Piezoelectric) Inkjet Presses. The results indicated that coated paper stocks impart better print contrast compared the uncoated in CIJ and DOD (Piezoelectric) printing presses. On a selected paper type, DOD (Piezoelectric) shows better results for print contrast.

KEYWORDS: - Continuous Inkjet, Drop-on-Demand (Piezoelectric), Inkjet Print Engines, Print Contrast, Matte Coated Paper, Gloss Coated Paper, Uncoated Paper

INTRODUCTION

Inkjet is a non-impact process in which ink is released from an array of nozzles to print on required substrate. The working of an inkjet printer is very easy and user friendly. This process supports not only paper but other substrates like plastic film and canvas etc. [1,2,3]. The print head takes the command from the computer and with the help of printer's motor. It moves left to right again and again to impart impression on the substrate. The paper moves in vertical direction continuously and impression is imparted again and again. Both horizontal and vertical rows of pixels are printed at a single time. Approximately half a second is the time taken by print head to print a strip [5.8].

In continuous inkjet, the ink is separated into very tiny droplets in the print head. The droplets are charged electrostatically. Then deflecting electrodes are used through which the droplets are passed and finally reaches to paper on the desired positions [9].

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In Drop on Demand Piezoelectric technology, the drops are ejected and reached to the substrate only in the positions where the droplets are required. Whenever the dot is needed, a current is applied to the piezo crystal which swells and compels the drop of ink to come out of nozzle. This process gives many advantages. The control over shape and size of drop is quite evitable. Higher nozzle density can be achieved. Also, more freedom remains for the development of new inks for this process. 700 dpi can be achieved with Epson piezoelectric systems. Droplets can maintain their shape resulting into very high print quality especially on coated or high glossy paper [10,11].

RESEARCH OBJECTIVES

Print Contrast is an objective characteristic of printing relating to the amount of shadow detail rendered by the process. Proper print contrast is important from quality point of view, as it helps in finding the better/optimum print details in the shadow areas. As inkjet is quite new technology, exploring print contrast on different inkjet technologies is the area of sound interest for the industry and researchers.

This paper focuses on finding the effect of printing substrates surface characteristics on print quality (print contrast) in Continuous Inkjet and Drop-on-Demand (Piezoelectric) Inkjet Print Engines on uncoated and coated (Matte and Gloss grade) paper stocks.

RESEARCH METHODOLOGY

Selection of Paper and Testing: - From the local market different varieties of papers were explored. The paper best matchable to ISO specifications were taken. The papers of GSM 130 for uncoated, matte coated and gloss coated papers were taken into consideration. The characteristics of papers are shown in table.1 measured in calibrated paper testing laboratory.

Master Test Chart Preparation: - A master test chart was prepared in Corel Draw Graphics Suite 2020 with the help of various elements i.e., line, text, solids, images and 234 colour gamut patches. The colour control having C, M, Y, K solids, 25%-50%-75% tint areas, slur patches and RGB were selected for master test chart with the help of PresSIGN Version 6.

Printing Work: - The printing work was carried out on Colornovo (Monotech), Canon VarioPrint i-seris, Codak Prosper 6000 names given DOD-1, DOD-2 and CIJ presses respectively. The prints were taken in standard pressroom conditions. 200 sheets of various papers ware printed and for testing purpose sheets were extracted each sheet after 20 sheets for each paper.

Print Contrast Measurement: - Print contrast was measured on 75% tint areas of CMYK with the formulae:-

$$PC = \frac{D_{100} - D_{75}}{D_{100}}$$

DATA COLLECTION

Table.1. Various characteristics of different paper stocks

Paper Types	GSM (g/m2)	Thickness (um)	Porosity (ml/min)	Roughness (ml/min)	Gloss-Top (% ISO)	Gloss-Bottom (% ISO)	Ash Content (%)
Uncoated	130.90	140.80	126.30	110.60	28.00	27.90	10.20
Matte Coated	131.00	130.50	120.70	25.50	29.20	30.00	11.30
Gloss Coated	131.00	130.50	103.00	10.50	75.00	72.00	13.00

Comparative Roughness Analysis:- As moved from rough uncoated to matte coated to gloss coated paper stocks, the roughness starts decreasing due to the presence of coating colour on the surface of the paper stocks (Fig.1).

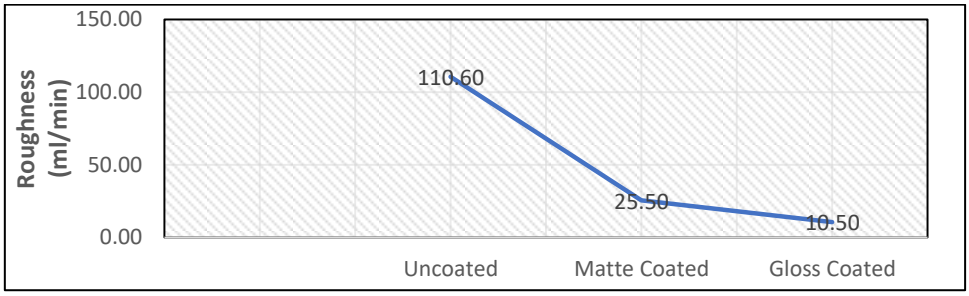

Fig.1. Comparative roughness analysis of different paper stocks

Comparative Paper Gloss Analysis:- As moved from rough uncoated to matte coated to gloss coated paper stocks, the gloss starts increasing due to the presence of coating colour on the surface of the paper stocks which gives a finished shining appearance of the surface of the paper stock (Fig.2).

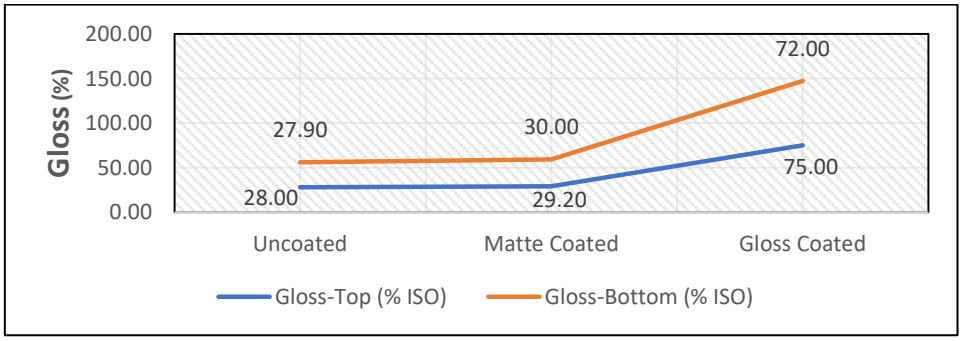

Fig.2. Comparative gloss analysis of different paper stocks

Comparative Ash Content Analysis: - As moved from rough uncoated to matte coated to gloss coated paper stocks, the Ash Content starts increasing due to the presence of coating colour inorganic particles on the surface of the paper stocks which results into better ash content for the specific paper stock (Fig.3).

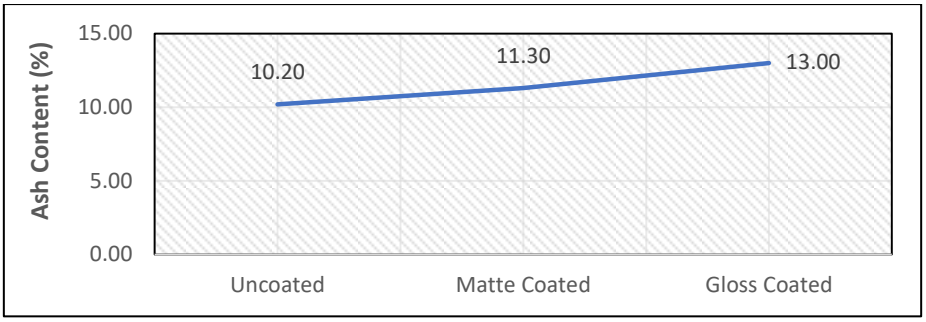

Fig.3. Comparative Ash Content analysis of different paper stocks

Comparative Paper Porosity Analysis: - Porosity of uncoated paper stock is found more compared to the matte and gloss coated paper stocks (Table.1). While moving from uncoated paper to the gloss coated paper, porosity is reduced because the pores of coated paper stocks are filled up by the coating pigments.

RESULT AND DISCUSSION

From the Fig.5,6,7 & 8 it is quite evident that print contrast of PIJ printing tends to have higher print contrast compared to CIJ printing. This is because PIJ printing provides precise control over the droplet size and placement, resulting in sharp and well-defined edges that can enhance the contrast between the printed image and the substrate. Additionally, PIJ printing can be done at higher resolutions than CIJ printing, which can also improve print contrast by increasing the level of detail in the printed image.

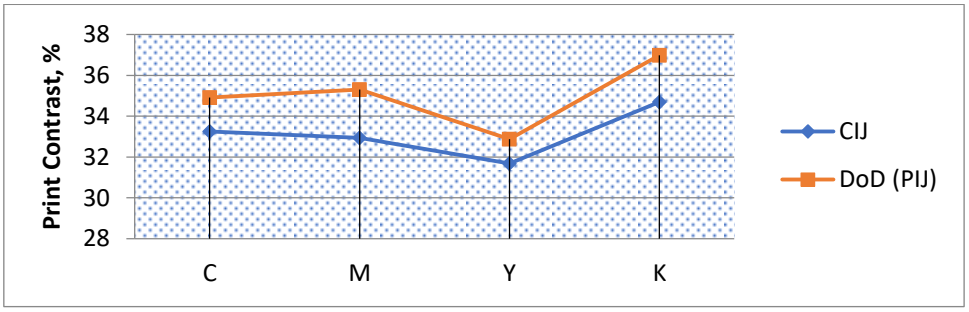

Fig.5. Print Contrast of CIJ and DoD-PIJ inkjet presses on uncoated paper

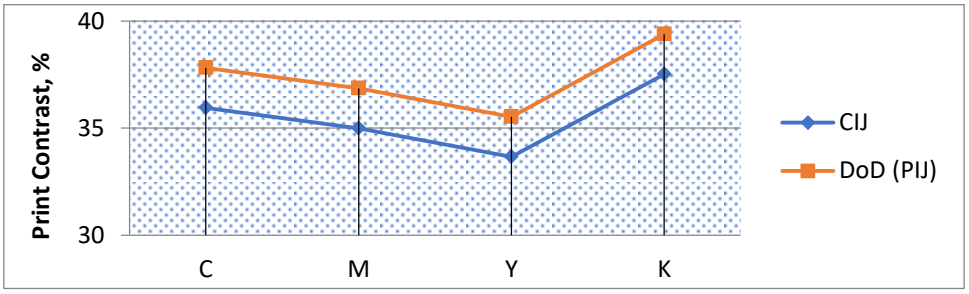

Fig.6. Print Contrast of CIJ and DoD-PIJ inkjet presses on matte coated paper

In the case of CIJ presses, continuous ink droplets generated by CIJ print heads have very less viscosity which penetrates the substrate beneath, causing lack in print density and contrast.

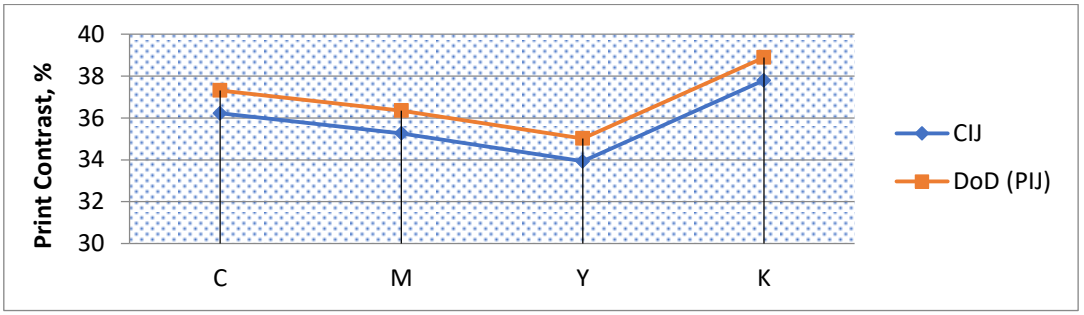

Fig.7. Print Contrast of CIJ and DoD-PIJ inkjet presses on gloss coated paper

The paper properties especially the roughness and porosity play a vital role here. Higher the roughness of paper, as in the case of uncoated paper (roughness 111ml/min), more will be the pores, which results into less ink hold out and causes less print contrast. On the other hand moving towards coated papers, pores are filled causing decrease in roughness and porosity, which helps in improving the print contrast (Fig.8).

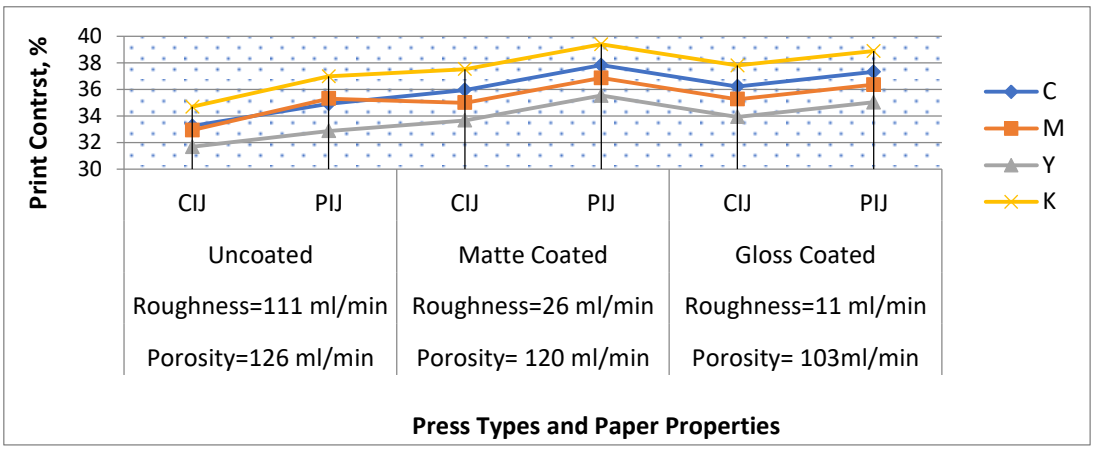

Fig.8. Print Contrast of CIJ and DoD-PIJ inkjet presses on different paper varieties

CONCLUSION

PIJ printing tends to have higher print contrast compared to CIJ printing. This is because PIJ printing provides precise control over the droplet size and placement, resulting in sharp and well-defined edges that can enhance the contrast between the printed image and the substrate. Additionally, PIJ printing can be done at higher resolutions than CIJ printing, which can also improve print contrast by increasing the level of detail in the printed image. Higher the porosity and roughness of the paper less will be the print contrast. The technological advancements, modifications in inks formulation, substrate properties, printing resolution, and printing speed can help in improving print contrast of both types of inkjet presses.

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